WorkUp: A Mobile Application to Support Health Guidelines

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Abstract: Objective: This paper presents a model of mobile application to assess patients and prescribe physical exercises offering interaction among health professionals and patients. Methods: The project is based on mobile platform and implemented using client-server architecture and cloud computing for data synchronization in different devices. Results: Health professionals and patients tested our application and answered questionnaire. The results indicate that the functionality and usability are satisfactory adhesion to our app design. Conclusion: Our approach may be a candidate model to government agencies to support in prevention of obesity and improve the health indicators of the patient to a healthier life.

1 INTRODUCTION

Communicable and non-communicable diseases are increasing in south of Brazil, becoming the main cause of death along with obesity risk factors (Capilheira et al., 2008). Prevention and early diagnosis of obesity are important for health promotion and the reduction of morbidity and mortality. Obesity has a direct impact in the individual's social acceptance due to the aesthetic concept widespread in contemporary society (Schmidt et al., 2011). A study conducted by the Brazilian Institute of Geography and Statistics showed overweight in 50.1% of men and 48% of women (da Saúde, 2014). Actually, there is evidence that the percentage of overweight in the global population has reached approximately 60% (Popkin, 2011).

Mobile health (mHealth) is the use of mobile computing and communication technologies in health care and public health (Free et al., 2010). Mobile applications are an option to support government agencies in order to monitor population health indicators, and manage the physical activities both of children and adults. In Brazil, government programs developed by the Ministry of Health, such as Food and Nutrition Surveillance, Family Health Strategy, and the School Health Program are part of the National Policy for Health Promotion. These programs have the physical activity as one of their priorities. Individuals diagnosed with chronic diseases and abnormal anthropometric data, should be referred to the Health Unit for treatment and monitoring (da Saúde, 2014).

Numerous systems have been developed in healthcare using mobile technologies. The applications enable collect data, usually by a questionnaire to assist public policies of disease control (Morrison et al., 2014). Recent studies have covered applications that promote the practice of physical activities that meet fundamental characteristics of mHealth and tracks physical activity and food comsuption behavior data (Al Ayubi et al., 2014). According to a recent mHealth apps review (Knight et al., 2015), there is no application that supports specifically public guidelines for aerobic physical activity (Tucker et al., 2011).

This study aimed to develop a mobile application model that supports public guidelines for aerobic physical activity. This paper is not focused neither in deploy nor test the app on site. It provides an opportunity to support government health programs. We show the development of application, called WorkUp. It enables the health professional such as physical educator linked to government health programs to evaluate patients and track medical histories with a variety of methods, such as: a) calculation of body fat index; b) determination of types of exercises and daily activities; c) class scheduling; d) interaction between both professional and patient; and, e) app data can be accessed with any mobile device connected on the Internet.

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The remaining part of the paper proceeds as follows: we discussed about related studies in second section. Section three presents the technologies, development process, software architecture, and tests and validation methods. In section four, the project implementation is presented. The fifth section is presented a qualitative evaluation about our design acceptance through users interview. Finally, we present our conclusion and limitations of our study in the section six.

2 RELATED WORK

Studies in several countries show success in combating obesity using physical activity together with combined interventions: changes to food/diet, increased physical activity, and behavioral strategies (Jebb et al., 2011; Turner et al., 2012). Face-to-face approaches are effective, but they are relatively expensive to implement, difficult to scale up, and do not suit those who work or live far from venues. The addition of mHealth apps in everyday life offers a practical and potentially cost-effective solution to the barriers of face-to-face approaches (Waterlander et al., 2014).

Researches demonstrated strong support for a mHealth weight management intervention; with 75% saying they would use a mobile app for weight management intervention (Gorton et al., 2011). Another study showed that the widespread use of information and communication technology tools offers an innovative and potentially beneficial avenue to increase the level of physical activity in Heart Failure (HF) patients (Franklin, 2015).

A survey performed in 2012, shows 50 applications available in Brazil within the health field, of which 20 belong only to the Android platform, 19 to the iOS platform, 6 on the Windows Phone platform, 1 supporting the three platforms (Diet and Health), and 4 common to Android and iOS platforms (SUS Procedures, SAESP, Measure One and Emagrecentro). They are mostly free (32 apps), but the Android platform leads to greater amount of paid applications. The content of more than half of these applications is aimed at professionals. The applications targeting the consumer public deal primarily with issues related to diet and physical conditioning (Bonome et al., 2012).

But still, comprehensive applications that enable a range of information about the patient and that allow the participation in the evolution process of his general state of health and weight are necessary. This is why we purposed and developed the WorkUp, based on users' needs becoming part of a National Policy for Health Promotion.

WorkUp, as other studies, has shown interest and adherence on the part of those involved. Some authors demonstrated that the success level of health services depends on the level of user acceptance and adoption (Sezgin and Yıldırım, 2014). Additional research is needed to explore several hypotheses. For example, if more engaging user interfaces, including easier navigation, simpler layouts, and refined aesthetics can contribute to the adherence of mHealth apps. Then, from this point of research design, the emerging studies should include more qualitative approaches and longitudinal studies in order to effectively understand the user's needs (Kaplan and Maxwell, 2005), which can strengthen the qualitative research conducted for the WorkUp.

3 METHODS

For the application's development, the system planning, design, and implementation were performed. Later, an evaluation of usability was applied in patients and health professionals.

3.1 Technologies and Tools

We adopted Android platform due to its highly used technology, its ability to support wide hardware compatibility, and to offer many components that provide a good user interaction. The codification is based on Java and eXtended Markup Language (XML) files describe in the user interface. The Android Development Toolkit (ADT) was adopted for application test through the use of its virtual device emulator.

The artefacts and requirements were modelled in Unified Modelling Language (UML) to design system diagrams using Astah Community Edition. The database was designed in BrModelo software that generates database script commands. SQLite was the system database employed for data persistence due to its native support for Android, good performance and low resources usage. In Android Development Tools (ADT) contains a manager for SQLite databases in order to handle data manually during development.

WorkUp data is stored on the cloud to get a wide geographic access and allow users access to their synchronized data, regardless of the device. Web service technology was chosen to synchronize the local data with the cloud, as it works as a neutral technology that can transmit data and be easily adapted to any other technology.

3.2 Data Synchronization

The application server was deployed on Amazon EC2 Services. The operating system was Linux Ubuntu 14.04, Java 8, and MySQL database to store all data through web services.

When our application is installed on a mobile device, it starts a service that periodically communicates with the data synchronization web service. Clients perform a query to check available updates in cloud database. The communication model is represented in Figure 1. If there is an update, the appropriate routine will be started automatically to synchronize the data.

The security of data communication can be treated in three ways. Firstly data is encrypted before it will be sent to server or retrieved from it. Before the data transmission to cloud, data is encrypted and its integrity is checked when arrives on the other side. In local SQLite database, there are libraries to encrypt data such as SQLCipher and SQLiteCrypt.

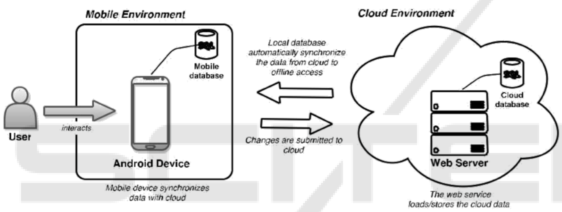


Figure 1: Data synchronization model of WorkUp.

4 PROJECT RESULTS

This section describes our app structure and use-flow. Our application has two user types: health professional (HP) and patient (P). Each one performs different activities on app. Both user type share functionalities such as account activities and view patient assessment, training set and class schedule. However, there are particular functions, which each user type can access. Health professional are able to create patient assessments, create or reuse training sets and manage class schedules. These functionalities are organized in modules, which are detailed in Table 1.

The basic use-flow consists in both user types create an account on app. After, health professional should add a relationship with his respective patients. The patients list of a health professional must be defined by the health unit. The patient must accept the request for relationship with the health professional. For each patient, the health team can schedule an assessment in order to verify patient health indicators. This assessment can be performed periodically in order to track the patients' health progress. Then, the physical educator can create a training set based on patient's physical needs and send it to him. The execution of exercises is registered by the patient on app, and it can be visualized by the physical educator. According to health program policy, there is an option to the HP schedule classes with patients individually or in groups. If the patient agrees with proposed schedule, he can accept it. Otherwise, the patient can message his health professional asking another available time.

4.1 Profile Management and User Communication

Local data persistence and guidelines to allow communication between the mobile app and web service to validate login (F1) were some of the features implemented. The Facebook API was integrated to provide access to the app using a Facebook account (F2). A notification and synchronization service (F16) had to be created in order to keep communication between the patient and the professional. We have also developed functions such as search user (F5), with the option of adding other users to the contact list. As stated earlier, a professional can establish connection with several patients. When clicking on a patient, the professional can manage his patients through an interface that allows access to assessments, training prescriptions, class schedule, and the removal of the patient (F6) from his list. The concern of the third sprint was the implementation of the interfaces for personal data handling through control panels, where the user has access to information and can update it as desired (F7).

4.2 Management of Assessments

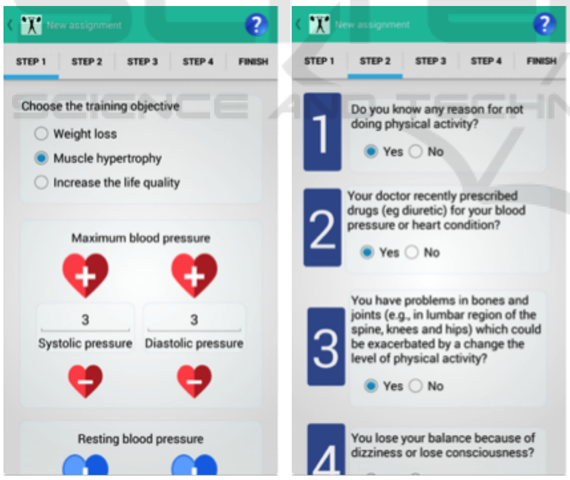
The second module deals with the management of assessments. It was concerned in keeping some characteristics in data collection, such as the interfaces understanding, separation of each type of evaluation, upload to web server, and both view and delete assessments.

The patient assessment tool (F8) was divided into four parts: a) verification of goals with the new training routine and verification of cardiorespiratory health through the maximum blood pressure during exercise and blood pressure at rest, as shown in Figure 2a; b) questionnaire of medical history through Pfeiffer questionnaire, which detect if there is any history or risk involving cardiorespiratory shortcomings, pain, recurrent chronic problems in implementing physical activity, loss consciousness, coronary problems or some other risk factors (Figure 2b); c)

Table 1: Functionalities of each use-case allowed for Health Professional (HP), Patient (P), and System (S).

Use Case	ID	Functionality	HP	P	S
Manage Profile	(F1)	Standard login	X	X	-
	(F2)	Facebook login	X	X	-
	(F3)	Create a standard account	X	X	-
	(F4)	Request relationship to professional	X	-	-
	(F5)	Search a user	X	X	-
	(F6)	View assessments, training set, schedule of patient	X	X	-
	(F7)	Update account	X	X	-
Perform Assessment	(F8)	Create a new patient assessment	X	-	-
	(F9)	Send collected data to server	-	-	X
	(F10)	Notify patient if new assessment is available	-	-	X
Training Management	(F11)	Create a training set	X	-	-
	(F12)	Send completed exercise to server	-	-	X
	(F13)	Reuse a training set	X	-	-
Class Schedule	(F14)	Schedule a new class	X	-	-
	(F15)	Confirm a class schedule	-	X	-
Non-functional	(F16)	Notification and synchronization service	-	-	X

the body fat assessment through a variety of skinfold methods; and, d) perimetry assessment, which enables log measures of body parts. Beyond the numerical evaluation functionality was integrated using the smartphone camera for photographic record of the evaluated body members.



(a) (b)

Figure 2: Evaluation management screens: (a) Objectives and blood pressure; (b) Questionnaire (QPAF); (c) Body fat calculation.

Existent apps adopt a unique skinfold method. However, each professional need a specific application, according to the physical characteristics of the patient. So, in this sense, WorkUp has a variety of skinfold methods to calculate body fat. We have implemented both Jackson Pollock 3 and 7-site, and Guedes methods. At the end of each assessment, the professional needs Internet access to send the collected data (F9) and automatically notify the patient (F10) that there is a new assessment available.

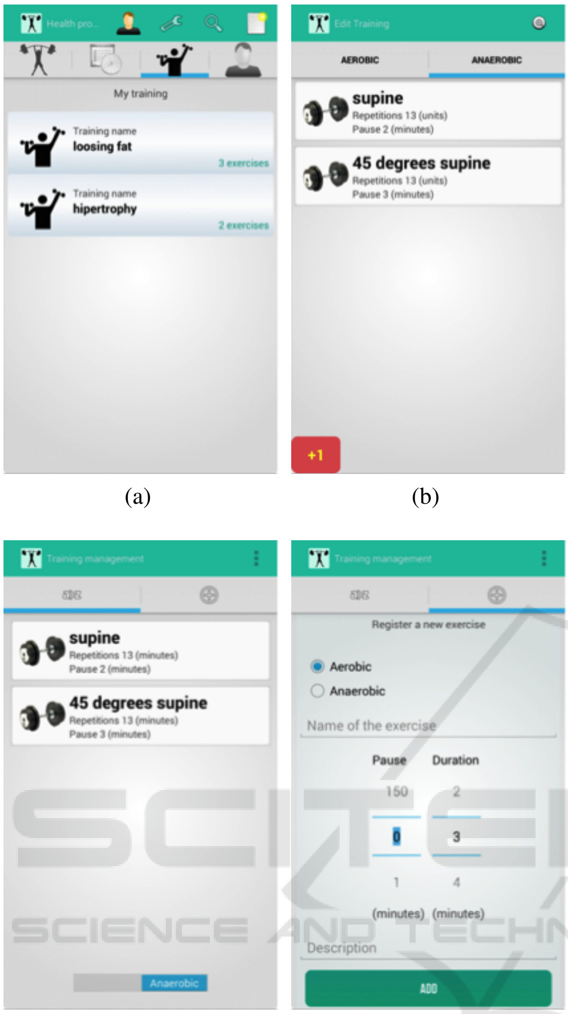
4.3 Training Management

The training has two types of exercises, which can be created by the own professional. Some rules were added to the application to improve system usability. After, it was marked by the inclusion of functionality to create a training list (F11) according to the purpose of the patient, inserting both aerobic and anaerobic exercises. Only the professional can mount the training set, leaving the patient with the exercises only. Following the conclusion of training, the patient's collected data are sent to a web database (F12) and will be available for professional access to track the patient's evolution.

These functionalities were developed and are shown in Figure 3. The training sessions that have already been created can be reused by the professional (F13), as shown in Figure 3a. In order to add a new training, it is necessary to enter a name, add exercises by clicking on the +1 button (Figure 3b), and view the registered exercises classified between aerobic and anaerobic (Figure 3c), with name, duration, repetition times, and rest duration (Figure 3d).

4.4 Class Management

This module allows the application to control the class scheduling (F14) to improve communication between patient/professional. To use it, the patient needs to bound to the professional, so the patient can schedule



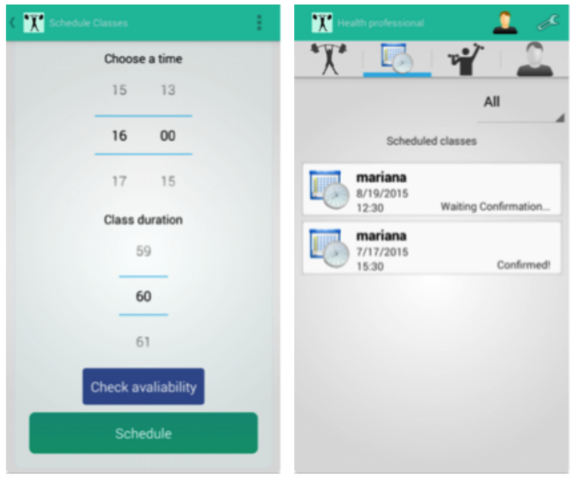
(a) (b) (c) (d)

Figure 3: Training management screens: (a) My trainings; (b) Edit training; (c) Registered exercises; (d) Characteristics of exercises.

a new class and the health professional can accept it or not. For a confirmation of a new class (F15), it is necessary that both agree and confirm the date and time. If there are any changes, both users will be notified by the system.

For the scheduling of a new class, the interface displayed in Figure 4a was built, requiring the patient/professional to select a date and time, with the ability to verify if the selected time is available. Users are notified to change the status of the class to confirmed, registering the schedule of classes. (Figure 4b).

In addition, we have considered good practices for interface design in order to assist the user of our application.



(a) (b)

Figure 4: Classes management screens: (a) Schedule new class; (b) User calendar.

5 EVALUATION

In order to validate our purpose, we adopted the qualitative research approach because it reveals a target audience's range of behaviour and perceptions. It uses in-depth opinions of small groups of people to support the construction of hypotheses through descriptive statements. The categories extracted from the answers of the participants were: a) effective registration method; b) ability to monitor more patients; c) accessibility of information; d) information distortion; and, e) interface and restrictions.

Sixteen participants, including health professionals and patients in both Cornélio Procópio and Serteneja cities, located in south Brazil, tested our application.

Several interfaces were sketched and tested by four health professionals and twelve patients. The app validation was performed by 17 questions focused on usability of the system. Participants were divided into HP1 to HP4 (Health Professional) and P1 to P12 (Patients). Participants were asked to download the application in order to explore and test the app functionality. Next, the participants were requested to answer the questionnaire. All data, comments, suggestions and detected problems were analyzed and used as a source of information to evaluate the system. Responses were categorized and described19-21 as: a) effective registration method for physical educators; b) ability to monitor more patients; c) accessibility of information; d) information distortion; and, e) interface and restrictions.

- Effective registration method As main results, participants emphasized that the control of physical activity is important for physical educators. Interviewed professionals highlighted the need to establish goals and analyze if the results obtained have achieved them. According to the answers, it is difficult to investigate the causes of inefficiency in the physical training because of the lack of effective registration methods to collect the patient's exercise routine. Table 2 presents the users reports referring to the registration method.

Table 2: User experience report about effective registration method from Health Professionals (HP).

User experience report
HP 1: "It is difficult to monitor patients efficiently without a digital record. Most of the time there is only an initial assessment and a pre-prepared program for the patient to conduct over a period of time without a complete record of case histories and prescribed activities."
HP 2: "You need an environment where the teacher can record all information, such as lessons, exercises and schedules, in order to effectively monitor the patient. In addition, through the systematization of information, you can organize and visualize where the gaps are in training."
HP 3: "It is necessary to check how the patient's training was in relation to the time for without this analysis, all is vague."
HP 4: "I need to know if the patient is actually losing weight with the training, and if the tracing objective is being achieved."

- Ability to monitor more patients It is common for a health professional to track multiple patients at the same time. This scenario is unfavorable for the quality of training provided to patients. Some interviewees pointed out that our app could help professionals to follow a larger number of patients with high quality. Table 3 shows the discourse of users that have tested the application, analyzing the resources to follow multiple patients.

- Accessibility of information Among the questions, the accessibility of the information required for patients' assessment was mentioned. The health professionals noted that some data are relatively complicated to extract, but are necessary for the proper development of activities, as described in Table 4.

- Information distortion The professionals point out that, in some cases, patients promote distortions in data collection, omitting important information about their health status (Table 5). There are cases where patients find unnecessary to fill out personal data in the application. The patient generally has no idea of the importance of evaluation for the prescription of activities.

Table 3: User experience reports about ability to monitor more patients.

User experience report
HP 2: "... I have on hand an easy way to record the data of my patients, which this training should follow. In addition, the schedule allows better distribution of times so I can organize myself."
HP 3: "It bothers me not keeping up with the patients, and not even knowing their workout for that day, because I cannot handle looking at the previous training and make the outline of the next."

Table 4: User experience report about accessibility of information.

User experience report
HP 1: "... I have on hand an easy way to record the data of my patients, which this training should follow. In addition, the schedule allows better distribution of times so I can organize myself."
HP 2: "It bothers me not keeping up with the patients, and not even knowing their workout for that day, because I cannot handle looking at the previous training and make the outline of the next."
P4: "I think the data is very specific and understanding it is complex."
P11: "At first sight, the need for data is difficult to understand, but once it is properly explained it is easy to understand its importance."

Table 5: User experience report about distortion of information.

User experience report
HP 1: "There are some points that can be filled incorrectly, which can work as a motivation to create new ways to reduce distortions."
HP 2: "The system as presented does not have methods that can prevent inconsistencies, for example, a patient who does not perform the exercises correctly."
P7: "We cannot guarantee that the data entered by the patients during the execution of exercises are really reliable."
P10: "This app would be of little use because I'm not used to perform this type of control."

- Interface and restrictions When participants were asked about the interface, system language, efficiency in performing the activities, arrangement of dialog boxes, error messages, and system iconography, there were no serious abnormality highlighted. But the health professionals pointed out that a more restrictive system would be interesting for more effectiveness in achieving results (Table 6).

Table 6: User experience report about interface and application restrictions.

User experience report
HP 3: “The application is very pleasing to the eye and easy to understand.”
HP 4: “It would be interesting if there was a way to make it easier for patients to access the training to be carried out.”
P6: “The interface is pretty nice and does not show navigation problems.”
P9: “I found no serious problems.”
P12: “Some data is complicated to collect and understand, it needs an improved interface.”

6 CONCLUSION

Physical evaluation software has been developed to desktop computers. However, with popularization of mobile technologies, the adoption of mobile apps is undoubtedly a useful solution. For health professionals, the advantage of portability overcomes some barriers and allows the tracking of training, improving professional-patient communication, and allowing the follow-up of training guidelines with more effectiveness.

The WorkUp can be a model to support health agencies to promote a healthier life and keep record of the patient physical assessments. The application also provides users with the ability to keep tracking important health indicators that show the patient’s evolution. As pointed out earlier, mobile technology is constantly evolving in the applications market, that is, every day there are new startups focusing on health and exercise routines. Therefore, WorkUp has to add up to this scenario, providing important information for health professionals. This information can assist professionals to achieve better results and improve the quality of life of their patients.

A limitation of this study relates to the performance of physical activities, as WorkUp currently restricts to patients the ability to perform physical activities proposed by a professional. However, these mechanisms are dependent on the use of the correct interface. The system is not integrated to sensors. Thus, for future work the integration of these technologies will be accomplished to provide better control of physical activities.

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