Development of a Web App to Enhance Physical Activity in People with Cystic Fibrosis: Co-design and Acceptability Evaluation by Patients and Health Professionals

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Table of Contents

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Abstract

Background: Cystic fibrosis (CF) is a genetic disease affecting the respiratory and digestive systems, with recent treatment advances improving life expectancy. However, many people with cystic fibrosis (pwCF) lack adequate physical activity (PA). PA can enhance lung function and quality of life, but barriers exist. The CF-DB-PA questionnaire assesses decisional balance for PA in pwCF, but it is not optimal for clinical use. Developing a digital app can overcome these limitations, improving efficiency in administration, results' interpretation, and communication between patients and healthcare professionals.

Objective: This paper aims to present the development process and to assess the acceptability of a web app designed to measure and monitor the decisional balance for PA in pwCF.

Methods: The study comprised two stages: (a) co-designing a digital app, and (b) evaluating its acceptability among healthcare professionals and pwCF. A participatory approach engaged stakeholders in the app's creation. The app's acceptability, based on factors outlined in the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2), is vital for successful adoption. Participants volunteered, gave informed consent, were over 18, and fluent in French. Data collection employed qualitative interviews, video presentations, surveys, and individual semi-structured interviews, with quantitative and qualitative data analyses.

Results: A total of 11 healthcare professionals, 6 pwCF, and 5 researchers were involved in the co-design phase. Healthcare professionals encompassed various roles. Findings revealed early promotion of physical activity by healthcare professionals, personalized recommendations, and perceptions of CF-DB-PA scale benefits and limitations. Regarding the CF-DB-PA scale, healthcare professionals reported benefits such as providing specific information about facilitators and barriers, evaluating motivation for PA, and challenging their own assumptions. They also emphasized the time-consuming aspect of processing results and the limitations of the paper-and-pencil format. In evaluating the digital tool, participants highlighted the need for a simple interface and secure data storage. Most participants expressed intention to use the digital format, with a few exceptions. In the acceptability evaluation phase, the sample included 47 healthcare professionals, 44 pwCF, and 12 researchers. The analysis revealed that the acceptability measures were positive, and that the app acceptability did not differ according to user profiles. Semi-structured interviews allowed to identify positive and negative perceptions of the app and the interface, as well as missing functionalities.

Conclusions: This study assessed the acceptability of the MUCO_BALAD app and demonstrated promising qualitative and quantitative results. The digital tool for measuring the decisional balance in physical activity for pwCF is encouraging for healthcare professionals, pwCF, and researchers, with valuable insights gained from the study's perspectives.

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Development of a Web App to Enhance Physical Activity in People with Cystic Fibrosis: Co-design and Acceptability Evaluation by Patients and Health Professionals

Original Paper

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Abstract (max 450 words):
Background: Cystic fibrosis (CF) is a genetic disease affecting the respiratory and digestive systems, with recent treatment advances improving life expectancy. However, many people with cystic fibrosis (pwCF) lack adequate physical activity (PA). PA can enhance lung function and quality of life, but barriers exist. The Cystic Fibrosis Decisional Balance of Physical Activity (CF-DB-PA) questionnaire assesses decisional balance for PA in adult pwCF, but it is not optimal for clinical use. A digital app might overcome these limitations by improving the efficiency of administration, interpretation of results, and communication between patients and healthcare professionals.

Objective: This paper presents the development process and reports on the acceptability of a web app designed to measure and monitor the decisional balance for PA in pwCF.

Methods: The study comprised two stages: (a) co-designing a digital app, and (b) evaluating its acceptability among healthcare professionals and pwCF. A participatory approach engaged stakeholders in the app's creation. The app's acceptability, based on factors outlined in the Unified Theory of Acceptance and Use of Technology 2 (UTAUT2), is vital for successful adoption. Participants volunteered, gave informed consent, and were over 18 years and fluent in French. Data collection employed qualitative interviews, video presentations, surveys, and individual semi-structured interviews, with quantitative and qualitative data analyses.

Results: Eleven healthcare professionals, six pwCF, and five researchers were involved in the co-design phase. Results of this phase led to the co-construction of an app named MUCO_BALAD, designed for pwCF 18 years old and over, healthcare professionals, and researchers to monitor the decisional balance for PA in pwCF. In the acceptability evaluation phase, the sample included 47 healthcare professionals, 44 pwCF, and 12 researchers. The analysis revealed that the acceptability measures were positive and that app acceptability did not differ according to user types. Semi-structured interviews helped identify positive and negative perceptions of the app and the interface, as well as missing functionalities.

Conclusions: This study assessed the acceptability of an app and demonstrated promising qualitative and quantitative results. The digital tool for measuring the decisional balance in PA for pwCF is encouraging for healthcare professionals, pwCF, and researchers, with valuable insights gained from the study's perspectives.

Keywords: Cystic fibrosis**,** Decisional balance**,** Digital app**,** Acceptability**,** Physical activity.

Introduction

Cystic fibrosis (CF) is a hereditary disease that mainly affects the respiratory tract and digestive system [1]. The disease is caused by a genetic mutation that affects the chloride transporter, a protein that regulates the water and electrolyte balance of cells. This mutation leads to the production of thick and sticky mucus that obstructs the airways, pancreatic ducts, and bile ducts [1].

Recent improvements in CF management have drastically improved the life expectancy of people with CF (pwCF) [2,3]. Adult symptoms vary, from cough and sputum to respiratory failure. Therapies aim to enhance patient quality of life: medications thin bronchial secretions, antibiotics treat infections, and enzymes aid digestion [4]. Innovative treatments like gene therapy and CFTR modulators show promise by correcting the malfunctioning protein produced by the CFTR gene [5]. Recent studies provided empirical evidence for improved survival rates with an estimated median age of survival of approximately 50 years today [2]. However, the long-term management of adult CF patients and the improvement in their quality of life are becoming increasingly important considerations.

Physical activity (PA) is crucial in adult pwCF care [6]. PA includes sports, adapted physical activity (APA), exercise, and recreational activities. It enhances lung function, fitness, and quality of life, and it lowers disease-related risks [7]. Importantly, PA is well-tolerated with no adverse effects in pwCF [8]. Recommendations for pwCF include aerobic exercise (e.g., walking, jogging, cycling, swimming) and strength training, tailored to individual factors (e.g., symptom variability, the initial level of physical fitness, preferences, and motivations) [9,10].

Many pwCF lack sufficient exercise, both in intensity and frequency [11]. Specific barriers to PA in adult pwCF include physical (i.e., fatigue, respiratory difficulties), psychological (i.e., negative perceptions, motivation, perceived ability), and environmental (i.e., competing priorities, lack of opportunities, social support) barriers [12,13]. These barriers can be counterbalanced by facilitators of PA, including physical (i.e., respiratory benefits, improvement of overall health, better preparation for transplantation), psychological (i.e., positive perceptions of PA, improved self-esteem and sense of achievement), and environmental (i.e., social support, availability of sports facilities) facilitators [13].

The transtheoretical model of behavior change [14] outlines several stages: (a) precontemplation, (b) contemplation, (c) preparation, (d) action, and (e) maintenance. The decisional balance [15] reflects the balance between facilitators of and barriers to PA. This balance is important at each stage and may fluctuate due to external factors (e.g., availability of sports facilities, social

support from peers) or internal factors (e.g., personal motivation, energy level, overall health status). In the specific context of CF, the Cystic Fibrosis Decisional Balance of Physical Activity (CF-DB-PA) questionnaire, described in Table 1, has been developed and validated [16]. This 23-item tool indirectly measures the readiness of pwCF to change their PA level by measuring the individual's facilitators of PA [i.e., 10 items divided into physical (F_{PHY}), psychological (F_{PSYCH}), and environmental (F_{ENVI}) factors] and barriers to PA [i.e., 13 items divided into physical (B_{PHY}), psychological (B_{PSYCH}), and environmental (B_{ENVI}) factors]. A global score of decisional balance can be calculated, as well as independent scores for each factor.

Table 1. Items of the Cystic Fibrosis Decisional Balance of Physical Activity (CF-DB-PA) questionnaire in French and [English] [16].

N°	Category	Items
1	$F_{PHY}1$	Cela développe mes muscles respiratoires et réduit mon essoufflement. [It develops my respiratory muscles and reduces my shortness of breath.]
2	$F_{PHY}2$	Cela améliore mon endurance. [It improves my endurance.]
3	$F_{PHY}3$	Cela améliore ma force et ma masse musculaire. [It improves my strength and muscle mass.]
4	$F_{PHY}4$	Une bonne condition physique favorise la réussite de la greffe. [A good physical condition promotes transplant success.]
5	$F_{PSYCH}1$	C'est l'occasion de penser à autre chose. [This is an opportunity to think about something else.]
6	$F_{PSYCH}2$	Cela me fait plaisir. [I am pleased to do it.]
7	$F_{PSYCH}3$	Cela me permet de rencontrer d'autres personnes. [It allows me to meet other people.]
8	$F_{ENVI}1$	Je bénéficie d'un encadrement compétent pour ma pratique. [I benefit from competent supervision for my PA.]
9	$F_{ENVI}2$	Je bénéficie de lieux adaptés à ma pratique. [I benefit from adapted places

		to do my PA.]
10	$F_{ENVI}3$	J'ai une offre de pratique près de chez moi. [I have a PA offer in my immediate area.]
11	$B_{PHY}1$	Cela me fatigue trop. [It fatigues me too much.]
12	$B_{PHY}2$	Je supporte mal l'effort physique. [I have trouble tolerating physical effort.]
13	$B_{PHY}3$	Je m'essouffle très vite. [I get short of breath really fast.]
14	$B_{PHY}4$	Je désature très vite. [I desaturate really fast.]
15	$B_{PSYCH}1$	J'ai peur d'être trop essoufflé.e. [I worry about getting short of breath.]
16	$B_{PSYCH}2$	J'ai peur d'être contaminé.e par des germes dans les lieux de pratique sportive. [I am afraid of being contaminated by germs in places for PA.]
17	$B_{PSYCH}3$	J'ai peur de tousser. [I am afraid of coughing.]
18	$B_{PSYCH}4$	J'ai peur d'être mal vu.e si je tousse devant les autres. [I am afraid of being frowned upon if I cough in front of others.]
19	$B_{PSYCH}5$	Je ne pense pas en être capable physiquement. [I don't think I am physically able to do it.]
20	$B_{PSYCH}6$	Je n'arrive pas à suivre le rythme. [I can't follow the rhythm.]
21	$B_{ENVI}1$	Je n'ai pas le temps à cause de mes contraintes familiales. [I don't have time because of my family obligations.]
22	$B_{ENVI}2$	Je n'ai pas d'offre qui me convienne près de chez moi. [I don't have a PA offer that works for me in my immediate area.]
23	$B_{ENVI}3$	Je n'ai pas l'encadrement adapté à mes besoins. [I don't have supervision that is adapted to my needs.]

Notes. F_{PHY} physical facilitator; F_{PSYCH} psychological facilitator; F_{ENVI} environmental facilitator; B_{PHY} physical barrier; B_{PSYCH} psychological barrier; B_{ENVI} environmental barrier. For each item, participants responded on a 6-point Likert scale from (1) "Totally disagree" to (6) "Totally agree." The introduction sentence was "The factors that would encourage me to regularly practice a physical activity are..." [*Les raisons qui m'inciteraient à pratiquer régulièrement une activité physique sont...*] for the facilitators and "The factors that would hold me

back from regularly practicing a physical activity are..." [*Les raisons qui me freineraient à pratiquer régulièrement une activité physique sont...*] for the barriers.

This tool, developed with the collaboration of CF centers, was initially well accepted by healthcare professionals and the pwCF but has been poorly used since. The reasons given informally by the CF centers were mainly linked to the considerable amount of time needed to use it (i.e., calculating each score is time-consuming) and the limited perspectives for using it efficiently in clinical practice. Developing the CF-DB-PA questionnaire in digital form had the potential to meet these expectations. A previous review has already demonstrated the added value of digitalized questionnaires [17], which provide high levels of compliance, feasibility and acceptability; improved data accuracy; and a reduction in data management and processing time. However, technical problems may occur, key factors of visual and ergonomic considerations must be taken into account, and the ease of using these questionnaires must be optimized [17]. It is therefore important to develop a digital format that is suitable for both healthcare professionals and pwCF, hence the interest of the co-design approach. Measuring the acceptability to the target population (i.e., adult pwCF and healthcare professionals) is usual in the process of technology development [18] and enables the user experience to be optimized. This paper presents the development process and reports on the acceptability of a web app designed to measure and monitor the decisional balance for PA in pwCF using the digital adaptation of the CF-DB-PA questionnaire.

Methods

Study Design

The study was conducted in two main stages: (a) the co-design of the digital app to define its content, and (b) the evaluation of its acceptability among healthcare professionals and adult pwCF.

The development of the digital app was based on a participatory approach between researchers and stakeholders (i.e., pwCF and healthcare professionals) throughout the research process. This co-design methodology enables the production of useful and accurate knowledge that is consistent with the realities of key actors, culturally adapted to the target audiences, and logistically feasible [19].

Acceptability is of paramount importance in the successful adoption and implementation of new technologies. This refers to the extent to which individuals perceive a specific innovation as useful, easy to use, and compatible with their values and needs. The Unified Theory of Acceptance

and Use of Technology 2 (UTAUT2 [18]) explains and predicts individuals' acceptability and usage behaviors regarding new technologies. According to this model, acceptability is influenced by several key factors: performance expectancy, effort expectancy, social influence, facilitating conditions, habits, price value and hedonic motivation.

Numerous studies have applied and validated the UTAUT2 model in various contexts, including healthcare, education, and organizations [18,20]. Understanding and considering the factors that influence acceptability can assist designers, decision-makers, and practitioners in enhancing the adoption and usage of innovations, thereby promoting more successful and sustainable changes.

Participants

Participants in the co-design phase included healthcare professionals specialized in CF, pwCF, and researchers. Objectives of this co-design phase (i.e., to build a prototype of the app to adapt the CF-DB-PA questionnaire in digital form) were presented to participants. Healthcare professionals and pwCF were recruited from two specialized centers in France selected for their advanced PA promotion practices. Researchers specialized in sports sciences, PA promotion to pwCF, or patients with other conditions were selected from two French universities. Participants were approached by e-mail and phone calls.

Participants in the acceptability of the digital app phase included pwCF, healthcare professionals specialized in CF, and researchers specialized in sports sciences. Objectives of this acceptability phase (i.e., to understand perceptions of the first version of the app) were presented to participants. Participants were approached face-to-face, by email or phone call. No relationship was established before the start of the study. After survey completion and when participants were available for 30 more minutes, a semi-structured interview was proposed.

Participants in the co-design phase were allowed to participate in the acceptability phase. All were over 18 years old and fluent in French.

Data Collection

Co-design of the digital app

The co-design of the digital app was divided into several steps. First, qualitative individual interviews were conducted with pwCF and health professionals. These interviews explored the perceptions of the CF-DB-PA questionnaire to promote PA among pwCF. The interview guide was composed of four parts: (a) current professional practice related to PA, including initial patient

encounters, assessment of patient PA, counseling and orientation toward PA; (b) perceptions of the CF-DB-PA questionnaire, including perceived tool benefits, identified limitations, and potential uses; (c) the functionalities that could be added to the digital version of the questionnaire; and (d) the prospects for using a digital app. Interviews were conducted by the first author (female PhD student in Human Movement Sciences), who was trained to conduct semi-directive and focus group interviews. The interviews were audio recorded and notes were taken.

Based on the results, the authors brainstormed a first pre-prototype of a digital app designed to measure and monitor the decisional balance for PA in pwCF. Three consecutive meetings were then organized by the first author alone with all the healthcare professionals, pwCF and researchers involved in the co-design phase to achieve a prototype. During the first meeting, the operational aspects of the digital form of the CF-DP-PA questionnaire were identified. The second meeting focused on listing the functions to complement the CF-DB-PA questionnaire administration. During the third meeting, the specifications were classified according to their importance into three levels: priority, secondary or tertiary. The second and third meetings were introduced with a summary of the previous meeting. An overall written summary was sent to the participants after the last meeting, listing the elements that needed to be included in the digital version of the questionnaire.

Acceptability of the digital app

The acceptability of the first version of the app was assessed individually by a wider group of the three types of participants. Participants were presented with a narrated video showing and explaining the different functionalities of the app, including: (a) an introduction to the definition of decisional balance and the barriers to and facilitators of PA among pwCF; (b) functionalities of the app from the perspective of pwCF, of healthcare professionals, and of researchers. After watching the video, participants were invited to complete a survey administered by LimeSurvey in the CF centers or by videoconferencing; the survey comprised several questionnaires.

Acceptability of the app. The French e-health scale based on the UTAUT2 [21] was specifically adapted to the presented digital app (i.e., “ICT for Health” was replaced by “this app”) and used. This scale is composed of 25 items divided into eight factors: (a) performance expectancy, (b) effort expectancy, (c) social influence, (d) facilitating conditions, (e) hedonic motivation, (f) price value, (g) habit, and (h) behavioral intention. Items were evaluated on a 7-point Likert scale from (1) strongly disagree to (7) strongly agree. The Cronbach alpha coefficients were high [22], as they ranged from .74 to .94.

Usage frequency of technology-based PA interventions. Based on the original UTAUT2 questionnaire

[18], questions on the actual usage of technology-based PA interventions (i.e., mobile application, sensors, social media, videos, active video games) were asked. Each technology was evaluated on a 7-point Likert scale as follows: (1) never, (2) less than once a year, (3) once a year, (4) once a month, (5) once a week, (6) once a day, and (7) several times a day. The Cronbach alpha coefficient was satisfactory [22] with a value of .70.

Computer anxiety. Four items of the computer anxiety trait subscale [23] were used. These items were selected based on their relevance to the study context. Computer anxiety was measured on a 5-point scale from: (1) not at all corresponding to (5) completely corresponding. They presented high internal consistency (i.e., Cronbach alpha coefficient = .93) [22].

Sociodemographic information. Questions concerning age, sex, socio-professional category and CF mutation type were asked.

In the second step, participants were asked if they would agree to participate in complementary, individual, semi-structured interviews. The interview guide comprised four parts: (a) perceptions of the app, (b) perceptions of the interface, (c) missing functionalities, and (d) overall feedback and app usage intentions. Interviews were conducted face-to-face by the first author at specialized CF centers after completion of the survey, or remotely through videoconferencing. The interviews were audio recorded and notes were taken. A summary was produced at the end of the interview to validate the participant's statements.

Data Analysis

Co-design of the digital app

The interviews were analyzed based on the core principles of thematic analysis [24–26]. First, the audio recordings of the interviews were transcribed *ad verbatim*. Second, the transcripts were read multiple times by the first author and a second person (mentioned in the acknowledgments) to gain a thorough understanding of the data. Deductive coding in the previously defined main categories was initially performed by them, followed by inductive coding in an Excel spreadsheet (Microsoft). The last two authors checked each verbatim coding and its classification. They had access to the original transcripts to contextualize the review of the coding. The first author and the last two authors discussed the codes and classification until consensus was reached. The second author acted as a disinterested peer [27] without access to the original transcripts. All researchers then discussed the coding until consensus was reached. To ensure methodological rigor, criteria were reported according to the COREQ guidelines [28].

Acceptability of the digital app

All analyses were performed using IBM SPSS version 23 (IBM Corporation). The sample had no missing data (online completion of the survey). The data were first analyzed by descriptive methods (means, standard deviation). Multiple regression analyses were then used to examine the explained variance and the main contributors to behavioral intention to use the app prototype. Differences between the dependent variables (i.e., UTAUT2 dimensions, frequency usage of technology-based PA interventions, computer anxiety) according to participant type (i.e., healthcare professionals, patients, researchers) were examined using multivariate and univariate analysis of variance tests.

Qualitative interviews were analyzed using the same methodology as previously described in the digital app co-design phase. To ensure methodological rigor, criteria were reported according to the COREQ guidelines [28].

Ethical considerations

The Research Ethics Committee of the University of Côte d'Azur approved this observational study (CER 2022-049). All participants were volunteers and had given informed consent. The Anonymity and confidentiality of participants and data were guaranteed in accordance with the General Data Protection Regulation. We ensured that no identification of individual participants was possible in the reported data and quotes. The interviews were transcripted without personal information and were deleted after transcription. No compensation was paid to participants.

Results

Co-design development of the app's content

Characteristics of the sample

Eleven healthcare professionals specialized in CF (i.e., two doctors, two coordinating nurses, two physical therapists, three adapted physical activity professionals - APA-P, one psychologist, and one dietitian), six pwCF and five researchers (specialized in health psychology and PA promotion) participated in the co-design phase. The healthcare professionals (3 males, 8 females) had a mean age of 39.91 (SD = 11.60) years, and took part in the individual interviews and the three co-design meetings. The six pwCF (2 males, 4 females) had a mean age of 28.17 (SD = 6.94) years. They carried the most common genetic mutation, which gave them access to CFTR modulator treatment. Their degrees of disease severity were classified as "average." They took part in the individual interviews and the three co-design meetings. No participant dropped out of the study or refused to

take part.

The interviews were conducted from January 2022 to May 2022, totaling 691 minutes (individual interviews: 560 minutes, mean = 32.94, SD = 4.46; focus group: 131 minutes, mean = 43.67, SD = 2.52). The interviews were ended when no new data were provided by the participants and a consensus was reached about emerging themes.

Outputs from co-design development interviews

Based on the interview guide, the following four categories were studied: (a) current professional practices related to PA, (b) perceptions of the CF-DB-PA questionnaire, (c) the functionalities that could be added to the app of the digitalized questionnaire, and (d) the prospects for using the digital app. Examples of verbalizations representing these categories are provided in Table 2.

Professional practice in PA management. This category was divided into two subcategories: (a) first encounter with pwCF, and (b) assessment of pwCF PA and referrals. During the initial consultations, healthcare professionals systematically promote PA to pwCF, starting from early stages of care. They conduct follow-ups during quarterly visits, emphasizing the benefits of PA and the various activities available at specialized centers. Advice focuses on safety, hygiene, nutrition, hydration, and functional capacity rather than performance. Support extends beyond hospitals, with respiratory physiotherapy as a common thread. A few tools, including pedometers and existing therapeutic education tools, are used to promote PA. Patients emphasized the importance of PA during visits (quote 1, Table 2). Assessments of pwCF PA were based on functional tests, medical files, initial interviews, and current and past sporting practices. Personalized PA recommendations were made according to individual objectives, preferences, and medical records. Referrals to an APA professional were made for individualized care. Specific limits were set for patients with respiratory issues (quote 2, Table 2).

Perceptions of the CF-DB-PA questionnaire. This category was divided into two subcategories: (a) benefits of the CF-DB-PA, and (b) limitations of the CF-DB-PA. The healthcare professionals reported several perceived benefits of the CF-DB-PA scale. Nine of them provided specific information about the facilitators and barriers encountered by pwCF (quote 3, Table 2). Seven healthcare professionals mentioned that the CF-DB-PA enabled them to evaluate the level of motivation for PA of the pwCF (quote 4, Table 2). Similarly, seven participants mentioned that this

would enable them to be aware of their patients' level of knowledge or beliefs and help them start discussions on the subject (quote 5, Table 2). Finally, five healthcare professionals and two pwCF mentioned that simply completing the CF-DB-PA would help the pwCF to think about starting or resuming PA. This is illustrated by quote 6 in Table 2.

The main perceived limitation of the scale noted by nine healthcare professionals and four pwCF was the amount of time needed to process the results (quote 7, Table 2). A second limitation, cited by six healthcare professionals and three pwCF, was the "paper and pencil" version of the instrument, which does not allow responses to the questionnaire to be quickly added to the patient file and shared with the entire medical team (quote 8, Table 2).

The app's contents. This category was divided into three subcategories: (a) user-friendly interface, (b) easy data extraction, and (c) secure patient data handling. The main element that emerged while creating the digital version of the CF-DB-PA through an app was the simplicity of the interface, mentioned by 15 participants (10 health professionals and 6 pwCF). A frequent request was to have an app that is easy to use, user-friendly, and intuitive so that needed information can be quickly retrieved (quote 9, Table 2). The second requirement mentioned by all 11 healthcare professionals was easy data extraction from the digital tool for uploading to the patient file (quote 10, Table 2). The last point mentioned by almost half the participants (i.e., 7 health professionals and 1 pwCF) was the importance of having a platform that guarantees the security and confidentiality of patient data (quote 11, Table 2).

Prospects for using the tool in its digital form. This category was divided into two subcategories: (a) willingness to adopt the digital format, and (b) reasons to adopt the digital format. Of the 11 healthcare professionals and six patients, only one patient (i.e., pwCF5) indicated that he was not inclined to use a digital app because he was not comfortable with this format (quote 12, Table 2). The other participants mentioned their intention to use the digital format for several reasons, such as to limit the use of the paper format (quote 13, Table 2). This also reflects the ubiquitous use of smartphones and other digital technologies in today's lifestyles (quote 14, Table 2).

Table 2. Representative quotes from the co-design development of the app's content with healthcare professionals (N=11) and people with Cystic Fibrosis (N=6).

Themes and categories	Participants	Quotes
Professional practice in PA management	N=11*	
First encounter with pwCF	n=11*	Quote 1. At every visit, we have at least one question about what we're doing [in PA], how it's going, and so on, we always have something to say about PA practice. [pwCF3]
Assessment of pwCF PA and referrals	n=11*	Quote 2. Yeah, we're encouraged to do a sport, but we can choose, and the good thing is that here [in the specialist center] they show us several, so at least we can try and see what we like and don't like. [pwCF1]
Perceptions of the CF-DB-PA scale		
Benefits of the CF-DB-PA	N=17	
Individualized results	n=9*	Quote 3. It lets us get to know our patients better, to see things that come to light that we wouldn't necessarily have identified, such as their motivations. [APA-P3]
Evaluation of motivation levels	n=7*	Quote 4. It might also be good to see who's sports-oriented and likes it, and who's not so keen on it. [Psychogist1]
Understanding pwCF knowledge	n=7	Quote 5. This will challenge us doctors, our misconceptions, what we think is obvious or taken for granted [by our patients] when it isn't. [Doctor1].
Encourages PA practice	n=7	Quote 6. Just the fact that the questionnaire is on display is a plus, it makes you question yourself, and why wouldn't it encourage you to start exercising again? [Nurse2]
Limitations of the CF-DB-PA	N=15	
Time-consuming	n=13	Quote 7. Consultation time is already sometimes not enough, so taking the time to carry out the analyses correctly seems very complicated to me. [APA-P1]
Paper-based format	n=9	Quote 8. In the department, we try to reduce the use of paper as much as possible, and now it would be even harder to scan it and include it in the patient's file. It would take even more time, and I don't think anyone would want to take that on. [Physical therapist1]
The app's contents	N=17	
User-friendly interface	n=15	Quote 9. It [the application] really needs to be simple so that people understand straight away and don't waste time looking for where to go. [pwCF4]
Easy data extraction	n=11*	Quote 10. We need something that we can retrieve and put in the patient's individual file, without having to print and scan it. [Dietitian1]
Secure patient data handling	n=8	Quote 11. It still has to be something serious, so that not just anyone can log on and see our answers and even our personal information. [pwCF2]
Prospects for using the tool in its digital form	N=1	
Willingness to adopt digital format	n=1	Quote 12. It's true that I'm not necessarily a big fan of anything connected. So personally I don't think I'll be using it. [pwCF5]
Reasons to adopt digital format	N=16	

		Limit the use of the paper format	n=14	Quote 13. Completely, because here we really have the objective, I think like everywhere else, of doing more and more without paper, so yes, if there was an application, we would use it all the more. [APA-P2]
		Increase in the use of smartphones	n=10	Quote 14. We have quite a few patients from a generation that is fairly positive about apps and things like that, so I think it could go down very well. [Doctor2]
*Notes. *healthcare professionals only.*				

Conceptualization of the app prototype based on the co-design meetings

User types of the app. The initial version of the application included three user types: (a) the healthcare professional type, (b) the pwCF type, and (c) the researcher type. Each user type has restricted rights in the app to ensure anonymization of the collected data.

Functionalities included in the app. Drawing on the three co-design meetings, the specifications for the functionalities to be included in the digital application were drawn up. The functionalities were defined according to three levels of importance: priority, secondary or tertiary. The priority functionalities were as follows: (a) data collection of the CF-DB-PA questionnaire, (b) intuitive visualization of the results, and (c) pwCF PA recommendations according to the results of the questionnaire.

For the data collection, healthcare professionals could add new users and send the CF-DB-PA questionnaire to their associated pwCF with a request for completion. Once the questionnaires had been completed, these professionals were able to visualize the overall and subscale scores according to the nature of the barriers, in schematic and numerical forms, and extract them. The answers to each question were also available and could be extracted. A graphic also depicted the evolution of the decisional balance scores between two measurement times. The recommendation generated at each time was also visualized.

The pwCF were able to complete the 23-item questionnaire (shown in Table 1) and then view and download their results. A schematic representation of their results was generated in conjunction with their PA recommendation. The evolution in their decisional balance scores between two measurement times could also be visualized.

Researchers could access the pwCF results and the visualization but without personal associated information. Researchers were not allowed to add other user accounts.

Development of pwCF PA recommendations. Based on the results of the CF-DB-PA questionnaire

and for each of the three dimensions (i.e., physical, psychological, environmental), participants could have one of the three following decisional swings: (a) barrier score > facilitator score; (b) barrier score = facilitator score; and (c) barrier score < facilitator score. For each of the nine potential situations, a specific recommendation was drawn up by the authors and is described in Table 3.

An algorithm (i.e., set of two rules) was created to attribute the right recommendation to the right pwCF results according to the following rules: (a) the global decisional balance score defines the swing selected, and (b) the higher score in the selected swing defines the targeted dimension.

Table 3. Physical activity recommendations drawn by the authors for the three swings of the decisional balance according to the three dimensions of the CF-DB-PA questionnaire.

	Physical dimension	Psychological dimension	Environmental dimension
Barrier score > Facilitator score	**Prevalence of physical barriers** Fatigue or the symptoms of your illness are frequent obstacles to physical activity. But these barriers can be reduced by regular exercise. This is adapted so that you can exercise while taking into account the progression of your disease. You can do it, so keep on doing it!	**Prevalence of psychological barriers** Lack of confidence in one's physical abilities and/or apprehensions often limit the practice of physical activity. Adapted physical activity instructors propose safe situations that are accessible to everyone. This will help you to gradually regain confidence in yourself and your physical abilities. You can do it, so keep on doing it!	**Prevalence of environmental barriers** Of all the physical activity options available near you, not all are suited to your needs or desires. Your local hospital can help you find the one that suits you best. You can do it, so keep on doing it!
Barrier score = Facilitator score	**Balance between barriers and physical facilitators** Fatigue and the symptoms of your illness are frequent obstacles to physical activity. Specialists in adapted physical activity can advise you and adapt the sessions to the progression of your illness. This will enable you to practice regularly at your own pace, and thus reduce these barriers as much as possible. You should know that the beneficial effects of physical activity are accentuated by regular exercise. You're on the right track, so keep up the good work!	**Balance between barriers and psychological facilitators** Lack of confidence in one's physical abilities and/or apprehensions often limit the practice of physical activity. Adapted physical activity instructors offer safe, accessible activities for everyone. They will be able to advise you on how to exercise and adapt the sessions to your own pace. This will help you to feel more at ease in your body. You'll find it easier to cope with the way others look at you if you've got someone at your side. You're on the right track, so keep up the good work!	**Balance between barriers and environmental facilitators** Of all the physical activity options available near you, not all are suited to your needs or desires. Your local hospital can help you find the one that suits you best. You're on the right track, so keep up the good work!
Barrier score < Facilitator score	**Prevalence of physical facilitators** You're aware of the benefits of physical activity for your body as a whole, and you're managing to exercise regularly. Well done − keep up the good work!	**Prevalence of psychological facilitators** You have confidence in yourself and your physical abilities. You know that physical activity is good for your health, which is why you don't dread exercise	**Prevalence of environmental facilitators** Your local environment is conducive to physical activity. You know where to turn and where to go to exercise. Well done − keep up the good work!

		sessions. On the contrary, they help you clear your mind and you enjoy them. Well done − keep up the good work!	

Development of the first version of the app. The technical specifications and their priorities, defined during the co-designed meetings, were sent to the company chosen to develop the first version of the app. Several meetings were held between the company and the authors to ensure compliance with the technical specifications. Some test users of the recommendation selection algorithm were realized to identify and correct any technical problems or errors.

Acceptability Evaluation of the Mobile app

Characteristics of the sample

The 103 participants involved in the acceptability of the digital app phase were as follows: (a) 47 healthcare professionals specialized in CF, (b) 44 pwCF, and (c) 12 researchers with an interest in health promotion or PA promotion research. The overall sample (36 males, 67 females) had a mean age of 37.92 (SD=11.07) years. The 47 healthcare professionals were composed of five doctors, 12 nurses (including coordination nurses, nursery nurses and advanced practice nurses), nine physical therapists, eight APA professionals, four dietitians, three psychologists, one pharmacist, and five who did not specify. The mean age of the healthcare professionals (6 males, 41 females) was 38.96 (SD=9.93) years. The mean age of the pwCF (22 males, 22 females) was 36.89 (SD=13.17) years. The mean age of the researchers (8 males, 4 females) was 37.67 (SD=6.04) years.

Out of this sample, 29 participants also agreed to take part in individual semi-structured interviews to further explore the acceptability of the digital app. We stopped recruiting new participants when we had no new emerging themes. No participant dropped out or refused to take part in these semi-structured interviews conducted from September 2022 to January 2023 with a total duration of 1208 minutes (mean = 41.66, SD = 8.03). The mean age of this subsample was 36.45 (SD=11.68) years and included 18 females and 11 males. There were 16 pwCF (8 females) with a mean age of 34.44 (SD=12.49) years, and 13 healthcare professionals (10 females; 4 APA professionals, 3 physical therapists, 3 nurses, 1 doctor, 1 dietitian and 1 psychologist) with a mean age of 38.92 (SD=10.55) years.

Quantitative results of the acceptability of the mobile app

Descriptive statistics of the acceptability of the mobile app, the usage frequency of

technology-based PA interventions, and computer anxiety are provided in Table 4 for the different types of participants (i.e., health professionals, pwCF, and researchers). Regression analysis showed that performance expectancy (β=.20, p=.030) and habit (β=.63, p<.001) were significant contributors to behavioral intention to use the mobile app. The other acceptability constructs were not significant (i.e., $\beta_{\text{effort expectancy}}$=.00; p>.05). The acceptability constructs explained approximately 84% of the variance of behavioral intention.

Table 4. Means and standard deviations of the acceptability of the mobile app based on the Unified Theory of Acceptance and Use of Technology-2 (UTAUT2) among people with cystic fibrosis (N=44), healthcare professionals (N=47), and researchers (N=12).

		Health professionals (N=47)	pwCF (N=44)	Researchers (N=12)	Total sample (N=103)
UTAUT2 overall score		5.63 (0.82)	5.62 (0.82)	5.64 (0.81)	5.62 (0.81)
	Performance expectancy	5.10 (1.45)	5.09 (1.13)	5.00 (1.65)	5.08 (1.33)
	Effort expectancy	6.23 (0.79)	6.14 (0.94)	6.71 (0.49)	6.25 (0.84)
	Social influence	4.84 (1.48)	5.26 (1.31)	4.50 (1.68)	4.98 (1.44)
	Facilitating conditions	6.38 (0.61)	6.28 (0.90)	6.44 (0.87)	6.35 (0.77)
	Hedonic motivation	5.25 (1.06)	5.21 (1.31)	5.22 (1.58)	5.23 (1.22)
	Price value	6.74 (0.58)	6.68 (0.55)	6.78 (0.38)	6.72 (0.54)
	Habits	4.64 (1.32)	4.49 (1.22)	4.50 (1.54)	4.56 (1.30)
	Behavioral intention	5.15 (1.40)	4.86 (1.41)	4.83 (1.73)	4.99 (1.44)
Usage frequency of technology-based PA interventions		3.40 (1.38)	2.84 (1.23)	3.27 (0.88)	3.15 (1.29)
Computer anxiety		1.50 (0.83)	1.48 (0.78)	1.54 (1.05)	1.50 (0.83)

Notes. pwCF people with cystic fibrosis; each item of the UTAUT2 scale was measured using a 7-point scale from: (1) strongly disagree, to (7) strongly agree; usage frequency of technology-based physical activity interventions was measured on a 7-point scale as follows: (1) never, (2) less than once a year, (3) once a year, (4) once a month, (5) once a week, (6) once a day, and (7) several times a day. Computer anxiety was measured on a 5-point scale from: (1) not at all corresponding, to (5) completely corresponding.

A one-way multivariate analysis of the variance revealed no effect of the participant type on the acceptability of the mobile app [Wilks' Λ=.77, F(16, 186)=1.61, p=.069, η_p^2=.12]. Two one-way univariate analyses of variance also showed no effect of the participant type on the usage frequency of similar technologies [F(2, 100)=2.27, p=.11, η_p^2=.04], nor on computer anxiety [F(2, 100)=0.02, p=.98, η_p^2=.00].

Outputs from semi-structured interviews on acceptability of the mobile app

Based on the interview guide, the following three categories were studied: (a) perceptions of the app, (b) perceptions of the interface, and (c) missing functionalities. Examples of verbatim representing these categories are provided in Table 5.

Perceptions of the app. This category covered both positive and negative perceptions of the app. Positive perceptions were cited by 27 participants (i.e., 93% of the total sample) and were divided into six subcategories: (a) monitoring and individualized management of patients (n=11) like the personalized results of the patients according to their responses to the CF-DB-PA questionnaire (quote 1, Table 5); (b) awareness of facilitators and barriers (n=10), such as obstacles and levers to PA, encouraging individuals to reflect deeply on their attitudes, beliefs and experiences related to PA (quote 2, Table 5); (c) reaching a large audience (n=10), as the digital version of the CF-DB-PA can be transmitted remotely and therefore can be delivered to more patients over the same time period (quote 3, Table 5); (d) time-saving and user-friendliness (n=9), expressed in terms of a fluid, intuitive interface and rapid access to essential functions (quote 4, Table 5); (e) increasing motivation to exercise (n=9), noted by the "facilitators" section of the CF-DB-PA presenting a list of the benefits of PA (quote 5, Table 5); and (f) responding to a need (n=7), meaning that there is no other standardized tool for measuring the PA decisional balance in pwCF and, therefore, no other way to personalize physical exercise (quote 6, Table 5).

Negative perceptions of the app were highlighted by 11 participants, and 60% of the participants mentioned the absence of negative perceptions of the app (quote 7, Table 5). Negative perceptions were divided into two subcategories: (a) lack of motivation and perceived constraint (n=8), illustrated by not wanting to complete the questionnaire (quote 8, Table 5), and (b) technological constraint (n=5), such as not being comfortable using digital technologies or not wanting to use them for healthcare purposes (quote 9, Table 5).

Perceptions of the interface. Positive and negative perceptions of the interface emerged. Positive perceptions of the interface were mentioned by 25 participants (i.e., 85% of the total sample). Three subcategories were mentioned: (a) its simplicity and ease of use (n=23), illustrated by quote 10 in Table 5; (b) its design (n=9), particularly the presentation of the results in the form of a balance (quote 11, Table 5); and (c) its intuitiveness and playfulness (n=7), as quote 12 in Table 5 shows.

Negative perceptions of the interface were cited by five participants and consisted of two subcategories: (a) its inappropriate terminology (n=3), with the terms "facilitators" and "decisional balance" being put forward (quote 13, Table 5); and (b) the training required before using it (n=2), particularly to create an account, download results or transmit a questionnaire (quote 14, Table 5).

Missing functionalities. Missing functionalities of the app were identified by 13 patients. These were

classed into four categories: (a) interactions with healthcare professionals (n=7), such as an exchange forum with healthcare professionals (quote 15, Table 5); (b) interoperability with other PA apps (n=3), like step-counting (quote 16, Table 5); (c) addition of PA content (n=2), such as videos, advice, examples of PA sessions (quote 17, Table 5); and (d) contact with sports associations and APA professionals (n=2), for example a map of APA professionals (quote 18, Table 5).

Table 5. Representative quotes of the perceptions of the app, of the interface, and of missing functionalities from healthcare professionals (N=13) and people with cystic fibrosis (N=16).

Themes and categories	Participants	Quotes
Perceptions of the app		
Positive perceptions of the app	N=27	
Monitoring and individualized management of patients	n=11	Quote 1. It can also help to identify any difficulties someone may be having, and so to create something individualized for the patient, something we hadn't really realized we could do. [Physio3].
Awareness of facilitators and barriers	n=10	Quote 2. I find the aspect of identifying biases for each person really interesting. It's quite innovative in terms of everything I've seen, heard or read about in sports and cystic fibrosis. [pwCF12]
Reach a large audience	n=10	Quote 3. I think the application could enable us to offer the tool to more patients, who could do it in their room, even here in the residential unit, without necessarily needing to be with us [...] It would enable, yeah well, more patients to have access to this tool, something that is a bit more limited when we do it on an individual basis. [pwCF19]
Time saving and user-friendliness	n=9	Quote 4. The digital tool would make test-taking a whole lot easier and save us a lot of time, that's for sure! [APA-P5]
Increased motivation to exercise	n=9	Quote 5. Some people will be able to pull themselves up by their own bootstraps, while others will use things like this to pull themselves up. [APAP9]
Responding to a need	n=7	Quote 6. I think it's very good, you even wonder why it wasn't done before. [Nurse16]
Negative perceptions of the app	N=11	
Absence of negative perceptions	n=18	Quote 7. Not at all, no. Really, absolutely not. [pwCF7]
Lack of motivation and perceived constraint	n=8	Quote 8. It's always a bit of a strain to have to answer questionnaires, even if they're not very long. [pwCF6]
Technological constraint	n=5	Quote 9. From time to time we have people here, whether professionals or patients, who are not at all at ease with IT tools. [APA-P24]
Perceptions of the app interface		
Positive perceptions of the app interface	N=23	
Simplicity and ease of use	n=23	Quote 10. Very practical, very clear. It's very well explained [...], so you don't feel lost on the application. [APA-P8]
Design	n=9	Quote 11. And it's easy because we've got the thing with diagrams. It's easier to visualize with graphics and everything rather than with just numbers. [pwCF10]
Intuitiveness and playfulness	n=7	Quote 12. It's a lot of fun. [pwCF26]
Negative perceptions of the interface	N=5	
Inappropriate terminology	n=3	Quote 13. At first, it's quite complicated to understand: the barriers, the figures. It's not difficult, but at first you think: it's not practical. But after a while you get used to it. [pwCF20]
Training required	n=2	Quote 14. It implies, all the same, training for each healthcare professional to say, well, that's what you have to do if you want to add a colleague, if you want to find a patient, and so on. [Physio1]
Missing functionalities	N=13	
Interaction with healthcare professionals	n=7	Quote 15. To have more interaction, to be able to contact, to have a sort of map of nearby health professionals or associations. [pwCF11]
Interoperability with other PA app	n=3	Quote 16. After that, it depends on whether we can link things like watches and the like, so that we can integrate them to get the heart rate and so on. [pwCF15]
Addition of PA content	n=2	Quote 17. Tutorials with perhaps "small recovery programs." Because, in fact, I think that on the whole, people with CF especially need this, I think… I think for myself of small programs to get back on track. [pwCF15]
Contact with sports associations and adapted physical activity professionals	n=2	Quote 18. To have a sort of map of nearby health professionals or associations. [pwCF11]

Final version of the app

The final version of the app was developed by adding features discussed during the semi-structured acceptability interviews. These modifications were either corrections of buggy features (e.g., correcting the display of algorithm attribution of pwCF PA recommendations) or additions of features that did not affect the initial structure of the app and thus did not require a new evaluation of its acceptability (e.g., adding the category "physical therapist" to the healthcare user type, adding a facility for healthcare professionals to search for their pwCF members not yet associated with their account, or deleting existing accounts). This final version was cleaned after user tests and is now operational. The app was named MUCO_BALAD.

Discussion

Main results

Results led to the co-construction of an app named MUCO_BALAD, designed for pwCF 18 years old and over, healthcare professionals, and researchers to monitor the decisional balance for PA in pwCF. It was important to carry out a rigorous evaluation of its acceptability among these individuals to determine whether it would be an acceptable tool.

An essential quality of our study is that the app acceptability was measured by the UTAUT2 integrative model [18]. The results provided by the UTAUT2 questionnaire showed that the acceptability of the mobile app was high (i.e., the scores were mainly above 5) and technological anxiety was low (i.e., mean scores below 2). In addition, no differences were found between the user types (i.e., healthcare professionals, patients and researchers). These results, associated with the high explained variance in usage intention, suggest that the application should be generally well accepted by different types of users.

This was also reflected in the interviews conducted with the 29 volunteer participants, who mainly expressed positive perceptions of the app that paralleled the dimensions of performance expectancy and effort expectancy of the UTAUT2 model. The categories “monitoring and individualized management of patients,” “awareness of facilitators and barriers,” and “reaching a large audience” were consistent with the “performance expectancy” category of the UTAUT2. Similarly, the identified categories “increased motivation to exercise” and “lack of motivation and perceived constraint” were congruent with the UTAUT2 model category “hedonic motivation,” and the category “responding to a need” matched with the “behavioral intention” of the UTAUT2 model.

Likewise, we observed a relationship between the “time saving and user-friendliness” and “simplicity and ease of use” categories with the “effort expectancy” dimension of the UTAUT2 model. Finally, “intuitiveness and playfulness” was consistent with the “habits” category from the UTAUT2, and "missing functionalities" was consistent with the UTAUT2 “social influence” category.

Usage frequency of technology-based PA interventions was moderate for the three types of users, which can theoretically be related to the moderate level of habits from the UTAUT2. Although our results showed that habits were a major determinant of the behavioral intention to use the app, the app is not intended to be used on a daily basis but rather during quarterly check-ups, and therefore this result can be questioned. Similarly, the moderate results obtained in the “social influence,” “habits” and “behavioral intention” categories, and the low results for “usage frequency of technology-based PA interventions,” may be explained by the observation that pwCF patients are over-solicited to complete questionnaires in the context of CF.

Finally, the semi-structured interviews provided an overview of the perceptions of the app, the interface and the missing functionalities for potential future users, following the categories in the interview guide. The fourth part of the guide (i.e., prospects for using a digital app) asked for a general opinion of the app. Subsequently, the interview concluded with a mostly positive evaluation of the app, with only minor difficulties identified. These qualitative results are therefore consistent with the quantitative results.

Limitations

This study nevertheless has a number of limitations. First, only the acceptability of the app was measured with a narrated video showing and explaining the different app functionalities. It would be interesting to assess its usability [29] in another study by actually testing the app. A high level of usability is associated with people's commitment to taking charge of their health and, therefore, being more successful in achieving their objectives in terms of disease management and health promotion [30]. Measuring acceptability and usability are two distinct but related concepts in the design and evaluation of digital apps. Acceptability focuses on users' overall perception of the app, while usability focuses on ease of use and performance. Both aspects are important for the success of a digital app, as it must be accepted by users and be easy to use in order to meet their needs.

Another limitation was the lack of elements that would have made the app usable on a regular basis. In practice, the app is designed for quarterly and annual visits, which leads to limited use. One

suggestion put forward by several professionals and pwCF would be to integrate PA content (e.g., tutorials, advice, examples of sessions), as well as ways of exchanging information with healthcare professionals and patient associations specializing in PA.

Participation in the semi-structured acceptability interviews was voluntary. A selection bias may therefore have occurred, with more participants with positive perceptions participating in these interviews. In addition, the interview coding was performed by one researcher. Although all coding was checked by two other researchers, some recommendations are in favor of double coding.

Comparison with prior work

This digital app for pwCF is consistent with the current development of technological support tools in the healthcare sector. A recent study have also sought to measure the acceptability of digital health applications for people with chronic obstructive pulmonary disease [31]. The results show positive acceptability on the part of these two vulnerable populations for the use of digital health applications.

In the same way, other recent studies have examined the effectiveness of a mobile app based on the transtheoretical model to encourage people with chronic illnesses [32] to adopt healthy lifestyle behaviors (i.e., physical activity, healthy eating). Results showed that participants using the app reported significant improvements in all areas of healthy living behaviors compared to those who received standard care. These studies suggest that digital apps based on decisional scales can be effective in promoting behavior change in a variety of contexts and for a variety of health behaviors. We can therefore expect that this app would be effective to promote PA in CF, although further research is needed.

Conclusions

This paper presents the various stages in the development of an app for PA promotion in the context of CF and reports on the measures of its acceptability to pwCF, healthcare professionals and researchers specializing in CF. The qualitative and quantitative results are encouraging regarding the use of this digital tool for measuring the decisional balance in PA specific to pwCF in the targeted population, namely healthcare professionals, pwCF and researchers.

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Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request. They are not made publicly available because the participants were not specifically informed of the publication of the raw data.

Conflict of interest

None declared.

Abbreviations

APA: adapted physical activity

BENVI: environmental barrier

BPHY: physical barrier

BPSYCH: psychological barrier

CF: cystic fibrosis

CF-DB-PA: Cystic Fibrosis Decisional Balance of Physical Activity

FENVI: environmental facilitator

FPHY: physical facilitator

FPSYCH: psychological facilitator

LAMHESS: Laboratoire Motricité Humaine Expertise Sport Santé

PA: physical activity

pwCF: people with cystic fibrosis

UTAUT2: Unified Theory of Acceptance and Use of Technology 2

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Supplementary Files

CONSORT (or other) checklists

COREQ_checklist_analysis of the perceptions of the app.pdf.
URL: http://asset.jmir.pub/assets/918bcb6618e36d3d44e02e5aded186da.pdf

COREQ_checklis_co-design development interviews.
URL: http://asset.jmir.pub/assets/acf4031cc5343c2c01912fdc51648cf1.pdf