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Benchmarking of mobile apps on heart failure

Benchmarking de aplicativos móveis sobre insuficiência cardíaca

Benchmarking de aplicaciones móviles sobre insuficiencia cardíaca

Virna Ribeiro Feitosa Cestari[I]
ORCID: 0000-0002-7955-0894

Raquel Sampaio Florêncio[I]
ORCID: 0000-0003-3119-7187

Thiago Santos Garces[I]
ORCID: 0000-0002-1670-725X

Vera Lucia Mendes de Paula Pessoa[I]
ORCID: 0000-0002-8158-7071

Thereza Maria Magalhães Moreira[I]
ORCID: 0000-0003-1424-0649

[I] *Universidade Estadual do Ceará. Fortaleza, Ceará, Brazil.*

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Corresponding author:
Virna Ribeiro Feitosa Cestari
E-mail: virna.ribeiro@hotmail.com

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ASSOCIATE EDITOR: Alvaro Sousa

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ABSTRACT

Objective: to analyze the mobile apps on heart failure available in the main operating systems and their usability. **Methods:** benchmarking of mobile applications, systematic research, comprising 38 mobile applications for analysis of general information, functionalities and usability. Usability was assessed using System Usability Scale and Smartphone Usability Questionnaire, followed by the calculation of the agreement index and the exact binomial distribution test, with a significance level of p> 0.05 and a proportion of 0.90. **Results:** mobile applications had English as the predominant language (73.7%), were directed to patients (71.1%) and the predominant theme was disease knowledge (34.2%). Functionalities ranged from general features to the need for an internet connection. In assessing usability, heart failure was shown to be 92.1% -94.7% and p <0.05. **Final considerations:** the mobile apps on heart failure have varied content and adequate usability. However, there is a need to develop more comprehensive mobile applications.

Descriptors: Heart Failure; Mobile Applications; Telemedicine; Health Promotion; Diffusion of Innovation..

RESUMO

Objetivo: analisar os aplicativos móveis sobre insuficiência cardíaca disponíveis nos principais sistemas operacionais e sua usabilidade. **Métodos:** *benchmarking* de aplicativos móveis, pesquisa sistemática, contemplando 38 aplicativos móveis para análise das informações gerais, funcionalidades e usabilidade. A usabilidade foi avaliada por dois instrumentos: *System Usability Scale* e *Smartphone Usability Questionnaire*, seguido do cálculo do índice de concordância e teste exato de distribuição binomial, sendo o nível de significância p>0,05 e proporção de 0,90. **Resultados:** os aplicativos móveis tiveram o inglês como idioma predominante (73,7%), eram direcionados aos pacientes (71,1%) e com temática predominante o conhecimento da doença (34,2%). As funcionalidades variaram de recursos gerais à necessidade de conexão com a *internet*. Na avaliação da usabilidade, mostraram-se insuficiência cardíaca interrevisores de 92,1%-94,7% e p>0,05. **Considerações finais:** os aplicativos móveis sobre insuficiência cardíaca possuem conteúdo variado e usabilidade adequada. Contudo, há necessidade de desenvolvimento de aplicativos móveis mais abrangentes.

Descritores: Insuficiência Cardíaca; Aplicativos M*óveis; Telemedicina; Promoção da* Saúde; Difusão de Inovações.

RESUMEN

Objetivo: analizar las aplicaciones móviles sobre insuficiencia cardíaca disponibles en los principales sistemas operativos y su usabilidad. **Métodos:** benchmarking de aplicaciones móviles, investigación sistemática, contemplando 38 aplicaciones móviles para análisis de información general, funcionalidades y usabilidad. La usabilidad se evaluó mediante dos instrumentos: System Usability Scale y Smartphone Usability Questionnaire, seguido del cálculo del índice de concordancia y la prueba de distribución binomial exacta, con un nivel de significancia de p>0.05 y una proporción de 0.90. **Resultados:** las aplicaciones móviles tuvieron el inglés como idioma predominante (73,7%), fueron dirigidas a pacientes (71,1%) y con un tema predominante el conocimiento de la enfermedad (34,2%). Las funcionalidades iban desde características generales hasta la necesidad de una conexión a Internet. En la evaluación de usabilidad, se demostró que la insuficiencia cardíaca era del 92,1%-94,7% y p>0,05. **Consideraciones finales:** las aplicaciones móviles sobre insuficiencia cardíaca tienen un contenido completo y una usabilidad adecuada. Sin embargo, es necesario desarrollar aplicaciones móviles más completas.

Descriptores: Insuficiencia Cardíaca; Aplicaciones Móviles; Telemedicina; Promoción de la Salud; Difusión de Innovaciones.

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INTRODUCTION

Heart failure (HF) is an emerging global threat, with a current prevalence of 64.34 million cases on the planet (8.52 per 1,000 inhabitants), representing 9.91 million years lost due to disability and spending of US$346.17 billion[1], with a prospect of an increase despite therapeutic advances. These data alert to the prioritization of preventive actions and {the imminence of considering new ways of care.

In order to facilitate the process of caring for people with HF, mHealth technologies, such as mobile applications (APP), stand out. In recent years, the number of APPs has increased exponentially in the most varied areas and has contributed to increase productivity and quality of health care, in addition to allowing the use of the most up-to-date clinical knowledge and supporting the clinical decision-making of professionals[2-3]. When undertaken in the care of patients with HF, APPs contribute to survival and improved quality of life[4-6].

After creating an APP, it is necessary to evaluate its content and functionality, to ensure the launch of a product suitable for the target audience. The development demands an understanding of functionalities and previous knowledge of APP already built for the theme. In this process, benchmarking is a technique that allows assessment of performance and results of this technology, analyzing, conclusively, whether they are positive or negative[7].

The evaluative concern was observed in studies that reviewed self-care APP for patients with HF[8-9], which corroborate that the existing ones are incomplete, of low quality, with bugs and unsuitable to the target audience, having little impact in disease management, in addition to excluding professionals and family members/caregivers. Still, they address only self-care, an important element in the complexity of a person with HF[10], but not the only one.

The need to expand the review of APPs is highlighted, to cover all content and resources produced about HF and to involve all participants in the care process. Thus, it was proposed a systematic survey of all APPs about HF currently available in the virtual stores Play Store and App Store, aimed at patients and their families/caregivers and health professionals. Investigating its functionality and usability is essential to maximize its potential health promoter.

OBJECTIVE

To analyze the mobile apps on heart failure available in the main operating systems and their usability.

METHODS

Ethical aspects

This study did not require prior approval from an Institutional Review Board. Even so, the researchers' ethical commitment is reiterated, as recommended by Resolution 466/12 of the Brazilian National Research Council (*Conselho Nacional de Saúde*).

Type of study

This is a benchmarking of mobile applications, a systematic survey that sought to identify all the APPs about HF and their usability in the main operating systems.

Methodological procedures

In order to systematize the data collection for conducting benchmarking, the steps of the Preferred Reporting Items for Systematic Reviews and Meta-Analyzes (PRISMA) checklist were followed. The steps taken were: 1) establishment of analytical objectives; 2) choice of terms; 3) enumeration of APP inclusion/exclusion criteria; 4) definition of information to be extracted; 5) analysis of results; 6) presentation of results and discussion.

Initially, the objectives of analysis were established: to identify APP over HF, download, analyze content and functionalities and classify them according to usability. The search was made easier with the use of heart failure terms.

APPs were included in the survey in any language that covered the HF theme and excluded if 1) required payment for installation, 2) needed author release for use (registration number and password), 3) were intended for event monitoring/scientific conference, 4) contained only books or guidelines, 5) acted as general health calculators, unspecific for HF and 6) provided only vital signs.

Data source

Searches for APPs were carried out in the Play Store and App Store virtual stores of iOS (Apple) and Android (Google) operating systems, respectively.

Data collection and organization

Two independent reviewers performed the screening of APPs in virtual stores. For this, three devices were used: a Samsung Galaxy S8, compatible with Android; an iPhone XS Max and an iPad Pro, version iPadOS 13.5.1, compatible with iOS.

Four searches were carried out in each virtual store, using each of the previously established terms individually. After the research, the APPs were previously selected via title and short description. This screening served to separate most APPs on cardiac health, in a generalized way. APPs that met the inclusion and exclusion criteria were downloaded and analyzed.

Each reviewer organized the APPs in an information matrix in Microsoft Excel®, with description of identification (name, developer, author (s) responsible, year of launch, language, country of origin), target audience (patient, family/caregivers and students or health professionals), APP data (description, current version, number of downloads, rating/evaluation), content, features (features) and usability.

Draft of the data extraction tool was modified and revised, as needed, during the data extraction process for each included APP. Additional information and comments were recorded individually for further analysis.

APPs were tested for two weeks, as some needed control for a minimum period of one week to provide data (graphs) to users. At the end of that period, the researchers felt safe to collect the data and assess its usability.

Data analysis

The two independent reviewers carried out usability assessment mediated by two instruments. The first was the System Usability Scale (SUS) questionnaire, created by John Brooke, in 1986, and validated in Brazil by Tenório[11]. The SUS questionnaire is used to evaluate products, services, hardware, software, websites and applications. It consists of ten questions and, for each one, users can answer on a scale of 1 (I strongly disagree) to 5 (I strongly agree).

For usability calculation, 1 is subtracted from the score for odd answers, and for even answers, the answer is subtracted from 5. To obtain the final average, multiply the value found by 2.5, which will give the final score (between 0 to 100). The SUS average is 68 points; below this value, the product has usability problems. Software that scores above 85 has excellent acceptance by users[12].

The second questionnaire was version 1.0 of Smartphone Usability questionnaiRE (SURE), built and validated by Wangenheim et al.[11] after an exhaustive systematic literature review and the use of Item Response Theory (IRT) for the construction of its items. This questionnaire has 31 items and measures the usability of a smartphone APP at levels ranging from 30 (all respondents are more likely to disagree partially or totally with the items) to 80 (respondents begin to fully agree that the help/tip given by APP was helpful)[13].

The variables contained in the information matrix were analyzed and, when necessary, described using absolute and relative frequencies. To calculate the percentage of agreement between reviewers, the Agreement Index was adopted, considering an acceptable agreement rate of 90%[14]. An exact test of binomial distribution was performed, indicated for small samples, with a significance level of p> 0.05 and a proportion of 0.90 of agreement, to estimate the statistical reliability of HF. Discrepancies in relation to the score were resolved through critical discussion among the reviewers.

RESULTS

The search resulted in 328 APPs, 250 in the Play Store and 78 in the App Store. After analyzing their titles, description of content and excluding duplicates, 316 were screened. After excluding those not related to the theme, 59 were selected for download and installed for complete evaluation. The APP selection process was described in Figure 1.

At the end, 38 APPs were analyzed. Figure 2 shows the APP logos, named, horizontally, from left to right: MyHeartAPP, CardioCALC, *Insuficiencia Cardíaca*, WOWME 2000, LifeCourse HF, Medly for Heart Failure, CardioExpert I, Heart Failure Manager, CardioSmart Heart Failure Explorer, Heart Failure-AZ Discussions, 3C-HF Score Calculator, Leben mit Herzinsuffizienz, LifeCurse Companion, Patient Education Atlas of Heart Failure, Rajan's HF (R-hf) Risk Calculator, FAQs Heart Failure, Cardiac Care Plan, Slabe Serce, CV Risk Prognostic Model iCerca, ICFEP, iCAPP, HF Log, Cardiac Nursing Care Plans, CardioEnf-IC, Heart Failure, Heart Failure Info, Heart Failure Storylines, Clinical Cardiology, HF Path, CardioMed, CardioVisual, CaPriMur, ADHF/NT-preBNP Risk Score Calculator, HF Buddy, TreatHF, MED-HF, and Systolic Heart Failure.

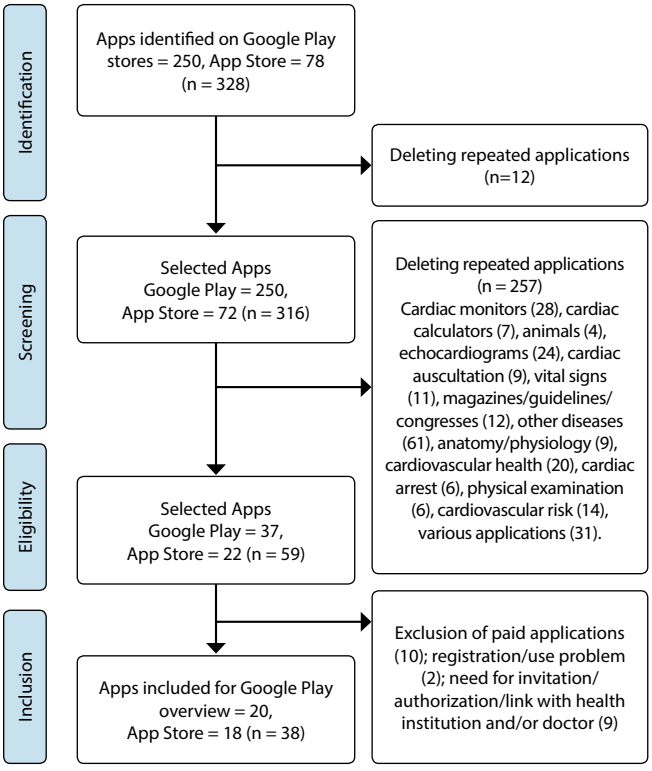

Figure 1 - Flowchart for selecting applications from selected virtual stores

Figure 2 - Logos of the selected applications

The first APPs developed for patients with HF were launched in 2012 (2; 5.4%). After 2013, there was a continuous increase, with a higher number launched in 2018 (11; 28.9%) and, as of 2018, there was a reduction in launches. With regard to the country of origin, the United States concentrated the largest number of APPs, with 13 (34.3%), followed by Spain (4; 10.6%), Canada and Brazil (3; 7.9%), Italy, United Kingdom and India (2; 5.3% each), France, Germany, Singapore, Netherlands, Kuwait, Russia, Indonesia, Nigeria and Poland (1; 2.6% each). Despite the variety of countries, English was the predominant language (28; 73.7%),

followed by Spanish (4; 10.6%), Portuguese (3; 7.9%), and French, German and Polish, with one (2.6%) each.

The themes (descriptions/objectives) were diverse and included knowledge (educational), self-care (management, self-management, monitoring and recognition of signs and symptoms and recording of physical activities), decision-making (choice of treatment and assistance guides), follow-up of patients (professional follow-up at the outpatient clinic and follow-up by the multidisciplinary team after hospital discharge), calculators for patients with HF (diagnosis, complications, prognosis and mortality/hospitalization) and Systematization of Nursing Care (care plans) (Table 1) .

APPs were targeted at health professionals, students and patients and their family members/caregivers. Among health professionals, two (5.3%) were specific to primary care physicians and four (10.6%) to nurses. Three (7.9%) APPs were also directed to university students in the health field and only two (5.3%) included family members/caregivers, although many patients with HF need their support to carry out their daily care.

The theme of knowledge was explored in 13 (34.2%) APPs; the themes of self-care and decision-making were found in seven (18.4%) each; six (15.8%) APPs were developed to prepare calculations for patients with HF; three (7.9%), for patient follow-up; two (5.3%) brought the Systematization of Nursing Care.

Table 1 - Characterization of selected applications in Google Play (Android) and App Store (Apple) stores

Application	Language	Description/Objective	Target audience	Version	Stars / ratings	Downloads
MED-HF	English	Support and guide health professionals on the use of medications and recommend appropriate actions and considerations for treatment;	Health professionals	2.1	NI[c]	NI
iCerca	Spanish	Help patients to recognize signs and symptoms and manage their disease;	Patient	1.1	NI	NI
HF Buddy	English	Empower patients with knowledge for self-management;	Patient	1.1	1.0/2	NI
LifeCourse Companion	English	Screen patients' daily aspects of their disease;	Patient	1.0.46	NI	NI
LifeCourse HF	English	Manage HF[a];	Patient	1.1	NI	NI
Medly for Heart Failure	English	Self-manage, with record of symptoms and real-time feedback on health status;	Health professionals and patients	1.4.0	4.0/9	NI
MyHeartAPP	English	Screen and share with your healthcare professional the HF status;	Patient and health professional	1.14	3.6/7	NI
WOW ME 2000mg	English	Help patients learn and perform their daily self-management tasks;	Patient and family member/caregiver	1.1	4.0/3	NI
CV Risk Prognostic Model	English	Assess mortality and hospitalization;	Health professionals	1.1	5.0/7	NI
Patient Education Atlases of Heart Failure	English	Help health professionals explain about HF in a clearer and more objective way;	Health professionals	1.0	NI	NI
Heart Failure Manager	English	Allow patients to screen and store relevant health information between visits to the doctor;	Patient and health professional	10.5.1	5.0 /2	NI
TreatHF	English	Assist physicians in confirming which therapies are suggested for their patients with reduced ejection fraction and provides guidance on the use of each therapy;	Health professionals	1.1.0	5.0 /2	NI
Heart Failure Storylines	English	Allow the recording of symptoms, vital signs and medications to help patients manage their disease;	Patient	7.17	4.0 /8	> 1,000
HFPath	English	Self-manage, teach how to control and manage symptoms, weight and medication and educate patients to take small steps to improve their quality of life;	Patient	6.1	3.6 /16	> 1,000
HF Log	English	Help patients screen their body weight and physical activity;	Health professionals and patients	1.0	5.0/2	NI
ADHF/NT-preBNP Risk Score Calculator	English	Predict 1-year mortality in patients hospitalized with acute HF and left ventricular ejection fraction below 30%;	Health professionals	1.0	NI	NI
3C-HF Score Calculator	English	Stratify the risk of mortality of patients in one year;	Health professionals	1.1	5.0/1	NI
Systolic Heart Failure	English	Guide treatment according to functional classification;	Health professionals	1.0	NI	NI
CardioCalc	French	Calculate diagnoses of complications of the disease;	Health professionals	1.4.1	4.0/1	> 1,000

To be continued

Table 1 (concluded)

Application	Language	Description/Objective	Target audience	Version	Stars / ratings	Downloads
CardioSmart Heart Explorer	English	Help patients understand their disease;	Patient	2.3.0.	4.5/213	> 50.000
CardioVisual	English	Provide explanations on risk factors, prevention, conditions and treatments;	Patient and health professional	5.1.6	3.6/869	> 100,000
Heart failure	English	Be an educational application;	Patient	1.0	NI	NI
Heart Failure-AZ Discussions	English	Be an educational application;	Health professionals, students and patients	1.0.6	NI	> 1,000
ICAPP	Spanish	Provide simulation algorithms and treatments for care processes;	Health professionals	1.1.0.	3.8/5	> 1,000
ICFEP	Portuguese	Calculate the probability for ICFEP diagnosis[b];	Health professionals	1.0	NI	> 50
Insuficiencia cardíaca	Spanish	Guide medical care in the diagnostic and therapeutic process;	Health professionals (primary care)	0.0.1	4.9/5	> 5,000
Clinical Cardiology	Portuguese	Be an educational application;	Health professionals	1.0	4.4/31	> 5,000
CardioExpert I	English	Calculate prognosis of the disease;	Health professionals	7.6.235	4.9/1.129	> 100,000
CarPriMur	Spanish	Present flowcharts, recommendations and protocols for primary care physicians;	Health professionals (primary care)	1.4.4	5.0/10	> 100
Heart failure	English	Improve patients' knowledge about their disease;	Patients, health professionals and students	3.0	NI	> 10
FAQs Heart Failure	English	Provide answers to many questions of anatomy and pumping function of the heart, HF causes, risk factors, types and symptoms, diagnostic tests, medications, implantable devices;	Health professionals, students, patients and family/caregiver	1.2	4.0/7	> 1,000
Cardiac Care Plans	English	Planning nursing care;	Nurses	1.2	NI	> 100
CardioMed	English	Guide on medicines;	Health professionals	1.3.1	NI	> 1,000
Cardiac Nursing Care Plans	English	Create nursing care plans;	Nurses	2.0	NI	> 500
Slabe Serce	Polish	Increase patient knowledge and awareness;	Nurses and patients	1.0.5	NI	<5
Leben mit Herzinsuffizienz	German	Help patients cope daily with the disease;	Patients	1.13	3.8/5	> 100
Rajan' s HF (R-hf) Risk Calculator	English	Estimate the risk of complications of patients;	Health professionals	2.0	4.8/12	> 100
CardioEnf-IC	Portuguese	Monitor the post-discharge signs and symptoms of HF patients by specialist nurses.	Nurses and patients	1.03	NI	> 10

a = Heart failure; b = Preserved Ejection Fraction Heart Failure; c = Not informed; HF - Heart Failure; ICFEP - Heart Failure with Preserved Ejection Fraction; NI - not identified.

CardioVisual and CardioExpert I had more than 100,000 downloads and were the most evaluated. CardioVisual is aimed at healthcare professionals and patients and is in version 5.1.6; has 3.6 stars out of 869 reviews. CardioExpert I is version 7.6.235, with 4.9 stars out of 1,129 reviews. Other APPs with more advanced versions were Heart Failure Manager (v.10.5.1), Heart Failure Storylines (7.17) and HFPath (v.6.1).

Table 2 discusses information on the content, features, and usability of the selected APPs. The contents covered involved, mainly, habits (physical activity, weight control, feeding and water intake), well-being (living with the disease, mood and cognitive assessment), clinical data (anatomy, pathophysiology of the disease, vital signs and treatment) and disease management (management, post-discharge, multiprofessional follow-up and financial planning).

APPs contained various features: general, data insertion, diagnostics and those that require internet connection to control the management panel. Among the general ones, the use of texts (44.7%), figures (21.1%) and videos (18.4%) was more common. In the data insertion features, users' profile data (15.8%) and clinical data (55.3%). As for the resources that required internet connection, the use of links (4; 10.6%) and sending e-mails to health professionals (4; 10.6%) were more observed.

In the usability analysis by SUS, it was observed that 34 APP (89.5%) scored with a score > 68 points, instrument cutoff score, and 16 (42.1%) score above 85. The agreement rate among the observers was 92.1%, with p>0.05 for all items of SUS. Four (10.5%) APP obtained a borderline score (between 50 and 67 points), but still acceptable. The APP that did not reach the cutoff point were Patient Education Atlas of Heart Failure (50 points), Heart Failure Manager (62.5 points), Systolic Heart Failure (62.5 points) and Clinical Cardiology (52.5 points). Scores below 50 are considered without usability.

Based on SURE, the agreement rate among the observers was 94.7%, with p>0.05. It was found that four (10.5%) APP were at level 30 (Patient Education Atlas of Heart Failure, Clinical Cardiology, Cardiac Care Plans and Cardiac Nursing Care Plans); two (5.3%) at level 40 (Systolic Heart Failure and Heart Failure Info); seven (18.4%) at level 50; eight (21.1%) at level 70; 17 (44,7%) at level 80.

Table 2 - Characterization of selected applications for content, features and usability

Application	Content	Resources	Usability	
			SUS[a]	SURE[b]
MED-HF	Recommendations for initiation, titration, evaluation and monitoring of medicines;	Texts, tables, algorithms and clinical issues;	92.5	75
iCerca	Symptoms, treatments, diagnoses, advice for the control of signs and symptoms and to live with HF, what to do during hospitalization and at discharge, advice to take care of health at home, control vital signs, intake of liquids and weight, and tips on how to prepare for consultation;	Texts, figures, map, questionnaire of knowledge of the disease, sending the responses and result on the spot. Audio option (reading content), educational videos, signals the contents already viewed, enter user information (editable);	100	91
HF Buddy	Definition, causes, diagnosis, treatment, monitoring of symptoms, physical activities, diet and medication;	Text, videos, figures, audio option, allows recording BP, HR, weight, daily liquids, daily exercises and follow by graphics, record medications in use and symptoms (submit to see tips), alarm, provides APP usage guide;	87.5	107
LifeCourse Companion	Medication, quality of sleep, food and well-being;	Video to learn how to handle the APP, record information about sleep, save files, medications in use, lifestyle (diet) - with graphics, diary, quiz (knowledge about the disease), library of medicines;	72.5	87
LifeCourse HF	Symptoms, medications, well-being, functional class and weight;	Registration and reminder of medications, weight, symptoms, daily well-being, HF classification;	72.5	87
Medly for Heart Failure	Symptoms, blood pressure, heart rate, diet, weight, laboratory tests;	Integration with the Health application to read and write your weight, blood pressure and heart rate readings, allows you to enter patient data and informs the doctor, real-time feedback about health, through alert messages generated, allows connection/phone call with the doctor/clinic, direct access to laboratory results, enter data of health professionals (multidisciplinary team);	75.0	96
MyHeartAPP	General information on HF and follow-up by health professionals (symptoms by date, weight, sodium, fluid intake);	Text, charts, stopwatch, daily steps, calendar, symptom list and activity list, enter daily weight, sodium and fluid intake. It makes it possible to filter and classify symptom information by date/symptom (identifies trends and patterns). Sending reports to health professionals by e-mail;	85.0	96
WOW ME 2000mg	Physiological parameters, water intake, physical activity and signs of cardiac decompensation;	Recording weight, heart rate, sodium intake, water intake, number of daily steps, list of medications in use, symptoms, BP, HR, information of professionals who follow them, from the pharmacy, outpatient clinic and emergency, allows to make a phone call to these professionals;	82.5	94
CV Risk Prognostic Model	Prognostic information in outpatients with chronic HF who receive the therapy recommended by the guideline;	Risk calculator and update of tests, register age, blood pressure, heart rate, ejection fraction, creatine, cholesterol, disease time, comorbidities, functional classification and use of ivabradine;	82.5	86
Patient Education Atlases of Heart Failure	Cardiac anatomy and physiology, ejection fraction (preserved and reduced), causes and consequences, signs and symptoms, classification, diagnosis and treatment;	Record the consultation (image and sound), annotate, zoom in and out of the page, send by email (print and save drawings), useful texts for explanatory purposes, 3D illustrations;	50.0	39
Heart Failure Manager	Well-being, mood and quality of life, life habits, levels of difficulties to perform daily activities and cognitive assessment;	Digital diary, insert photo, textual information and links, graphics, allows medical access, allows to compare how patients feel in relation to the previous day, manage medications and treatments, screen symptoms and specific side effects, option to print the graphics, allows to connect with the multidisciplinary team;	62.5	71
TreatHF	Evaluation parameters of HF (functional classification and ejection fraction) and medications;	Text, enter general patient information, option to send e-mail;	72.5	83
Heart Failure Storylines	Symptoms, vital signs, medications and well-being;	Medication reminder, follow-up of symptoms and side effects and levels of physical activity, record vital signs, synchronize with other devices (import data from other health APP) and daily (report of well-being);	85.0	88
HF Path	Physical activity, well-being and medications in use;	APP explanatory video, chat room, insert daily activities, weight, sleep, blood pressure, glucose and allows the visualization of these data in graphs;	95.0	94
HF Log	Weight and physical activity;	Enter weight, classify patients by zone (green, yellow and red), mark the day of the week, insert contact of the physical educator and allow notifications;	90.0	78

To be continued

Table 2 (concluded)

Application	Content	Resources	Usability	
			SUS[a]	SURE[b]
ADHF/NT-preBNP Risk Score Calculator	Calculation of mortality based on calculated glomerular filtration rate, chronic obstructive pulmonary disease, blood pressure, serum sodium, hemoglobin, type B natriuretic peptide, tricuspid regurgitation, previous hospitalization for HF;	Reversal function for background/text colors, insert parameters (scans) and calculation of immediate result;	82.5	69
3C-HF Score Calculator	Laboratory tests, comorbidities and therapy;	Enter test values, save results, and link to the study;	82.5	77
Systolic Heart Failure	Classification and appropriate treatment;	Text and flowchart;	62.5	40
CardioCalc	Laboratory and imaging tests and vital signs;	Menu with search bar, calculator with immediate response;	87.5	85
CardioSmart Heart Explorer	Functioning of the heart with failure;	Explanatory animations, 3D figures, videos and link for sending comments;	80.0	56
CardioVisual	Cardiac function, HF types, management, monitoring, functional class, treatment and ventricular assist devices;	Explanatory video for use of the application and about the disease, search option, records audios and chat with professionals;	80.0	70
Heart failure	Definition, signs and symptoms, causes, pathophysiology, diagnosis and classification, prevention and management, prognosis, epidemiology, economics and research;	Change background color and text, videos and connection to Facebook;	77.5	40
Heart Failure-AZ Discussions	Etiology, signs and symptoms, complications and treatments for patients with HF and acute pulmonary edema, refractory HF and diastolic HF;	Text, pictures and e-mail to authors	75.0	57
ICAPP	Diagnosis, treatment and organization of care (multidisciplinary programs: early post-discharge visit and palliative care);	Checking for signs and symptoms for clinical history and physical examination. The options show an evolutionary process: from the initial approach to treatment;	85.0	62
ICFEP	Probability score based on body mass index, age, medication use, presence of atrial fibrillation and doppler result;	Enter patient name and data, probability calculation and immediate response;	90.0	79
Insuficiencia cardíaca	Definition, signs and symptoms, complementary tests, causes, follow-up, treatment and differential diagnosis;	Text;	82.5	79
Clinical Cardiology	Definition, etiology, pathophysiology, compensation mechanisms, signs and symptoms, clinical classification, functional classification, complementary tests and treatment;	Link that directs to a PDF text;	52.5	29
CardioExpert I	Prognosis, risk of mortality and six-minute walk test;	Enter age and clinical data, risk stratification for mortality;	90.0	92
CarPriMur	Follow-up of HF in primary care, hospital discharge and therapeutic protocols;	The options show an evolutionary process: initial approach, symptoms presented and indicates whether to seek a health institution. Cardiovascular risk calculators;	87.5	80
Heart failure	Definition, pathophysiology, etiology, epidemiology, prognosis, clinical cases, differential diagnosis, diagnosis, treatment, risk factors, complications and prevention;	Text, images and e-mail option for authors;	77.5	61
FAQs Heart Failure	General knowledge about HF;	Text, images and videos;	75.0	52
Cardiac Care Plans	Nursing care plans (diagnoses, interventions and justifications);	Text;	70.0	32
CardioMed	HF treatments: enalapril, digoxin, dopamine, hydrochlorothiazide;	Search bar, text;	75.0	51
Cardiac Nursing Care Plans	Nursing care plans (diagnoses, interventions and justifications);	Text, option to increase or decrease the font size;	70.0	35
Slabe Serce	Lifestyle and symptoms;	Educational material with photos, quiz, printing option;	87.5	82
Leben mit Herzinsuffizienz	Signs and symptoms, causes, classes of medications;	Texts, video sequences, audio to written text and diary to enter relevant information, option to increase/decrease letter size, warnings that help to recognize the worsening of your disease in a timely manner and react correctly;	95.0	84
Rajan's HF (R-hf) Risk Calculator	Insert EF, eGFR, Hb and NT-proBNP;	Enter values and estimate calculation;	85.0	75
CardioEnf-IC	Information about the pathology and its clinical manifestations and types of treatment.	Enter general information, charts and reminders (medications and consultations).	90.0	102

a = System Usability Scale; b = Smartphone Usability questionnaiRE; HR - Heart Rate; EF - Ejection Fraction; eGFR - Estimated glomerular filtration rate; Hb - Hemoglobin; HF - Heart Failure; BP - Blood pressure; NT-proBNP - N-terminal fragment of type B natriuretic peptide; SUS - System Usability Scale.

DISCUSSION

The growth of the Internet increases the sale of smartphones and, with this, studies of construction and validation of APP, which already exceeds 165,000[15], portraying interest in the development of mobile technologies, collaborating in the construction of a new modality of health care[4]. This statement becomes clearer when observing the increasing construction of APP over the years.

Mobile APPs are shown to be innovative health care technologies. They are educational resources that allow improvement of teaching-learning, applied in different contexts[16]. In this sense, APPs, focusing on promoting patient knowledge, aims to meet the implementation of self-care practices[17]. In HF, self-care is vital to successful management. In an almost experimental research, HFApp, app for monitoring symptoms, reminders, education and screening of physiological data, proved effective to self-care, but was not significant in terms of awareness of the symptoms of the disease[6].

The APP enables adequate follow-up of patients and assists in the clinical decision-making process of professionals, contributing to the development of reliable diagnoses and targeted therapeutic guidelines/conducts[3], in addition to remote consultations[18]. In order to test the viability of a teleguidance APP with 692 german HF patients, a prospective study showed the technology as promising because it continuously reflected patient health information daily[19]. Thus, it allowed effective monitoring by health professionals, in addition to guiding decision-making.

With this technology, we can see the use by all those involved in the care process, in order to promote comprehensive care. When used by health professionals, it enables evidence-based practice. Therefore, it is relevant that professionals appropriate these tools to strengthen care and invest in safer care[17]. When developed for patients, APPs work as strategies that facilitate self-care, maintain autonomy and independence. For family members/caregivers, who play an important role in the care of HF patients, APPs are an additional form of information[5].

Family members of patients with chronic diseases, such as HF, use the Internet to seek medical information more than the general public; on the other hand, use app[20]less. One justification found by these authors is that, possibly, family caregivers do not have enough time or find it difficult to use mobile APP focused on care. Sociodemographic factors and poor health and digital literacy are also associated with limited access to and use of APP in health. However, when they use them, they become more informed and empowered[21].

The development of an APP involves more than producing and delivering the product ready for the customer, requires a whole procedure that covers, including, the characterization of versions. Semantic versioning (SemVer) is a set of particularity rules that show how app version numbers were developed, that is, the amount of changes you have made and which changes were compatible or not with the previous version[22]. It is a set of good practices and customs of software development that indicates the larger version (major), minor version (minor) and patch version, arranged among ready: major.minot.patch.

SemVer is important to give the customer a notion of the software's stability status, enabling you to identify whether the new version has new features or bug fixes[23]. Thus, users can know what to expect when they will update the software[24]. In the APP analysed, increasing versions were observed, indicating adaptation of contents with terms and words used worldwide, such as the addition of functionalities. Thus, it is perceived that SemVer is a break from the way of being moved by keeping the APP up to date.

There was a number of varied downloads, a value calculated by the number of users who enter the APP page and download. However, this number does not mean number of mobile phones with the APP installed. Some factors can influence the count of downloads, such as competition between search engines. The best way to minimize this problem is to invest in both stores to host the APP. In addition, having both versions is recommended for good performance, in addition to the reach of a larger number of people without restriction of use on only one of the operating systems.

In addition, APPs presented a variety of functions, essential for disease management. Although HF has no cure, changes in lifestyle can increase patients' quality and life expectancy. Continuous monitoring and care of daily vital signs allows to recognize changes or complications early. However, self-monitoring rates are low, as patients often forget to record relevant information, such as signs and symptoms, vital signs, and medications in use[4]. This complicates check-ups and makes it difficult to identify your condition's worsening.

Thus, APP that provide resources that offer a comfortable use for patients, with interactive elements that provide reliable information, such as data insertion, can increase patient safety, decrease hospitalization episodes, and share their data with health professionals. APP with risk stratification and diagnostics are essential tools for health professionals and patients for providing prognosis and personalized treatment[25].

When designing an interactive system, it is necessary to seek an understanding of users' needs, so that one can meet, with objectivity and quality, the desired experience in performing the task that will be projected[26]. The criterion regarding the material relevance and its applicability is important if it presents a valid and understandable content for a target audience, but does not have viable and relevant applicability, this material needs to be critically rethought[27].

Usability is a prerequisite for spreading mobile APP use to health and is defined as a set of software attributes that are based on the effort required for the use and individual evaluation of such use by an implicit set of users. The usability score is intrinsically correlates with better reliability of[28]content. Added to these factors are the lack of confidence in technology, frustration with design and navigation features, and an interest in having technology to support your self-management of the[29-30]disease.

The use of mobile APP usability questionnaires is important because of special components such as connectivity issues, battery and security and privacy challenges[31]. There are several ways to conduct a usability study, being the use of questionnaires, the fastest and most practical way. The usability of the APPs analyzed was evaluated by two independent researchers using two instruments: SUS, which evaluates the general context[11] and SURE, smartphone-specific[13]. According to the SUS

instrument, the vast majority of APPs scored above the cut-off score of the instrument.

Although SUS is widely used, this instrument was not designed to evaluate the usability of mobile health APP[31]. Thus, it was also decided to use SURE. It was found that the majority were at level 80 of sure, level at which respondents begin to fully agree that the help /tip given by the APP was useful, in addition to anure with the other items. This demonstrates the high level of satisfaction, which establishes intelligibility, learning, operability, attractiveness, and compliance with the[32] usability goals.

The repercussion of APPs for HF is vast and relevant, as it includes important themes, directed to all those involved in the care process. Therefore, it is necessary to support development and improvement, with a view to improving health practices. However, it was observed that themes such as vulnerability in health, mental health, sexual activity, social and family support, palliative care, side effects of medications, vaccinations and family planning were not addressed.

It was observed that, among health professionals, only physicians and nurses were contemplated. Multidisciplinary team support plays a crucial role to improve the quality of life of patients and family members since the diagnosis of the disease[33], being the gold standard for monitoring patients with HF and its multiple comorbidities. This includes physicians, nurses, psychologists, nutritionists, pharmacists, dentists, physiotherapists, physical educators and social workers[34]. Furthermore, it is important to highlight the absence of a caregiver as a user.

Study limitations

It is worth noting that the research presented limitations regarding searches, such as the non-inclusion of paid APP and/or that required registration by the institution or health professional, making it impossible to handle.

Contributions to nursing and health

Furthermore, the results strengthen the current knowledge about the APP available for download and handling about HF, by exploring the thematic scope and usability. Furthermore, it makes possible the identification of gaps, aiming at the development of new APPs that address relevant and indispensable themes, together with the appropriate usability. Moreover, it directs the use of resources that assist professionals, patients and family/caregivers in the involvement and adhering of care and in clinical decision-making.

FINAL CONSIDERATIONS

The APPs currently available on HF have comprehensive content and adequate usability that can guide patients, family members/caregivers, health students, physicians and nurses. However, the findings showed the need to develop PAAs with more themes, such as vulnerability in health, palliative care, mental health, social support, sexual activity, essential in the care of patients with HF, in addition to the integration of other professionals from the multidisciplinary team.

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