



VALIDATION OF RENAL TEST MOBILE APP

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**ABSTRACT**

Mobile applications are important tools used in contemporary medicine to facilitate access to information and improve health care. The aim of this research was to develop and validate a mobile application (app) on laboratory tests in chronic kidney disease (CKD). The content of the app was developed based on an updated review of the main guidelines on CKD. Validation was carried out by judges (nephrologists and general practitioners), using questionnaires that assessed the content, comprehension, language and graphic presentation of the app. Cronbach's alpha coefficient was used to analyze the internal consistency of the questionnaires, and the Content Validity Index (CVI) was used to assess physicians' agreement on aspects of the app. The value adopted for the CVI was greater than 80%. It was concluded that the reliability of the answers to the questionnaires was good and there was excellent agreement between the judges on aspects of the app.

**KEYWORDS :** Renal Insufficiency, Chronic. Laboratory Test. Mobile Applications. Validation Study

**INTRODUCTION**

Chronic kidney disease (CKD) is a growing public health problem that affects more than 800 million people worldwide<sup>1</sup>. According to the World Health Organization (WHO), kidney disease is among the ten leading causes of death<sup>2</sup>, and CKD is more prevalent in older individuals, women, racial minorities and in people with diabetes mellitus and systemic arterial hypertension<sup>3</sup>. New possibilities to help diagnose and monitor diseases have emerged through advances in technology. Among these technological products are mobile applications, which have been continuously used as a method to improve the management and self-management of patients with chronic diseases, representing a significant potential for improving the health of the population<sup>4</sup>.

Therefore, the aim of this study was to develop and validate a mobile application (app) for general practitioners on basic aspects and laboratory routine in the different stages of CKD.

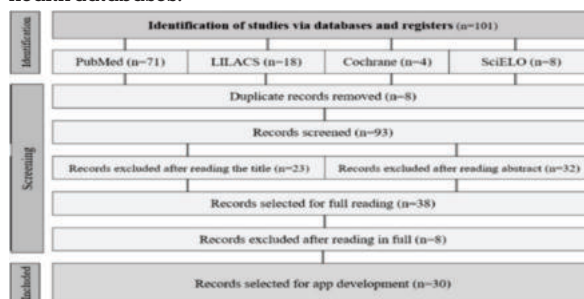
**METHODS**

Study was approved by the Ethical committee of the Dr. José Antônio Garcia Coutinho School of Medical Sciences. Informed consent was obtained from all participants. The research is a technological production, based on software engineering, developed in 4 stages. The first stage consisted of a literature search in the main health sciences databases. For the eligibility of the articles that provided the content for the app, the inclusion criteria were the presence of one or more of the keywords "chronic kidney disease", "laboratory tests", "mobile applications", "clinical laboratory techniques", "general practitioner" and "validation study". Exclusion criteria included duplicate articles, not having one or more keywords in the title, abstract and full text that were not aligned with the study's objectives. The Ministry of Health's "Clinical Guidelines for the Care of Patients with CKD" were used for guidelines on patient management and follow-up<sup>5</sup>. The second stage involved the construction of the app by an Information Technology (IT) professional, encouraged by the literature review carried out by the researchers. The app was developed with the aim of guiding general practitioners on which laboratory tests should be ordered in the different stages of CKD and when, according to the guidelines, the patient should be referred to a specialist. The third stage was

the validation of the app by nephrologists (specialists) and general practitioners. Studies propose that the ideal number of judges for content validity research should be between six and twenty<sup>6</sup>. To validate the app, a questionnaire was developed to be answered by nephrologists and general practitioners. The questionnaire was divided into two parts: the first was about the characteristics of the doctors and the second was about the evaluation of the app. Regarding the app, the questions assessed the content, comprehension, language and graphic presentation. The answers to the questions about the app followed the Likert scale model. At the end of each question there was a space for comments and suggestions from the participants. In the fourth stage, which took place after the app had been validated and adapted with the relevant suggestions, the software was registered and implemented for use. The answers to the questionnaires were analyzed using the Content Validity Index (CVI), which indicates agreement on aspects of the app. The value adopted for the CVI was greater than 0.80<sup>7</sup>. Cronbach's Alpha Coefficient was used to analyze the reliability of the survey questionnaires<sup>8</sup>.

**RESULTS**

Figure 1 shows the flowchart for selecting articles to develop the app on laboratory tests in CKD, adapted from the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA)<sup>10</sup>. One hundred and one articles were identified in national and international journals in the main health databases.



**Figure 1:** Flow diagram of the records for the development of the mobile

application "Renal Teste" for laboratory tests in chronic kidney disease. Adapted from Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).

Based on an algorithm created with the information provided by the literature review, a prototype of the mobile application (app) was developed by an Information Technology professional. Initially, it was developed as a WebApp, i.e. with access via a URL in the browser of any cell phone, to later migrate to the Android and IOS platforms. The language used in the development was Javascript, along with the React Native library, which makes it possible to develop hybrid applications natively, which can be used for both Android and IOS, in a fluid and performant way. To make up the app, a design professional created a logo combining the images of an Erlenmeyer flask and a kidney. The name "Renal Teste" was chosen because it is a simple combination, which makes it easier to find in WebApp search engines and app stores. The app has four bars on its home screen: "Chronic Kidney Disease", "Calculators", "Laboratory Tests" and "About the App". It allows the user to successively access general and relevant information about CKD; the main glomerular filtration rate calculators for staging the disease; the laboratory tests recommended in the different stages of CKD and their frequency of performance, as well as specific characteristics of each test such as definition, material used, patient preparation, methods used, reference values, periodicity and interfering factors (Figure 2).



Figure 2: Initial screen and laboratory tests of the mobile application "Renal Teste", WebApp version. <https://renalste.vercel.app/>

To validate the app 9 nephrologists and 13 general practitioners answered the questionnaire. Fifty-five percent of the nephrologists and 54% of the general practitioners were female, with a median age of 40 (range: 35-71) for the nephrologists, and 45 (range: 30-50) for the general practitioners. The median length of training in medicine was 17 years (range: 8-31) for nephrologists and 11 (range: 5-23) for general practitioners. Table 1 shows the Cronbach's alpha coefficient and the CVI for validation of the app by nephrologists. Table 2 shows the Cronbach's alpha coefficient and the CVI for validation of the app by general practitioners.

Table 1- Cronbach's alpha coefficient and the CVI for validation of the app by nephrologists (n=9).

Questions/Answers	Cronbach' alfa	CVI
Graphic presentation	0,79	0,78
App layout	0,80	1,00
Information flow	0,81	1,00
Update	0,78	0,89
Relevance of CKD	0,81	1,00
About CKD	0,78	0,89
Risk factors for CKD	0,81	1,00
CKD staging	0,81	1,00
Laboratory tests at CKD	0,80	1,00
About laboratory tests	0,80	1,00
Global Values	0,80	0,96

CVI: Content Validity Index      CKD: chronic kidney disease

Table 2- Cronbach's alpha coefficient and the CVI for validation of the app by general practitioners (n=13).

Questions/Answers	Cronbach' alfa	CVI
Graphic presentation	0,89	0,92
App layout	0,91	0,92
Information flow	0,94	0,92
Update	0,91	0,92
Relevance of CKD	0,91	1,00
About CKD	0,91	0,77
Risk factors for CKD	0,91	1,00
CKD staging	0,91	0,89
Laboratory tests at CKD	0,89	1,00
About laboratory tests	0,89	0,92
Global Values	0,91	0,92

CVI: Content Validity Index      CKD: chronic kidney disease

The nephrologists made a total of 10 suggestions for the app, of which four were fully accepted and six were not in line with the objectives of the study. Some questions received no suggestions and others received more than one. The suggestions that were accepted were: on the graphic presentation, it was suggested that "the results of the calculators be placed in a larger font"; on the content, there were three suggestions: "make it clear that the albumin creatinine ratio is measured in urine", "replace the word "label" with "leaflet", "emphasize that the general practitioner should refer the patient to the nephrologist when the CKD stage is 4 or 5". The general practitioners made three suggestions, all related to content, and the researchers accepted the suggestion to include the Sanaka formula for calculating glomerular filtration rate in frail elderly patients. After validation by the judges and adjustments made by an Information Technology professional, a version of the application for mobile devices with no apparent errors was registered with the National Institute of Industrial Property (INPI), Brazil.

DISCUSSION

The development and validation of mobile applications for the management of CKD have proven to be a promising approach to improving patients' self-care, providing treatment support and increasing the effectiveness of medical monitoring<sup>10</sup>. However, it is essential that these applications are well developed and validated to ensure their effectiveness and safety. Both development and validation must be based on solid scientific evidence, which includes internationally recognized treatment guidelines and clinical recommendations. It should be considered that adherence to clinical guidelines in the design of mobile applications results in a safer and more effective approach to the management of CKD<sup>11</sup>.

In this study, the careful selection of bibliographic references was fundamental for the development and validation of the app and aimed to ensure the accuracy and reliability of the information to guarantee safety for users and the effectiveness of the proposed information. The use of references based on well-conducted, peer-reviewed scientific studies was crucial to ensure that the information included in the app was based on solid evidence<sup>12</sup>. Diaz-Skeete et al.

(2021) in their research emphasizes that the use of high-quality scientific evidence is essential to provide accurate and updated information to users of digital technology, especially in the medical field<sup>13</sup>.

Some mobile applications, whose users are patients with CKD, were developed with educational objectives and are aimed at monitoring health conditions, providing information

about treatment and promoting self-care. Most of these apps offer resources that address issues such as dietary guidance, medications, comorbidities and disease progression<sup>14</sup>. Validated software aimed at general practitioners working in primary health care is rare in the literature and mobile application platforms. When developing the "Renal Teste" app, the researchers created an introduction to CKD and focused on laboratory tests that are important for the diagnosis and monitoring of patients, within the scope of primary health care.

Validation by nephrologists involved a careful analysis of the accuracy of the information provided by the app on the clinical aspects of the disease and, mainly, on the laboratory tests to be carried out in the different stages of CKD. Experts must ensure that guidance on treatment, laboratory tests and relevant aspects of CKD are in accordance with updated clinical guidelines<sup>15</sup>.

In accordance with nephrologists' suggestions, the graphical presentation of the app underwent a review and improvement in the interface of the glomerular filtration rate calculators. The advantages of improving the interfaces of a mobile application are significant and can result in a more positive experience for users, greater engagement, satisfaction and efficiency in using the software<sup>16</sup>.

Monitoring patients with CKD within the scope of primary health care aims to track and delay the progression of CKD and, when necessary, the patient should be referred to a specialist. Educational measures for primary care professionals aim to assist in training to diagnose CKD efficiently and appropriately refer patients at the correct time<sup>17</sup>.

Registration with the INPI grants the registration holder(s) the legal right to commercially exploit the app, in addition to preventing third parties from using, copying or distributing the app without authorization. Although the "Renal Teste" app has no commercial purpose, as it will be made available free of charge to all general practitioners in Brazil, the purpose of registration was to give credibility to the app, which indicates that the product was recognized as original and exclusive by the competent authorities<sup>18</sup>.

## CONCLUSIONS

The *Renal Teste* mobile application was validated by expert judges (nephrologists) and general practitioners, to be used by them in the context of primary health care.

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