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mHealth Data Collector: An Application to Collect and Report Indicators for Assessment of Cardiometabolic Risk

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Abstract. Traditional population surveys use paper forms that are filled manually by an interviewer. This process can take a long time; in comparison, computerizing the process reduces time, promotes safety and accuracy of data, improves patient care, and offers better control over the compiled information. From this perspective, it can be argued that mobile health supports mechanisms for the diagnosis, control, and prevention of metabolic diseases. In recent years, mobile devices have been applied in several health areas, such as remote monitoring, data logging, clinical decision-making, and with applications that can help maintain or initiate practices beneficial to individual health and wellbeing. However, there is a lack of applications for conducting population surveys. Thus, this work presents an application called mHealth Data Collector (mHDC) as a model for applications used in population surveys that contain such data as Body Mass Index (BMI), health- related issues, and health habit indicators. The design of this system occurred through interviews with health professionals who utilized a prototyping method to extract requirements. To develop this mobile app, the Android platform was adopted and the SQLite database was used to store patients' health data. The JEx- celAPI and AchartEngine were also employed to generate spreadsheets and charts. The mHDC was tested using a case study in a Brazilian city. The results indicated that the health team took half the time to interview patients. In addition, the sys- tem has reduced the use of paper; centered and organized data; and allowed quick data recovery and standardization to improve the readability of data input. The mHDC proved efficient at collecting, analyzing, and safely exporting the results, thus reducing time collecting and analyzing the population survey.

Keywords. Mobile health, Nutritional and Metabolic Diseases, Assessment

1. Introduction

With the advent of chronic diseases, there is an interest in monitoring epidemics and proposing mechanisms for their control and prevention. A form of analysis is individual

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nutritional assessments based on medical history, nutrition, medications, physical examinations, biochemical data, and anthropometric data to identify or confirm the existence of risk for nutritional disease processes, such as obesity and dyslipidemia, that can lead to the risk of such illnesses as cardiovascular disease [1].

A nutritional assessment using the computerization of such processes reduces time, promotes safety and accuracy of information, improves patient care, and offers better control over the compiled information. Moreover, it facilitates the assessment process in remote places [2], featuring the concept of mHealth (mobile health) what is the use of portable devices to help with medical practice and public health; such portable devices include wireless equipment as defined by the Global Observatory for eHealth [3,4].

In recent years, many systems have been developed in the healthcare area that utilize mobile devices are applied to the mobile collection of data, usually through questionnaires that assist public policies aimed at combating diseases, remote monitoring, data logging, telemedicine, assisting with clinical decision-making, educating patients and health professionals, and particularly, encouraging users to initiate or maintain beneficial habits to their health and wellbeing [5-7].

Currently, there are 50 software applications that can be found in the list of mobile healthcare software available in the Brazilian market, and the Android platform contains an even greater number of applications. Only five out of these 50 applications were produced through public initiative, and they deal primarily with issues related to diet and fitness, hypertension monitoring, diabetes, chronic diseases, immunization, and public health emergencies [8]. However, there is a lack of applications for conducting population surveys.

In this context, the main objective of our research is to develop a software application called mHealth Data Collector (mHDC) for mobile equipment as a model for applications suitable to population surveys. The health profile of a population was collected to validate the software, and it includes information regarding the Body Mass Index (BMI); health-related issues such as hypercholesterolemia, hypertension, diabetes mellitus; and habits such as physical inactivity, smoking, and alcohol and food consumption.

2. Materials and Methods

In order to develop the mHealth Data Collector (mHDC), we performed planning, system design, and implementation. Afterwards, a usability evaluation was realized.

Thereafter, a study of the application requirements was performed with two nurses, three nurse technicians, and a nutritionist to model the system. These requirements include: a) anamnesis—personal data form; b) blood pressure, biochemical exams, calculation of Body Mass Index (BMI); c) dietary assessment; d) survey of health conditions and calculation of coronary risk based on the table provided by the American Heart Association; e) model of a database in which to store questionnaires; f) ability to generate statistical reports; g) chart visualization; and h) data export through e-mail. Figure 1 illustrates the sphere of user-system interaction.

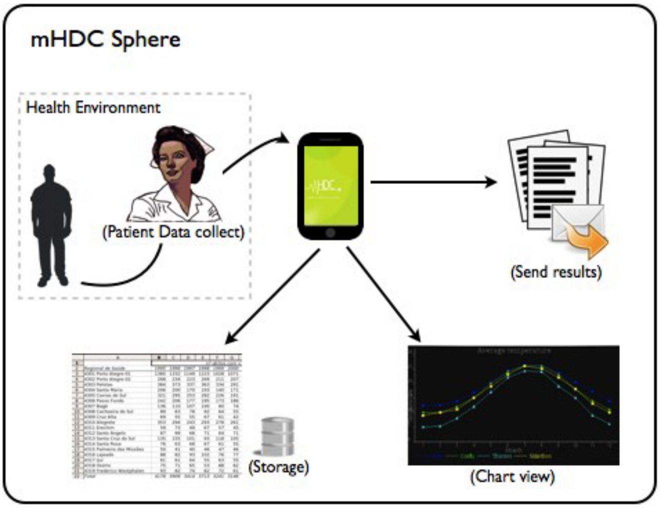


Figure 1. mData Health Collector Sphere

The artifacts and requirements were modeled using Unified Modeling Language (UML) in order to create system analysis diagrams using Astah Community Edition. To model the logical and physical database, DBDesigner software was used because it generates the SQL database automatically.

To develop the mHDC, the Android platform version 4.1 was used. SQLite was the system manager database adopted for data persistence because of its native support for Android, good performance, and low resource usage. And, to generate spreadsheets, the JExcelAPI was employed. With this library, it is possible to generate formatted spreadsheets according to the requirements established by the customer.

For data visualization, the AchartEngine API was integrated in order to plot graphs of the indicators of coronary heart disease development. These graphs are organized by gender in age groups consisting of 18-40, 41-59, and 60 or higher.

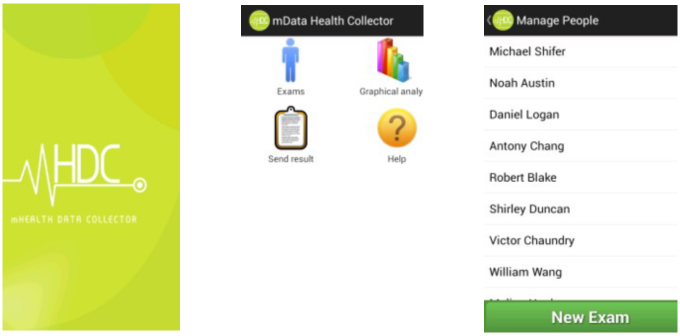
In addition, we also considered best practices of interface design in order to ensure a system ease-of-use (usability) experience by the user [9,10]. Thus, several interface models were designed and tested by four health professionals. To evaluate the usability and validation of the software, we conducted four meetings with health professionals who were interviewed during the design phase to clarify the software's purpose.

Once development was completed, the application was installed on tablets in order to allow four healthcare professionals (one nurse and three nurse technicians) to collect health data for testing purposes conducted in Londrina, Paraná, Brazil. In this study, 45 individuals were interviewed in the period ranging from April to June 2013. This research was approved by the Ethics Committee from the Federal University of Paraná under Opinion 218 193.

Finally, the collected data were exported by mHDC in Excel format to an e-mail address entered by the interviewer. All results were compared and analyzed using parametric statistical tests and nonparametric as Student T, Mann Whitney, and Kruskal Wallis test, adopting as a criterion of significance $p < 0.05$.

3. Results

Our proposed software greatly demonstrated its significant contribution to data collection. The use of technology leads to a reduction in the use of paper, which shows sustainable research. Given that data are centralized in a database, different inquiries can be made quickly and efficiently for an examination through the graphical user interface (GUI) represented in Figure 2 (c).



(a) (b) (c)

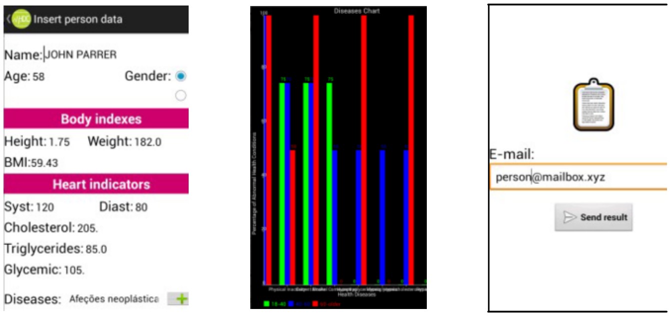
Figure 2. mHDC GUI: (a) Splash screen (b) Menu screen (c) Inquiry screen

The GUI menu organization (see Figure 2 (b)), including the position of elements along with the color scheme used, also contributed to the acceptance of the application by users. The careful design of the splash screen surpassed users' expectations: the symbol "M" included in the logo corresponds to a heartbeat (see Figure 2 (a)).

The electronic form (see Figure 3 (a)) provides character legibility and data consistency, unlike the handwritten form previously used, which generated confusion in reading and unreliable results. Another factor relevant to the interface is the use of graphical components such as radio buttons and drop-down lists that allow standardization of frequently used data inputs, thus expediting form completion.

Another key point that should be mentioned is that mHDC is fast because it automatically calculates an individual's BMI based on the height and weight entered and, calculates Body Fat Index based on skinfold measurement. In addition, mHDC allows for data tables to be exported using the Excel format. The use of this format provides better analysis and data filtering, thereby allowing visualization of dynamic data.

In order to better secure access to the stored data, mobile devices are best because the mHDC application can export through email the saved exams (Figure 3 (c)). Still, the program automatically plots graphs, thus helping to reduce typing time, time to analyze the data (Figure 3 (b)), and possible errors in manual calculation.



(a) (b) (c)

Figure 3. mHDC GUI screens: (a) mHDC exam (electronic form) (b) Chart view (c) Sent results

The software was evaluated for its usability in the following aspects: ease of use, charging time, matching the screen resolution, frequency of use, and data relevance. In general, mHDC has met the goals set up by the professionals interviewed, scoring 100% in data relevance; 83.3% in ease of use; and 100% in repeated use. These professionals work for the Basic Health Units that serve the Family Health Strategy Program, which assesses the population nutritional status. Interoperability is achieved by promoting adequate screen resolution of different mobile devices and support for the most- used Android versions.

The results reported by mHDC for the population interviewed are worrying, and demonstrate a high condition for the development of chronic non-communicable diseases, as well as disorders of existing pathologies.

4. Discussion

The use of technology to aid in the collection, processing, and analysis of information suggests an efficient and faster method to further disseminate this knowledge within the scientific community. Currently, there are several studies that use mobile solutions to aid healthcare work available in the literature [11-15]. Such is the aim of this work: to provide software that can collect population data for future decision-making and that can allow disclosure of the current situation in the form of research.

There are several advantages to the use of mobile applications by health professionals for daily data gathering, such as reducing (or even eliminating) the use of paper, reliability of data through input validation, and no need for retyping when collected data might need to be entered into management information systems. Furthermore, mobile devices are capable of accessing the Internet, thereby providing access to a rich tool that has actively engaged patients and health professionals in using a variety of equipment to help monitor, prevent, and treat diseases [16].

Some authors report that it is difficult to collect data that are recorded manually on paper, since it is hard to interpret the recorded data, and have found errors that resulted in data being discarded from a study. The error rate is reduced when compared to data collected in electronic protocols using registered papers that can be lost over time. Electronically, the data quality is related to the readability of a filled form and to the amount of time the form can be stored without being lost [17]. Our findings are in agreement with these studies, since the mHDC allows for the results obtained in the field to be exported as soon as the form is finalized, e-mailed to researchers, and stored online with several copies stored in multiple computers. In Brazil, the Ministry of Health, through the Council for Science, Technology, and Innovation in Health, promotes and disseminates research priorities in health technology assessment (HTA), and encourages training with international cooperation to make decisions about health technologies [18,19]. In this way, this work contributes with mobile technology applied to the Brazilian public health sector to collect, record, and track data about the population's health.

Zanetti [18] affirms that health professionals and others need to reflect on the production of knowledge and the use of technology, considering the prevalence of Chronic Non-communicable Diseases (NCDs) in the population, as well as aspects related to operating cost, load monitoring, and trend of these diseases. Thus, Zanetti recognizes the need for finding strategies that strengthen scientific creativity, with a view to the development of research based on new technologies. Nursing should embrace the challenge of increasing scientific production technologies in health, and should provide new tools for the information and communication of chronic diseases, looking to the effectiveness of health services. Such technological advents increase the speed of scientific knowledge, provide aid in the decision process as Evidence-Based Medicine, improve assistance efficiency leading to an optimization of benefits, minimize costs and risks, and increase patient wellbeing [20].

The developed software program meets the need for collecting information from the Brazilian population, especially in areas where non-communicable diseases are the leading cause of death and disability in adulthood and old age in Brazil. These types of diseases account for 34% of all causes of death and are related, in large part, to obesity, eating habits, and inadequate lifestyles, all of which constitute risk factors for health problems such as ischemic heart disease, hypertension, cerebrovascular accidents, diabetes mellitus type II, cholelithiasis, osteoarthritis, neoplasms, reflux esophagitis, hiatal hernia, and psychological problems [21,22].

Thus, early identification of risks involving dietary, anthropometric, and biochemical data can promote health and rehabilitation by the health team in pursuit of the development of healthy habits, including making good choices in the consumption of functional foods in the population at risk.

In this sense and according to Kac [21], in Brazil, contrary to what is observed in the United States and some European countries, conducting population surveys does not occur systematically. However, there are some studies that do not report the reality of the country as a whole, and that tend to be more regional analyses, perhaps caused by the difficulty of manual data collection in a country with a territory as vast and heterogeneous as is Brazil.

Therefore, the continuous monitoring of all Brazilian regions in terms of health and nutrition is extremely important. The mHDC has been developed with this purpose in mind: to collect information and to draft future comparisons in data collection after the population has been provided with preventive measures, to offer greater flexibility in this process, and to contribute to the monitoring of a population served by government programs in the area of public health.

5. Conclusion

The mHealth Data Collector (mHDC) proved efficient in collecting, analyzing, and safely exporting results, thereby reducing time collection and analysis by researchers in the health field. It is expected that mHDC can be used as a model for future research applications as a population survey tool.

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