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The feasibility of the PicPecc application as an mHealth tool: Reflections from South African children

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Background: Access to technology (and data) through mobile health (mHealth) can alleviate some of the challenges children experience in accessing healthcare services. However, the South African context is unique with children living in under-resourced and rural communities, with limited transport, long commute times to reach clinics, and poor access to technology. Therefore, even though mHealth tools can be beneficial, researchers need to determine the feasibility of such an application for the South African context.

Aim: The study focussed on determining the feasibility of the PicPecc application (app) (an mHealth tool) in South Africa for children requiring mental health support.

Setting: The study included 20 children between the age of 7 years and 18 years in different mainstream schools and a special school.

Methods: A qualitative research design was used to conduct structured interviews with children, either via an online meeting (e.g., Google Meet) or in a natural setting (in the child's school or home context).

Results: The data were analysed and themes were identified according to five dimensions of access to healthcare and technology, namely acceptability, availability, accessibility, affordability, and accommodation.

Conclusion: This study found that the PicPecc app is promising for implementation in the South African clinical setting. Participants reported various advantages when utilising the app to self-report health symptoms and thus considered it feasible for implementation in the South African context.

Contribution: The study highlights important considerations for the implementation of mHealth technologies in the South African context.

Keywords: access to healthcare; children; eHealth; health technology; mobile health; paediatric.

Introduction

Access to healthcare in South Africa is largely influenced by socio-economic status. Often individuals with more financial resources tend to access healthcare services more efficiently than those with fewer resources (McLaren, Ardington & Leibbrandt 2014, Moeti et al. 2023). Mbarathi, Mthembu and Diga (2016) and Moeti et al. (2023) mention that many South African families are plagued by inequality, poverty and unemployment, and these barriers disproportionally affect the most vulnerable within a family, specifically children. Many children below the age of 15 years have difficulty accessing healthcare services, especially in rural communities, requiring transport and long commute to reach clinics (Adedini et al. 2020). Restricted access to healthcare can cause children to have reduced autonomy and self-care capacity, with limited opportunities to voice their needs (Moeti et al. 2023). However, with a high percentage of access to mobile phones for children in South Africa (Porter et al. 2015), access to mobile health (mHealth) support might be a viable option.

Providing access to technology (and data), creates better opportunities for mHealth applications to facilitate self-monitoring of health outcomes in children and may give children a voice in decision-making about their own healthcare (Fiordelli, Diviani & Schulz 2013). Furthermore, mHealth tools can support children's communication of their symptoms to healthcare practitioners, to not only include physical ailments but also anxiety and other psychosocial support needs (Wiljén et al. 2022). Oja et al. (2018) conducted a review on mHealth tools and concluded that the implementation of such tools in South Africa is feasible, but a paucity of empirical evidence exists.

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Therefore, there is a need to improve the implementation of mHealth interventions aimed at providing comfort and support in conjunction with medical interventions in paediatric care and providing all children, regardless of their communication skills, the opportunity to make decisions about their care whenever possible (Nilsson et al. 2015). As such, a group of researchers from Sweden and South Africa developed the PicPecc application (app) to enable children with long-term illnesses to communicate their symptoms (Wiljén et al. 2022).

The development of the PicPecc app followed a user-centred design approach (Wiljén et al. 2022). Initially, the app development was guided by input from Swedish children with cancer, their parents, and healthcare practitioners (Wiljén et al. 2022). The study by Esplana, Olsson and Nilsson (2022) confirmed that the app is feasible to use in a specific healthcare setting in Sweden. This begged the question of whether such an app that was developed for a high-income country (e.g., Sweden) would also be feasible in a low middle-income country (e.g., South Africa). For this purpose the Gini Index – a statistical measure indicating the inequality of a country's income distribution, which provides a score between 0 (perfect equality) and 1 (very high economic inequality) – was employed (Hasell & Roser 2023). The rationale of this study therefore was to determine whether the PicPecc app, which has proven to be effective in Sweden (a country with one of the lowest Gini coefficient of 0.29) (https://ourworldindata.org/grapher/economic-inequality-gini-index) will yield similar results in South Africa (a country with one of the highest Gini coefficients of 0.63). A comparison of the contextual factors for application of the PicPecc app in Sweden and South Africa follows. This was performed by specifically exploring the perspectives of South African children on the feasibility of the PicPecc app.

The wide range of the Gini coefficient between these two countries implies certain differences. For example, although the structure of the healthcare system is similar in Sweden and in South Africa with both countries having public and private hospitals, the healthcare system is free of charge for all children (birth to 18 years) in Sweden (Laugesen et al. 2021). In contrast, although the South African public healthcare services are free of charge for children younger than 6 years (Moeti et al. 2023), this is not true for children between 7 years and 18 years who are the population for this study. No private healthcare in South Africa is free. Another difference relates to language. In Sweden, there is only one official language (Swedish) despite reports of Sweden also becoming more multilingual (Bohman et al. 2021), whereas South Africa has 12 official languages including sign language – verifying the multilingual diversity of South Africa. English however, is the *lingua franca* [common language] in healthcare (Van der Walt & Evans 2017).

Sieck et al. (2021a) suggest that challenges in accessing healthcare cut across five dimensions specifically relating to the technology implementation such as telehealth. These dimensions include: acceptability (the relationship between the healthcare organisation's telehealth tools and workflows, and the patient's attitude toward and comfort with these tools and workflows); availability (the relationship between existing telehealth services and resources and the patient's needs and abilities); accessibility (the relationship between the patient's digital skills and literacy and the supports available to use them); affordability (the relationship between the costs of internet services and devices, and the patient's ability to pay for them), and accommodability (the relationship between requirements of digital platforms and the patient's ability to navigate them). Table 2 provides the revised and adapted definitions of the five dimensions conceptualised from Sieck et al.'s (2021a) study (acceptability, availability, accessibility, affordability, and accommodation) that should be considered when implementing an mHealth tool such as the PicPecc app. These five dimensions are used to conceptualise the findings of this study.

This study aimed to determine the feasibility of the PicPecc app (an mHealth tool) as perceived by South African children by utilising the five dimensions for the implementation of mHealth.

Research methods and design

Design and setting

The study followed a qualitative research design (Hissong, Lape & Bailey 2015) to describe and explore the feasibility of the PicPecc app as perceived by South African children. Data were collected through semistructured interviews and children were given a choice to participate either online (e.g., Google Meet) or in a natural setting (in the child's school or home context).

Description of PicPecc app

The PicPecc app is an mHealth tool that was developed to allow children to communicate for symptom relief and improved well-being during hospitalisation (Wiljén et al. 2022). The app is based on the principles of universal design, meaning that all content is explained and implemented with support functions such as text, images, and sound (Thunberg et al. 2022). Children have the right to actively take part in decisions regarding their health. However, they require support to communicate their symptoms and also to function in their everyday life. Such communication support largely relies on information, a variety of communication methods, and technology.

Participants and sampling

Purposive convenience sampling was used, based on the following selection criteria: age (7–18 years); language (English or Afrikaans proficiency). Ethics approval was obtained after which data collection procedures commenced once parental consent and child assent were obtained. Table 1 provides detailed biographical information of the 20 participants. The different first languages (Afrikaans [$n = 10$], English [$n = 4$]; Zulu [$n = 4$]; Sepedi [$n = 1$] and Sesotho

TABLE 1: Demographic information of participants (N = 20).

Number	Gender	Age (years)	First language	Mobile phone	Device	Owner of device	School use	Other uses	Hours spent per day	Use on weekends	Hours per day	Internet access	Wi-Fi	Service provider
P1	F	18	Afrikaans	Yes	iPhone	-	Yes	Phone calls, music, games, YouTube, take photos, take videos, leisure searches	8	Yes	10	Yes	Yes	Vodacom
P2	M	12	Afrikaans	Yes	Samsung	-	No	Phone calls, music, games, YouTube, take photos, take videos, leisure searches	2	Yes	5	No	-	-
P3	F	13	Afrikaans	No	Does not know	Mother's phone	No	Music, games, YouTube, tikTok, take photos, take videos, Netflix, homework searches, leisure searches	1	Yes	1	No	-	-
P4	F	11	Afrikaans	Yes	Huawei	-	No	Phone calls, voice notes, music, games, Facebook, YouTube, TikTok, WhatsApp, take photos, take videos, netflix, leisure searches	5	Yes	10	Yes	Yes	Does not know
P5	F	16	Afrikaans	Yes	Samsung	-	Yes	Phone calls, music, games, YouTube, take photos, take videos, leisure searches	8	Yes	10	Yes	Yes	Vodacom
P6	M	11	Afrikaans	Yes	Samsung	-	No	Phone calls, voice notes, music, games, Facebook, YouTube, WhatsApp, take photos, take videos, Netflix, homework searches, leisure searches	5	Yes	8	Yes	Yes	Telkom
P7	F	12	Afrikaans	Yes	Samsung	-	No	Phone calls, voice notes, music, games, YouTube, TikTok, Snapchat, WhatsApp, takes photos, Netflix, homework searches, leisure searches	2	Yes	3	Yes	Yes	Vodacom
P8	F	18	Afrikaans	Yes	Samsung	-	Yes	Phone calls, voice notes, music, games, WhatsApp, homework searches, leisure searches, voice recordings, takes photos, takes videos, YouTube, Netflix	5	Yes	6	Yes	Yes	MTN
P9	F	12	Afrikaans	No	Does not know	Mother's phone	No	Phone calls, voice notes, music, games, WhatsApp, homework searches, leisure searches	2	No	-	No	-	-
P10	M	13	Afrikaans	Yes	Motorola	-	Yes	Phone calls, music, games, YouTube, Facebook, WhatsApp, voice recordings, Netflix, homework searches	1	Yes	1	Yes	Yes	Umatel
P11	M	11	Zulu	Yes	Nokia	-	No	Instagram, WhatsApp, voice notes, games, YouTube, take photos, take videos, homework searches, TikTok	2	Yes	3	Yes	Yes	Vodacom
P12	F	10	Sepedi	No	Hisense	Mother's phone	No	Music, games, YouTube, take photos, take videos, voice recordings, homework searches, leisure searches	1	Yes	2	No	-	-
P13	M	12	English	No	Huawei	Mother's phone	No	Phone calls, voice notes, music, games, WhatsApp, YouTube, take photos, Netflix, homework searches, leisure searches	1	No	-	Yes	Yes	Does not know
P14	M	12	Sesotho	No	Does not know	Mother's phone	No	Music, games, Netflix, YouTube, homework searches, leisure searches	1	Yes	2	Yes	Yes	Does not know
P15	M	11	English	No	Does not know	Mother's phone	No	Phone calls, games, YouTube, Netflix	3	Yes	8	Yes	Yes	Does not know
P16	M	12	Zulu	No	iPhone	Dad's phone	No	Phone calls, voice notes, music, games, WhatsApp, YouTube, take photos, voice recordings, Netflix, homework searches, leisure searches	1	Yes	8	Yes	Yes	Cell C
P17	F	13	English	Yes	Samsung	-	No	Phone calls, voice notes, music, games, YouTube, WhatsApp, takes photos, takes videos, voice recordings, leisure searches	1	Yes	2	Yes	Yes	MTN
P18	F	12	Zulu	Yes	Kika	-	No	Phone calls, voice notes, music, games, YouTube, WhatsApp, takes photos, takes videos, TikTok	1	Yes	5	Yes	Yes	Telkom
P19	F	11	Zulu	Yes	Hisense	-	No	Phone calls, voice notes, music, games, YouTube, WhatsApp, Facebook, take photos, take videos, voice recordings, Netflix, Snapchat, TikTok	2	Yes	8	Yes	Yes	Telkom
P20	F	11	English	No	Ag	Mother's phone	No	Phone calls, voice notes, music, games, YouTube, take videos, take photos, Netflix, WhatsApp	2	Yes	8	No	-	-

P, participant; F, female; M, male.

[n = 1]), of the 20 participants in this study represented diverse languages and cultural backgrounds. The biographical information was obtained from a questionnaire completed by the parents.

Nineteen participants lived in the provinces of Gauteng and the Western Cape. Eight participants did not own a smartphone, but they had frequent access to either their mother's (n = 7) or their father's phone (n = 1). All participants used their smartphones for leisure activities while only four indicated that they also used it for schoolwork. Their devices ranged from lower to higher price ranges (phone costs range between R500.00 to R30 000.00). The phones on the lower end of the price range included Ag (n = 1), Kika (n = 1), and Hisense (n = 1), with mid-range devices included Motorola (n = 1) and Nokia (n = 1). Phones in the higher price range included Samsung (n = 6), iPhone (n = 2), and Huawei (n = 2). Four participants were unsure of the brand names of the phones their parents used. A mean time of 2 h per day was spent on the devices during the week with a range of 1 h – 8 h. On the weekend, participants spent an average of 5 h per day on the phone with a range of 1 h – 10 h per day. Fifteen participants reported that they have Wi-Fi access at home with five who did not have any Internet access.

Materials and equipment

The following materials and equipment were utilised for data collection: mobile device with data or Wi-Fi (mobile phone or tablet with either iOS or Android), PicPecc app, interview script, and procedural checklist. The interview schedule was developed based on the five dimensions of mHealth implementation proposed by Sieck et al. (2021a).

TABLE 2: Development of an interview script based on the five dimensions that should be considered when implementing an mHealth tool.

Dimension	Definition	Examples of interview questions
Acceptability	Covers the acceptance of the child's use of the app.	1. What do you think about the app in general? 2. Is there something that you would have changed in the app?
Availability	The objective possibility to engage in the app.	3. How easy was it for you to find the app on the Google Play Store or App Store? 4. How easy was it for you to get into the app once was downloaded?
Accessibility	Describes whether you can, or perceive that you can, access the app.	5. How did you experience the downloading of the app? 6. How easy was it for you to navigate through the app?
Affordability	Covers not only financial constraints but also, if the amount of effort in both time and energy expenditure is worth the return to engage in the app.	7. What would help you to use this app? 8. What do you think would prevent (keep) you from using this app?
Accommodation	Describes whether the app can be adapted in certain contexts and with different users.	9. How do you think the PicPecc app can be used?

Source: Sieck, C.J., Rastetter, M., Hefner, J.L., Glover, A.R., Magaña, C., Gray II, D.M. et al., 2021a, 'The five A's of access for TechQuity', *Journal of Health Care for the Poor and Underserved* 32(2), 290–299. https://doi.org/10.1353/hpu.2021.0064

app, application.

Table 2 provides an overview of the development of the interview script based on the five dimensions to consider when implementing an mHealth tool. (Refer to Appendix 1 for the complete interview schedule.)

Data collection procedures

Participants were recruited from healthcare practitioners who were invited to refer potential participants. These healthcare practitioners consulted the parents of children from their private practices and asked parents to provide contact details if they consented that their children could participate in the study. The potential pool of participants was increased by also extending the invitation to colleagues and friends with children who met the selection criteria.

Parents were then contacted electronically and provided with an information letter stating the aim of the study and what would be expected of them and their children when downloading and using the PicPecc app. Parents were further asked to complete the informed consent letter and upon receiving this written parental consent, all children were approached and given written assent before data collection commenced. Thereafter, the children were provided with a username and a pin to login into the PicPecc app and were requested to use the app for at least 5 days. Finally, they were asked to indicate their preference regarding an online or an in-person interview at their preferred location.

The last author conducted all the interviews with participants and made field notes to increase personal reflexivity. A procedural checklist was used to prepare the interview and an interview script was used to guide the interviews. This ensured that the same procedure was followed with all participants thereby increasing the trustworthiness of results. The interviews lasted approximately 60 min – 80 min and were audio recorded.

Data analysis

The audio recordings of the interviews were transcribed verbatim by the last author. To ensure the trustworthiness of the transcriptions, the first author reviewed all the transcripts to check for correctness. All transcriptions were imported into ATLAS.ti – an electronic software programme for qualitative analysis (Friese 2019). Inductive thematic analysis was used to analyse qualitative content obtained in the interviews and to aid in holistically understanding the data through pattern recognition of the separate parts (Nowell et al. 2017).

During data analysis, an analytic process was followed to ensure the trustworthiness of the findings (Clarke & Braun 2013). The five phases of thematic analysis that were used include: (1) reviewing and rereading transcripts to increase familiarisation with data and obtain a deep understanding of the content; (2) searching for themes; (3) generating initial themes independently and reviewing the generated themes; (4) organising a meeting to compare and review themes and

compile a codebook to increase consistency of coding; and finally (5) defining themes and linking these themes to the theoretical framework in a collaborative manner (Clarke & Braun 2013; Nowell et al. 2017; Roberts, Dowell & Nie 2019). A mutual agreement between the two coders (the first and the last author) was required for all steps of thematic analysis.

Trustworthiness

In this study, four components of trustworthiness were targeted, specifically credibility, transferability, conformability, and researcher bias. Credibility refers to data that truthfully represents the population of this study (Roberts et al. 2019). Credibility was increased through reviewing transcripts multiple times and by multiple authors and although collective data analysis to ensure that the findings were accurate and reflective of the participant's experiences (Harper & Cole 2012). Transferability refers to the applicability of information representative of a larger population (Roberts et al. 2019). Thick and rich descriptions were provided in different settings. This assisted in increasing transferability, as the different settings may be more representative of a larger population. Conformability refers to the clarity of data collection procedures and documentation (Harper & Cole 2012). To maintain conformability in this study the authors made field notes and conducted a within-group discussion. The aim of these steps were to reduce researcher bias and possible assumptions that could influence the findings.

Ethical considerations

Ethical approval to conduct this study was obtained from the Research Committee of the Faculty of Humanities, University of Pretoria and the University of South Africa (UNISA) College of Education (No. HUM003/0219; 2023/03/08/90438574/02/AM).

Results

The questions of the interview schedule were based on the five dimensions of the implementation of mHealth as proposed by Sieck et al. (2021a). The findings are thus presented accordingly.

Table 3 provides comprehensive information on participants' quotes as linked to the relevant themes.

Theme 1: Acceptability

All the participants mentioned that they liked the app, adding comments such as the 'app is cool' (P6; P7; P10; P13) or the 'app is fun' (P9; P11; P16; P18), 'it is cute' (P7; P8), 'it is a good app' (P1) and 'I like everything' (P13; P18). The participants further indicated that they enjoy the app features, particularly the avatar. Some participants mentioned that the avatar could have been created based on their personal preferences (P1; P2; P4; P13; P16) or '… I can choose their preferred facial expression and hairstyle' (P4; P17). The participants specifically favoured the icons of pets and the adaptability of the pets (e.g., changing the pets' names; P15, P16), which encouraged their frequent use of the app (P1; P4; P8; P20). In contrast, some children did not find the app appealing and engaging because of performing the same activity repetitively ('commenting on how you feel over and over again' [P5]; 'little boring because it doesn't have games to play' [P11]). Despite these comments, the participants mentioned that this will not hinder their use of the app when they are sick.

Although many participants (P1, P2, P9; P10; P13, P15; P20) did not provide any recommendations to improve the app, some had innovative suggestions for app development. For example, participants suggested changing the background to include different scenes, such as at the beach (P11; P18); at home (P12), jungle (P18), a field with dogs (P11) or a friend's house (P12) 'to help the sick child to feel better' (P4). Apart from adjusting the background to visual scenes, some participants suggested changing the background colour to their preference. Currently, the background is green in colour, but other colours were mentioned such as 'yellow or lime green' (P20); 'pink' (P7; P2; P19); 'purple' (P2; P19), blue (P2; P9; P18). These colour adaptations were also suggested for the hair colours of the avatar (at the time of data collection this option was limited to different shades of brown, black, reddish brown, pink and white or the option of no hair).

Generally, the participants enjoyed the app features, but recommended making the app more interactive especially referring to the avatars and pets (e.g., feeding, playing or dressing the avatar or pet [P4, P6, P8; P12; P14; P16, P17, P18, P19]). Furthermore, participants suggested adapting the app to allow them to access their favoured games (P5, P14, 17) and watch YouTube videos for entertainment (P11).

Theme 2: Availability

During the time of data collection, there were challenges with the downloading of the app, which resulted in technical glitches. Some participants complained that it was time-consuming to request a pin code to log into the app or that they had limited access to data and/or Wi-Fi ('I do not have my own phone or access to data' [P2]).

Theme 3: Accessibility

Participants had older model phones or phones in the lower price range, which affected the amount of storage available for downloading the PicPecc app as well as the compatibility of the device with the app ('My device wasn't compatible and I couldn't download it from Play Store' [P4]). Some participants could not download the app because of outdated software or found the spelling of the word 'PicPecc' difficult to remember. Adult assistance was required as mentioned by one participant who stated, 'my mother had to help me'

TABLE 3: Themes and subthemes.

Theme	Subtheme	Grounded	Code examples
1. Acceptability Covers people's acceptance of a person's presence in a situation. If there is an expression of values or common beliefs, which are of a subjective nature, then this is also acceptability.	• App is cool; fun	44	'I think the app is cool because it has a lot of details'. (P6) 'It is cool because you can say anything for it [*the app*]'. (P7) 'I liked everything'. (P18; P20)
	• Interactivity and gamification	51	'It can be more interactive'. (P5; P14; P17) 'The animals can be more interactive'. (P8) 'To feed the animals'. (P19) 'Avatars and pets should talk'. (P12) 'More fun if there were games and videos'. (P11) 'I want different hairstyles and hair colours. I want to add blue hair with a black stripe'. (P17) 'Put in some hats/crowns to use'. (P4; P18); 'Add jewelry to pets'. (P4); 'Add clothes'. (P4; P6) 'I would also like to add an emoji in the textbox of the pet names'. (P16)
	• Background	20	'Add visual scenes, e.g., home, beach, jungle, park'. (P3; P8; P11; P12; P18); 'Perhaps options that you can change the background with clouds or plants – that there is a tree where the children can have a picnic'. 'They [*sick children*] should have the option to change the background to make them feel better'. (P4) 'Add colours for background: pink (P2; P7; P19), purple (P2; P19), blue (P2; P9; P19), green (P2), red (P2; P15), yellow (P11), lime green' (P11), 'I want the colours of the rainbow' (P16).
	• Icons or drawings	9	'The drawings are cool' (P5; P6; P10) 'because you can understand them well' (P11); 'Drawings are beautiful' (P18); 'Excellent drawings' (P4).
	• Avatar	8	'I liked the App and how you could customise the avatar … nice to change so many things'. (P5) 'You can change the facial expressions on the avatar face'. (P5)
	• Pets	11	'I like the cat'. (P20). 'The cat is so cute, furry and poofy'. (P16). 'I liked the pets because there are horses, unicorns and dragons'. (P9) 'Add some more animals'. (P17; P18); 'Add puppies, dragon, dinosaur'. (P3); 'snake, lion' (P15).
	• Motivation for use: Positive comments	24	'I liked it that the pets appeared as you use the app'. (P4; P8); 'Rewards motivate you to use the app when you are in pain'. (P1; P20)
	• Motivation for use: Negative comments	8	'Bit boring'. (P3; P5; P11; P12; P13) '… do the same thing every day'. (P5) 'I like apps that are more like games … like Minecraft'. (P3) 'It is boring because I can't play any games'. (P11; P14)
	• No recommendations	11	'I do not think anything should change'. (P10); 'I think they developed the app good. It is really a great app' (P1).
2. Accessibility Describes whether you can, or perceive that you can, access the context for the situation.	• Access to Play Store/iStore	13	'It was difficult because the spelling of the word PicPecc is difficult'. (P3; P4; P15; P19) 'Easy to find the app'. (P6; P7; P8; P10; P11; P13; P14)
	• Download	15	'Easy to download the app'. (P1; P2; P5; P6; P7; P8; P15; P17; P20;) 'It was easy because it didn't take long to download'. (P14) 'Difficult to download the app on my phone'. (P4) 'It was difficult because it takes time to download'. (P20)
	• Install	3	'You just press the install button and then it installs'. (P7; P11) 'No, my mother had to help me'. (P2)
	• Login	14	'It didn't want to work properly because of the pin code'. (P16) 'It was easy. My mom had to help me to put in the login details. She was trying to get into the app and was typing her password in, but it didn't work'. (P15). 'It was difficult to login and my phone jams'. (P19).
	• Navigation	32	'It was easy to use the app'. (P1; P2; P3; P4; P5; P18; P9; P10) 'It was easy because I asked my mom to help me'. (P20) 'Learning how to use it'. (P15; P17) 'It was a bit difficult at the beginning because I didn't know the app. It was also a little bit easy because when I got used to it, I could use it properly'. (P13) 'It was easy. It was not that hard to go through the app'. (P11)
	• Access to communication aid	9	'The app will improve communication'. (P8) 'You can be in contact with the doctor all the time'. (P1) 'This app can help me communicate and talk. If I am not in the mood to talk, I can just show the picture in the app'. (P12)
3. Availability The objective possibility to engage in a situation. In terms of services, it refers to the objective provision of facilities or resources	• App use	25	'Use maybe once or twice a day' (P9; P18; P20) 'because I like to play games on my phone and with the app, I can do it' (P12). 'Every day'. (P1; P6; P8; P13; P14; P15; P16) 'Once a week'. (P2)
	• Device compatibility	8	'My phone jams'. (P9) 'My device was not compatible with the app, and I could not download it on the Play Store. I did spell it right, but I could not find it'. (P18) 'My phone died all the time'. (P17)
	• Links on the app	15	'It could work if they add links to a website'. (P15) 'It will be more fun if there were links to games and videos'. (P11)
	• Need pin code to log in	6	'I did not know my grandmother's email or pin'. (P6) 'It was hard due to the login details and the registration of your account and pin code'. (P17; P18)
	• Data/Wi-Fi	3	'I might not be able to use the app if I do not have data or Wi-Fi'. (P3; P8)
4. Affordability Covers not only financial constraints but also whether the amount of effort in both time and energy expenditure is worth the return to engage in the situation.	• Data /Wi-Fi/size of app	16	'It [*app*] does not use a lot of Wi-Fi'. (P6) '… need data to use app'. (P2; P10; P14; P19) 'Internet'. (P16) 'I don't have data to use the app'. (P15) 'Need Wi-Fi to use the app. When I try to use the app, the Wi-Fi goes off'. (P15) 'I thought it was going to cost money, but it didn't'. (P15) 'It takes time to download. It takes a lot of data to download the app'. (P19)

Table 3 continues on the next page →

TABLE 3 (Continues...): Themes and subthemes.

Theme	Subtheme	Grounded	Code examples
5. Accommodability Describes whether the app can be adapted	• App content: express symptoms (e.g., emotions, pain, how you feel)	37	'You do not have to tell the doctor the whole time how you feel. It is a good motivation for children to be honest about their pain'. (P1) 'You can tell the app to tell your parents that you need medicine'. (P20) 'I would use to app when I am sick, and I want to tell my mom how I feel'. (P14) 'If you cannot talk, you can show how you feel [*by using the app*] '. (P9) 'I liked the idea that the complexity of emotions could be expressed'. (P8) 'You can tell the app how you feel'. (P4; P7) 'Sometimes parents think that your feelings aren't real and using the app to tell them how you feel will help'. (P8) 'I would like to use this app to talk to my friend about how I feel'. (P17) 'It was great because of the all the questions about feelings'. (P15) 'When someone is in hospital, and they want to sleep they can use the app to tell someone their tired and need sleep'. (P19)
	• App features: Customise to meet individual profile	47	'I like the fact that you can change the avatar and pets and give it names'. (P4) 'Change avatar into a girl'. (P16) 'Be a boy or a girl'. (P11) 'I like the avatars because I can change the hairstyle and hair colours'. (P13)
	• App features: Diary; statistics	4	'You can see that you feel today better than yesterday, e.g., my headache is better – it decreased from an 8 to a 2'. (P1) 'to look back and see today was a good day'. (P8)
	• App features: Speech-to-text; typing	4	'I just battle with one thing and that is how you spell but I saw there was a little microphone, and I will just use that'. (P7) 'Anyone can use it. We are all different and we can all use it. Even if you don't have hands or feet'. (P16)
	• App users (children in hospital; when sick; in school)	44	Children in hospital: 'They [*children in hospital*] can share their stories over and over'. (P3); 'It [*app*] is something nice to do and they will not have to talk to the doctors the whole time'. (P1) When you are sick: 'Use app when you are sick, and you cannot verbally tell others how you feel'. (P1; P7) 'To tell others that I am sick and need help' (P3; P11). 'I tell my mom everything and I will use this to talk to my mom when I am sick'. (P17) In school: 'Ask how was school'. (P12)
	• Share app with others	14	'When someone is shy, you can use the app to show others how you feel'. (P8) 'I can show the app to tell my mom how I am feeling'. (P2; P4; P13; P14) 'Share with a friend or connect with 'n friend'. (P8)

Source: Sieck, C.J., Rastetter, M., Hefner, J.L., Glover, A.R., Magaña, C., Gray II, D.M. et al., 2021a, 'The five A's of access for TechQuity', *Journal of Health Care for the Poor and Underserved* 32(2), 290–299. https://doi.org/10.1353/hpu.2021.0064

(P2) when installing the app, although some mentioned that it was easy to install the app – 'press install button' (P7, P11). Even though downloading the app was generally considered to be easy, participants commented that the consistent loadshedding (the interruption of electricity supply during specific times of a day) and weak and/or slow Wi-Fi connection negatively impacted their use of the app (P8, P3).

Some participants commented that the fact that they needed a pin code to access the app made it slightly difficult to login: 'It was hard due to the login details and the registration of your account and pin code' (P18); 'It [*download*] was easy, but the login was difficult because you needed the password and pin code' (P17). Comments on the navigation of the app ranged from 'First bit difficult – get used to it, easier' (P1; P13); 'learning how to use it' (P15) to 'easy' (P2 – P9; P11; P17 – P19).

Participants mentioned that they would have loved it if the app could be used as a communication aid to communicate with somebody else in the hospital as a:

> '[*K*]ind of social networking to support each other – like WhatsApp but on the app regarding how you are feeling today and sharing it with somebody that is going through the same experience.' (P15)

Participant P9 commented that one can 'show the pictures to someone else to tell them that you are sick when you cannot talk', and Participant P13 mentioned 'It helps you when you not feel well I can just give it to my mom or brother'. Participant P12 also noticed, 'This app can help me communicate and talk. If I am not in the mood to talk, I can just show the picture in the app'.

Theme 4: Affordability

The participants' socio-economic status impacted the use of the app, with comments such as 'data' or 'Wi-Fi' when asked about challenges or stating their phone's incompatibility with the app (P2, P6, P8, P12 – P16, P19). Participants utilised the app for different reasons, for example, to report anxiety (P15) or to report when the child was feeling sick at home, at the hospital or at school (P14).

Theme 5: Accommodability

Participants shared ideas on how the app could be adapted for various contexts and different users. They particularly enjoyed the idea that symptoms such as emotions, pain and nausea could be expressed with a link to a diary, and how the use of statistics could reveal how their current feelings compared to their previous ones, for example, 'You can see that you feel today better than yesterday, e.g., my headache is better – it decreased from an 8 to a 2' (P1).

The participants agreed that the app can be used by sick children at home; in the hospital; and in school and that 'they [*children in hospital*] can share their stories over and over' (P3) or that they can share the app with others 'I can show the app to tell my mom how I am feeling' (P2, P4, P9; P13, P14).

Discussion

As the future implementation of the PicPecc app in a clinical setting in South Africa is being considered, South African children's perceptions of the PicPecc app are necessary. Children's voices are essential to understand their concerns related to healthcare (Nilsson et al. 2021; Schiariti 2022; Thunberg et al. 2022). Schiariti (2022) also confirms the importance of purposefully including children's voices in research, especially when they are involved in activities that will affect them, such as using the PicPecc app to report their symptoms to obtain treatment. As such, this study aimed to determine the feasibility of the PicPecc app by South African children by utilising the five dimensions of implementation of mHealth as adapted from Sieck (2021a) through children's voices.

Interactivity and gamification

Acceptability refers to participants' perceptions of the app's features, which affect motivation to use the app. Although most participants believed that the 'app is cool', this study highlighted the importance of interactive and gamification features in apps to maintain and increase children's engagement with the app (e.g., children suggested features to dress the avatar or links to access games in the app). Gamification builds on a person's instinct to play (Treiblmaier et al. 2018a, 2018b). The aim of gamification is, therefore, to use game-design elements in non-game contexts (such as healthcare) to boost a person's extrinsic and intrinsic motivation by helping them to analyse information to achieve better goals, and/or to change their attitude and subsequent behaviour (Treiblmaier et al. 2018a). Gamification should introduce a novelty component and avoid unnecessary repetition to appeal to this age group. The children preferred features such as interactive avatars and pets, for example, feeding, playing or dressing the avatar or pet. Additional comments addressed interactivity by allowing children to access their favoured games and YouTube videos for entertainment. Children utilise YouTube to watch videos on topics such as humour, nursery rhymes, television shows, and animal videos (Neumann & Herodotou 2020b). Neumann and Herodotou (2020a) also evaluated the content of YouTube videos of interest to children and found that learning increased when educational videos included interactive elements. This interactivity element was confirmed by the work of Linder et al. (2021) who found that interactivity can help children improve their creativity, specifically when they are sick and are required to report their symptoms. Although the children in this study highlighted the importance of interactivity, they stated that regardless of this feature, they would still utilise the app to report their symptoms when they are sick. Previous research shows the need to design a meaningful experience to increase the value of gamification. The quality of gamification is more important than quantification (Auf et al. 2021).

Colour and background

Participants suggested that they preferred changes to the colour of the background, which is currently a shade of green. A variety of other colours such as yellow, lime green, pink, purple, and blue, were suggested. This may be related to the fact that colours have specific affective meanings. For example, Jonauskaite et al. (2019a) found that a lighter shade of yellow was associated with joy, yellow-green with relaxation, and that a darker yellow was perceived as a less pleasant colour. Although pink and blue have traditionally been linked to gender – blue for boys and pink for girls (Jonauskaite et al. 2019b) these authors found that both pink and blue are linked to positive emotions. Therefore, this may be the reason why participants in this study opted for these colours.

Participants also suggested that the background should be changed to specific visual scenes 'to help the child to feel better'. Since the participants believed specific happy scenes that are unrelated to the medical event might help the children to feel better, it may also be related to the fact that these types of scenes are often linked to specific colours. For example, Jonauskaite et al. (2019a) found that imaginary scenes, such as the beach scene may be linked to the colour blue and a sunset to red.

Social determinants of health

Non-medical factors that influence health (social determinants of health) (Richardson et al. 2022) related to the availability and accessibility dimensions were mentioned in this study. The World Health Organization (https://www.who.int/health-topics/social-determinants-of-health#tab=tab_1) defined social determinants of health as the environmental conditions (i.e., the circumstances within the surroundings where individuals are born, reside, acquire knowledge, engage in employment, participate in recreational activities, practice religion, and grow older) that impact various aspects of children's health, abilities, and overall well-being, as well as the likelihood of encountering risks. Social determinants of health are also responsible for health disparities as they are influenced by the dispensation of money, power, and resources (Richardson et al. 2022). For example, in this study, these disparities were observed as some participants had to borrow a phone from a parent while some owned their own, some had older phones that were incompatible with the PicPecc app, while some had the latest high-end phones. Some had limited data or experienced poor or no Wi-Fi access while some had access to uncapped, unshaped Wi-Fi. Another challenge was that nationally scheduled power cuts (loadshedding) negatively influenced participants' Wi-Fi access resulting in long download times. Challenges because of loadshedding have also been reported by various authors who confirmed that the continuous loadshedding in South Africa has a huge impact on healthcare, including the use of mHealth tools (Githaiga et al. 2023; Malange 2023; Romski et al. 2023).

The availability and accessibility dimensions also highlighted the importance of acknowledging the participants' digital literacy. Some participants also complained that they misspelled the name of the app when searching for it on Google Play Store or had to ask someone to help them search and download the app. They also believed it was time-consuming to request the pin code to log into the app. Therefore, Sieck et al. (2021b) mentioned that healthcare practitioners should be aware that some participants may need support on the use of digital tools, for example, how to create an email account or log into an app. These recommendations should be followed when the PicPecc app (or any other app) is introduced to patients in a clinical setting.

There was a difference in the frequency with which the five dimensions to consider regarding the implementation of mHealth were reported in the findings. For example, the 'affordability' dimension was mentioned the least. Previous research reported that the affordability dimension was more difficult to interpret than the other four dimensions (Adolfsson, Johnson & Nilsson 2017).

Limitations

A possible limitation of this study is that the participants' exposure to the app was relatively short, which might have influenced their perceptions of the feasibility of the app. Research has shown that the longer a person uses an app, the interest in the app decreases as the novelty wears off (Romski et al. 2023). Another limitation could include the socioeconomic inequality in South Africa as many South African children may not have access to smartphones. However, as found in this study, most children use their parents' or relatives' phones if they do not own one. Therefore, the findings may impact generalisation to the larger representation of South African children.

Suggestions for future research include replicating this study with parents and healthcare practitioners as they are often enablers for children to access mHealth. Furthermore, the PicPecc app could also be utilised as a reflective journal to express children's emotions related to medical procedures.

Conclusion

According to participants' perspectives, the PicPecc app is feasible for implementation in the South African context. When conceptualising the features of the app according to the five dimensions mentioned by Sieck et al. (2021a), namely accessibility, acceptability, affordability, availability and accommodability, the findings indicate advantages when utilising this app for the reporting of health symptoms. Participants stated that they thought that the app was promising in the South African context. However, when implementing mobile health technologies, a variety of important considerations should be considered to ensure that such a solution does not defeat the intended purpose by increasing health disparities (Sieck et al. 2021b). Therefore, future recommendations should systematically assess individual patients' access and digital literacies when implementing mHealth tools in clinical settings.

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Authors' contributions

E.J. and S.N. conceptualised the study, obtained funding, and planned the methodology. A.K. refined the methodology, did data collection and together with E.J. analysed the data. All five authors (E.J., K.M., S.N., J.B. and A.K.) were involved in the writing and revision of the manuscript drafts.

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Data availability

Data supporting the findings of this study are available from the corresponding author, E.J.

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Appendix starts on next page →

Appendix 1

Interview schedule

Aim of section	Time	Interview questions
Consent	5 min	Good day, I am …….. We are trying to find out what children think about the app that you used the past week. What we discuss here will be confidential and your names will not be used in any report on this study. You have the right to withdraw at any time during the study and it will not influence your or your child's cancer treatment We are going to make recordings (audio) of the discussion and it will only be used by us to refer back to the discussions. We would like you to help us by giving your opinion about the app?
Background information Introduction (Acceptability)	5–10 min	This app was originally developed for children with cancer to communicate their symptoms. Children, their parents and medical staff gave their input during the development of the app. 1. What do you think about the app in general? (Tell me more) 2. What do you like about the app? 3. What don't you like about the app? 4. What do you think about the avatars? 5. What would you have changed in the app? 6. Is there anything else that you think should have been added to the app?
What are your ideas (expectations) on the app?	5–10 min	7. Would you have liked to have an app like this that you could use it every day to tell someone how you feel? (Tell me more.) 8. Do you think that children with cancer would use the app? Please elaborate/tell me more. 9. What do you think about the pet that you could "win" as you are using the app? (Do you think you will use the app more to gain more pets?)
(Availability) The objective possibility to engage in a situation. In terms of services it refers to the objective provision of facilities or resources (Accessibility) Describes whether you can, or perceive that you can, access the context for the situation.	10–20 min	10. Could you find the app on Google Playstore or iStore? (Tell me more) 11. How easy was it for you to download the app? (Tell me more) 12. How easy was if for you to get into the app? (Did the pin code work?) 13. How easy was it for you to navigate through the app? (Tell me more) 14. Was it possible for you to change the Avatar to suit your profile? (e.g. change haircut and colours? Change face colour? Add your name to the Avatar?) 15. Did you change the name of the pet? (Was it a specific pet name that you chose?)
(Affordability) Covers not only financial constraints but also whether the amount of effort in both time and energy expenditure is worth the return to engage in the situation.		16. What would help you to use this app? (Internet? Data costs? What else?) 17. What do you think would prevent (keep) you from using this app? (Tell me more) 18. Do you think that you will be able to go to the links offered in the app? (Tell me more)
(Acceptability) Covers people's acceptance of a person's presence in a situation. If there is an expression of values or common beliefs which are of a subjective nature, then this is also acceptability.		19. What do you think will help you to use this app? 20. What do think about the app in general? 21. What do you think about the illustrations in the app? 22. What would you have done differently in the app? (Why do you want to change something in the app?) 23. Tell me about the colours used in the app? (Do you think it works? If not, why not? What would you have done differently?) 24. How can this app help you to win/gain something?
(Accommodibility) Describes whether a situation can be adapted		25. This app was originally developed to help children with cancer to communicate their symptoms. Do you think that this app can be used by children like you to to communicate their symptoms? (For example, during Covid, many children experienced a lot of anxiety – do you think this app could help you to share your experiences with somebody?)
Conclusion		Thank you for helping us to give your opinion about the app. You are welcome to use the app in future if you would like to do it.