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Renal Health: An Innovative Application to Increase Adherence to Treatment Through Self-monitoring for Patients With CKD and Provide Information for the General Population



To the Editor: A growing global public health problem in recent years is chronic kidney disease (CKD), due to its increasing prevalence. Approximately 10% of the general global population currently suffers from CKD.^{1–3} In Brazil, approximately 126,583 patients underwent dialysis in 2017,⁴ and a total of 5929 kidney transplantations were performed in 2017.⁵

CKD treatment, especially dialysis, is recognized for the high demand in care. Adherence to therapy and control of all associated comorbidities is a difficult task for both patients and caregivers. The complex disease context requires a high level of patient involvement and self-care skills.⁶ Improving patient education and awareness is one of the most effective strategies to increase adherence to treatment, although an ideal level of adherence is yet to be realized even in industrialized countries.^{7–9}

The use of technology for health promotion, more specifically the personalized care proposed by the mHealth field (mobile health), offers new opportunities for supporting preventive care and monitoring diseases with the possibility to customize to individual needs. In many societies, public access to technology has been

democratized and is present across the different social classes. According to data from the National Household Sample Survey conducted in Brazil, in 2015, approximately 102.1 million Brazilian inhabitants, aged 10 years or older, accessed the Internet during the survey reference period.¹⁰ We report the design and development of an innovative health application for patients with CKD available on cellular phones, with information and services to support their treatment through self-monitoring, as well as information about kidney diseases and its ways of prevention for the general population.

The proposed tool is an application for use on mobile devices, which we have called “Renal Health,” initially designed for the Android platform, in Portuguese, with free access (already available at the Google Play store: <https://play.google.com/store/apps/details?id=br.unifor.renalhealth>), and a Web-based administration tool, built on the JAVA platform. The brand “Renal Health” was registered and linked to this application in Brazil. This application was developed within the activities of the “Renal Health Project,” a multidisciplinary project from the University of Fortaleza, northeast of Brazil, in partnership with other universities and supported by the International Society of Nephrology, through its Clinical Research Program (approved in the 2017 call).

Initially we have identified the requirements¹¹ based on the target population and patients’ responses during the interviews and the researchers’ experience, and the basic needs, established during the meetings together with the information technology team, which would meet the assessed requirements, such as: information on CKD and treatment, calculation of the glomerular filtration rate, weight-management calculators, nutritional guidelines, and medication and consultation day alerts, among others. The complete requirement’s list is available on request.

After establishing the requirements, defining the functionalities that would be developed, the first screen interfaces that comprise the application were drawn and widely discussed in meetings with the multidisciplinary team. Based on the prototypes generated in the previous stage of the technological artifact design and development, the interactive version of the Renal Health application was developed with several functionalities for individuals without a CKD diagnosis and patients with CKD undergoing renal replacement therapy, in the hemodialysis and transplantation modalities, as summarized in Table 1.

For individuals without a CKD diagnosis, sessions were developed with contents on disease definition, signs and symptoms, preventive measures, causes, treatment, and frequently asked questions, as well as a risk stratification questionnaire and glomerular

Table 1. Functionalities of the Renal Health application

Public	Functionalities	Explanation
General population	Information Tests	About kidneys: What are the kidneys Which are the main functions of the kidneys What is chronic kidney disease (CKD) Main causes Main symptoms Treatment How to prevent CKD Frequent doubts No examinations: Hydration test Questionnaire of CKD risk With examinations: Calculator of glomerular filtration rate
Hemodialysis patient	Treatment Agenda Informations Nutritional Table	Fluid control Weight control Examinations History Medications Examinations Medical appointments General About treatment Stay tuned Amount of phosphorus in food Amount of potassium in food Amount of sodium in food
Kidney transplantation patients	History Agenda Information	Creatinine Blood pressure Blood glucose Weight Medications Examinations Medical appointments Stay tuned: Signs and symptoms of infection and rejection Recommendations: About medication General Nutritional Frequent doubts

filtration rate calculator. Functionalities were developed to help patients self-monitor their hemodialysis and kidney transplant treatments, in relation to medication needs, for example, dialysis patients generally need a large number of pills each day¹² and non-adherence to drug therapy is a common problem among renal transplantation patients.^{13,14} Therefore, due to the frequent occurrence of this attitude and its important effects on prognosis, strategies to stimulate adherence, such as usage of the Renal Health application, need to be implemented. Researchers have concluded that the main strategies for drug therapy adherence among renal transplant recipients were pill counting, reminders, and alarms.¹⁵ To reach the final version of the application, we have conducted an interactive process, with researchers, patients, and health care providers in the field of nephrology, through which we have discussed patients’ needs,

Table 2. Patients' responses to the tasks asked during the usability test of the Renal Health application

	Very hard	Hard	Normal	Easy/very easy
• Level of difficulty to login to the application		2	2	6
• Level of difficulty to register information regarding the amount of water you can drink per day			6	4
• Level of difficulty to change the daily limit of water amount you can drink per day		1	2	7
• Level of difficulty to calculate your weight	1	1	5	3
• Level of difficulty to register a laboratory test result		1	7	2
• Level of difficulty to search for information about your last 2 registered body weights		5	1	4

presented a preliminary version of the applications, and then proceeded to the suggested modifications to get to the final version of the application that was launched in the virtual stores. Detailed information about the creation process of the Renal Health application is available in the supplementary material.

The usability test of the application was performed with patients and health care providers, and it is a different test for patients and professionals. Although patients are asked to use the application, performing some tasks, health care providers are asked to evaluate the functionalities of the application and give their opinion about the adequacy for patients regarding its contents, its language, and so forth. The first system usability test was conducted with 10 patients with CKD, aged between 19 and 47 years (mean 32 years, SD = 10.2). Of these patients, 4 were college graduates, 2 were high school graduates, 2 had not finished high school, and 2 had not finished elementary school. Before beginning the test, all participants signed the free and informed consent form. The test consisted of performing 7 tasks that have greater relevance in the application. Soon after the evaluation, the users were asked to complete a form with their impressions about the software and questions about the degree of difficulty when performing the respective tasks in the application. Most patients classified the questions as "normal," "easy," and "very easy." Table 2 summarizes the responses of the tasks that patients were asked to complete during the usability test of the application.

The test with specialists in nephrology was performed in the computer laboratory of University of Fortaleza. Six professionals attended the test, including a nutritionist, psychologist, 2 nurses, and 2 nephrologists, all working in the respective field for more than 5 years. After the presentation, guests were asked to log in to conduct the evaluation and to complete a form regarding the objectives, structure, functionality, and relevance of the application. The specialists made

Table 3. Results of the tests of the Renal Health application with specialists (health care providers)

Tasks ^a	Mean index
Language is compatible with patients	1
Information/Contents are adequate	0.83
Functionalities are adequate	1
The application can promote behavioral changes regarding adherence to treatment	1
The application can be publicized to the nephrology community	0.83
The content is motivating and encourages patients to navigate in the application	1
The application is adequate to guide patients and the general population regarding chronic kidney disease	0.83
The scientific information presented is correct	1
The material is appropriate regarding sociocultural aspects of the population	1
The content and messages are attractive	1
The illustrations (images) are adequate	1
The colors are adequate	0.83
The size of the fonts is adequate	0.66
The amount of information is adequate	1
The material presents the necessary contents regarding chronic kidney disease	1
The material presents the necessary contents regarding hemodialysis	0.83
The material presents the necessary contents regarding kidney transplantation	1
The material is adequate to help health care providers to educate their patients	0.83

^aContent Validity Index.¹⁶

comments and suggestions that were useful for the evaluation of qualitative analyses. Of all the application assessments, only 3 showed a Content Validity Index below the threshold level of 0.78, and those were related to the font size, text size reduction, and content adequacies to improve users' understanding. All the other items had a higher Content Validity Index, which is considered high.¹⁶ The positive approval percentage was 89.6%. The results of the tests with specialists are summarized in Table 3. The main screens of the Renal Health application can be seen in the supplementary material (Supplementary Figure S1).

Besides the innovative character of the tool, our study was conducted in a multidisciplinary approach, with a team of professionals from diverse fields involved in the designing of the application. The development of mHealth applications, such as Renal Health, represents a new approach for health care systems, as they face difficulties regarding resource scarcity, health management, and the growing demands of patients with chronic conditions in low- and middle-income countries. According to Levine *et al.*,¹⁷ mHealth applications can solve the disparities in access to health services and shortage of human resources, along with inadequacies of health care infrastructure and limitations in financing. Future studies are needed to investigate the clinical outcomes of hemodialysis patients and renal transplant recipients continuously

using the Renal Health application and to explore whether using this technology is associated with a reduction in CKD treatment problems and its associated complications. We will conduct a study to investigate if use of this application increases patients' adherence to treatment and consequently decreases complications (in patients on hemodialysis and after renal transplantation). By now we have information that hundreds of patients have already downloaded the application in all the regions of Brazil.

In summary, the first version of the Renal Health application was assessed positively by patients with CKD and by experienced professionals in the area. The need for some application modifications was identified, aimed at improving it by making it easier to use. These modifications have been incorporated into the latest versions. Technological advancements offer opportunities for screening new cases of CKD in the general public, achieving early diagnosis and periodic follow-up of patients with underlying diseases. We believe that using the Renal Health application can be an important tool for providing knowledge on CKD control not only to patients with CKD, health care professionals, family members, and caregivers of patients with CKD, but also to the general population.

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DISCLOSURE

All the authors declared no competing interests.

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SUPPLEMENTARY MATERIAL

Supplementary Methods.

Figure S1. Renal health application's main screens.

Supplementary material is linked to the online version of the paper at www.kireports.org.

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