Understanding the user: Patients' perception, needs, and concerns of health apps for chronic constipation

V Vien Lee[1],* (ID), Smrithi Vijayakumar[1], Ni Yin Lau[1], Agata Blasiak[1,2,3,4],*, Kewin Tien Ho Siah[5,6],* and Dean Ho[1,2,3,4],*

Abstract

Objective: Chronic constipation is a prevalent gastrointestinal disorder that requires long-term management and treatment adherence. With increasing smartphone usage, health app adoption represents an opportunity to incorporate personalized, patient-led care into chronic constipation management. Despite the number of apps available targeting patients with constipation, studies have not yet examined user needs and barriers towards successful app adoption and sustained usage. Accordingly, the current study explored user perception, needs, and concerns of health apps in patients with chronic constipation.

Methods: Fifteen participants with chronic constipation (age range = 28–79 years, 10 females) in Singapore completed a 60 min semi-structured qualitative interview exploring participant's experiences with and attitudes towards chronic constipation and health apps. Participants also completed two questionnaires regarding their constipation symptoms and general technology usage. Interviews were audio-recorded, transcribed verbatim, and coded using NVivo.

Results: Four themes and 10 sub-themes were identified using inductive thematic analysis. Themes and sub-themes cover importance of patient identity, disease-based expectations of health apps, barriers towards adoption and sustained usage of health apps, necessary conditions when adopting health apps (including perception of supportive benefits, clear understanding of app intention, personalized technology, and trusted sources), and push factor expectations which includes creative engagement and incentivization embedded within the app.

Conclusion: The findings captured barriers and key elements necessary for successful health app adoption and continued usage by patients with chronic constipation. Identified elements that matter to patients can provide app developers with user-focused insights and recommendations to develop effective health apps that sustain user engagement.

Keywords

Digital health, chronic constipation, health app, mobile health, qualitative

[1]The N.1 Institute for Health, National University of Singapore, Singapore
[2]Department of Biomedical Engineering, College of Design and Engineering, National University of Singapore, Singapore
[3]The Institute for Digital Medicine (WisDM), Yong Loo Lin School of Medicine, National University of Singapore, Singapore
[4]Department of Pharmacology; Singapore's Health District @ Queenstown, Yong Loo Lin School of Medicine, National University of Singapore, Singapore

[5]Division of Gastroenterology and Hepatology, Department of Medicine, National University Hospital, Singapore
[6]Department of Medicine, Yong Loo Lin School of Medicine, National University of Singapore, Singapore

*Co-corresponding authors.

Corresponding author:
Dean Ho, The N.1 Institute for Health (N.1), National University of Singapore, Centre for Life Sciences, 28 Medical Drive, #05-COR, Singapore, 117456, Singapore.
Email: biedh@nus.edu.sg

Introduction

Digital health tools (e.g. wearables, mobile phone applications, telemedicine) have the potential to offer accessible, personalized, sustained, and patient-centric interventions and monitoring. Empowering patients to engage in their own medical care through digital health tools can improve patient's self-efficacy and management of medication use.[1] Sample components of the digital health tools are patient-reported outcome measures, self-report medication journals, and educational resources.[1] Efforts to implement digital health into varying types of patients have been growing and there is substantial activity in digital health across major gastroenterology conditions, with mobile phone apps and telemedicine being the most readily available for clinical use.[2] Given the increasing accessibility to smartphones and tablets, the integration of mobile phone apps into clinical care presents a viable opportunity to initiate greater individualized, patient-led gastroenterology care.

With a global prevalence of 10–15%, chronic constipation is a prevalent gastrointestinal complaint voiced to general physicians and gastroenterologists.[3] In Singapore, up to 25% of the population reported having chronic constipation, with the highest prevalence being amongst men aged 70 years and above (35.8%), followed by women aged 20–29 years (30.5%).[4] Constipation describes symptoms relating to difficulties in defecation and chronic constipation can be characterized by symptoms that persist for at least three months.[5] While patients can often manage their constipation with medication and lifestyle modification, including changes in diet and physical activity,[6] there are opportunities for improvement in patient adherence to treatment and medical protocols as well as their quality of life related to managing disease. Health apps have the potential to play a substantial role in filling the current gap in the tools available to patients and clinicians in the gastroenterological space. For instance, a recent meta-analysis reported a 10% higher adequacy of bowel preparation for colonoscopy in patients that have access to educational material on smartphone apps.[7] In patients with irritable bowel syndrome, health apps such as Zemedy and Heali have reported improvements in quality of life and burden of illness following four to eight weeks of self-management using the apps.[8,9] Nevertheless, despite the potential of health apps as effective and efficient tools for gastroenterology, minimal studies have explored health apps as tools in patients with chronic constipation.

Generally, patients with gastroenterology issues have been reported to be receptive towards health apps, and perceive health apps to be feasible, valuable, and minimally obtrusive.[10] Perceived benefits include self-awareness from tracking, convenience and efficiency, better patient–clinician communication, and immediate access to resources.[10]

Specific to constipation, patients with constipation were more willing to use an app to receive personal feedback compared to patients without constipation.[10] Given the interest and acceptance of health apps in patients with chronic constipation, there is a need to further develop our understanding of their needs and concerns as a user to optimize uptake and sustainability. Based on the Information System Research framework,[11] which is grounded in design and behavioral science, three research cycles should be applied to the development and implementation of health apps. The relevance cycle involves understanding the environment (e.g. problems and opportunities) of the end-user; the rigor cycle involves the evaluation of existing theories and health apps to contribute to knowledge base; and the design cycle involves the building and evaluation of the health app.[12] To better understand end-users in the relevance cycle, the current study aims to conduct interviews to obtain user perspectives (i.e. one of the user-centered design strategies) to gain insights about preferences, experiences, and priorities of potential users.[13] App development without user involvement can result in inadequate and unmeaningful apps, which has been cited as a concern by gastroenterology patients.[10,14] Accordingly, effective user involvement, including user interviews, user testing in the wild and user-centered design workshops, are essential to understand the problem, user needs, context of use as perceived by the users, and user concerns.[14]

Moreover, part of understanding user needs includes considering usability within the local context as different countries have been shown to indicate different factors that influence app adoption and reasons for abandoning an app.[15] For instance, users from China are more likely to select the first app on the list presented to them while users from the United States are more likely to be influenced by app price.[15] Integrating contextual factors, such as culturally specific information and communication style, can help provide meaningful experiences to encourage sustained usage.[16] Therefore, as studies have not yet examined user needs and concerns within the Singapore context, the current study aimed to explore user perception, needs, and concerns of health apps in patients with chronic constipation in Singapore.

Methods

Recruitment

This study recruited patients with chronic constipation from the National University Hospital (NUH) in Singapore through purposive sampling. The study investigator at NUH identified potential participants and obtained their informed consent to be contacted by the research team via phone calls. The research team provided an overview of the study and a copy of the participant information sheet. Interested participants were screened based on the following inclusion criteria: (i) meet the ROME IV criteria for

Table 1. Interview topic guide.

Topic	Guiding topics for discussion
Patients' experience	Discuss symptoms related to constipation
	Discuss touchpoints with healthcare system
	Discuss ongoing or past treatments received for constipation
	Discuss thoughts on current constipation care
	Discuss quality of life affected by constipation
Health apps	Discuss current or past usage of health apps
	Discuss views on health apps
	Discuss views on health app usage specific for constipation
	Gather opinion on currently available features in constipation-related apps (e.g. stool classification, symptom tracking)
	Discuss specific features patients would like to see in constipation-related health app
	Discuss barriers towards adoption and continued usage of constipation-related apps

functional constipation or irritable bowel syndrome-constipation; (ii) have symptoms for at least three months for the last six months; (iii) English fluency; (iv) aged 21 years and above. Participants were not eligible for the study if they met the following exclusion criteria: (i) drug-induced constipation; (ii) evidence/diagnosis of cognitive impairment; (iii) current diagnosis of psychiatric disorder; (iv) previous colectomy procedure; (v) significant hearing impairment. Recruitment took place over a period of five months and ended when the target sample of 15 was obtained. A total of 32 patients were contacted, 14 patients declined to participate and two were excluded due to past history of colectomy. Data saturation was achieved after 11 participants.

Data collection

This study adopted a grounded theory, qualitative approach to allow an in-depth exploration of patients' experience with constipation and their attitudes toward health apps. 60 min semi-structured interviews were conducted either in-person or via online Zoom video-conferencing, depending on participant's preference. Only researchers from the study team and participants were present for the interview. Prior to commencing the interview, participants were informed about study goals and informed consent was obtained. All participants gave consent to audio-recording of the interviews for the research team's transcription purposes. No relationship between participants and researchers were established prior to study commencement. Participants aged 65 years and above completed the Mini-Mental State Examination to ensure normal cognitive functioning. Open-ended questions were asked during the interview to explore participant experiences with chronic constipation and health apps. Guiding topics for discussion during the interview are presented in Table 1. Reflective notes were made after the interviews to identify additional questions for the interview guide. All interviews were conducted in English and by the same researchers (VVL and NYL) with prior experience and training.

Following the interview, participants completed two questionnaires regarding their (i) symptom frequency and severity, and (ii) smartphone usage. All participants were also reimbursed for their time. The study procedures were approved by the National University of Singapore Institutional Review Board (IRB; IRB number: NUS-IRB-2020-696). All data collected, including signed consent forms, interview recordings, and questionnaire data were de-identified, encrypted, and stored in a secure database. No repeat interviews were conducted and only one participant requested for an interview transcript. Participants were not contacted for feedback on findings.

Data analysis

Interview recordings were transcribed verbatim. Inductive thematic analysis was used to identify emerging or recurring themes. Primary coding, during which data were

Table 2. Demographic data of study participants.

Participant	Age	Gender	Ethnicity	Highest education level	Other medical conditions
1	73	Female	Chinese	Secondary	CVD, diabetes
2	47	Female	Chinese	University	None
3	51	Female	Chinese	Master's	None
4	73	Male	Chinese	Secondary	CVD, diabetes, kidney disease
5	79	Female	Chinese	Senior Cambridge	B12 deficiency
6	65	Male	Chinese	Master's	High blood pressure
7	28	Female	Chinese	Master's	None
8	31	Female	Chinese	Master's	Migraine, gallstones
9	49	Male	Indian	Master's	None
10	47	Female	Malay	Diploma	Fibromyalgia
11	46	Female	Chinese	Master's	None
12	72	Male	Chinese	'O' Levels	CVD, diabetes, high cholesterol, high blood pressure, GERD
13	36	Female	Chinese	Master's	Allergic rhinitis
14	47	Female	Chinese	'A' Levels	Hepatitis B carrier
15	53	Male	Chinese	Post-graduate	Orthopaedic issues, migraine

CVD: cardiovascular disease; GERD: gastroesophageal reflux disease.

descriptively labelled, was conducted on the interview data using NVivo. Primary coding was conducted independently by two researchers (VVL and SV). Primary codes from both researchers were compared and discussed to resolve any discrepancies. Secondary coding, where labelled data were grouped into categories, was subsequently conducted on Excel. Categories emerging from secondary coding were analyzed and grouped in broader, overarching themes.[17] The final set of codes and broader themes were generated from discussions and iterations by two researchers (VVL and SV).

Results

Participant characteristics

Fifteen participants with chronic constipation (5 males; mean age = 53.1 years, SD = 15.9) completed the study. Participants were of Chinese (86.7%), Malay (6.67%), and Indian (6.67%) ethnicities and all participants were fluent in English. Participant demographic data are presented in Table 2. All participants (except Participant 15

who did not complete the symptom questionnaire) reported inability to pass stools, straining during bowel movement, and abdominal bloating. More than half of the participants (57.1%) reported experiencing severe or extremely severe incomplete bowel movement. Thirteen participants reported using a smartphone regularly and seven participants are currently using or have experience with health or fitness-related apps. Participants' smartphone usage data is presented in Table 3. Participant 15 also did not complete the smartphone usage data questionnaire.

Interview data

A total of four themes and 10 sub-themes were identified from the participants' responses. The number of mentions for each subtheme by current health app users/ex-users and non-users is presented in Table 4.

Disease driven technology attitude

Inclusion of patient identity in technology. Participants discussed their identity as a patient with chronic constipation

Table 3. Smartphone usage data of study participants.

Participant	Do you regularly use a smartphone?	Brand of smartphone	What do you use your smartphone for?	List of apps used and/or currently using
1	No	Apple	Communication	None
2	Yes	Huawei	Communication, social media, entertainment, health tracking, web browsing	PinkBird
3	Yes	Apple	Communication, social media, entertainment, web browsing	None
4	Yes	Huawei	Communication, music	None
5	Yes	Apple	Communication, entertainment, web browsing	None
6	Yes	Oppo	Communication, stock market	Fitbit
7	Yes	Samsung	Communication, social media, entertainment, health tracking, web browsing	MyFitnessPal
8	Yes	Apple	Communication, social media, entertainment, web browsing	None
9	Yes	Apple	Communication, social media, health tracking, web browsing, business	Sleep tracking
10	Yes	Xiaomi	Communication, social media, entertainment, health tracking, web browsing, online shopping	Samsung Heath, ActiveSG
11	Yes	Apple	Communication, social Media, entertainment, health tracking, web browsing, meditation, eBooks	HealthHub, Lifesum, Health365, MindFi
12	Yes	Apple	Communication, social media, entertainment, health tracking	LumiHealth
13	Yes	Apple	Communication, social media, health tracking	None
14	Yes	Apple	Communication, social media, web browsing, online shopping	None

and highlighted the lack of validation received as a patient, most often due to a heavy focus on diagnosis and medication during consultations and the importance of increased focus on overall patient well-being. Participant 3 shared that, "Sometimes we get a little bit frustrated… can someone acknowledge I'm having this issue." Generally, participants do not have issues sharing their constipation-related experiences with others, including medical professionals, friends, and family. Participant 6 mentioned that, "I don't think it's uncomfortable to talk about [constipation]… there's nothing so private about it." While participants understand that constipation can be a chronic issue, most participants conveyed hope of being able to return to a state of normalcy and carry out activities that have

been disrupted by their chronic condition. Participant 15, when asked about his goals, said, "I know there's actually no particular cure to IBS, to constipation. I still pine for a day whereby I'm able to go and sign up for [a] tour package and go to a country." Accordingly, participants highlighted the need for addressing patients as a whole when designing digital health technologies.

It's also able to address the emotional side of a patient. That [will] make this app more like a human. You're talking to a human, not just to a phone. That will make the app very approachable. [It is] something I will look for in an app. So, it's not so much like data collection but a more humanistic approach. (Participant 3)

Table 4. Number of mentions of subthemes by study participants (health app users/ex-users and non-users).

Themes and subthemes	Users/Ex-users (N = 7)	Non-users (N = 8)
Disease driven technology attitude		
Inclusion of patient identity in technology	2	3
Disease-based efficacy expectations	3	5
Pre-existing technology resistance & barriers		
Technology skepticism	1	4
Hesitancy	0	4
App as unavailing	5	0
Perception of technology benefits and conditions		
Perception of supportive benefits	5	3
Clear understanding of app intentions	5	3
Personalized technology	6	4
Push factor expectations		
Creative engagement	4	3
Technology incentivization	3	3

Disease-based efficacy expectations. Given the chronic nature of constipation in participants from the current study, participants repeatedly cited the difficulty in symptom management as a long-standing issue. Participant 8 elaborated, "As a child, you will bring it up to your [family] but you know over time, they will just tell you, drink more water, eat more vegetables. When that doesn't work, you think that you are being the problem. So, it has been a habit for about as long as I know it." As constipation has been a persistent issue for most participants, participants have a high expectation of technology when asked about incorporating mobile phone apps into their constipation management. A number of participants are not interested in using healthcare apps to manage their constipation unless it completely resolves their constipation symptoms. Participant 6 described that, "People, including me, will not go and take [the app],

unless I know it's meant for ultimate solution [or] cure… or because the doctor says collect this for him so that he can prescribe the cure, then I think I will do it." This was also emphasized by Participant 15 who stated that, "something that will not help me eradicate my IBS totally, I will not use it." Therefore, participants looked to technology to provide a complete solution with good efficacy.

Pre-existing technology resistance and barriers

With existing expectations of technology, participants feel uncertain about currently available technology and identified three barriers that have prevented them from considering mobile phone apps for constipation management.

Technology skepticism. Participants who were not currently using health apps were skeptical about the use of mobile phone apps for health purposes. Participant 15, when asked about his thoughts on apps for constipation management, replied, "I really wonder how much they can do… after all it's only an electronic app." Participants also did not see apps as an option for symptom management and were uncertain about how apps are different from searching online for a solution.

Hesitancy. Non-health app users were reluctant to engage with apps for constipation management unless they were prompted by their doctors or if they were having substantial difficulties with their symptoms or medication. Instead, participants cited preference for obtaining information through online search or learning from peer experiences. Participant 3 shared that, "For preliminary information, [it] would be [the] Internet. Then I would try to get among my network, people that I thought I might be able to get secondary or more detailed information based on their experience[s]."

App as unavailing. Participants with health-related apps experience expressed frustration and stress over their existing app usage. Frustrations were often due to unclear instructions and long-term goals. Participant 2 shared her experience with a points-based reward app and said, "I scan [but] I don't know what to claim so I gave up. I know that I'm just collecting but I don't know what are the benefits. I don't know if I'm going to get something." This experience was further exacerbated by poor instructions on information tracking. Information tracking has also contributed to stress among participants due to strict goals. When asked about her experience with a fitness and food tracking app, Participant 7 shared that, "[I was] quite stressed because you will see the figure [and] you will think that okay, that's the remaining [carbohydrate] intake for the night. Then you start to think [about] what to eat at night in order not to exceed that figure."

Perception of technology benefits and conditions

Despite the barriers identified, participants were open to incorporating technology into their constipation management if several conditions are met. Participants discussed the importance of perceived benefits from the app, clear understanding of app intentions, personalization and app promoted by a trusted source.

Perception of supportive benefits. When deciding to use health-related apps, participants indicated the importance of clearly conveying the potential benefits upfront and experiencing actual benefits gained by app usage with regards to their constipation management. As Participant 15 relayed, "If I do see that the app is able to benefit me in a certain way, I would gladly try it, but if I find that it's just an experimental app, I don't think I will." Benefits highlighted include improving patient–clinician communication, better understanding of their constipation triggers, and improvement of constipation severity. With the increasing accessibility to technology, participants were conscious about the need to have readily available information about apps to allow them to thoroughly review risks and benefits prior to adopting an app.

> In this era of us being more affluent and more educated, I think you want to have information that is freely available on the [Internet]… whereby you can read more about a particular app and then, see what the app can do for you. (Participant 15)

Clear understanding of App intentions. Participants expressed the need for clear goals and purpose in relation to constipation when using health apps. When discussing functions such as diet and symptoms tracking, Participant 6 inquired, "What's the purpose of asking me to log in [my symptoms]? Track this, track that. What do I get out of it?" As most participants did not have a specific objective in mind when looking for a constipation-related app, they looked to the app to provide them a sense of purpose in relation to their journey in managing constipation.

> I don't know because I am not very sure what is the intention of this app? What are the target audience[s] you are looking at? What is the shelf life of this app you expect to use? Is it going to be a short-term one for case study? Or is it going to be a long-term one? It's going to evolve along the way… evolve as the app user mature along the way so that the app user will continue using it or what? (Participant 14)

Personalized technology. Most participants have raised concerns regarding their gaps in disease knowledge, including uncertainty about their disease severity, lack of detailed knowledge about stool guides, and uncertainty about next steps when experiencing specific symptoms. Accordingly, participants have discussed their preference for specificity in the app with regard to targeted feedback and solution-making. Participant 3 stated that, "Sometimes my stool can be long but not the long, normal one. And at times during severe constipation, it can be as small as 2 cm. So what are the difference[s]? What does that mean? And with this kind of stool, what should I do next?" In addition to specific feedback, participants relayed the importance of relating data collected back to disease outcomes. Participant 3 further elaborated her preference for specific symptom tracking and feedback in relation to her constipation:

> The questionnaire will be very targeted… how is it like for you for these two days? How [has] your sleep pattern been? Your diet? So, it's very targeted, rather than your general [question of] what is your well-being? Even mood is very targeted. How [does] mood correlate to your constipation? (Participant 3)

Relating specific solution-making strategies back to a patient's disease knowledge was essential for participants when engaging in health apps. Participants 14 summed up that, "An app [can] help in gelling what we know, the statistic[s] that we are going to put in [and] what we need to know."

App from trusted sources. Participants have highlighted the importance of balancing needs with security and privacy. Participant 15 shared, "An app [must be] safe to use before I will explore [it]. I would say that meeting my needs is [an important factor]… but [it has] to be balanced off with security." To feel safe when using the app, participants preferred if the app was initiated by the government or healthcare providers. In regard to accessing medical records, Participant 14 described, "Since it's a government app, [medical records] are already in the government data[-base]. They are just compiling it into one for ease of reference… but if it's not linked to [the] government, it's more of a health app… lifestyle app then I think there will be people who [will be] mindful of that." Participants also cited their doctors and hospitals as trusted source to learn about the app. This was highlighted by Participant 6 who shared, "If it's hospital-initiated… that [will be] more trustworthy. Compared to online search, you read a lot of things [and are] not sure if [it] really work or don't work."

Push factor expectations

Finally, participants highlighted the need for creative engagement and incentivization as push factors for technology adoption and sustained usage.

Table 5. What matters to patients with chronic constipation and recommendations to app developers.

What matters to patients	Recommendations to app developers
Perceived benefits	• Highlight efficacy of the app • Allow better patient–clinician communication • Allow better understanding of constipation triggers
Clear app goals	• Install sense of purpose in relation to patient's journey from diagnosis to symptoms management • Provide explanations of why each symptom is being tracked
Localization of content	• Tailor information to local context, e.g. include local food in the nutritional guide
Acknowledgement of patient identity	• Empower patient through disease-oriented approach
Personalization	• Provide individualized feedback relevant to the experience of patient • Relate data collection back to patient-specific disease knowledge and outcomes
App from trusted sources	• Highlight sources of content provided, preferably from healthcare providers or government
Relevant push factors	• Provide interactive design and user experience/interface features through visual and audio feedback, quizzes, or regular summary of information input • Incentivize through cultivating sense of achievement • Instil sense of relatability to patient's journey and needs • Provide connectivity with peers or healthcare professionals

Creative engagement. When asked about what participants would like to see in constipation-related apps, participants highlighted the importance of an engaging journey and local relevance. For participants, an engaging journey with an app encompasses interactivity and building a personal relationship with the app. Suggestions for interactivity include visual and audio feedback when hitting milestones, interactive quizzes at regular intervals, and daily or weekly summary of information input. These findings indicate the potential need to address key design and frontend/backend architectural elements of an app that may include but are not limited to co-creation and the interaction design process, user interface (UI) and user experience (UX), and artificial intelligence (AI), among others.

> *It needs to have an interactive functionality… example if you want to get the person to drink sufficient water, you just tap [the information] in, okay I [drank] my water today and dah dah dah [singing tune] and the cuter ones will just make a sound blup blup blup [like] water. You need something that is incentivizing… so it'll be great if the app could travel the journey with me.* (Participant 8)

Most participants expressed the importance of building a personal relationship and trust with the app through specific feedback to information tracking, app functions being aligned to their needs at different point of their disease journey and personalized advice on dos and don'ts.

> *When everything becomes a lot more personable, I develop a sense of relationship and trust with the app… maybe along the way, it [tells] me stuff that I can or cannot do… restaurants I can order from for example. What I find myself liking is quality advice on a timely manner.* (Participant 8)

Participants that have previously used food tracking apps have raised the issue of the lack of local food options. Participant 11 described, "I tried to use [food tracking apps] but… usually their menu [has] more of the western menu. There's no char kway teow or kway teow soup. So how to input? Then I realized I waste[d] my money to subscribe to it." This was also raised by participant 7 who stated, "Sometimes I cannot find relevant food when we eat at hawker so if the app can be customized to have our Asian food inside, [it] will be better." Besides local food options, feedback and advice needs to be tailored to the local context. Participant 10 shared an example of an advice that did not consider the local context, "[My friend told me to] take turmeric powder. I told her, why [do] you follow the English [advice]? We fry our fish [with turmeric] every day." Accordingly, participants have raised the need for customization of the app to suit local needs.

Technology incentivization. Participants identified the need for incentivization as nudges for adoption and sustained usage. When discussing incentives for app adoption, participants were interested in the ease of use, linguistic

compatibility, and direct relevance. When discussing ease of use, Participant 15 shared that "I would want to feel comfortable using the app. It must be an app that is easy to use… doesn't require too much of my effort, or too much of my thinking." When assessing the ease of use of an app, participants consider the amount of effort required, the ability to use it without help and being able to use it in the comforts of their own homes. In regard to linguistic compatibility, participants prefer the inclusion of words that are relatable to their condition when browsing for apps.

> It has to be in a lingo that help. If you use the word chronic, I think it will be [relatable]. Normal constipation will happen to everyone thus, if you use the word chronic, it will likely [attract me]. Are you frustrated? Are you sick of taking laxative? You know, [the] kind of questions that push the buttons. (Participant 14)

Participants also described the importance of catching their attention with information or functions that are directly relevant to their needs. Participant 14 described that, "It has to flash out something that will catch the person's attention to Google or read more… so at least [people will] go in and look at the function, give it a chance rather than dismiss it."

In regard to nudging for sustained usage, most participants want to see improvement in their data, or outcomes, when using health apps. Participant 13 discussed the feeling of achievement as an incentive to use the app and described that, "I got this Fitbit from working in [the] hospital. [I'm] trying to clock number of steps… it's a bit of an achievement because you see the numbers grow in [the] app]." Participants also highlighted the importance of seeing the improvements for themselves and not just tracking information for doctors. For continual app usage, participants have emphasized the need for an action plan with consistent feedback that corresponds with their input from information tracking. Participant 7 relayed that, "If the app can have a guide to [take] me step by step and let me know what to do, and after you do this step, what improvements you will [see]? Then at least you know that you're on track." Finally, participants also described the usefulness of being able to connect with someone on the app who is able to understand their issues. Participant 13 suggested, "I think it would be good to have a constipation hotline because constipation can be quite embarrassing, so we don't really speak to friends. We don't also share… with our family members. It's quite a personal thing." Accordingly, being able to have a connection with their peers or a healthcare professional through the app can be useful in sustaining usage.

Discussion

The current study identified user concerns and needs for health apps in patients with chronic constipation within Singapore. Findings highlighted user barriers and recommendations when optimizing apps for management of constipation (see recommendations in Table 5). Overall, participants in the current study had mixed feelings about the efficacy of currently available health apps. However, participants were generally optimistic about new technology ideas, and open to adopting apps to aid with constipation management if perceived benefits from app, clear app intentions, localization of content, acknowledgement of patient identity, personalization and trusted sources were incorporated.

Non-health app users and current health app users expressed different barriers that prevented them from adopting or continuously engaging with health apps. Non-health app users conveyed skepticism and hesitancy, and preferred to obtain knowledge about disease and treatment from healthcare professionals, peers with similar experiences and internet searches. The majority of skepticism and hesitancy arose from the uncertainty of usefulness of constipation-related apps. Originating from the Technology Attitude Model, perceived usefulness, alongside perceived ease of use have been linked to attitude towards using the technology.[18] As attitude towards technology can influence intention of use, strategies to increase perceived usefulness and ease of use need to be implemented to encourage positive attitude towards health apps.[18] Importantly, despite not currently using health apps, non-users are open to using health apps if prompted by their healthcare professionals. Accordingly, active engagement from clinicians to embed constipation-related apps into clinical use and treatment plans may encourage app adoption of non-users through building credibility and perceived benefits of the app. These findings stress the importance of developing evidence-based and clinically-validated health apps.

On the other hand, current health app users or ex-users cited poor app goals, including ambiguous and inflexible goals, and the lack of localization to Singapore as barriers for continued long-term use. Clear understanding of app purpose has been consistently cited by participants as a fundamental expectation when using apps. In line with this, a qualitative longitudinal study on continued use of health apps reported independent goal setting and the need for flexibility when setting up goals as essential for users when using health apps.[19] Furthermore, being able to pursue the goals and consistently getting feedback about their progress can further cultivate user motivation which is vital towards continued app usage.[19] In regard to the lack of localization to the Singapore context, current and ex-users of food tracking apps described issues with the lack of local food options as a barrier towards sustained app usage. While Singapore is a technologically fluent country with adequate resources to implement health app initiatives, efforts must be made to tailor health apps towards local experiences, values, and culture to fully optimize app usage.[20] Given the high awareness and positive attitudes towards health apps in Singapore,[21] there is

considerable potential to build upon through focused but flexible goal setting and localization of content.

When developing health apps, it is essential to consider patient identity and prior technology expectations. Digital health technologies have the potential to foster patient empowerment through patient engagement and self-responsibility for their health.[22] Nevertheless, patient empowerment requires more than self-management of disease and treatment. Patient empowerment has been shown to intertwine with patient's sense of identity and security, and an important dimension of empowerment is the assignment of meaning to their illness experience.[23] In addition to becoming more knowledgeable and autonomous about their own disease and treatment, it is essential that meaning attached to their experiences as a patient be acknowledged as a personal representation.[23] Moreover, as chronic constipation has been a long-standing and burdensome problem for most patients in the current study, patients had high expectations of technology to completely alleviate their symptoms. While these expectations may stem from the patient's desires to regain some sense of normality, it is essential for constipation-related apps to address this issue to avoid discrepancy in patient and app goals. Points for consideration include duration and severity of constipation, quality of life and management of constipation (e.g. self-managed or treated by physician). A possible strategy to facilitate acknowledgement of patient's identity and alignment of technology expectations is by taking into account differing patient journeys and evolving the narrative of compliance to empowerment, with a greater focus on illness experience.[23]

Another prominent feature discussed by participants is personalization of feedback. The majority of participants highlighted their preference for receiving tailored feedback in relation to data collected for tracking purposes. In addition, feedback received should be tied back to disease outcomes and patient's existing knowledge. This is in line with findings from a qualitative study of user perception of mobile health apps which reported participant's preference for personalized coaching and guidance with specific plans.[24] Nevertheless, care should be taken to ensure that the tone of feedback is affirmative and constructive to prevent demotivation.[24] Personalization of messages have been shown to be effective in promoting health behavior change (e.g. smoking cessation, physical activity, healthy diet) and encourage continued app engagement.[25,26] Specific strategies may include dynamic tailoring (i.e. iterative assessments and feedback), and framing of messages based on patient demographic, journey (e.g. newly diagnosed, maintenance of current treatment) and readiness (e.g. current motivation level).[26,27] These findings stress the potential need to personalize health apps that are capable of accounting for dynamic changes in user requirements and motivations during the course of engagement.

Participants also preferred for the app to be initiated by trusted sources, such as government agencies or healthcare providers. This was similarly observed in rheumatology[28] and oncology[29] patients who indicated security as an important app characteristic. As trust in the security and privacy of an app can influence the uptake of health-related apps,[30] steps should be taken to address these concerns throughout app development and implementation. This can include encryption, user authentication, flexible security settings, obtaining permission before data collection, remote wipe and ability to stop data collection.[31] While the app does not have to be developed by government agencies or healthcare providers, participants indicated the importance of learning about the app from a trusted source. Accordingly, highlighting sources of content provided and research partnerships throughout development can be beneficial.

In addition to the essential features identified, participants described several push factors, including creative engagement and incentivization, that would further motivate them towards app adoption and sustained usage. Gamification elements such as interactive quizzes, visual and audio rewards, comparison of progress and social connectivity have been cited as effective strategies to nudge patients towards continued health app usage. While strategies such as goal setting, incorporation of patient identity, and personalization tap into patient's intrinsic motivation (i.e. engaging in behavior for autonomous reasons), elements such as rewards and scoring systems are important tools to tap into patient's extrinsic motivation (i.e. behavior done for reasons other than their inherent satisfactions).[32] When incorporated well into digital tools, incentive-based features have been shown to promote uptake of health apps and drive continued user engagement.[33,34] Besides the need to visualize their achievements through the app, participants from the current study also highlighted ease of use, linguistic compatibility, relevance as push factors when deciding to adopt a health app. Due to the large amount of health apps currently available in the market, it is essential to stand out by evoking a sense of relatability when presented as an option to potential users. Accordingly, strategies such as using pertinent keywords and highlighting relevant functions can help nudge patients towards further exploring app functionalities. Of note, beyond the intervention itself, the processes of creative engagement, incentivization, and nudging, among others may potentially also personalized and explored as part of a health app's developmental roadmap.

While the current study successfully recruited participants with varying demographics and level of mobile phone usage, all participants were predominantly English-speaking. As Singapore is a multilingual country, there may be groups of users not covered by the current study. Multilingual health apps are limited due to the complexities of translating health messaging and intent.[35] Therefore, there is room for future studies to explore language-specific barriers and needs. Additionally, the current study attempted to capture

the general landscape of technology barriers and needs of patients with chronic constipation. Correspondingly, the study is unable to classify participants into different user personas (beyond non-users, current users and ex-users) for further analysis and explore the impact of cost or risk categorization (i.e. high-risk/low-risk app) on the uptake of health-related apps. Tailoring nudges according to specific user personas can be highly beneficial thus, customization of nudges based on user groups should be further explored. Furthermore, depending on the cost, specific app functions and risk categorization of the health app, additional, focused feedback should be sought from target user group. Finally, as the current study focused on chronic constipation patients in Singapore, some of the findings may be specific to the Singapore context. Accordingly, future studies can build upon this and explore user perspective in different contexts.

Overall, the current study identified barriers specific to non-users and current users or ex-users when adopting and using health apps. Despite existing barriers, participants were generally positive towards new technology ideas and open to adopting health apps for constipation management if several essential factors were incorporated. Factors that were considered necessary include perceived benefits, clear app goals, localization of content, acknowledgement of patient identity, personalization and trusted sources. In addition to the key elements necessary for successful app adoption and continued usage, the current study identified several design considerations and push factors, such as interactive engagement, incentivization, and compatibility, that can be incorporated into constipation-related apps to further support app adoption and sustainability. Beyond providing a better understanding of the users, the findings set a foundation for any focused enquired into the perceptions of the specific context app developers might be interest in, pertaining to app risk-classification (e.g. perception of app depending on regulatory framework the app has to align with), user profile (e.g. perception of app depending on complexity of patient condition) and cost.

Chronic constipation is a prevalent and ongoing issue in Singapore,[4] and there is considerable potential in harnessing digital technologies to assist in constipation management. Accordingly, further conversations with patients and clinicians are needed to continue providing insights in regard to successfully designing and implementing a health app that is effective in supporting constipation management. In summary, the study objectives and insights may collectively serve as a framework to inform downstream design considerations to promote sustained engagement, technology development, and implementation strategies for health apps that address a broad spectrum of indications to catalyze potential wider adoption.

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Guarantor: VVL.

ORCID iD: V Vien Lee https://orcid.org/0000-0002-0216-9032

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