Development, effectiveness and usability of a mobile application to assist in the pharmacological and non-pharmacological treatment of arterial hypertension

RESEARCH PROJECT

FLORIANÓPOLIS

13/09/2022

2 Objectives (general and specific):

2.1 General objective

Develop an application for the two most popular *smartphone platforms* (Google Android and Apple iPhone) aimed at treating SAH, with tools aimed at medication adherence, blood pressure monitoring, monitoring and promotion of physical activity and lifestyle habits healthy subjects of Brazilians with SAH.

2.2 Specific Objectives

The specific objectives of the study will be:

a) develop a prototype application aimed at treating patients with SAH, including tools to improve medication adherence, monitor blood pressure values, monitor and promote physical activity and healthy lifestyle habits;

b) test the effectiveness of this application on laboratory systolic and diastolic blood pressure, adherence to drug treatment, habitual physical activity and lifestyle in hypertensive adults.

c) test the usability of this application on hypertensive adults.

3 Materials and methods

The study will be developed in three stages, according to the objectives outlined. Initially, a prototype of a cellphone application will be developed to help Brazilian adults diagnosed with SAH, with tools related mainly to medication adherence, promotion of physical activity and monitoring of blood pressure values, in addition to health tips (food, smoking, alcoholism and stress management). Subsequently, this prototype will be made available to a group of adult hypertensive patients so that the effectiveness of this application can be tested on laboratory blood pressure values, medication adherence and lifestyle aspects, including physical activity and, subsequently, physical activity. Application usability will be tested. Subsequently, after making the necessary adjustments, the application will be made available on the Apple iTunes and Google Play platforms and disseminated in groups of Basic Health Units and in the media (advertisements on television, newspaper, radio). From there, the number of downloads and the grade assigned to user reviews (one, two, three or

four stars) will be evaluated, according to the user's sociodemographic characteristics (gender, age, place of residence).

App Development

3.1 General Description

The main focus of the application is to assist in the treatment of patients with SAH. The application will address the components of adherence to medication use, blood pressure monitoring and promotion/monitoring of physical activity. In addition, health education tips will be provided, including guidelines for reducing sodium consumption, adopting an adequate and healthy diet, controlling body weight, moderate alcohol consumption and stress management, in accordance with the recommendations of the main guidelines related to the theme [1, 3].

After downloading, patients must manually enter demographic data (date of birth, sex), their body mass and height, information regarding the use of the drugs used, the presence of comorbidities (diabetes, dyslipidemia, chronic kidney disease, coronary artery disease, peripheral arterial disease, among others). In addition, the user must enter data related to their lifestyle, including information about: physical activity, nutrition, alcohol consumption, tobacco use, stress and relationships, according to an adapted version of the Fantastic lifestyle.

Based on this information entered by the patient (*input)*, the application will issue reminders: a) for the use of the medication(s), according to the time registered by the patient, daily; b) to perform blood pressure measurements. The patient will be instructed to take blood pressure measurements while sitting, in a calm environment, after five minutes of rest, with the bladder emptied and there is at least 30 minutes of abstention from food, cigarettes and/or alcoholic and caffeinated beverages. Such measured BP values must be entered in the application and, if a BP level above the recommended values is identified, the insertion of the importance of the correct use of antihypertensive medication and adoption of a healthy lifestyle will increase. It will also be suggested that you consult your doctor for possible medication adjustments.

In addition, the user will be given the possibility to self-monitor their physical activities and, based on this information, the application will generate

feedback informing whether or not the user has reached the recommendations currently in force [17, 18]. If the user does not meet the recommendations throughout the week, illustrative messages or videos will be generated with stimuli and guidelines for the patient to increase their level of physical activity, according to such recommendations. Illustrative messages or educational videos will also be made available with tips on healthy living habits, including recommendations for body weight control, reducing sodium consumption, adopting healthy eating habits, stress control and smoking cessation, as recommended by the main guidelines related to thematic [1, 3].

Reports for the patient regarding blood pressure values and physical activity will be available, showing the evolution over time. For programmers and researchers, these same reports will also be generated, in addition to reports with application usage statistics and general user characteristics (*business intelligence*), so that, with this information, the system can be feedback.

Patients will be able to designate family members and/or friends to have access to the data captured and generated by the application, so that these people can provide social support for the treatment of hypertensive patients. In addition, a communication channel will be opened between patients that the application identifies in closer locations, in case the patient wants to share doubts, challenges and achievements.

3.2 Effectiveness testing

3.2.1 Participants

This stage of the study will involve the performance of a randomized and controlled clinical trial that will be conducted at the Sports Center of the Federal University of Santa Catarina, Florianópolis, SC. Based on a previous behavior change study[19], taking systolic blood pressure as a reference, taking into account an effect size of 0.8, power of 80% and alpha error of 0.05, the estimated sample size is 52 participants (26 per group). The recruitment of these participants will be based on the dissemination of the research in the local media (radio, newspapers, internet) and in social groups, distribution of pamphlets and posting of posters in the vicinity of the evaluation sites.

3.2.2 Screening

As inclusion criteria, participants must be over 18 years old, have a clinical diagnosis of SAH[3], have been using antihypertensive medication for more than three months, and cannot be involved in the regular practice of physical activities. In addition, participants must have a *smartphone,* they must not have cognitive disabilities that limit the understanding and use of an application and/or physical limitations that make it difficult to practice physical activities. Changes in the type and/or dose of antihypertensive drugs used during the study will be considered as exclusion criteria.

3.2.3 Randomization

After the pre-intervention assessments, participants will be randomized into two groups: app group (GA) and control group (CG). This randomization will be performed in blocks, according to sex and pre-intervention blood pressure, from a table of random numbers, by researchers who are not directly involved with the recruitment of participants and with data collection.

3.2.4 Experimental Design

Participants will be submitted, before the start of the intervention (pre-intervention), to laboratory blood pressure assessments, adherence to drug treatment, physical activity and lifestyle. Afterwards, the GC will participate in an informative lecture on healthy habits and general aspects of SAH control and treatment, while the GA will be submitted to the use of the application for eight weeks. At the end of these eight weeks of intervention (post-intervention), the participants of both groups will be reassessed in all the items analyzed at the pre-intervention moment. It is noteworthy that the researchers involved with the evaluations and data analysis will be blinded regarding the randomization of the participants.

3.2.5 Application group

Participants undergoing the GA will be instructed on how to *download* the application and how to use it. From there, all personal data must be entered into the application so that alerts, tips and incentives can be issued to each one, individually, as described in item 3.1 (application development).

3.2.6 Control group

The GC, in turn, will participate in a single lecture, in the first week of the intervention, with basic guidelines related to the key points of the treatment of SAH, including the importance of medication adherence, monitoring of blood pressure values and/or capillary glucose, lifestyle modifications linked to physical activity, eating habits, smoking cessation, stress management and moderate alcohol consumption.

3.2.7 Laboratory blood pressure assessment

The laboratory blood pressure (systolic and diastolic) will be obtained in two days, at a similar time, using the OMRON automatic equipment, model 742HEM. On each day, three measurements will be performed with an interval of one minute between them, with the cuff placed on the left arm, elevated to the height of the midpoint of the sternum. If the variation of these three measurements is greater than 4 mmHg for systolic and/or diastolic blood pressure, new measurements will be performed until this established criterion is met. The average value between the measurements obtained on the different days will be recorded as a reference value at the different moments of the study.

3.2.8 Assessment of medication adherence

Adherence to the medication will be assessed using the Morisky's Therapeutic Adherence Scale of eight items, translated into Portuguese and validated by Oliveira-Filho et al.[20], in the pre and post-intervention moments.

3.2.9 Assessment of habitual physical activity

Habitual physical activity will be assessed using accelerometry, using devices of the GT3X and GT3X+ models (Actigraph Pensacola, FL, USA) and the Actilife software (Actigraph Pensacola, FL, USA). Each participant will be instructed to use the accelerometer for seven consecutive days, removing it only to sleep, shower or perform water activities. The device will be placed on an elastic belt and fixed on the right side of the hip. Data will be collected at a frequency of 30 Hz and analyzed in 60 s epochs. Periods with consecutive zeros for 60 min or more (with a 2 min tolerance) will be interpreted as non-use time

and excluded from the analysis [21]. For analysis purposes, a minimum of 10 hours of daily activity recordings, for at least four days, three weekdays and one weekend day will be considered valid data. The average time spent in each intensity of physical activity will be calculated from the cut-off points proposed by Freedson et al. [22], considering sedentary behavior as 0 – 99 counts/min, light physical activities as 100-1951 counts/min, moderate physical activities as ≥ 1952 counts/min and vigorous or very vigorous activities as ≥ 5725 counts/min. Data will be analyzed in min/day, adjusted by number of days of use and daily time of use.

3.2.10 Lifestyle assessment

Lifestyle will be evaluated using an adapted version of the Fantastic questionnaire which includes questions related to the following components: nutrition, physical activity, preventive behavior, social relationships and stress control. For each question, patients will answer whether such behavior is not part of their lifestyle, rarely matches, almost always matches, or always matches.

3.2.11 Evaluation and patient satisfaction with the application

At the end of the intervention, patients undergoing the GA will be invited to answer an adapted version of the assessment scale for *smartphone applications* for health care, proposed by Jim and Kim [24], which contains 23 items in total, related to the assessment of content, objectivity, interface design, writing style and technology, with response options ranging from zero (not at all) to four (a lot), generating an overall score. From there, all adjustments that are considered relevant will be made so that the final version of the application will be available on Apple iTunnes and Google Play.

3.2.12 Statistical analysis plan (SAP)

Initially, the normality and homogeneity of variance will be analyzed using the Shapiro-Wilk and Levene tests, respectively. For data that do not have a normal distribution, logarithmic transformation will be performed. Student 's t test for independent samples and the chi-square test will be used to compare the groups at the pre-intervention moment, regarding continuous and categorical variables, respectively.

For the Intra and inter-group comparisons of quantitative and qualitative variables, the method of generalized estimation equations will be used (group: GA and GC; time: pre and post-intervention assessments; interaction (group vs. time), after confirming the appropriate assumptions. In all analyses, when a significant effect is verified, the Newman-Keuls post-hoc test will be used, with a P value <0.05 being considered significant.

3.3 Usability and patient satisfaction testing

After the application is made available on Apple iTunes and Google Play and the application is disseminated in groups of Basic Health Units and in the media (advertisements on television, newspaper, radio), the number of downloads and the grade assigned to user evaluations will be evaluated (one, two, three or four stars), according to the sociodemographic characteristics of the user (gender, age, place of residence).

3.4 Ethical issues

This study will be submitted to the Research Ethics Committee of the Federal University of Santa Catarina, will follow the rules of Resolution 466/12 of the National Health Council on research involving human beings and the stage involving the performance of the clinical trial will be registered at ClinicalTrials.gov.

FREE AND CLARIFIED CONSENT TERM

Title: DEVELOPMENT, EFFECTIVENESS AND USABILITY OF A MOBILE APPLICATION TO ASSIST IN PHARMACOLOGICAL AND NON-PHARMACOLOGICAL TREATMENT OF ARTERIAL HYPERTENSION

Responsible Researcher: Dr. Aline Mendes Gerage da Silva (CDS/UFSC)

You are being invited to **voluntarily participate in** this study, which is linked to the Sports Center of the Federal University of Santa Catarina. If you decide to take part in the study, you will need to know the possibilities of risks and benefits and confirm your participation through this free and informed consent form. This document clarifies the study you wish to participate in. If you have any questions, please feel free to contact the team responsible for conducting the study and we will clarify your doubts. This research is based on Resolution 466/2012 of the National Health Council and the researchers are committed to complying with all its items.
The decision to take part in the study is **voluntary** and you can refuse or withdraw from the study at any time without prejudice.

1. The **objective** of this research is to analyze the effectiveness of a mobile application aimed at drug and non-drug treatment of arterial hypertension on systolic and diastolic blood pressure, adherence to drug treatment, habitual physical activity and lifestyle in hypertensive adults .

2. Justification: Arterial hypertension is a multifactorial cardiovascular disease, which stands out as an important risk factor for the development of other cardiovascular diseases, which are the main causes of death in Brazil and in the world. Despite the evidence of several effective treatments for arterial hypertension, in Brazil, it is estimated that more than half of hypertensive patients do not undergo any treatment. Among the possible reasons for this, low adherence to the proposed treatment (drug and non-drug) and deficiencies in health care systems in approaching the treatment of chronic diseases such as hypertension stand out. In this context, in order to improve the control and treatment of the disease, the development of innovative methodologies that provide strategies to increase adherence to drug treatment and facilitate changes in lifestyle are necessary.

3. Experimental Phase Procedures: One of the guardians will explain in detail all the procedures that you will undergo when you agree to participate in the study, as specified below.

- Before inclusion in the study, you will be screened in order to identify if you fit the profile of our study. You will answer some questions about your age, income, medications in use, lifestyle and adherence to drug therapy, as well as your blood pressure and your usual level of physical activity will be measured.

- After inclusion in the study, for eight weeks, you will participate in a group that will have access to a cell phone application or a control group, which will participate in a single lecture, with basic guidelines related to key points of the treatment of arterial hypertension, In addition, at the end of these eight weeks, you will be evaluated again regarding the medications in use, lifestyle and adherence to drug therapy, as well as the measure your blood pressure and your usual level of physical activity.

4. Expected Discomfort or Risks: All examinations and tests in this research are safe and well tolerated. The collections will be carried out by health researchers, experienced and trained for each measure. However, some discomforts may occur. In general, you can expect:

- The blood pressure measurement in the office can generate pain because the cuff will keep squeezing the arm, but it is important to emphasize that the procedure is very fast (on average 30 seconds for each measurement);
- Questions related to income, medications in use, lifestyle and adherence to medication therapy may cause you embarrassment, however you have the right not to answer any questions you are not comfortable with. ;
- Monitoring your physical activity can cause discomfort, as you will have to remember whenever possible to attach a small monitor (accelerometer) to your waist, not forgetting to take it off when you go to sleep or when you shower or when perform any water activity.

As they are health professionals, in case of eventual complications that may arise at the time of collection, the researchers will take the necessary measures to stabilize the patient.

5. Expected benefits: The data used in this research will help to know if the application under test improves blood pressure and adherence to drug and non-drug treatment (lifestyle changes) of hypertensive patients on a daily basis. In addition, by participating in the project, you will have an assessment of various parameters of your health that will be made available whenever you want.

6. Withdrawal of Consent: You may withdraw your consent and withdraw from participating in the research at any time, without prejudice.

7. Guarantee of Confidentiality and Indemnity: The information obtained in this research will be analyzed together with that of other patients, and their identification will not be disclosed at any time. However, it is important to inform that there is a remote possibility of an involuntary and unintentional breach of confidentiality of the participants (for example, loss or theft of documents, computers, software, flash drive) and, in this situation, the consequences will be dealt with under the terms of the law. You may, at any time, have access to the information contained in this statement or to any other information you wish about this study, including the results of your exams. There are no costs for you related to the exams, consultations of this project. The research team guarantees the reimbursement of possible personal expenses arising from participation in this study. There is also no financial compensation related to your participation. If there is any additional expense related to the experimental procedures, the research team will make the corresponding reimbursement. The data collected

will be used exclusively for the purposes of this research. In addition, in the event of any material or immaterial damage resulting from the research, you will be entitled to compensation as recommended by the current resolution.

8. The Research Ethics Committee (CEP) is an interdisciplinary and independent collegiate, which must exist in institutions that carry out research involving human beings in Brazil, created to defend the interests of research participants in their integrity and dignity and to contribute to the development of research within ethical standards (Regulatory Norms and Guidelines for Research involving Human Beings – Res. CNS nº 466/12). The CEP is responsible for the evaluation and monitoring of research protocols in terms of ethical aspects.

- **Address of the CEP of the Federal University of Santa Catarina:** Rectory Building II R: Desembargador Vitor Lima, nº 222, room 401, Trindade, Florianópolis/SC. CEP 88.040-400. Contact: (48) 3721-6094. E-mail: cep.propesq@contato.ufsc.br

After these clarifications, we ask for your consent to participate in this research. Two copies of this document were prepared and will be initialed and signed by you and the researcher in charge, and one of these duly signed copies will remain with you.

At any stage of the study, you will have access to the professionals responsible for the research for clarification of doubts.

9. Post-Information Consent:

I, _____, after reading and understanding and discussing this information and consent form, understand that my participation is voluntary, and that I can withdraw from the study at any time, without prejudice. I confirm that I have received a copy of this consent form, and I authorize the carrying out of the research work and the dissemination of the data obtained only in this study in the scientific environment.

_____

Participant's Signature

Date: ____/____/_____

10. I, _____ (responsible researcher), certify that:

a) Research ethics implies respect for human dignity and the protection due to participants in scientific research involving human beings;

b) This study has scientific merit and the team of professionals involved is trained, qualified and competent to perform the procedures described in this term;

c) This research is based on Resolution 466/2012 of the National Health Council and the researchers are committed to complying with all its items.

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