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AN MHEALTH SYSTEM TO SUPPORT HEALTH EDUCATION AIMING THE TREATMENT OF OBESITY IN ADULTS

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ABSTRACT

The purpose of this article is to present an mHealth system based on the Transtheoretical Model of Behavior Change, on persuasive technologies and on mobile design heuristics for touch screen devices to promote healthy habits and obesity reduction. The research was descriptive and explanatory with applied nature and quantitative approach. Regarding technical procedures, a quasi-experimental research was characterized. A pilot study was conducted with a sample of 58 users, organized into two groups with different levels of intervention. Group 1 (G1) had interaction via the developed application and Group 2 (G2) had interaction via the developed application plus social networks. The metrics applied to assess the results were: weight, waist and hip reduction, as well as application usage time. In both groups, a reduction was observed in the measures considered in the intervention. This research allows several developments, such as the motivation of users through gamification and the encouragement through social networks. In addition, due to the potential amount of user data, several studies of Data Mining for Big Data can be performed with the information obtained by the system. The idea is to keep the system free, open source, with an anonymous data usage policy in order to maintain users' privacy, but open for further research.

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INTRODUCTION

At the 71st World Health Assembly[1] in 2018, the potential of digital technologies to assist public health was recognized, and the resolution taken by the rulers was to prioritize the development and greater use of digital technologies in health, as a means of promoting universal health coverage. Eysenbach (2001) defines eHealth as an emerging field at the intersection of medical informatics, public health, and business, referring to health services and information provided or improved over the Internet and related technologies. The dissemination of the Internet via mobile devices led to the emergence of a subdivision of eHealth, where the use of Information and Communication Technologies (ICTs) for health care using mobile devices was called Mobile Health or mobile Health (mHealth). Although there is no standardized definition of the new concept, mHealth can be understood as the provision of medical and/or public health services through the technological support of mobile devices, such as mobile phones, sensors and other wearable equipment, such as devices directly connected to the user (WHO, 2011).The study published in Lancet journal[2] shows that the number of obese people in the world has grown six-fold in the last four decades, from 105 million overweight people in 1975 to 641 million in 2014, a fact that has been worrying several countries. The use of mHealth as support for health education can bring great advances in this field, and several studies in the area of health and technology are emerging to understand and create effective persuasive technological systems. The use of mobile devices in the health context can be justified by the concentration of three factors: the chronic diseases increase, the decrease in access to clinical care, and innovations in the field of mobile technologies (Morris, 2012).

[1]https://apps.who.int/gb/ebwha/pdf_files/WHA71/A71_20-en.pdf

[2]https://www.thelancet.com/pdfs/journals/lancet/PIIS0140-6736(16)30054X.pdf

The purpose of this article is to present an mHealth system based on the Transtheoretical Model of Health Behavior Change (TTM), on persuasive technologies and on mobile design heuristics for touch screen devices to promote healthy habits and obesity reduction. The intention is to offer a mobile application to be used as support for health education, contemplating a portion of the population that does not have social and financial conditions for acquiring more targeted information, profile oriented and according to their reality. The article is structured in six sections including introduction and conclusion. Section II summarizes the theoretical framework from the main authors on which studies this research was based. Section III describes materials and methods used, and section IV brings the development of the system application, and more details about its implementation. The interpretation of the results will be described in section V and the conclusion in section VI.

II. THEORICAL FRAMEWORK

The theoretical framework that supports this research comes from the areas of education, psychology, information technology and design, in order to present and relate important concepts to demonstrate the relevance of using persuasive technologies in health education. Initially, we bring the concept of health education as an education process of building knowledge for the general population to understand the theme, it is not a professionalization or to build a career in health. It is also related to a set of practices that contribute to increasing people's autonomy on their care and the debate with professionals and managers to reach a type of attention that answers people's needs (BRASIL, 2012). This research was based on the Dialogic Model of Education in Health, understanding education in health as a process of awareness, change, and transformation, characterized by a philosophy of subject emancipation (Figueiredo et al., 2010). The concept of mobile learning with the use of mobile technologies, by itself or together with other information and communication technologies (ICTs), is interconnected, allowing learning anytime and anywhere (Unesco, 2014). Thus, learning can happen in different ways, as people can use mobile devices to access educational resources, connect with other people, or create content, in or out the classroom. Mobile learning has exclusive features if compared to conventional technological learning and can be used as a support to formal and informal learning, having great potential to transform the way education and training are offered (Unesco, 2017).

Persuasive technologies are defined as those intentionally developed to change one's habits (Fogg, 2009). They can be used inside or outside school to motive users to acquire new knowledge and abilities. Besides this, the author highlights that persuasive technologies can also motivate individuals to start certain learning processes, do some tasks, revise materials when needed, as well as continuing a certain activity. Hence, systems could be developed to help the learning process, providing information to people anytime anywhere. The Transtheoretical Model to Behavioral Change (Prochaska and DiClemente, 1987) is proving to be promising on understanding and explaining most behaviors in health. It was created through the comparative analysis of 29 theories and models of the main psychotherapy approaches, such as the cognitive-behavioral, humanist, psychoanalysis, and Gestalt. While other behavioral change models are exclusively focused on change dimensions (for example: theories focused mainly in social and biological influences), the Transtheoretical Model to Behavioral Change (TTM) tries to include and integrate key-constructions of other theories into a broader one that can be applied into a variety of behaviors, populations, and configurations. The TTMis considered an integrative and biopsychosocial model based on principles developed from more than 35 years of scientific research and aims to understand and explain most health behaviors. The model applicability proves to be very successful for health education, as it seeks to understand how people make lasting changes in their lives, and that they go through different stages until the changes in attitudes, intentions and behaviors are perceived, taking into consideration the existing motivation for these changes to occur.Certain principles and change processes work better in each stage to reduce resistance, ease progress, and avoid relapses. The authors point out that the construction of stages represent a time dimension and change implies phenomena that take place during time, recognizing self-efficacy as a predictor of promoting and maintaining behavior change. It is worth highlighting that the concept of self-efficacy is from the Social Cognitive Theory of Bandura and refers to the understanding that individuals have the capacity to conquer their objectives, even their difficulties (Bandura, 2006). Besides this, TTM identifies change as a process that develops during time, involving the progress through the following stages of motivation:

1. ***Precontemplation*:** the individual does not have the intention of changing the behavior in the following six months. A common saying among people in this stage is "I am chubby, but I am happy, I can't live without a little sweet".
2. ***Contemplation*:** the individual is more aware of the pros of changing, but also its cons. An example of a typical saying of those in this stage is: "I really think that my health should improve, but I can't see myself dieting or even exercising".
3. ***Preparation*:** the individual has already taken a significant action but has not reached an effective action. These are the ones that should be recruited to action-guided programs and have already verbally expressed themselves with phrases such as: "this week I went to several gyms close to my house, I checked prices and schedules. I want to choose one of them and start next week".
4. ***Action*:** the individual has done specific changes in his/her lifestyle and the behavioral changes are more evident, demanding more time and energy. An example of phrase at that stage is "I can follow the dietary tips the nutritionist gave me and I'm exercising at least three times a week".
5. ***Maintenance*:** the individual has done specific changes in his/her lifestyle and is working to avoid a relapse. A common testimony of those in this stage is: "I've changed my lifestyle, I am keeping my weight with healthy food and exercising for the past six months, and I'll continue to prioritize my health".

Prochaska, DiClemente, and Norcross (1992) highlight that any activity that helps the alteration of behavior, feeling, or way of thinking is a process of change. Such processes can be divided into two groups: cognitive- experiential (characterize the first three stages if change) and behavioral (more present in the stages of action and maintenance). However, one of the main problems associated to behavioral health changes is not only the adoption of healthy behaviors but maintaining them and avoiding a relapse.Besides the Transtheoretical Model[3], we were based on Fogg´s Behavior Model[4] and Margaret Morris's guidelines (2012), both focused on persuasive technologies to change behavior aiming the adoption of healthy habits, having in mind the support of mobile learning in health education.

According to Fogg (2011), the main factors that affect which path (peripheral or central) an individual uses to process an image are: motivation (the wish to process a message); ability (the ability for critical evaluation); and trigger (any stimuli, external or internal, that indicate an action). The role of the trigger is to indicate the ideal moment to do a certain action, becoming one of the most important environmental elements.

There are three initial phases to FBM (Fogg, 2014). The first is to identify a specific result you want to reach, for example, losing 10% of body weight. The second is identifying easy behaviors to acquire, what the author calls "tiny habits"[5] , that will lead the way to the wished result, the aim is to project the need to feel highly motivated to fulfil a task, as motivational levels come and go. It is important to highlight that a method might work for some people and not for others. For example, meditating can reduce stress but might not initially work to help changing a behavior in certain types of people. Perhaps walking or having a massage might reduce more stress than meditating. A third phase is to find a trigger, something that is already a habit and perceiving a new habit in it. For example, placing an apple in the countertop as you turn on the coffee maker every morning or always taking a deep breath before going to bed. That is, you do not need to eat an apple every morning nor meditate before sleeping. If an action is "tiny", does not demand a lot of effort, it is easier to make it when starting a new habit. As you start the first action, the rest of the desired behavior naturally unfolds: "if I had already put the apple in the counter, maybe I could eat it" or "if I had already taken a deep breath, I could try meditating a whole five minutes" says Fogg (2014).

Other important points to consider in this model, which meet the aims of the mHealth proposed, is that to create a persuasive system there needs to be a clear definition of the purpose and the exact moment in which the behavioral change takes place by converging three factors (motivation, ability, and trigger).Margaret Morris (2012) writes that, as it is intertwined in almost all aspects of life, mobile technology is suited to guide health life choices. However, to change a behavior, they need to go beyond self-tracking, providing tips and access to an online community. Apps focusing on the adoption of healthy habits need to solve disconnections between long-term intentions and immediate choices. To do so, she proposes seven guidelines based on a series of techniques that were evaluated to health interventions, as well as persuasive communication, focusing on adopting healthy habits through mobile apps. These are:

1. ***Remind people of who they want to be,*** clarifies two efficient ways to resort to personal ideals, that are through the contrast between values and behaviors and positive reinforcement, when people feel special doing what they are doing and are willing to consistently keep healthy habits.
2. ***Foster an alliance,*** explains that the devices should know users' objectives and point to the correct direction, something like the relation between a therapist and the patient.
3. ***Apply social influence,*** aims to portray detailed narratives or videos that show other people's successful strategies, in the same or similar context, that can influence behavior and promote self-efficacy.
4. ***Show people what they could lose,*** reinforce that people need help to understand the health losses they could endure due to poor self-care.
5. ***Put the message where the action is,*** explains the importance of establishing the message in the context of use, that is, the closer a reminder is in time and target activity, the more efficient it will be. For example, instead of encyclopaedical nutritional indexes, it is better to have health messages with simple heuristics, such as the common reference of using the hand palm as a guide for portion sizes.
6. ***Raise emotional awareness***, aims to deal with users' emotional awareness, in which cloud computing eases the analysis of individual and group data and allows a quick feedback to individuals about their own tendencies and how they compare to others, enabling an interference in their motivation.
7. ***Reframe challenges***, examines people's reactions to daily events and considers alternatives, helping them respond, more constructively, to challenging situations.

We considered that, to develop the proposed mHealth system, these guidelines would help understanding the ways mobile devices can interact with users, to incentivize behavioral challenges related to health, as well as maintaining the adoption of healthy habits. In terms of user interface, we considered the design principles suggested by Inostroza et al. (2013) regarding interfaces of touchscreen smartphones focusing on usability.

According to the authors, traditional methods to evaluate usability are not worried with the nature of touchscreen devices. So, there is the need to develop new methods to evaluate usability, or, at least, to use the existing methods in a new way. To define their principles, Inostroza et al. (2012) relate some challenges to evaluate usability in these types of devices, such as: context of mobile use, size of the small screen, screen resolution, limited processing capability, memory, and energy, besides the methods of data entry. To create its heuristic set, they used a methodology composed of 6 stages:

1. ***Exploratory stage***: bibliographic research to collect issues related to the main research topics, such as specific applications, characteristics, heuristics of related usability (if any).
2. ***Descriptive stage***: highlight the most important characteristics of the information previously collected, formalizing the main concepts associated to the research. Re-examines the meaning of usability in the context of specific applications.
3. ***Correlational stage***: identify the characteristics that usability heuristics should have for specific

[3]https://www.prochange.com/transtheoretical-model-of-behavior-change
[4]http://www.behaviormodel.org/
[5]https://www.tinyhabits.com/

applications, based on traditional heuristics and the analysis of case studies. Nielsen's 10 heuristics establish its base.

4. ***Explicative stage*:** specify the set of proposed heuristics, using the standard template.
5. ***Validation stage*:** check new heuristics vs traditional ones, through heuristics evaluation in specific case studies, complemented by users' tests. The application is evaluated by two separate groups of evaluators, with similar experiences, in equal conditions. A group has used the heuristics set defined by stage 4, while the other used only Nielsen's heuristics. Usability problems found by both groups are compared.
6. ***Refinement stage*:** based on the feedback given in the validation stage, the heuristics defined in stage 4 are refined.

After the six stages proposed, a set of heuristics was created to evaluate usability in mobile devices based in touchscreen. Such principles were based on Nielsen's heuristics and its definition methodology supported the process of development and refining described above. Aware of the importance of the validation stage to add value to the product, the authors did some experiments (Inostroza et al., 2013), including a second heuristics evaluation in another model of mobile device. Totalizing, at the end, a set of 12 revised heuristics to mobile touchscreen devices: 1) visibility of system; 2) match between system and real world; 3) user control; 4) consistency and standards; 5) error prevention; 6) recognition; 7) customization and shortcuts; 8) efficiency and performance; 9) minimalist design and aesthetic; 10) help to recognize and recover from errors; 11) help and documentation; 12) physical interaction and ergonomics.According to Inostroza et al. (2013), user loyalty can be achieved through an easy-to-use interface. Efficiency, efficacy, and satisfaction in use mean a good usability.

Thus, we intend to make users' interaction pleasant and make their use of the app motivating, keeping the theoretical basis focused on the previously mentioned stages which involve the understanding of the process of behavioral change, as well as the evaluated techniques to health intervention, such as persuasive communication.This research was also support in a study conducted to understand the main functionalities of mobile applications aimed at controlling obesity (Barbosa et. al, 2016), as well as a systematic review on the use of mHealth to assist in weight loss (Barbosa et. al, 2017). With the results obtained, it was possible to improve the Emagreça@Saudável (Lean@Healthy) system.

III. MATERIALS AND METHODS

The research was initially structured as descriptive and, later, explanatory, with an applied nature and quantitative approach. The use of resources and statistical techniques were considered. From the point of view of technical procedures, a quasi-experimental research was carried out.First, the main theoretical references and the main functionalities of mHealth for behavior change in health were analyzed, focusing on the control of obesity in adults, reconciling some concepts with theories arising from the areas of psychology and education, as well as the area of Design.

After that, the idealized mHealth system was developed, including prototyping, database elaboration, interface definition and implementation, which will be described in session 4. Before making the prototype available to the public, its usability was assessed. This assessment was based on the standard ISO/IEC 25062 (2011), using a questionnaire based on the five-point Likert scale, considering the score: 1 = Totally Disagree, 2 = Partially Disagree, 3 = Indifferent, 4 = Partially agree and 5 = Totally Agree. The questions were based on the design principles suggested by Inostroza et al. (2013), which are: Satisfaction, Utility and Ease of Use. 10 specialists answered the usability questionnaire, which are considered enough to achieve significant results according to ABNT ISO/IEC 25062.

The specialists were selected in the areas of health, computing and education. Among computing specialists, two had experience in usability regarding touch screen cellphones. The results validated the good mobile application usability (2018).Regarding data collection, we considered the sampling technique for quantitative analysis, besides the observation with content analysis, and questionnaires for a qualitative analysis. Regarding technical procedures, we did a quasi-experimental research. It is worth highlighting that all adopted research procedures follow the Ethics Criteria for Research with Human Beings, according to the Resolution nº. 466/12 of the National Health Council. The project was registered and approved by the Ethics Committee/Brazil, number 63164016.9.0000.5347.

The defined sampling technique was non-probabilistic for convenience, which al-lows any individual to comply with certain characteristics, to have their representativeness in the universe. Regarding the sample, the participants were invited using the Facebook Social Network, between February and June 2019. The inclusioncriteria were the interest in reducing weight; BMI ≥25 kg/m²; between 18 and 59 years old; literate; and having a compatible smartphone. The 78 participants that accepted the invitation and fit into the inclusion criteria were divided into 2 groups:

- *Interaction Group 1 (G1)*: use of the mobile application, with usage guidelines only through tutorials on the YouTube Channel; Questions could be made only using the general Whatsapp group; Access to the Facebook page; Reception of information through the App.
- *Interaction Group 2 (G2)*:same of G1 but including participation in a private group on Facebook (allowing a more direct interaction with a specialist in physical education).

The experiments with the participating users were based on quantitative data evaluations, mainly weight, waist circumference and hip measurements. The data was inserted by the user using the mobile application. The analysis was performed using the statistical package SPSS version 20.0 and the Microsoft Excel 2010 spreadsheet. To evaluate quantitative variables changes over time, the Generalized Estimating Equation Model (GEE) was used. A significance level of 5% was considered for the established comparisons. The analysis of the application use was made including only users with participation above 75% considering the duration of the experiment. The results are discussed in section V.

IV. SYSTEM'S IMPLEMENTATION

The health education support system entitled as Emagreça@Saudável (Lean@Healthy) is constituted by an Android application on the client mobile device and a server application on the cloud. It has interfaces and functionalities that consider the concepts and theories related to health behavior changes mentioned in section II. The system is nonlinear, since the components related to context, persuasive technologies and design principles influence each other directly. The first three boxes of Figure 1 (Transtheoretical ofBehavioral Change, Behavior Model, Seven Guidelines) illustrate the behavioral theories and guidelines that support the construction of the system, to allow an effective behavior change using persuasive technologies.

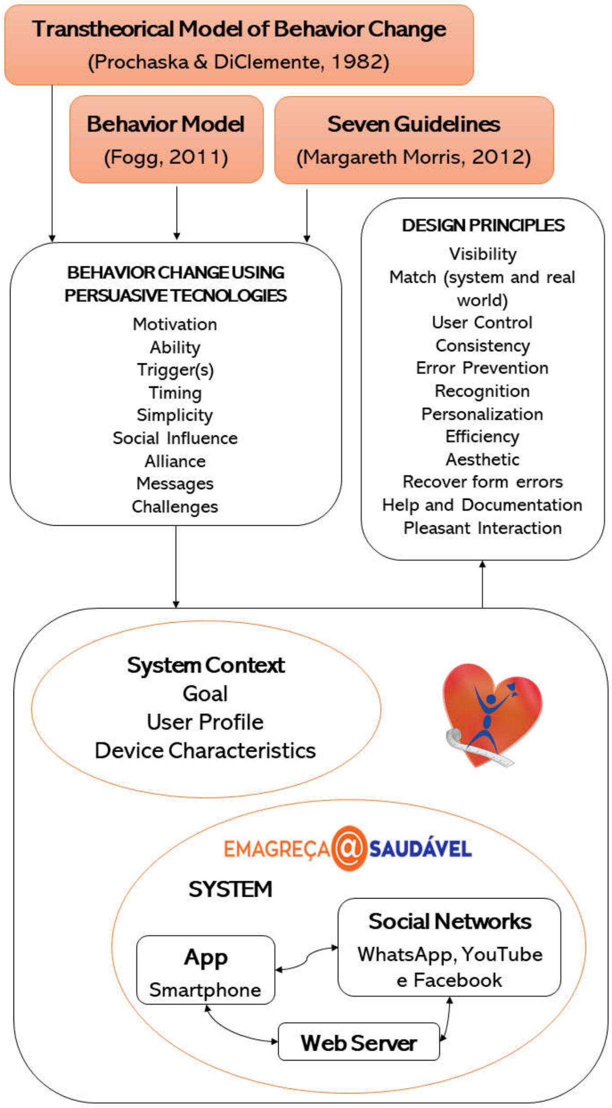


Figure 1. Macro Vision of the System

The biggest box shows the context of Emagreça@Saudável system. We considered the system objective (to make available an app for mobile devices related to health care, with incentives to individual behavioral changes to prevent and treat obesity, supporting actions of health education); the user's characteristics (general characteristics of people using it - age, gender, educational level, etc. - and their health needs, intentions, and their environment); and also the characteristics of devices (advantages and limitations to use a smartphone).

The Emagreça@Saudável system is composed by:

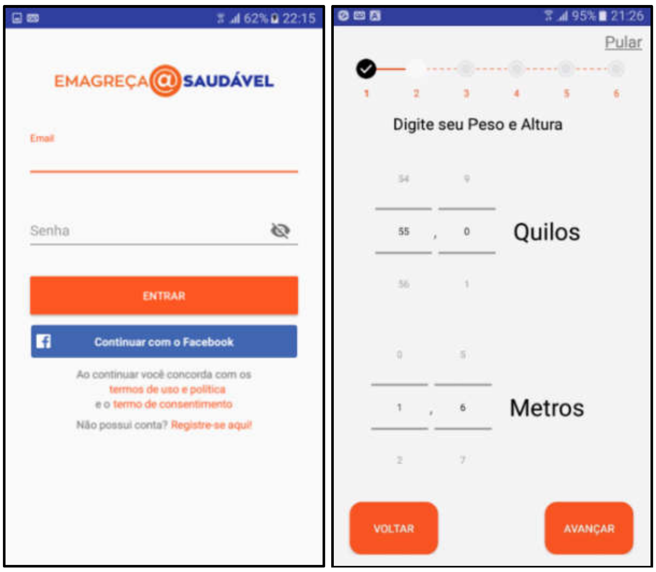
a) *Application for mobile devices:* the app is the main interface where users can register their data, do the proposed tasks and challenges, watch educational videos, follow their developments, and receive guidance. The data are locally stored and sent to server.
b) *Social networks:* Facebook page, YouTube channel, and WhatsApp were used as support for app users, as storage for videos, audios, and texts with health tips. As well as spaces in which users could talk, share experiences, and "compete" in the gamification model. Through WhatsApp via app, it is also possible to group users by profile and send messages to specific groups. Such features are available in the Server.
c) *Server:* has the database that stores all users' information, working as a communication support with the mobile devices and social networks. It is a system that, besides generating statistics, allow the follow-up and work of a multidisciplinary network of professionals. The content is inserted by experts in the area. The system architecture was developed focusing on the separation between code and content, that is, the health professional inserts/removes content straight to the server, with no intermediation of a developer. The server also allows sending messages directly to certain profiles or to the whole group. This is key for the communication between the multidisciplinary team and the participants.

The mobile application was developed at this phase only for the Android platform, since this is the most widely used mobile operating system in the world and in Brazil[6]. For the development of the server-side application (on the server), the JAVA language was used employing the Model View Controller (MVC) software architecture, using the Java Server Faces (JSF)[7] framework, a technology that allowed great modularity to the system. The application hosting was made using Oracle GlassFish Server. The server allows access to information through Representational State Transfer (REST) services, generating a data communication interface layer, which in turn is made available to the mobile application, allowing CRUD operations (Create, Read, Up-date, and Delete) to be performed in the data stored in the database. PostgreSQL[8] was used for bank management. The application's web interface allows administrators to access the system, create and update the mobile application content, as well as managing and viewing the data of registered users. For communication between application and server, the HTTP Retrofit[9] client was used, which simplifies the task of consuming Web Services. In order to the client in the mobile app retrieve information, it must issue an HTTP request using one of the methods GET, POST, PUT, or DELETE. The requested data is returned formatted in JSON[10] (JavaScript Object Notation) format.More than 15 Web Services were created, each of them with at least one of the four methods mentioned above. In addition to the server database, an in-app database was used, which is a local database used only for

[6]http://gs.statcounter.com/os-market-share/mobile/brazil
[7]http://www.javaserverfaces.org/
[8]https://www.postgresql.org/
[9]https://github.com/square/retrofit
[10]https://www.json.org/

user-level data persistence, seeking efficiency and speed of response in the mobile device application. This strategy avoids, for example, performing multiple downloads of user profile information and tasks, which would take unnecessary time if reloaded every time the application starts. The app also counts steps via the Android SDK. In order to facilitate maintenance and improve performance, other strategies were used, such as the injection of dependencies and reverse control. Aiming to prepare the system for future research in BigData, Data Mining and Deep Reinforcement Learning, the system captures as many data as possible to allow future data mining research on how to increase application effectiveness through increased motivation, learning and commitment of the users. Thus, in addition to the profile information, more data is collected, as the exercise preferences, extract of points, motivational messages issued, among others.

The communication protocol between the mobile application and the Web server was based on Web Services (Papazoglow, 2008), because it allows the integration of different applications into different operating systems, such as the developed system, which integrates, in addition to social networks, an Android mobile device application and a Linux Web server. The application "polls" the server at regular intervals (hourly), checking for new notifications. The first time the user enters the app, a welcome message appears and then the user needs to log in (or sign up), with an account using the application, or using the private Facebook community (Figure 2a).



2a **2b**

Figure 2. Access and Registration

After, profile information is requested, such as age, schooling, alcohol/cigarette,and medications use. Weight, height measurements (Figure 2b),waist and hip are essential to calculate user follow-up metrics, such as Body Mass Index (BMI) and Waist to Hip Ratio (WHR). Such measurements are self-reported and must be inserted by the users. An image is provided in the application to show the correct location of the measurements, and a video tutorial is available on the YouTube Channel.Figure 3 shows the "Tasks" screen, with a summary of the user's progress (number of steps, stage, score, goal points to be met, and how many days the user must finish the tasks).

It also presents Challenges and Activities that must be fulfilled throughout this stage. When activities are completed, a check icon appears in the square next to the activity title and they go to the end of the list. Activities and Challenges were pro-posed aiming a complete reeducation of habits in many areas, like physical activities, nutritional habits, motivation, relaxation, among others. The user is not obliged to do all activities and can adapt them according to their lifestyle and needs.

Figure 3. Tasks Interface, with summary in the top

The main interface has a blue bar on the bottom (Figure 3) with buttons that lead the following areas of the application:

Food: the intention is not to control calories, but to bring nutritional tips, as well as information about healthier eating styles so that the user can understand and make more accurate choices.

Exercises: displays a list of common physical activities with average kcal spent for training time. In this tab the user can register the time they performed an exercise, and the resulting points will be added to the user score, motivating him/her to use the application and to record their physical activities.

Score: explains and displays the user score in the system, seeking to motivate them in a kind of gamification, comparing the score of the registered users.

Evolução (Evolution): displays graphs of weight evolution, waist, hip, BMI and WHR.

To almost all presented derivations, the app brings, in textual format, graphics, audios, or videos, information and tips that may help users to understand the health losses they might suffer, if they opt to not follow a satisfying self-care routine. At the upper left corner of the screen (Figure 3), there is the icon . By clicking on it, you can access:

- ***Profile***: here users can edit their personal information and the photos they wish to use. It also shows their measures (initial and current), there is the option to see the BMI and WHR tables, following their progress.

- ***History***: users can visualize their history of tasks done and points gained, as well as exercises and minutes of registered trainings.
- ***Motivational***: the system sends a message with a motivational phase each day, which are stored in this space, in case user wants to read it again, save, and share.
- ***Messages***: directly sent, through an interdisciplinary support team, in suitable moments considering each user's profile. The place where messages are stored in case user wants to check them.
- ***Configurations***: allows users to adjust the configurations of the app, define times to receive the notifications of motivational messages or reminders of weekly measurements, for example.
- ***Frequently Asked Questions***: allows accessing the most frequently asked questions about the app, as well as service channels available via e-mail and help channel via WhatsApp.
- ***WhatsApp Group***: integrate participants into social networks to allow information and message sharing with other people in similar situation, or the exchange of knowledge.

To keep users' self-monitoring, measurements of weight, waist, and hip circumferences, are asked weekly, via notification sent to the smartphone. By touching the notification, the app automatically opens a screen to insert those measurements. As can be seen, the suggested interface proposal, as well as its unfoldings, aim to contemplate the recommendations for a persuasive communication focused on behavioral change to adopt healthy habits through mobile apps. It also considers the dialogic model of education in health, trying to stimulate users' reflection and critical spirit for them to act in the transformation of their realities. To access the server of Emagreça@Saudável, one needs a login, previously authorized by the admin. The Web address is http://emagreca.inf.ufrgs.br/. The server was designed so that the operation could be run by a multidisciplinary team with no strong knowledge on programming. Thus, the content is created by one or more specialists in the key areas of the project, inserted in the server database, and automatically updated and downloaded through the app. When visualizing a specific task, one can click into "edit" and change title, description, image or link to video, score, among others. Mobile-device users will receive a notification next time they enter the app. By checking a specific user, it is possible to see details of their profile. One can easily visualize indicators of medicine, measurements, graphics, and the balance of all their tasks, challenges, and exercises done. This allows, for example, to graphically check the tendence of weight loss, waist, and hip measurements, as well as BMI and WHR (Figure 4).

The paragraphs above detail a bit how the server works and all the possibilities that were designed and implemented towards an effective persuasive communication, respecting the theoretical references that grounds this research. In the content available, the remote follow-up, messages sent in certain situations, we took into consideration that an effective behavioral health change goes beyond adopting healthy behaviors but keeping them and avoiding a relapse.

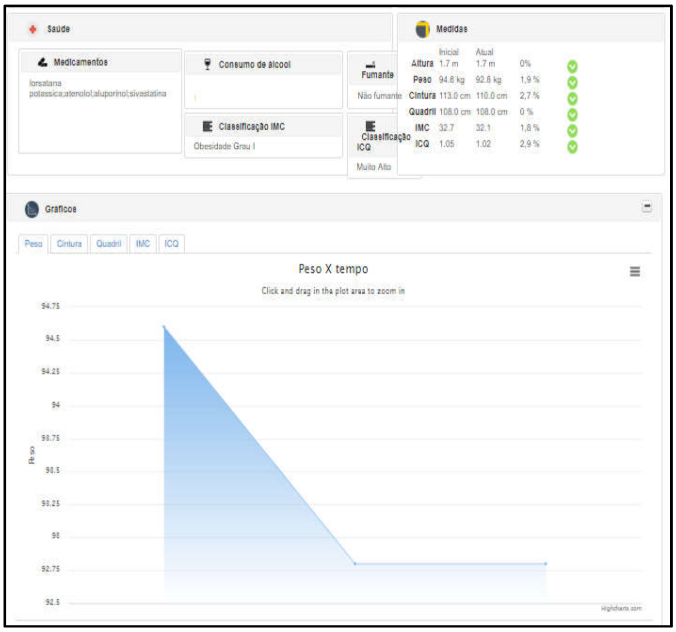


Figure 4. Interface exemplifying details of a specify user

V. RESULTS ANDDISCUSSION

The experiment had an initial amount of 97 participants organized as follow: 25 classified as "Normal weight" (BMI between 18.5 and 24.9); 39 were "Overweight" (BMI between 25.0 and 29.9); 19 classified as "Class I Obesity" (BMI between 30.0 and 34.9); 9 with "Class II Obesity" (BMI between 35.0 and 39.9) and 5 users with "Class III Obesity" (BMI >= 40.0). Among the 25 users classified as "Normal weight", only 14 had low Waist to Hip Ratio (WHR), and 11 had moderate to very high WHR, mostly women. This fact shows the relevance of associating both indices (BMI and WHR) to assess a higher or lower risk of overweight and obesity-related diseases, and not only BMI. That is because the BMI only checks weight in relation to the individual's height and does not reflect the distribution of the body fat.

From these 97 participants, only 78 met the inclusion criteria mentioned in section 3 and were considered in the research. So, these 78 users were organized into 2 groups of 39 participants (G1 and G2). Both groups presented loss of users, which did not update weekly their measures. Group G1, initially with 39 users able to participate, ended with a total of 28 users. Group G2, initially with 39 as well, finished with a total of 30. With the results obtained, it was calculated that the sample size of 58 users makes it possible to detect statistically significant differences in any evaluated quantitative variable (90% of the standard deviation), considering a power of 90% and an α=0.05.

Table 1 shows the statistical analysis of comparison between the two groups at the beginning of the study. When comparing the initial characteristics of the participants, there was a statistically considerable difference for gender. Group 1 had 85.7% of females, and Group 2 had 100% of females.However, this difference does not seem relevant from the point of view of the composition of the groups, since the groups are practically equal statistically (if rounding were used, it would already be with significance level of 5%).

Table 1. Group comparison at the beginning of the study

Variables	Group 1 (n=28)	Group 2 (n=30)	P
Female, n(%)	24 (85,7)	30 (100)	0,048*
Use time in days; average ± standard deviation	48,1±19,4	58,4±22,8	0,071**
Age in years; average ± standard deviation	36,8±10,5	37,7±8,9	0,731**
Height in meters; average ± standard deviation	1,62±0,07	1,62±0,04	0,939**
Initial weight in Kg; average ± standard deviation	80±11,2	77,3±8,8	0,315**
BMI in Kg/m2; average ± standard deviation	30,3±2,4	29,4±2,4	0,157**
Waist in cm; average ± standard deviation	96,3±12,0	93,1±8,2	0,840**
Hips in cm; average ± standard deviation	109,6±4,1	112,0±7,3	0,123**
Hip Waist ratio; average ± standard deviation	0,85±0,11	0,83±0,06	0,325**

*Exact Fisher Test; **Test t of Student for independent samples

Thus, it is assumed that the groups are statistically equal, and the differences obtained from weight loss were not affected by the fact that group G1 had 14.3% more men. It is observed that the time of application use, age of groups, initial BMI and initial WHR are very close between the two groups, further validating the sample chosen.The variables weight, BMI, waist, hip and WHR were compared before and after between groups, and the results are presented in Table 2.

Table 2.Comparison of groups before and after the intervention

Variables	Group 1					Group 2						
	Initial		Final		P Initial-Final	Initial		Final		P Initial-Final	P interaction	P final
	Average	SD	Average	SD		Average	SD	Average	SD			
Weight (kg)	80,0	11,2	75,0	11,2	<0,001	77,3	8,8	71,2	9,0	<0,001	<0,001	0,150
BMI	30,3	2,4	28,4	2,7	<0,001	29,4	2,4	27,0	2,6	<0,001	<0,001	**0,047**
Waist (cm)	93,6	12,0	85,5	11,6	<0,001	93,1	8,2	82,1	7,3	<0,001	<0,001	0,182
Hip (cm)	109,6	4,1	105,0	4,8	<0,001	112,0	7,3	105,0	6,6	<0,001	<0,001	0,982
WRH	0,85	0,11	0,81	0,10	<0,001	0,83	0,06	0,78	0,05	<0,001	<0,001	0,117

SD: Standard Deviation; P values obtained through Generalized Equation Model (GEE)

It can be perceived by the column "P initial-final" that there was a significant difference in both groups, between the beginning and end of the intervention for all variables ($P<0.001$).This table clearly shows that both groups improved in relation to the variables studied. Both groups lost weight on the Average.The interaction effect (present on Group G2) was also noticed, however, only in BMI this difference is considered statistically significant at the end of the intervention ($P=0.047$). Weight loss in G1 was 5.01 kg (standard deviation of 1.96) and in G2 it was 6.15 kg (standard deviation of 2.06). To be fairer with both groups, we normalized the participants weight on a weekly basis, since the experiment took longer on Group G2. The weight loss of G1 was 0.73 kg/week (5.01/48*7) and G2 was 0.74 kg/week (6.15/58*7). This shows that, while the users were engaged in the program, the weight loss of G1 was only 0.1 kg per week lower than in G2, showing that the system alone, without the private group on social networks, successfully contemplates the behavior change process.

VI. CONCLUSION

The obesity epidemic is a public health problem that has been affecting all social layers. The technology proposed in this article, using behavioral models of education and psychology, combined with information technology, provided its users with a greater awareness of their health habits, leading to a behavioral change for a healthier life. It was found that the usability of the system is an important factor in the design of the application. Two groups were used (G1 and G2) with a total of 58 participants using the application until the end of the experiment. In both groups the results showed a reduction in weight,waist and hip circumferences, consequently a decrease in BMI and WHR. The application is available on the Google Play Store and more than 500 new users have installed it by the date of delivery of this article.This research allows several developments, such as the motivation of users through gamification and the encouragement through social networks. In addition, due to the potential amount of user data, several studies of Data Mining for Big Data can be performed with the information obtained by the system. The idea is to keep the system free, open source, with an anonymous data usage policy in order to maintain users' privacy, but open for further research.

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