Universidade de Aveiro
Departamento de Eletrónica, Telecomunicações e Informática
2019

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Obeone: Uma Abordagem mHealth Para Pacientes Obesos

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"*The way you learn anything is that something fails, and you figure out how not to have it fail again*"

— Robert S. Arrighi

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Dissertação apresentada à Universidade de Aveiro para cumprimento dos requisitos necessários à obtenção do grau de Mestre em Engenharia de Computadores e Telemática, realizada sob a orientação científica do Doutor Samuel de Sousa Silva, Investigador do Instituto de Engenharia Eletrónica e Informática de Aveiro, e do Doutor Ilídio Fernando de Castro Oliveira, Professor Auxiliar do Departamento de Eletrónica, Telecomunicações e Informática da Universidade de Aveiro.

Dedico este trabalho aos meus pais, Maria e Carlos, à minha irmã, Ana, por todos os esforços feitos para que a realização dos meus sonhos fosse possíveil. A vocês, um enorme obrigado não chega por terem tornado possível a realização de mais um sonho.

Dedico também este trabalho à minha namorada, Joana Valente, pois sem o apoio dela nos momentos mais conturbantes e o seu conhecimento médico, o resultado deste trabalho não teria em conta certos aspectos visuais e científicos.

Por fim, quero também dedicar este trabalho aos meus amigos mais próximos. Com eles, pude aprender a tornar-me uma melhor pessoa e experienciar momentos únicos da minha vida.

o júri / the jury

presidente / president

Prof. Doutora Maria Beatriz Alves de Sousa Santos
professora associada com agregação da Universidade de Aveiro

vogais / examiners committee

Prof. Doutor José Casimiro Nunes Pereira
professor adjunto do Instituto Politécnico de Tomar

Doutor Samuel de Sousa Silva
Doutorado (nível 2), Instituto de Engenharia Eletrónica e Informática de Aveiro da Universidade de Aveiro

agradecimentos / acknowledgements

Gostaria de agradecer a todas as pessoas que me apoiaram e me incentivaram a conquistar o meu sonho, mesmo quando as dúvidas e as incertezas estiveram presentes.

Gostaria também de agradecer aos meus orientadores de dissertação, o doutor Samuel de Sousa Silva e ao professor Ilídio Castro Oliveira, e também à Daniela Melo. Através da sua orientação e disponibilidade, o trabalho desenvolvido nesta dissertação foi bastante enriquecido e, sem eles, o resultado final em nada se assemelharia ao obtido. Ao doutor Samuel gostaria também de agradecer pelas suas palavras de conforto e incentivo, tais como conselhos dados quando estes eram pedidos. A vocês, um enorme obrigado.

A todos os colegas que encontrei ao longo da minha vida, e em especial nestes 5 anos de trabalho árduo. Em especial, ao Leonardo Oliveira por me ter demonstrado que bondade, perseverança e amizade são mais do que palavras que servem para descrever bons momentos, mas sim, essencialmente para os maus momentos. Obrigado por teres sido um dos meus pilares durante os anos de licenciatura. Ao José Castanheira por mostrar que por trás de uma pessoa bastante discreta, está sempre uma pessoa pronta a ajudar e a proporcionar momentos de alegria nos momentos mais inesperados. Com estas duas pessoas, ganhei amigos para a vida. Também gostaria de deixar uma palavra de apreço por todos os bons momentos vividos nestes 5 anos de curso às seguintes pessoas: Diogo Daniel Ferreira, Diogo Peixoto Ferreira, Pedro Martins, Davide Leira, Miguel Maia, Domingos Nunes, João Amaral, Inês Moreira, Armando Sousa, Ricardo Jesus, Diogo Duarte, Tiago Madeira, Fábio Cunha, Inês Lemos, Ana Cruz e ainda ao David Ferreia, Tiago Almeida e Andreia Machado. Por fim, a todos os meus colegas de curso por sempre terem mostrado que todos juntos somos mais fortes e que enquanto unidos não há nenhuma força capaz de travar tamanha união.

A toda a minha família, mas em especial aos meus pais, Maria e Carlos, por me terem dado a possibilidade de me formar, por me mostrarem que nada se consegue sem esforço e por me terem dado muitos bons valores de educação; à minha irmã, por sem saber, alegrar-me por já ter vivido momentos semelhantes e conselhos dados.

À Joana por ser uma companheira de todas as horas, por todo o carinho, suporte e paciência, especialmente nos momentos de dúvida. A ti, um enorme obrigado por todos os maravilhosos momentos vividos a por aqueles que ainda estarão para vir.

Por último, à Inês Borges por todos os belos momentos vividos nas nossas caminhadas da estação para a universidade, tal como as viagens de comboio. Contigo aprendi que por detrás de uma rapariga bastante engraçada, reside uma rapariga com um bom coração; à Neuza Tavares por me demonstrar que de duas pessoas desconhecidos, uma grande amizade pode nascer. A ti quero agradecer todos os conselhos e momentos vividos ao longos destes anos de universidade.

Palavras Chave

obesidade, *mobile Health*, aplicações móveis, perda de peso, saúde mental, multidisciplinaridade.

Resumo

A obesidade é uma das doenças mais preocupantes no mundo. Tem crescido significativamente nas últimas décadas e em diferentes faixas etárias. Isto tem um impacto considerável na prevalência de um conjunto diversificado de condições de saúde, como diabetes tipo 2, doenças cardíacas, problemas respiratórios, privação de sono e cancro. Na componente psicológica, condições como a ansiedade e depressão são fatores que podem aumentar o peso das pessoas, devido a alguns dos medicamentos que precisam de ser prescritos, e pelo facto de que as pessoas podem transformar comida em conforto emocional. Além disso, estas condições podem levar a problemas de integração social devido, por exemplo, à discriminação de pessoas com obesidade. Portanto, combater a obesidade é um dos objetivos mais importantes da saúde no mundo.

A vasta oferta de tecnologias móveis tem motivado a proposta de vários sistemas de suporte aos utilizadores num conjunto de acontecimentos quotidianos, incluindo também tecnologias relacionadas com a saúde. As abordagens de *Mobile Health* - mHealth - também têm sido vastamente propostas para abordar diferentes aspectos relacionados com a obesidade, como nutrição e exercícios físico. No entanto, a adesão a estas ferramentas é frequentemente pobre, resultando principalmente num rápido decréscimo de motivação, e seu impacto no prognóstico do paciente carece de evidências mais objetivas, por exemplo, sobre quais funcionalidades podem ser mais úteis e como elas afetam os pacientes por longos períodos de tempo. De forma a providenciar bases para um esforço de pesquisa a longo termo na proposta de soluções para apoiar pacientes com obesidade, abordando algumas dessas questões em aberto, este trabalho adota uma abordagem iterativa de *design* e desenvolvimento centrada no utilizador, para perceber as necessidades e motivações de pacientes obesos, e materializa as informações reunidas num conjunto de Personas e cenários de contexto para as diferentes partes interessadas. Seguidamente, identifica também um conjunto de requisitos que devem ser considerados de forma a permitir este esforço sustentado centrado no utilizador.

Como resultado, e trabalhando como uma prova de conceito dos requisitos, é apresentada para o contexto de obesidade uma abordagem *mHealth*, a *ObeOne*. A sua marca distintiva assenta na sua abordagem modular, multiplataforma e na adoção de uma visão multidimensional para o contexto da obesidade, considerando explicitamente a necessidade de providenciar, na mesma ferramenta, suporte para múltiplos aspectos, como as dimensões nutricionais, mentais, educacionais e físicas.

Keywords obesity, mobile health, mobile applications, weight loss, mental health, multidisciplinarity.

Abstract

Obesity is one of the most concerning diseases around the globe. It has been significantly growing, in the last decades, and across different age groups, with a considerable impact on the prevalence of a diverse set of health conditions, such as type 2 diabetes, heart disease, respiratory problems, sleep deprivation, and cancer. In the psychological component, conditions such as anxiety and depression are factors that can increase people's weight, due to some of the medicines that need to be prescribed, and the fact that people can turn food into emotional comfort. Also, these conditions can lead to social integration problems, for example, the discrimination of obese people. Therefore, tackling obesity is one of the most important health goals worldwide.

The widespread availability of mobile technologies has motivated the proposal of several systems supporting users in a multitude of everyday situations, including those pertaining health. Mobile health – mHealth – approaches have also been widely proposed to tackle different aspects concerning obesity, such as nutrition and physical exercise. However, the adherence to these tools is often poor, mostly resulting from a rapid decrease in motivation, and their impact on patient prognosis lacks more objective evidence, e.g., regarding which features might be more helpful and how these impact patients over long periods of time.

In order to provide the grounds for a long-term research effort in proposing solutions to support obesity patients, addressing some of these open questions, this work adopts an iterative user-centered design and development approach, to understand the needs and motivations of obese patients and materializes the gathered information in a set of Personas and context scenarios for the different stakeholders. Then, it identifies a set of requirements that should be considered to enable this sustained user-centred effort.

As a result, and working as a proof-of-concept of the devised requirements, ObeOne, an mHealth approach for the obesity context is presented. Its distinctive mark relies on its multiplatform, modular approach and in adopting a multidimensional view over the obesity context by explicitly considering the need to provide, in the same tool, support for multiple aspects, such as the nutritional, mental, educational and physical dimensions.

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Glossary

UCD	User Centered Design	**OS**	Operative System
BMI	Body Mass Index	**UI**	User Interface
mHealth	mobile Health	**UX**	User Experience
RCT	Randomized Controlled Trials	**SUS**	System Usability Scale
JITAI	Just-in-time, adaptive intervention	**HCI**	Human Computer Interaction

CHAPTER 1

Introduction

Obesity is a worldwide concern, which has nearly tripled since 1975, and can be defined, as abnormal or excessive fat accumulation that may impair health, [1], [2]. This treatable disease is caused by genetic and environmental factors and can be difficult to control through dieting alone [2].

A common mistake that is normally made when speaking about obesity is that it is people's fault or that it can be managed alone. Another common mistake is that this health problem is just about food or it can be "miracle treated" [2].

1.1 Context and Motivation

When talking about obesity, and since body fat is hard to measure, a relation between weight and height exists, named BMI. This mathematical relation, which is expressed by dividing a person's weight by the square of its height resulting in the following equation: $BMI = weight/height^2$. When the range of BMI is higher the normal range, 18.5kg/m^2 - 24.9kg/m^2, this disease can increase the risk for chronic diseases, including diabetes, cardiovascular diseases and cancer.

As any other disease, obesity has its causes, the most common being [3]:

- eating a poor diet, being constituted by foods highly caloric;
- having a sedentary lifestyle;
- having sleep deprivation, which can lead to hormonal changes that make feel people hungrier and crave certain high-calorie foods;
- genetics, which can affect how body processes food into energy and how fat is stored;
- pregnancy, since the weight gained during pregnancy can be difficult to lose and may lead to obesity;

- prescription of medications which can cause weight gain of up to several pounds each month;

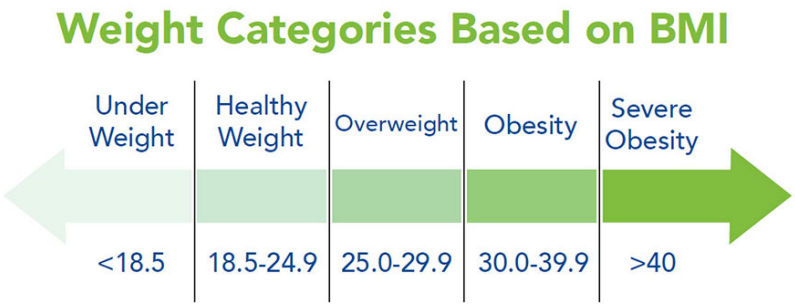


Figure 1.1: Body Mass Index chart [4]

To treat obesity, medical help is always a good choice. To start treating obesity, people's lifestyle and behaviour should change, in which a medical team can educate patients better on healthier food choices and develop a healthy eating plan, allied with a structured exercise program and increased daily activity are a good starting point for the treatment.

Doctors are able to prescribe medicines if other methods of weight loss have not worked and if patients have a BMI of 27 kg/m^2 or more in addition to obesity-related health issues, [3].

Since obesity increases the risk for a slew of chronic health conditions, including blood pressure, high cholesterol, type 2 diabetes and heart disease, obesity can also take a toll on mental and emotional health, making daily activities, like socializing and dating for example, more challenging, [5]. Obese people may fear being humiliated by doing small tasks, working out at the gym, turning them more anxious. Anxiety disorders are frequently associated with depression, turning out that obese people are can be depressed. People who suffer from depression disorders feel sad or hopeless, and might lose interest in activities they used to enjoy. To defeat their mental health issues, trying to restore their self-esteem, some obese patients attend psychology / psychiatry treatments.

The availability of mobile technology, namely smartphones, has been growing at a fast pace. Nowadays, about 2.71 billion of the world population owns a smartphone [6]. Some of the greatest benefits of mobile applications for health – mobile Health (mHealth) [7], is their convenience, since mobile applications are portable, provide rapid access to information and multimedia resources, flexible communications, and a choice of powerful applications to accomplish many different purposes. They also provide better clinical decision-making since many medical applications make mobile devices invaluable tools that support clinical decision-making at the point of care, along with the improved accuracy because mobile devices have repeatedly been found to improve the completeness and accuracy of patient documentation, an effect that has often been attributed to ease of use and their increased efficiency so that enhanced productivity can be achieved.

There are great benefits for obese patients to have an application designed to obesity

treatment, since it allows them to play a more active role in the medical decision-making process, and it can also serve as a tailored and customized educational, social support and social engagement tool for weight loss, it is possible to keep track of what have been people eating and how much they actually exercise (self-monitoring), providing low-cost mechanisms to obese people, having the power to strengthen the relationship between patient and doctor.

Despite of applications aimed at promoting weight loss / management, they often fail in maintaining patients interested and motivated in the application's control plan and features, with the consequent poor adherence, demotivating them to try other treatments. Besides, applications do not have any clinical support, missing evidence-based strategies for weight loss and mental health support, concluding that weight loss applications do not support either patients or clinicians. The majority of the proposed applications target weight loss, monitoring patients, control eating habits, but most of them are abandoned, after a few days, with the typical medical or fitness applications having a 90 days user retention rate of only 27% to 30%, [8], and 50% of these applications are downloaded less than 500 times [9].

Providing support to obese patients through mobile tools seems promising, in many ways, but the outcomes have yet to show stronger evidence of this potential.

1.2 Challenges

Considering the large group of applications and respective studies aimed to promote weight loss, along with an analysis of literature revising studies performed to access the feasibility of weight loss applications, it was possible to gather a set of challenges.

- One major issue is poor adherence, which might be motivated by approaches designed without the involvement of patients (i.e., physicians define the requirements) and by a lack of an individualized patient-centered intervention;
- Most applications only target the nutritional aspects, failing to focus the psychological/psychiatric dimension;
- Most literature does not adopt a clear method that explicitly identifies the audience and context, along with a complete description of the adopted interventions, which makes it hard to understand what works and in which settings;
- There is no explicit consideration of bidirectional information exchange between patient and physician during intervention and/or to support doctor-patient time;
- The adopted design and development methodologies do not serve the purpose of an iterative approach serving the identification, refinement and evaluation of intervention components for inclusion. What works and what to extent?
- The majority of the proposed systems do not have any kind of assessment of their impact on patient prognosis. Those that present it, e.g., randomized control trials, have a duration below 6 months and suffer from the rapid obsolescence of the technology that support them, i.e., by the time they produce evaluation results, the technology is no longer used;

- While the development of mHealth approaches to support obesity patients involves a wide range of disciplines, the teams involved have yet to match the required multidisciplinarity, with the benefits and challenges it brings;

1.3 Objectives

Considering the challenges mentioned in the previous section, our overall objective is to perform first contributions to a long-term effort in innovating the support provided to obese patients in different contexts of their daily life.

To achieve this overall goal, our work envisages to address the following more concrete objectives:

- Adopt design and development methodologies that serve a multidisciplinary approach to support obese patients;
- Perform a detailed characterization of the targeted audience, contexts of use, and interventions by adopting an iterative user-centered approach considering both the patients and the health professionals;
- Propose a technologically-agnostic approach enabling the support for a long-term effort in researching and providing solutions for obese patients;
- Deploy and evaluate a proof-of-concept system implementing an illustrative subset of the extracted requirements.

1.4 Overview

The remainder of this document is organized as follows:

Chapter 2, presents some notable examples of applications for weight loss and how those applications were included in Randomized Controlled Trials (RCT) and a brief discussion regarding aspects that might deserve further attention is performed.

Chapter 3 mainly focuses on providing an overall characterization of the target users and the motivations that need to be addressed. To that effect, it provides the description of two primary personas and two secondary personas along with a set of context scenarios and a list of requirements that the system must meet in the long term.

Then, chapter 4 describes the development of the proposed system, *ObeOne* by providing a summary of each phase that the system has gone through from its first paper prototype design and evaluation up to its current version.

Finally, in chapter 5, the work developed is discussed and a few ideas deemed relevant for future consideration are presented.

CHAPTER 2

Background and Related Work

Mobile applications enhance the clinical decision-making, since mobile devices with medical applications can be invaluable tools in the decision-making process.
mHealth! (**mHealth!**), mobile Health, is the field of research harnessing the potential of mobile technologies to tackle health-related aspects, providing users with a set of tools which can help them. Therefore, mHealth solutions for obesity were not an exception.
Obese patients can thus benefit these solutions by being more active in the decision-making process, having a tool that serves them in different kinds of support, e.g., educational and social. Also, mHealth solutions for obesity can monitor certain aspects of their users daily life. Although there is a large group of applications aimed for obesity treatment, they lack in several important aspects for maintaining users focused and motivated in the application's control plan.

In this chapter, it will be described some reviewed applications used in RCT studies, to test their feasibility and efficiency. It is also described the methodological approach adopted in each application. Then it is presented a discussion of the research done about mobile applications for weight loss and what improvements must be done in order to improve their quality. Finally, is presented the definition of User Centered Design (UCD) and some of its methods and evaluation techniques.

2.1 Methods

To better understand the chosen methodology used in applications whose main goal is obesity treatment, two main approaches were used.

The first step consisted gathering randomized controlled trial studies which used applications whose objective was weight loss for users. This enabled the perception of how these applications aim to promote weight reduction, i.e., their main features. Over time while studying them, it was possible to undertand their background, i.e., if their scope

of development involved requirements from clinicians and/or patients, or it they were another "*me too*" applications. A "*me too*" application is just an application that does not offer nothing new from the one it was inspired. On this point, back to application features, it is necessary to understand if these mHealth tools allow external support to their users, through doctors or just user's friends. When this was understood, it was needed to understand how these applications were then used in real life situations. This is the reason why RCT studies were chosen so that it was possible to know which kind of users were recruited and how interventions were planned for each application. RCT present some limitations: the time duration is often not enough, normally two months, for sound conclusions. On the other hand, the application's development tends to continue, and when the trials are started, they use technologies and methodologies that may not be the most recent.

The second step consisted in gathering weight loss application reviews. These reviews included many other applications which are not described in this document neither were taken into account for their study. These reviews contributed to get more knowledge on other applications and their methods to promote weight loss. It also contributed to discover lacks in these mHealth tools and provided some solutions to improve the quality of applications aimed for weight loss.

As a result of the two previous steps, is possible to see in Figure 2.1 an illustrative table, using some acknowledgements from each study and application so that it is possible to understand each application's features and failures, as well as their scope of development and how the respectively RCT was performed.

2.2 Studied Applications

Here it will be briefly described the main features of each studied application and their development scope, so as their RCTl study. This will allow to understand better each application, their environment and the results they had made in people who have used them. The applications here studied are applications that have published studies, and some of this set of applications are available in stores.
At the end of this section, it is possible to see an exhaustive table, in Figure 2.1, with all the important aspects about each application and its RCT study.

2.2.1 OnTrack

OnTrack, is an iOS application which works in conjunction with an existing behavioural weight loss program (Weight Watchers online weight loss program) and it tries to assist users to adhere to that program. This study, [10], evaluated the feasibility, acceptability and preliminary effectiveness of *OnTrack* among a group of 44 overweight or obese adults assigned to a structured commercial weight loss plan for 8 weeks.

Participants had to record dietary intake using the *Weight Watchers* mobile application and enter data related to lapses. Users also had to complete semi-random surveys six-times a day during waking hours. To prevent dietary lapses, this application uses a machine learning algorithm and delivers a targeted intervention designed to prevent lapses from occurring.
Participants indicated that this application was easy to use and that they had minimal technical issues. They rated the application as moderately useful and enjoyable with a somewhat positive behavioural intention to use. Participants lost an average of 3.13% of their weight, with this application demonstrating the feasibility and acceptability of a Just-in-time, adaptive intervention (JITAI) method for preventing dietary lapses, and also the preliminary effectiveness in reducing unplanned dietary lapses and facilitating weight loss.

However, this application does not implement evidence-based strategies. It was not developed with clinical or patient requirements, failing to be a user-centered design application. Also, it does not allows clinicians or patient's related people support (friends or family). One big gap of this application is that it does not have support for mental health.

2.2.2 SlipBuddy

SlipBuddy is a composition of an Android mobile application, a server and a web provisioning system for clinicians to monitor user's progress and to manage delivery of individually tailored interventions. This application was developed to gather data related with overeating episodes and to deliver behavioural modification interventions, in order to, help them focus on reducing the frequency of overeating episodes. *SlipBuddy* employs the evidence-based behavioural strategy referred as stimulus control.
This application collects user-centered data and passively sensed data when a over-eating episode occurs. Also, contextual data is regularly collected during the day so that after a period of use, the data collected is analysed to generate a predictive model.
In this study, [11], 16 participants were enrolled, with age greater or equal to 18 years, and the results indicates that 9 of the 16 participants lost weight, with an average of 2.3%, while others maintained or gained some weight.
SlipBuddy presents a novel approach to support weight loss, and takes advantage over traditional counselling is that this application flags stimuli control in the moment for the user, and provides a just in time intervention.

SlipBuddy, just like *OnTrack* does not have clinical's or patient's requirements, mental health support for its users. Also, it does not provides any kind of support from clinicians or patients relatives.

2.2.3 SmartLoss

SmartLoss is a smartphone-based weight loss intervention application which aims to reduce body weight and secondary end points. It provides the ability to deliver intensive behavioural

weight loss interventions, consistent with treatment guidelines. This platform provides remote monitoring of progress and the delivery of personalized treatment recommendations and lessons material via smartphone.
In this study, [12], 38 overweight and obese patients between 18-65 years old were enrolled in the trial. Participants were randomly assigned to the *SmartLoss* Condition, in which *SmartLoss* provides the ability to deliver intensive behavioural weight loss interventions, or the Health Education condition, in which participants received health information via text messages or e-mails delivered to the smartphone during the 12 week trial study.
The *SmartLoss* group experienced significantly greater weight loss and better systolic blood pressure than the Health Education group. This way, *SmartLoss* promoted clinically meaningful weight loss compared with the Health Education group. *SmartLoss* intervention was feasible and efficacious over the short time of the trial.

SmartLoss does not implement any evidence-based strategies. Also, it does not have any clinician's or patient's requirements in its design and development, neither has support for mental health.

2.2.4 Noom Coach

This is one of the most popular publicly available applications for weight loss, however, it does not deliver behavioural strategies, rather a paid trained coach.
While using the application, users are asked to record their daily intake food, with their number of steps walked per day being saved on the application. As long as the application is being used, reports are generated demonstrating the user's weight trends, as well as calorie and nutritional summaries of their diet, providing feedback, including the types of exercises that help users to achieve their target weight.
This study, [13], is a retrospective designed to investigate the effect of *Noom Coach* application on weight reduction, identify independent influencing long-term success or failure factors and maintenance of weight reduction after using the smartphone application. The analyses of this study, were based on users who installed this application between October 10 of 2012 and April 9 of 2014, having recorded data more than two times during 6 months and with an age different of 42, since it is the application's default age. As a result, data about 35921 users were included in the analysis.
This study demonstrated which aspects of daily life need to be recorded and monitored frequently to achieve effective body weight reduction. Of these factors, the most important criterion was dinner input frequency. Thus, this study demonstrated the clinical utility of an application for successful weight reduction in the majority of the application users.

Besides being one of most popular weight loss applications, it has some gaps. To start with, it is not possible to know if it implements any evidence-based strategies. Also it is not possible to know if it has any medical or patient's requirements in its design and development,

nor if it has support for clinicians and users. With regard to the mental health support, it is not possible to know if this feature is implemented.

2.2.5 Habit App

Habit is an application which was designed to automate problem-solving therapy for weight loss, and this study, [14], tested its feasibility. Two iterative pilot studies were performed so that feasibility and acceptability of *Habit* application could be tested. In each pilot, obese or overweight adults were enrolled in an 8 week trial intervention, which included this application plus support via a private Facebook group.
A steering committee of clinicians (4 dietitians, 5 psychologists, 1 Master's level counsellor and 1 health educator) was queried in order to create a database of weight loss problems, and problem-solving sessions with patients were conducted, as well as, the development of an algorithm tailored to user characteristics.
To participate in both pilot studies, participants age had to be greater or equal than 18 years, had a BMI between 30 kg/m^2 and 45 kg/m^2 and fulfil other inclusion criteria. In both pilots, participants lost weight, with results showing an acceptable use of the *Habit* application, suggesting that, it may have been useful for some participants. Also, they agreed that the diet habits in the application were helpful so as the exercise habits, showing this way the feasibility of the application. An important factor that is important to be improved, were the problem solving skills.

2.2.6 HelpMeDoIt

The application *HelpMeDoIt!*, used in study [15], is a mobile application / website that harnesses social support for weight loss by allowing participants to nominate friends or family to help them with their weight loss goal. It is focused in goal-setting, self-monitoring and social-support, guided by several theories (control, social cognitive, self-determination and social support), to explore the views and experience of trial participants and their helpers, [16].
To measure physical activity, an accelerometer was used on the right hip for a week during waking hours. As for mental health, it was measured with the General Health Questionnaire, a validated and frequently used 12-item self-report questionnaire. A gamification element was also used to encourage the frequent support by participants and helpers so that virtual medals or trophies could be awarded.
This intervention consisted in two stages. Stage 1 focused on the development and formative evaluation of the intervention, and stage 2 described the implementation of the intervention within a feasibility randomised controlled trial, including process, outcome and health economic evaluation.

2.2.7 MyFitnessPal

One of the most widely used calorie trackers is *MyFitnessPal*, a mobile application in which users can track and input their daily food intake. It allows them to set some goals, as well as, it includes elements of social cognitive theory, evidence-based and theory-based approaches, self-monitoring and feedback.
It was designed for usage in healthy and overweight populations to help users reach weight and health goals, [17]. Designed by software engineers in collaboration with dietitians to create an application for calorie counting, it provides a database over 3 million foods and easy-to-use interface for logging food and exercise in which users can enter their current weight, goal weight and goal rate.
In the randomized controlled study performed, [18], 212 primary care patients with BMI greater or equal than 25 kg/m^2 and over 18 years old, were randomized in two groups during six months: primary care (control group) with 107 individuals, and the primary care plus *MyFitnessPal* application (intervention group) with the remaining. Patients were recruited from two University of California Los Angeles (UCLA) primary care clinics.
At the end of the study, in both groups, there were participants who lost more than 2.7 Kg, being the major loss belonging to the intervention group, and the frequency of logins declined rapidly after enrolment. Participants reported high satisfaction with *MyFitnessPal* and they also stated that they would recommended it to a friend. The principal finding of this six month trial, was that the *MyFitnessPal* application delivered to overweight patients in primary care did not result in increased weight loss compared to usual primary care. Most participants quit using it after the first month of the study and a few individuals continued to login regularly in the sixth month.

Despite being a very well known application for weight loss, it does not have any clinical support or patient's requirements. At this point, this application joins the group of applications which does not offer support for mental health.

2.2.8 CITY

City (Cell Phone Intervention for you), [19], is a randomized controlled trial of behavioural weight loss intervention for young adults, comparing the effect on weight over 24 months. About 365 individuals, between 18 and 35 years old were selected. In this study, participants were divided into 2 groups: the Cell Phone (CP) and the Personal Coaching (PC). Both these interventions, were based on social cognitive theory and the trans-theoretical model, and used techniques of behavioural self-management and motivational enhancement. The difference between interventions, was the source of delivery, through a smartphone application (CP), or by dietitians trained in Motivational Interviewing.
The results of this RCT, show that participants lost weight, however the PC group had the greatest mean weight loss. Also, results suggests that the CP intervention did not lead to any significant weight loss and may have been ineffective because it involved no human

intervention contact.

This application, also has a gap in respect to the medical or patient's requirements. Just like, *MyFitnessPal*, can join the group of applications which does not offer mental health support. Finally, it does not have neither of clinician's or patient's requirements.

2.2.9 WeightWatchers

In this study, [20], were enrolled 92 participants between 18 and 70 years with a BMI of 27-40 kg/m^2 with access to Internet-connected computer during six months, and its purpose was to evaluate the effects of the Weight Watcher Online (WWO) program. This randomized controlled trial was conducted simultaneously at Brown University/The Miriam Hospital and the University of Tennessee Knoxville.
Participants were instructed to track their daily food intake and physical activity via mobile application or the WWO website. Half of the participants were randomized to an "Enhanced" program (WWO-E) that automatically transmitted body weights to participants WWO accounts, via a smart-scale and a pre-scripted email feedback message was sent weekly for 24 weeks. In both groups, WWO and WWO-E, significant weight loss was achieved, however it was possible to show that a greater portion of WWO-E compared with WWO achieved a clinically significant weight loss greater or equal of 5% at three months, but this effect did not persist at 6 months.

Besides the fact that this study had some limitations such as the sample size, since it was not adequate to detect smaller, but clinically differences between groups in weight loss, it is not possible to know if evidence-based strategies were implemented, just like if patient's or clinician's support and requirements were available. Finally, mental health support is not available in this application.

2.2.10 Lose It!

This study used the *Lose It!* mobile application, and it was approved by the University of Pittsburgh [21]. The aim of this study, was to test the feasibility of providing 1 to 4 daily feedback messages, tailored to dietary recordings via a smartphone, and compare the effect of (1) self-monitoring alone, with (2) self-monitoring and tailored feedback, and (3) self-monitoring plus tailored feedback and face-to-face group sessions. This randomized controlled trial of behavioural treatment for weight loss had a duration of 12 weeks, in which 39 adults were randomized to one of the three groups:

- Group 1 used the *Lose It!* application for self-monitoring in dietary intake;
- Group 2 used the application for self-monitoring and received one to 4 daily feedback messages;

- Group 3 used the application for self-monitoring, received one to 4 daily feedback daily and attended 3 group behavioural weight loss sessions at weeks 2, 4 and 8.

At the end of the study, there were no significant differences in the mean percent for weight loss among the three groups, however there were more significant weight losses within three groups. More specifically 26% of the participants lost more or equal of 5% of their baseline weight, which is clinically significant, being the third group the one which had lost more weight.
This study demonstrated that participants, who used only a mobile phone for self-monitoring diet could lose weight that was comparable to those who received the same feedback messages and attended three face-to-face group sessions. In conclusion, all three groups achieved comparable weight loss, improvements in blood pressure and self-efficacy.

Just like some other applications seen above, *Lose It!*, is one more application in which is not possible to know if has clinical support, nor if it have requirements from clinicians and patients. Just like the other applications here mentioned, it does not also have mental health support.

2.2.11 Application's description table

App name	Year	EB Strategy	C. Supp.	P. Supp.	C. Reqs	P. Reqs	M.H. Supp.	Study Period	Main Features	Accessories	P. Nº	P. Age	ML Alg.	Platform	Feasibility	Accep. / Eff.
OnTrack	2018	NO	NO	NO	NO	NO	NO	8 weeks	Lapse records;Semi-random surveys;Lapse alert;	NO	44	18 - 65	YES	iOS	YES	YES
Habit App	2018	YES	YES	YES	YES: weight loss problems database development	YES: problem solving sessions	Not Defined	8 weeks	Update profile; Address a diet or exercise challenge; Visualize solutions already scheduled; Weekly check-in; Adding habits to database; Solutions list for habits help; Visualize scheduled habits;	YES: smart scale	Pilot 1: 27 Pilot 2: 16	≥ 18	NO	Android	YES	YES
SlipBuddy	2017	YES: stimulus control	YES	NO	NO	NO	NO	22 days	Overeat button; Data collection for overeating episodes; Help in detecting an overeating episode; Collection of contextual data; Generation of a predictive model to prevent users from overeating;	NO	16	≥ 18	YES	Web: clinicians Android: patients	Not Defined	YES
HelpMeDoIt!	2017	YES: behaviour change	NO	YES: social support	Not Defined	YES	YES	1 Year	Goal setting; Progress monitoring; Social support; Promote interaction between participants and helpers; Goal setting and planning support; Helpers nomination;"Gamification" element;	YES: accelerometer	120	18 - 70	NO	Web and Android: Partipants and helpers;	YES	YES
WeightWatchers	2017	Not Defined	Not Defined	YES	Not Defined	NO	NO	6 months	Intaken food and water tracking; Points for intaken food; Dietary intake records; Daily SmartPoints goal; Weekly SmartPoints bank; Online chatting;	YES: smart scale	92	18-70	NO	Web, iOs, Android	Not Defined	Not Defined
Noom Coach	2016	Not Defined	Not Defined	Not Defined	Not Defined	Not Defined	NO	1.5 years	Body weight targeting; Records of daily intaken food and daily steps, Reports based on data recorded; Feedback supply; Exercises plan for targeting desired body weight;	NO	35921	ALL ≠ 42	Not Defined	Android, iOS;	YES	YES
Lose It!	2015	Not Defined	Not Defined	YES	Not Defined	Not Defined	NO	12 week	Goal setting; Calorie counting; External support Self-challenging;	Possible to use a scale	39	≥ 18	Not Defined	Web, iOs, Android	YES	YES
SmartLoss	2015	NO	YES	YES	NO	NO	NO	12 weeks	Remote progress monitoring;Delivery of treatment recommendations;Goal of achieving 10.00 steps per day; Calculation of weight to be lost during a period of time; Calorie prescription;	YES: accelerometer, scale	38	18 - 65	NO	BlackBerry OS	YES: clinically	YES
CITY	2015	YES: social cognitive theory	YES: Motivational Interviewing dietitians	YES	NO	NO	NO	2 Years	Self-monitoring; Goal-setting; Challenge games; "Buddy System": exchange of pre-determined messages to a randomly assigned byddy participant;	YES: smart scale	365	18 - 35	NO	Android;	Not Totally	NO
MyFitnessPal	2015	YES	NO	YES	YES: dietitians	NO	NO	6 months	Food database; Logging food and exercise; Registering weight loss goal rate; User's calorie daily goal visualization; Real-time reports: weight trend, nutrirional summaries, intaken calories of last week; Barcode scanner for store-bought foods; Social networking: friends finding and progress sharing;	NO	212	≥ 18	NO	Android, iOS	YES	YES

Figure 2.1: Table of reviewed applications and a summary of their main features.

Abbreviation	Designation	Description
App name	Application's name	Application tested in the RCT
Year	Year	Year of the study
EB Strategy	Evidence-Based Strategy	Implementation of evidence-based strategies
C. Supp.	Clinical Support	Clinical support for participants using the application
P. Supp.	Participant Support	Participants having external support without being explicitly clinical support
C. Reqs.	Clinical stated Requirements	Clinical requirements in application development
P. Reqs.	Participant stated Requirements	Participant requirements in application development
M.H. Supp.	Mental Health Support	Indicates if participants have mental health support while using the application
Study Period	Study Period	Indicates the study's time duration
Main Features	Main Features	Application's main features
Accessories	Accessories	Indicates if were used external accessories in participant's treatment for tracking physical activity
P.Nº	Participants Number	Number of elements participating in the study
ML Alg.	Machine Learning Algorithm	Indicates if applications use a machine learning algorithm
Platform	Platform	Indicates in which platform the application was developed
Feasibility	Feasibility	Indicates if the application used in study offers evidence about their feasibility
Accep. / Efficacy	Acceptability	Indicates the efficacy and/or the acceptability of the application being tested

Table 2.1: Clarification of the designations and descriptions used in Figure 2.1

A comparative and resumed table can be observed in 2.1, where the main features of each application used in a randomized controlled trial is detailed.

2.3 Discussion

By the analysis of the table in Figure 2.1 is possible to see that some applications do not implement evidence-based strategies, and they also do not have clinical support for patients. Also, clinicians and patients do not have involvement in the development of applications, so most of these applications are not focused on patient motivations and needs. Lastly, but a very important failure in these applications it that they do not make any explicit consideration of mental health support for patients in weight loss treatment.

Despite the above applications have been validated and tested, there are several applications for weight loss/management. To start with, the only application that cares about the

user mental health was only *HelpMeDoIt!*, which is a very important failure in all existing applications for weight loss/management. Our aim is trying to improve patient's health in a physical way, however mental health must be a part of the obesity treatment too.

Studies show that multicomponent interactions, with self-monitoring option, as well as access to website present greater potential in obesity treatment, because mobile applications allow their users to be constantly connected to several spaces of information, facilitating real-time feedback, production and consumption of information, making this type of technology more advantageous for health monitoring if compared to traditional alternative methods [22].

Several studies and reviews about this kind of applications were made, and valuable information could be retrieved from their analysis. About 0.05% applications were developed by professional sources, so quality is a concern. Even those applications that were developed with professional input are not backed up by clinical studies on their effectiveness and validation, since self-monitoring of weight, diet and physical activities are key components for a successful weight management, but tools required for self-monitoring and interactive feedback with clinicians are often limited in a clinic-based setting [23]. A patients social network, social influence and social support are important aspects to consider and these factors are typically lacking in clinical management of obesity.

The most common strategy for this kind of applications is self-monitoring, which allows users to track weight-related metrics during treatment, such as weight, energy balance, water intake and quantity of physical activity, and another few applications included metrics for tracking options such as nutrition, sleep and cardiometabolic indicators. As noticed before, none of the applications allowed tracking of the mental health indicators, environmental influences or allowed the creation of customized metrics [24].

The second most common strategy is physical activity support, since mostly applications included fitness plans, exercise guides, and tracking of daily physical activity.

Another common strategies include healthy eating support, goal setting, but none of the applications included creation of customized goals. Gamification is another strategy for weight loss, but only a few applications apply it. An example, is that adherence to self-monitoring and timely recording have been significantly associated with weight loss, and frequent monitoring of food intake has been associated with twice as much weight loss as infrequent monitoring [25].

Also, to prevent users from quitting treatment, is important to create an attractive application to keep user's involvement over time and result in real challenges of behaviour, with the acquisition of healthier life habits, improving their quality's life [22].

One aspect that is important to consider is that requirements from both clinicians and patients are very important, in order to create an application based on UCD so that patient's motivation and adherence may increase for applications whose aim is weight loss, being one

possible way for the boost of efficacy in obesity treatment.

Efforts between developers, researchers, clinicians and patients are highly recommended, to develop and test high-quality science-based mobile applications, for the effective implementation of mHealth weight management programs before they can be widely distributed into online markets [26].

Finally, the majority of the proposed systems for weight loss do not have any kind of assessment of their impact on patient prognosis, and those which have it, e.g., RCT, even for a time duration below six months, they suffer from the fast obsolescence of the technology that supports them, since when trials are started, they use technologies and methodologies that may not be the most recent. In order to provide a system that is technology agnostic, the development of such systems should be made, e.g., using a cross-platform environment, enabling the fact that if the technology that supports such systems evolves or becomes obsolete, their development processes are ready to quickly adapt.

2.4 Cross-platform approach

The term cross-platform is in general used in different ways across many parts of the IT industry, [27]. A product of this type can work across multiple operating environments. Each device and Operative System (OS) has its own programming interface for dealing with applications so that a built cross-platform application is able to work across various platforms, being also referred as a multi-platform or platform independent.

A cross-platform product has many advantages like their unlimited use of code so that a piece of code can be engaged through multiple platforms. Also, is quicker to develop in fewer costs, since it enables to create a product with less time consuming and with a higher range of different systems, [28].

In order to develop this multi-platform product, a framework for its development will be used, more specifically, React Native, [29]. This framework helps to create mobile applications with the help of JavaScript, for both Android and iOS platforms, helping to save development time.

2.5 User Centered Design

UCD is an iterative process in which designers mainly focus on users and their needs. This process involves users in the design process via a variety of research and design techniques in order to create a highly usable and accessible product for them, [30]. Therefore design is based upon an explicit understanding of users, tasks and environments, which is driven and

refined by user-centered evaluation, and addresses the whole User Experience (UX), [31] .

As it is possible to see in Figure 2.2, each iteration of the UCD approach involves four distinct phases, which will be briefly explained.

1. First is necessary to specify the context of use. In this phase is necessary to identify the people who will use the product, what they will use it for and in which conditions they will use it. Therefore, designers attempt to understand the context of use in which users may use a system;
2. For the second phase of the process, it is necessary to specify the requirements, i.e., the identifying of any business requirements or user goals must be specified in order to make the product successful;
3. In the design phase, the design team develops some solutions, and this part of the process may be done in stages, building from a rough concept to a complete design;
4. Lastly, the fourth phase, consists in the evaluation of the designs against the users context and requirements. Ideally, this evaluation is made through usability testing with actual users to check how well and how close the design is matching the users specific context and their relevant satisfying needs. From this point, further iterations of these four phases are done until the evaluation results are satisfactory;

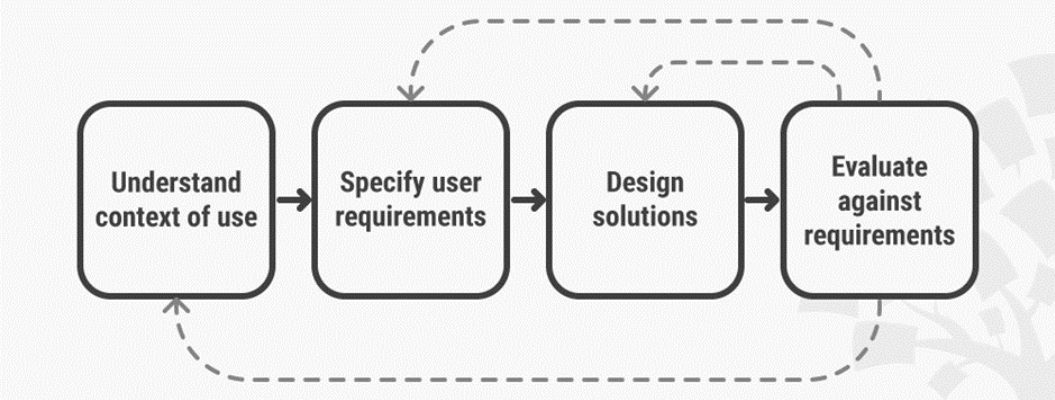


Figure 2.2: Example of User Centered Design process [32].

In UCD, designers base their projects upon an explicit understanding of the users, tasks and environments. This process aims to capture and address the whole user experience so that professionals from across multiple disciplines (doctors, software and hardware engineers), as well as domain experts, stakeholders and users must coexist in the design team. The evaluations of the produced designs may be made by experts using design guidelines and criteria.
A crucial point in UCD, in order to span the entire user experience, designers must involve users in evaluation, [30].

In UCD there are, five major principles, [33]:

- A clear understanding of user and task requirements;
- Incorporate user's feedback to define requirements and design;
- An early and active involvement of the user, in order to evaluate the product's design.
- Integrate other development techniques with UCD;
- Iterative design process;

UCD, follows a series of well-defined methods and techniques for analysis, design and evaluation for the development of a product, [34].
In UCD, the design and evaluation steps are built in from the first stage of projects through implementation. Despite having several variations of the UCD processes, the basic principles and techniques remains the same.

Some steps are included in each of the Analysis, Design and Evaluation phase. To begin with, in the Analysis phase, steps like the (1) Vision, goals, objectives; (2) User analysis; (3) Task analysis; (4) Workflow analysis, among others are included.

In the Design phase, is typically included the (1) Conceptual/mental model and design concepts; (2) Navigation design; (3) Prototypes of low-fidelity, for example, paper-prototypes; (4) Medium-fidelity prototypes and (7) Functional, high-fidelity prototypes, among other steps.

Finally, for the Evaluation phase, techniques such as cognitive walkthroughs, heuristic evaluations and usability tests from low fidelity prototypes to high fidelity prototypes are included.

2.5.1 Personas

During the Analysis phase, more specifically in the User Analysis step, personas are created. They are "hypothetical archetypes" of real users for a given product. However, in spite of not being real people, they represent real people during the design process, i.e., they are a fictional characterization of users, [34].

Personas are the fictional representation of a person, since they are based on behaviours and motivations of real people we have observed and are represented throughout the design process. They are simple in concept, providing designers a precise way of thinking and communicating how users behave, how they think, what they wish to accomplish and their motivation to that accomplishment. One of the key elements which allow personas to be successful as user models is that they are personifications, being appropriate and effective because of the unique aspects of personas as user models.
Personas provide helpful information to determine what a product should do and how it should

behave, to communicate with stakeholders and developers, build consensus and commitment to the design, measures the design's effectiveness and contribute to other related efforts [35].

2.5.2 Scenarios

During the Workflow analysis step, in Analysis phase, scenarios are created. A scenario, just as a persona, is an individual, fictional account of a data workflow. They are built on the information gathered in Workflow analysis and are usually narratives that tell a story describing one or more tasks in a specific environmental situation,[34].

Scenarios are commonly used to describe a problem solving concretization method, making use of a specific story to construct and illustrate design solutions for specific needs or behaviours of the system, [35].
When using scenarios, it is important to make use of personas, since they provide a tangible representation of the user to act as a believable agent in the setting of a scenario. The use of personas in scenarios is better for behaviour patterns and motivations, since it focuses on describing how users accomplish tasks so that motivations should inflect and prioritize future tasks, because personas model goals and not tasks, therefore, scenarios can be broadened to include product definitions which are addressed by specific problems, [35].
Both content and context used in scenarios are derived from information gathered during the research and modelling phase. Lastly, personas and scenarios are used to test the validity of design ideas and assumptions throughout the process, [35].

2.5.3 Requirements

In order to ensure the user needs are satisfied, it is important to formulate a set of requirements. These requirements are found and defined through methods like focus groups, more specifically a multidisciplinary team. To have a better idea of what the target users want, personas and scenarios are analysed, [33].

To determine what information and capabilities our personas require to accomplish their goals, requirements must not be misunderstood with the term used in industry. In many product-development organizations, requirement is commonly a synonym of feature or function, requirements must first be thought as a synonym of need.
So requirements determines what is needed to fulfil personas main goals allied to their motivation. So before moving on how will the product looks, how it behaves and feels is absolutely critical to define and reach a consensus to what the product will do, avoiding the risk of turning the product into a never-ending circle of iteration, [35].

2.5.4 Paper Prototyping

Paper prototyping is the process of sketching screenshots on a paper as substitutes for digital representations, [36]. It can be extremely helpful during the early-stage of conceptualization, since it allows the quickly visualisation and testing of various ideas, [37].

The design of a paper prototype allows a rapid iteration, since it takes a few minutes to create different versions of a design. It is also very inexpensive due to the fact that it only requires pen and paper. Experimental designs are easier to develop than with software packages, enhancing the creativity. It enables a low commitment since it is much easier to throw out a sketch that took a few time to create. Lastly, it elicits honest feedback, making people more comfortable criticizing sketches rather than high level designs, , [37] and [36].

2.5.5 Functional Prototyping

A functional prototype (high-fidelity prototype), is more advanced than the paper prototype (low-fidelity prototype), and it is more aesthetically pleasing, so as their function, since it is closer to the final product, [38].

Examples of high-fidelity prototypes include Interactive, Digital and Coded prototypes. Coded prototypes, are very realistic and the closest to the final design of a product, since they look and behave as much like the final product as possible. Also, they are the best option to guarantee user's feedback and are ideal for usability testing.

2.5.6 Heuristic Evaluation

An heuristic evaluation consists in a usability inspection method for computer software that helps to identify usability problems in the User Interface (UI) design. An evaluation of this kind specifically involves different evaluators examining the presented interface and judging its compliance with recognized usability heuristics, [39]. An advantage of this evaluation, is that it can provide some quick and relatively inexpensive early feedback to designers in the design process, [40].

2.5.7 Usability Testing

As seen above, a usability testing, is a technique used in the evaluation phase in UCD. It is used to evaluate a product by testing it on users in which quantitative and qualitative data from real users performing real tasks with a product is provided, [34] and [41]. An usability evaluation is useful for learning the ability of how well users can learn and use a product to achieve their goals, [42].

CHAPTER 3

Users, Scenarios and Requirements

Personas are not real people, but they represent them during the design process in UCD, making users seem more real and humanized so that realistic ideas of users can be kept in mind by designers throughout the design process. To better understand user motivations and the contexts of use, one important step of the work carried out was the research and definition of the personas presented in this chapter. Therefore, the definition of the context and persona needs was achieved by proxy, i.e., with the help of a psychology professional who deals daily with obese patients from bariatric and non-bariatric surgery. Each persona has its own characteristics and motivations aligned with those that the users of the proposed system will have.

The development of scenarios identifies important aspects of using a product in the real world. They are useful throughout the design process, particularly for the definition of requirements and, for instance, for choosing the tasks relevant for usability testing.

One additional reason why the adoption of personas and scenarios is important, in the work carried out, is the fact that they enable the description of the users, their needs and motivation, and the contexts of use in a language that can be easily shared by the members of a multidisciplinary team, since it focuses on describing behaviour rather than technical aspects or clinical terms.

Thus, it was adopted an UCD approach in the design and contextualization of personas and scenarios so that requirements for the system could be retrieved, which is possible to see in detail in this chapter.

3.1 Personas

The design and development of *ObeOne* is supported on four personas deemed relevant for a proper characterization of obese patients: two primary personas, José and Marta, both obese patients, and two secondary personas, Leonardo, an Psychiatrist; and Joana, a clinical and

health Psychologist.

Obese users can be considered primary personas since they represent the primary target for the design of an interface, [35]. Since José and Marta have motivations for designing system interfaces, they were considered personas of this type. On the other hand, the clinicians are considered secondary personas due to the fact that they are satisfied with the primary persona's interface, but they also have specific additional needs. An example, is the existence of a module, that besides allowing obese users to monitor their progress in the system, also allows clinicians to be more aware of the evolution of their patients in their obesity treatment.

While obese patients contact with a larger number of medical specialties (e.g., nutrition, endocrinology) these were not included, at this time, since the main purpose was to include professionals that could provide the most feedback on the patient's motivations, needs, mental condition, and overall life context. Thus, it was included psychiatrist and psychological personas.

3.1.1 Primary Person: José, an obese patient attended at the Hospital.

Figure 3.1: José, an obese patient.

José, forty years-old man, who is divorced, lives with his kid in a flat on the fourth floor with no elevator and actually is attending psychiatric appointments.

During major part of his life, José has been living with health problems such as diabetes type 2, hypertension and sleeping apnea, which concerns him a lot. José does not admit, but he feels depressed about his health condition. To get worse, José started to have physical problems on his back, joints and knees, since he has to climb four floors, sometimes loaded with shopping bags. His kid, is a very active child who likes to play around every time, and José desires to play with him more easily since due to his obesity, he has a lot of struggles.

Besides his personal life, on his job, José gets tired easily and can not perform so well and so fast as his colleagues. He lacks motivation to improve his lifestyle and even to try a bit harder to change his body weight, because he wants very fast results and do not want to spend lots of time with doctors, since he does not feels very comfortable to share with them. José would like to follow a treatment in which regular monitoring with motivation included could be presented to him, such as monitoring his physical exercise and present him some increasing challenges which he could complete successfully so that his kid could also participate with him, increasing his motivation. Along with the physical monitoring, José would like to have his psychiatrist supporting him when he feels sad so that José would not feels so fragile.

Motivation: José would like to change his lifestyle so that he could play more with his kid, improve his efficiency on his job, increase his motivation in obesity treatment, and also improve his physical appearance so that his knees can also stop hurting and mostly important, improve his health.

Image adapted from [43].

3.1.2 Primary Person: Marta, an obese patient attended at the Hospital.

Figure 3.2: Marta, an obese patient.

Marta, a twenty-five years-old woman, is starting her career in her first job, which she is enjoying. She graduated in Aveiro's University in Informatics Engineering and due to her profession she spends a lot of time sat on front of her computer. During her academic career, she was never a social person, and people tend to move away from her, due to her physical appearance. To lower her self-esteem even more, Marta used to be discriminated by men, for the simple fact she was obese. She believes that overweight young adults have low chances of dating or finding a marriage partner, since she never had a boyfriend.

To get worse, she does not have any control in her diet and has no physical activity. She eats a lot on her meals, since she is not used to have breakfast, nor does she eats for several hours, and when she eats, she is always feeling over satiated, not drinking enough water too.

Since she can not control her appetite for unhealthy food, her body weight allied with her low self-esteem and with her discrimination, Marta started to get depressive and looked for mental health support.

To defeat her eating disorders, Marta would like a system which in she could customize alerts for eating more often so that she can eats less, and to reminds her to drink water.

Also, it would be great for her if that system could monitor her meal time duration and increase her chewing time with personalized challenges.

Motivation: Marta would like to increase her self-esteem and also improve her eating habits so that she can start to have more motivation for her obesity treatment and to relate with others, decreasing her weight and changing her lifestyle.

Image adapted from [44]

3.1.3 Secondary Persona: Leonardo, an Internal psychiatrist

Figure 3.3: Leonardo, a psychiatrist.

Leonardo is a thirty-two years-old psychiatrist who obtained his degree 5 years ago. Besides his studies, he enjoys playing the guitar, reading and going to the cinema with his girlfriend Ana. During his studies, he never had specific training with obese patients and how to best support them. He only had a few knowledge from one of his books about obesity and how these people need to be supported while they are being treated. The first contact he had with an obese patient happened with José, who felts very sad about his health condition and none of his previous treatments nor his "fast-result" diets had success.
Coincidence or not, Leonardo started to have more appointments with more obese patients, which present him very low motivation in obesity treatment, do not have very social skills due to their health condition, have autonomy issues in daily life, such as moving from one place to another without strain and suffer from low self-esteem.
Leonardo is willing to replace the current standard procedure of assessing obese patients just in their scheduled time, in which, some patients hide some facts from him or do not feel comfortable to share, by an alternative supported on technology, that could be more versatile and easier to use. A system sending some results about patient's daily life and offering some mental support tool which aims to improve obesity treatment and increase patients welfare.
During his first contacts with obese patients, Leonardo had some struggles to prescribe some medicines and advice to patients, since there are additional criteria establishing treatments such as for depression and anxiety, sometimes based on non true facts that patients report.

Motivation: Leonardo would like to improve the way he prescribes treatments to obese patients during his practice and be more certain that his prescriptions consider all the applicable criteria.

Image adapted from [45]

3.1.4 Secondary Persona: Joana, a clinical and health psychologist.

Figure 3.4: Joana, a psychologist.

Joana is a thirty-four years-old psychologist that has been working in Aveiro's Hospital for the last 11 years. She is a very patient, nice and caring person and often does volunteering work where she lives.

Some years ago, Joana started to deal with obese patients in her psychology appointments and she struggles to deal with obese patients. However she started noticing that sometimes obese patients are not willing to share with her as much as she desires, and she thinks that an innovative idea is needed, such as technological so that patients can keep a record of things in a mobile application and when they feel ready to share with her, they can share what they want, without running the risk they may forget in a short period of time. Joana thinks that an idea like this would improve her skills and also that patients would feel more comfortable with such system.

Motivation: Joana wants to improve her skills when dealing with obese patients, in order they can feel more comfortable to share things with her so that appointments and treatments can get more efficient.

Image adapted from [46]

3.2 Scenarios

The contextual scenarios presented below try to depict how the proposed system integrates with end-users activities so that their enhancement when being performed can fulfill the motivations of each persona.

3.2.1 Providing nutritional support

Meal alert

Marta can not control her meals times, since she is not very used to it, having days in which she does not have breakfast or lunch. She already tried to used timers to remind her that she has to eat, however Marta dismiss those alarms, resulting in a forgetfulness. To avoid this, Marta needs a system that can not be fooled by clicking in a button just for dismissing the meal alert, since the system has to be smart enough for measuring a meal time.
To help reminding her that she has to eat on time, Marta uses this system to improve her meal habits, avoiding the skipping of her meals and improving her eating habits.

Water alert

Marta also wants to drink more water, but sometimes she can not fulfill this goal. To help her, Marta sets customizable alerts in the system so that she can be reminded to drink more water. Every day, this system notifies her to drink water at given periods of the day. If she drinks water, she can registry in the system the amount of water drunk. By drinking water everyday, points will be awarded to Marta.

Chewing Time

One day, at one of her appointments with her psychiatrist, Leonardo asked Marta a question that she not felt comfortable to answer. Leonardo only asked her what was the average time she used to spend when she has her meals. Marta always felt guilty, since she always knew that food should be chewed slowly, but she was never able or had motivation to chew food as good practices demand. To improve her ability of chewing food slowly Marta uses this system to help her. So, in her first time using this system's feature, her meal time will be measured, and on her next meals, the system will try to help her to delay a little bit more, by suggesting initially to taste the food by increasing the chewing time, then moving to drop the cluttering when chewing the food, decreasing the portion ingested by changing of a normal plate to a dessert plate, and other helpful suggestions. By achieving these goals gradually, points will be awarded to her.

3.2.2 Providing physical activity support

José has been an obese person for almost of his life, and to improve his physical activity, José had already tried some fitness applications. However, José lacks motivation using such applications since he feels that the goals of these applications are very difficult to reach and José ends up uninstalling them, being even more demotivated since he feels he will never be able to reach some physical goals. To help him, José uses this system that gradually will improve his physical activity. It starts by suggesting José to go for a walk until he feels tired so that the system measures the time elapsed and the walked distance.
Next time, the system will suggest José to make the same walk as in the first time, and if José wants, he can try to walk a bit more. Therefore, José does not feel pressed to reach a certain goal, but motivated to reach personalized goals that he knows he can gradually reach, gaining points for his objective.

3.2.3 Providing mental health support

Both José and Marta are people of low self-esteem and they need mental support when they feel more depressed. They wish they could look better and sometimes they can not look themselves in the mirror and they avoid it as possible as they can. They would need something that would encourage them to look at the mirror and do not feel ashamed of themselves. To help them, both José and Marta uses the system that gradually will improve their mental health.

The system starts by suggesting them to look in the mirror and gradually will improve by suggesting them to try to achieve a silhouette that they would feel comfortable with themselves. This way, José and Marta can start to look themselves in the mirror more often and gradually improve their mental health.

3.2.4 Providing psychological support

Motivational support

On a given day, José could not fulfill a given goal in Exercise Module. To do not demotivate José on his obesity treatment, since he is doing great, the system will assign José a symbolic punctuation for his effort, informing him that his effort is recognized and next time it will be better. This way, the system supports José for his effort so that he may not demotivate.
With Marta happened the same. One day, she was in a rush, and she could not take the time the system desired for one of her meals. To do not demotivate Marta, the system assigned her a symbolic punctuation for her effort and provided her some positive feedback.

Clinician's support

On a given day, José could not fulfill a given goal in Exercise Module. So, José sent a voice message to his psychiatrist, Leonardo. saying that he is feeling that he is incapable of lose weight and continue his obesity treatment. When Leonardo hears José's message, he answers José with a helpful feedback about his efforts so far, trying to motivate José on his treatment.

3.2.5 Providing educational support

Tip of the week

José and Marta have been using this system for some time and every week, they receive illustrative and short tips that might be of their interest about obesity, and where they can discover more information, if they feel like it.
One day José received a tip that interested him a lot. Since he is very focused on physical exercise, the tip informed him that with the increasing physical activity, muscular mass is gained and this mass is heavier than fat mass. So, José, pressed this tip to discover more information about it.
With Marta, since she is focused on drinking more water and having more meals, she received a tip on how unhealthy is skipping meals in obesity treatment. So, she pressed this tip to learn more about it.

Tips related with obesity

Since Marta is a woman with low self-esteem, she always had struggles to ask things that could make people make laugh of her. This happens not only with related people but also

with her psychiatrist Leonardo. She knows that she can ask and clarify her doubts with him, however she had never felt comfortable with it.
One day, when Marta was using the system, she discovered a component where she had several short tips about aspects related with obesity. Marta, chose a certain short tip, in which she could see in detail a long description about that tip and how she could improve her obesity treatment. Thus, Marta is able to be more clarified with aspects related with obesity, without taking the risk of feeling embarrassed when clarifying her doubts.

Make a better use of the system

José is a forty-years old man and he always had struggles when dealing with technology. He never feels comfortable when he has to perform more complicated tasks in a mobile application. He had already tried some applications for weight loss without success, sometimes due to his demotivation, or the fact that he does not know how he can make progresses using such applications.
One day, when José was using the ObeOne's system, he realized that there was a component dedicated with frequently questions that users may have using this system. So, José saw a question about how he could progress in the different dimensions of the system and then he pressed that question and was able to see a detailed explanation on how to progress. This way, José could be more enlightened and realize how he can make better use of the system.

3.2.6 Providing statistical demonstrations

Both José and Marta have appointments with their psychiatrist Leonardo, who is always very interested to hear how their progress in obesity is going. To better inform Leonardo on his achievements on physical exercise, José shows his statistics and how his progress is going so far. Marta, on her turn, does the same thing as José. She shows Leonardo her statistics on her ingestion of water and how her meal time has increased.

3.2.7 Proving gamification challenges

To ensure users can stay motivated using the system, when accomplishing tasks in certain modules, points are awarded to them, so as long as they are using the system, they can evolve to different levels. Both José and Marta had already had some evolution, keeping them more motivated to continue gaining points.

3.2.8 Tracing profiles

When José and Marta used the system for the first time, they had to enter some personal information which is stored locally in the device. They first entered their name, date of birth, gender, weight and height, moving then to some questions about their habits such as their sleeping hours and their food patterns so that based on their personal data a profile could be

traced.

3.2.9 Sharing with Doctor

Both Leonardo and Marta have some struggles when they ask their patients to report how they are evolving in their obesity treatment. Both clinicians notice sometimes that the reported information is not always true or sometimes patients do not fully remember, which can lead to a bad prescription of some treatments. So, in order to increase their ability to prescribe treatments and to make their patients feeling more comfortable to share, a sharing module could improve the information exchange. Obese users can select the information they would like to share with the doctor, generating a QR Code that has to be read or through charts indicating evolution in certain modules.

3.2.10 Setting external patient's configuration

On one of Leonardo appointments with José, Leonardo suggested José a system which may help him in his obesity treatment. José accepted and was very happy to try a system that could motivate him. So, when José used the system for the first time, he noticed that the system could be used for people who are not being followed for clinicians, whose main interest is to lose weight, and for people like him, being clinically followed. José selected the clinically followed option, since he is being followed by Leonardo. Then Leonardo, with a system he owns, generated an invitation card, which José had to read with his new system. Then, José's system presented to him by informing it already had some of his personal information and it was ready to help José in his obesity treatment.

3.2.11 Measuring weight without patient's knowledge

Since Leonardo has been gaining experience dealing with obese patients, he noticed that one of their biggest fears is to measure their weight. He realises that some people may not feel totally comfortable with the weight scale. However, Leonardo has on his cabinet a device, disguised in a chair, in which people can sit and that device measures his patients weight without them knowing. All Leonardo has to do is to invite people to sit, wait for a while and when the weight is finally measured, Leonardo can see his patient's weight.

3.3 Requirements

Based on the previously defined scenarios with the help of a health professional psychologist, it was defined a set of requirements for the proposed system, which can be seen below.

- Support obese patients in their condition with different dimensions;
- Support the management of the several dimensions: nutritional/mental/physical/educational;

- Support exercises/ development of practices which allow to evolve in each dimension;
- Approach each patient in a personalized way;
- Keep a record of the evolution, not in a negative way;
- Allow the integration of relative quantitative measures for the different dimensions (e.g. weight, movement);
- Allow access / navigation based in motivations instead of features;
- Present progress without being based in *"basic"* measures (e.g. walked distance, lost weight);
- Allow the configuration of the system by the clinician with the patient profile / action plan;
- Allow the system to be multi-language in order to support more obese patients in their health condition;

CHAPTER 4

Iterative Development of ObeOne

The development of *ObeOne* system was based in UCD, in a sequence of low-fidelity prototypes and high-fidelity prototypes. This chapter is divided into five parts, so that, each part corresponds to each iteration of the proposed system, Therefore, it is intended to show the different stages of the carried out work, as well as the methodology followed at each stage.

4.1 System Overview

In order to achieve the objectives defined for our work, as described in section 1.3, and the requirements elicited by the work described in chapter 3, several design options were considered for the system to be proposed.

Contrary to the existent applications aimed for weight loss, which fails in keeping users motivated, it was necessary the adoption of a method that explicitly identifies the audience and context and a complete description of the adopted intervention. As seen before, the help of a psychology professional was crucial in order to identify system's modules that could help improving user's health condition. As it was possible to verify in the third chapter, an UCD approach was adopted, that through the defined requirements, in section 3.3 enabled the conceptualization of dimensions that the system would have to support.

Therefore, it was necessary that the system would have to support physical, nutritional, mental and educational dimensions, different from what others systems offer. The first three dimensions would have to include exercises suited for each user, allied with a gamification module, assigning points for the success or failure of a challenge.

Allied with this module, a psychological module that provides positive feedback whenever a user achieves or not the goal of a given challenge was necessary. This way, besides the assigned punctuation, users can feel motivated even if they fail to accomplish the goal of a challenge.

In order to provide information in which users can obtain knowledge about obesity's related aspects, the implementation of an educational module was necessary. In this module, users can also learn how to better interact with the system, so that, their ability using the system can be improved.

To increase the sharing between doctor-patient times, so that, doctors can be more aware of how patients are evolving in their obesity treatment, and also, users can track their evolution in each system's dimension, a statistical module helps users tracking their evolution and the sharing of progress data with clinical professionals. In this module, users can see charts, e.g, about their increase of physical activity.

Finally, a profile module for users enter some of their personal information such as their name, age, gender, weight and height, so that, the system can trace users profile. In this module, some users information can be used to provide data to the statistical module, e.g., showing a chart about their weight loss over time.

The conceptualization and interaction between these modules can be seen in the diagram depicted in Figure 4.1. In addition, it was developed a system in which doctors can configure patient's profile, so that, when using the *ObeOne* system, obese users already have their profile configured and ready to improve their health condition.

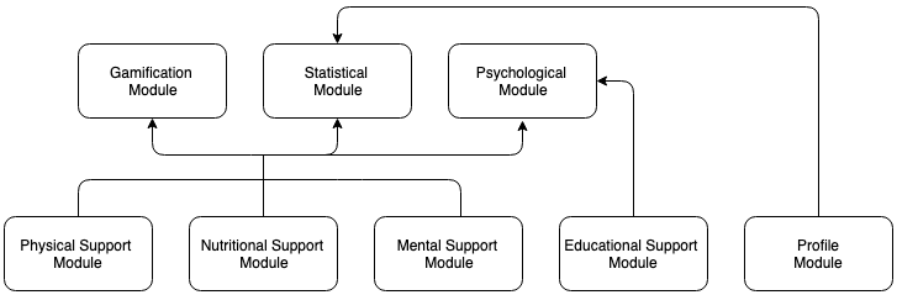


Figure 4.1: Conceptualization and interaction between system modules.

Contrary to the existent adopted designs and developed methodologies which do not serve the purpose of an iterative approach of serving identification, refinement and evaluation of intervention components for inclusion, the proposed system was developed within different phases:

1. The first phase consisted in the design and evaluation of a first paper prototype;
2. In the second phase, suggestions and feedback about the first paper prototype were implemented in the design of a second paper prototype, being then evaluated;
3. Then, in the third phase, application screens were implemented, being evaluated by users in a Heuristic Evaluation;

4. The fourth phase, some corrections and suggestions from Heuristic Evaluation were implemented in a second functional prototype, which was then evaluated by participants in a Usability Test and also a SUS questionnaire;
5. In the fifth phase, some suggestions made at the end of the Usability Evaluation were implemented and the system's screens were totally developed based in requirements and recommendations based from both evaluations;

Those adopted designs do not adopt designand development methodologies that serve a multidimensional and multidisciplinary approach to support obese patients, or neither pay particular attention to the mental health dimension. They also do not make a detailed characterization of the targeted audience, contexts of use, and interventions by adopting an iterative user-centered approach considering both the patients and the health professionals, and they do not adopt a technologically-agnostic approach enabling the support for a long-term effort.

Lastly, the development of mHealth approaches to support obesity patients involves a wide range of disciplines. To achieve this objective, the design and development of the *ObeOne* system was possible due to a multidisciplinary team, which involves professionals from Baixo Vouga Hospital Center (CHBV), the Department of Electronics, Telecommunications and Informatics (DETI), and the Departament of Education and Psychology (DEP).

4.2 First Paper Prototype

After the gathering of the essential information for designing the support dimensions for the *ObeOne* system, a first paper prototype was designed and evaluated by a group of stakeholders. These stakeholders consisted in a group of a psychiatry and psychology professionals, Human Computer Interaction (HCI), mobile computing and Informatics Engineering professionals. Stakeholders evaluated and suggested improvements in both design and evaluation of the paper prototypes. To achieve the paper prototype design, it was taken into account the defined personas, scenarios and requirements, defined in sections 3.1, 3.2 and 3.3 respectively.

4.2.1 Requirements

To achieve a first paper prototype, motivations from all the defined personas were taken into account, so that, the system would have to include the following requirements for the obese personas, 3.1.1 and 3.1.2:

- A module which could present monitoring and motivational support for physical exercise, so that, José would not demotivate from his obesity treatment so easily;
- A nutritional support module in which Marta could remember to have meals on a specific time of the day and could present her exercises for increase her chewing time;

- Both personas need the system to also support a module for their mental health, so that, they can improve it;
- A statistical module, since it allows José and Marta to monitor their progress when using the system, and have a better understanding on how they are evolving in their treatment;
- Lastly, it was important an educational module in which Marta and José could be more aware of certain aspects that can lead to weight loss / gain;

For the clinician's personas, Leonardo and Joana, 3.1.3 and 3.1.4 respectively, the application needed to include some other modules:

- Since Joana would like that her patients could share more easily with her their progress in obesity treatment, without taking the risk that the shared information could not be trusted, a sharing module is necessary. In this module, obese users can select what kind of information they can share, making them more comfortable to share with her, improving her skills when dealing with her patients;
- For Leonardo, the system would mostly need a module for supporting his patients' mental health, since they may suffer from low self-esteem, depression and anxiety, so that, he can establish a better criteria for prescribing treatments. Just like Joana, he would like that the system could support a sharing module to improve the understanding of his patients treatment evolution, and increase the quality of sharing between doctor-patient time.

4.2.2 Description

The first paper prototype implementation options will be here fully explained. This prototype can be seen more detailed in Figures 4.2 and 4.3. It is possible to see that the paper is divided into 9 rectangles in front and 3 in the back with non empty rectangles containing one screen of the system proposed, being the number of each screen given in the following order: top to the bottom and from the left to the right. This prototype was designed in English, since it aims to be a sketch of a multi-language system to cover a wider range of users.

The first screen is the main screen (Home) of the application. It is possible to say that it is divided into four parts: on the top, it has two circles pretended to show the daily moving minutes and the daily total points that users conquered within the dimensions. Then, below is possible to see another bar intended to show the total number of daily walked steps and distance in kilometres. Below this bar, some buttons are presented to the users, which can lead them to the different modules supports: Nutritional, Mental, Physical, Sharing, Statistical and Educational. Finally, at the bottom of this screen, a navigation bar with options for users to access another screens such as the Profile screen is presented.

Moving then to the Profile screen, users can see their personal information such as their name, age, gender, the classification level which they currently are in the system, their birthday, height, weight and BMI. At the top right of this screen, users have an option, where they can navigate to the Edit Profile screen.

Back to the Home screen, when users hit the button of Nutrition, then they navigate to the Nutrition screen, where they can add or customize alarms accordingly to the type, Food or Water alarm. For the customization of the alarm, a set of questions are asked such as the time they use to wake up, or about their meal times so that the alarm itself can schedule an hour to ring and advises users that they have to eat or drink water, in Add Alarm screen.

In Mental Health screen, people can choose this module to feel better mentally. At the the time of this prototype, this module was not yet implemented, since it was not clear how to design and/or implement this module.

Moving to the Exercise screen, the physical support module, some challenges are presented to users, so that, they can try to improve their physical activity. Also, at this screen, users can hit the Notifications button, which leads them to the Notifications screen, where it is possible to see some notifications related to the weight loss or gain accordingly with the physical exercises already performed.

When users hit the Share with doctor button presented in the home screen, they navigate to the Sharing module. Here users can select a beginning and an end date. After, content containing information of activities carried out in the other modules will be loaded. Then, users can select the information they want to share with their doctor, so that, a QR Code can then be generated. Finally, doctors would just have to read that QR Code and users information would be available on doctor's device.

The Statistical module screen, users can see some charts about their progression. These charts can present them their evolution in each module. For example, charts about the recorded users weight and physical exercise would be a good manner to understand their progress.

Finally, the Tips screen, is the Educational module, containing obesity related tips to, clarify and educate users about aspects that can lead to weight loss or gain. Here they can select a tip to see more information about it. Then, a detailed description about that tip can be seen, so that, users can be more aware about obesity aspects, in More Info screen.

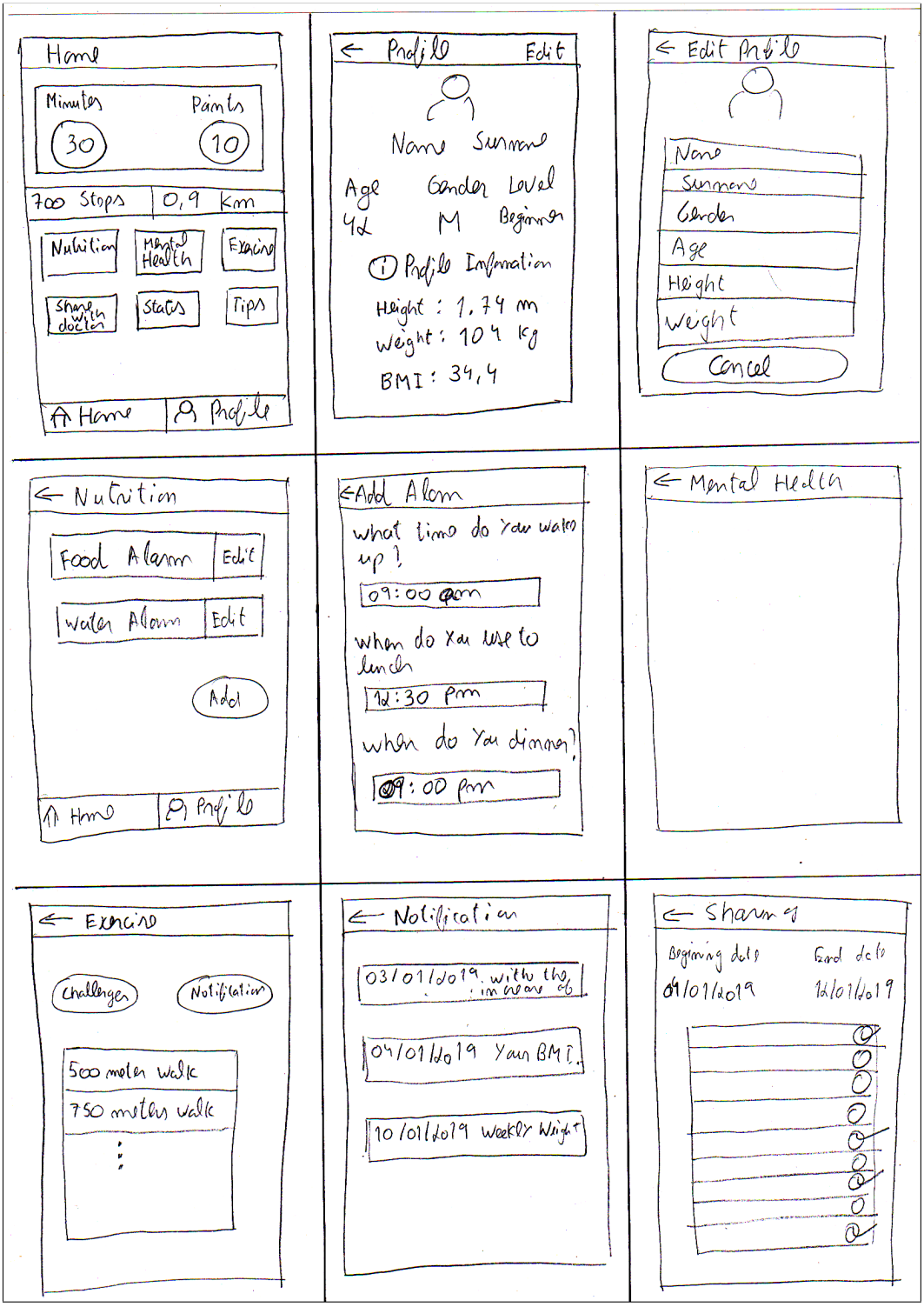


Figure 4.2: First paper prototype front page.

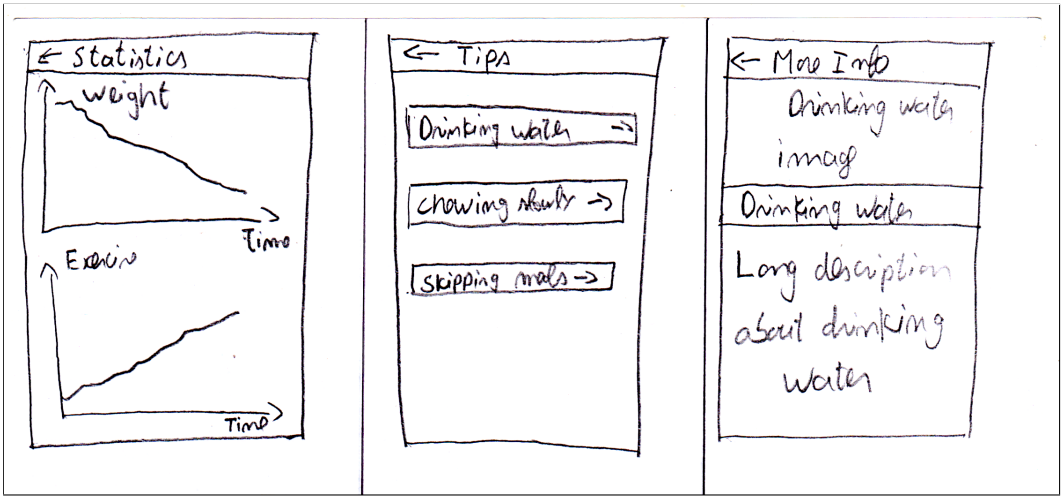


Figure 4.3: First paper prototype back page.

4.2.3 Stakeholders Feedback

After the design of the first paper prototype, it was evaluated by the same group of stakeholders mentioned before. These evaluators feedback was important to achieve a new paper prototype with several changes.

To begin with, evaluators did not approve the Home screen. They noticed that screen could be easily confused with other fitness applications, since it would display information like moving minutes, the number of daily steps and walked distance. They also reported, that users would not approve an interaction like the proposed one, which could immediately lead them to uninstall the application from their smart device, since they could misunderstand this system with other fitness applications and they could not fulfil the challenges that would be presented. Another comment made was the fact that the textual description for each button for the different support modules was not the best indicated, due to the fact, that obese users have been dealing with another systems for weight loss, like fitness mobile applications, so they could misunderstood this system with fitness applications.

About the Nutrition screen, the mobile application, informatics engineering and and HCI stakeholders reported that by introducing alarms that could not be dismissed before a predefined amount of time for having a meal, this alarm could be annoying and could easily be tricked, without fulfilling the objective that was designed to.

Another screen which was strongly criticised was the Physical support module. As it is possible to see, the Exercise screen presents a list of exercises that users can pick and try to perform. Stakeholders reported that this could demotivate users in general, since it could make them misunderstood the proposed system as a regular fitness application, which obese users may have dealt several times. Also, the psychology professional reported that these physical challenges could be very easy for average people, however for obese people, who

easily quit, could discourage them just by seeing an exercise that they thought they could not perform. This, in a way, would lead to a potential user's demotivation and a subsequent poor adherence to the system.

The Notification screen was also a source of criticism. It should not be accessible from the Exercise screen, but instead, it should be mixed somehow with the Educational Support, the Tips screen, since they both provide information that are related with obesity.

Finally, the Sharing screen, could be improved. If user's used to play a very active role in the system, then they could have a lot of items they would have to select within dates. On the other hand, if users did not play a very active role in the system, then they would not be motivated to use the system, making them feeling guilty

4.3 Second Paper Prototype

Here it will be described in detail each phase that the second paper prototype went through, from the gathering of requirements to its evaluation.

4.3.1 Requirements

The constructive reviews made in the evaluation of the first paper prototype, were gathered to design a new paper prototype which could better suit obese patients and that could make them not to demotivate when using the system.Therefore it was also important to have in mind the personas motivations and needs, in order to design a more interactive system, so that, instead of a system that "obligates" users to achieve certain goals, it should politely presents to them as a system that wants to help in their health condition.

4.3.2 Description

The second paper prototype can be seen in Figures 4.4 and 4.5. It is possible to see that the paper is divided into 9 rectangles in front and back with non empty rectangles containing one screen, being the number of each screen given in the following order: top to the bottom and from the left to the right.

In the welcome screen, the system introduces itself to users with an appealing information to help them in their obesity treatment. Then, all the Personal Information screens, the system asks users to input some of their personal information, such as, their name, age, gender, height and weight. This prompts the system to get to know its user.

At the Home screen, several buttons which can lead them to other screens, each one with different purposes. Also, here they can see three progress bars, each one representing their

evolution in the Physical, Nutritional and Mental dimensions.

When users press the *Feeling better physically* they navigate to the Physical Support module. At this screen, they can perform physical challenges suited for them. Before performing a physical challenge, users can see a textual description of it. Then, they can press the *Start* button and their number of given steps so as the time duration and the exercise state can be seen.

If they press press the *Feeling better nutritionally* or the *Feeling better mentally* they navigate to the Nutritional Support or Mental Support screens respectively. These screens are the same, however, the textual description for these challenges will be different accordingly to each type of exercise.

When users hit the *Know additional information* button, then they navigate to the Educational Support module, in Additional Info screen. Here they can find some tips, which they can hit to see a more detailed description about that tip. Similar to this screen, users can also find a *Frequently asked questions* module, Questions screen, where they can clarify certain doubts that they may have, by pressing an existing doubt and reading the detailed description about it.

To access the Statistical module, users have to press the *Know my progress* button to check their statistics while using the system, My Progress screen. Here useful statistics such as the evolution of users weight and exercise are helpful, so that, they can understand how they are evolving when using this system in their obesity treatment.

Finally, if users hit the Profile button, they can see their profile. Here at the Profile screen, they can find their personal information and their current level at the application and their BMI. Also, they can edit the information displayed in their profile, such as their name, age, height, weight, gender.

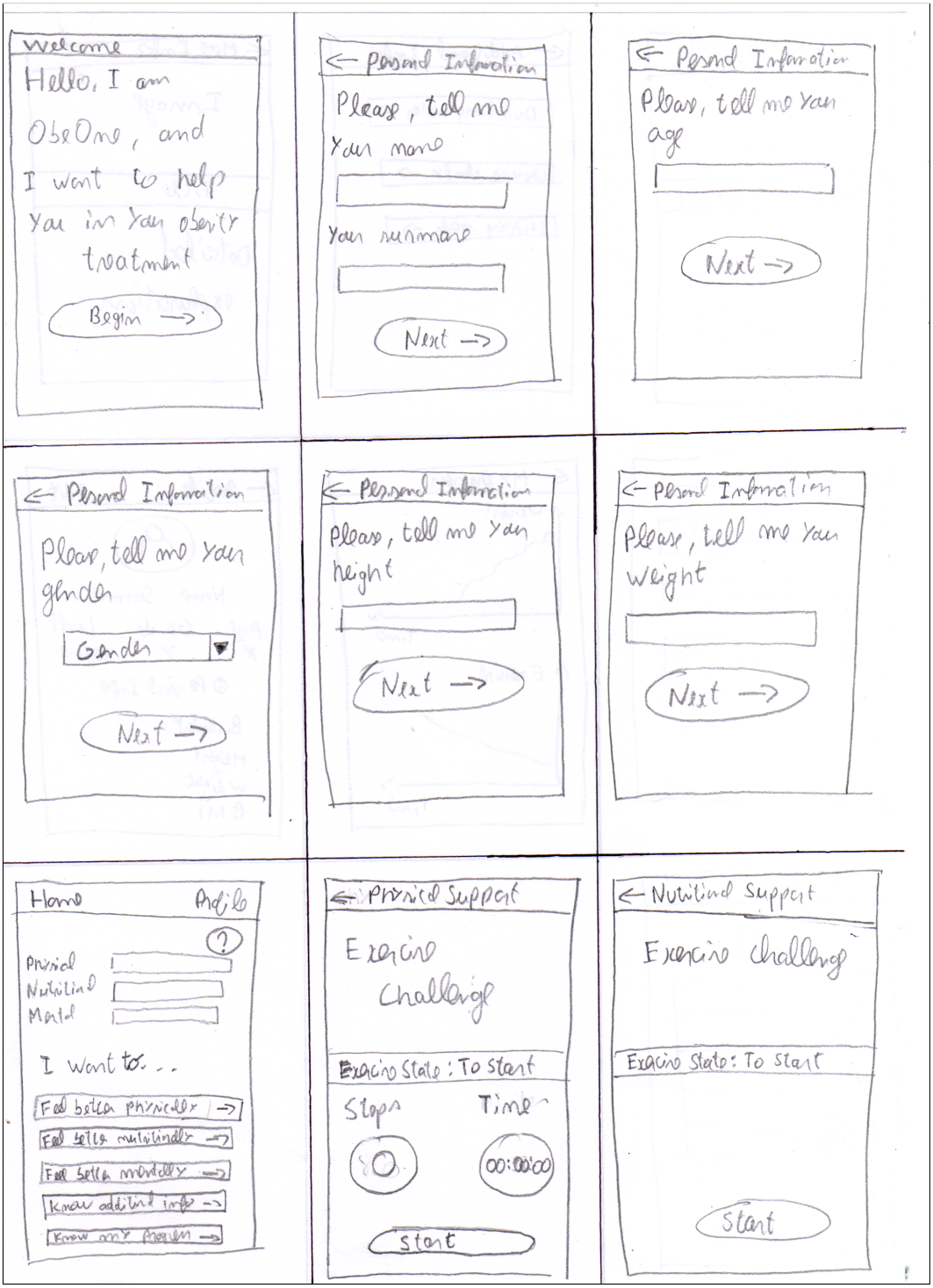


Figure 4.4: Second paper prototype front page.

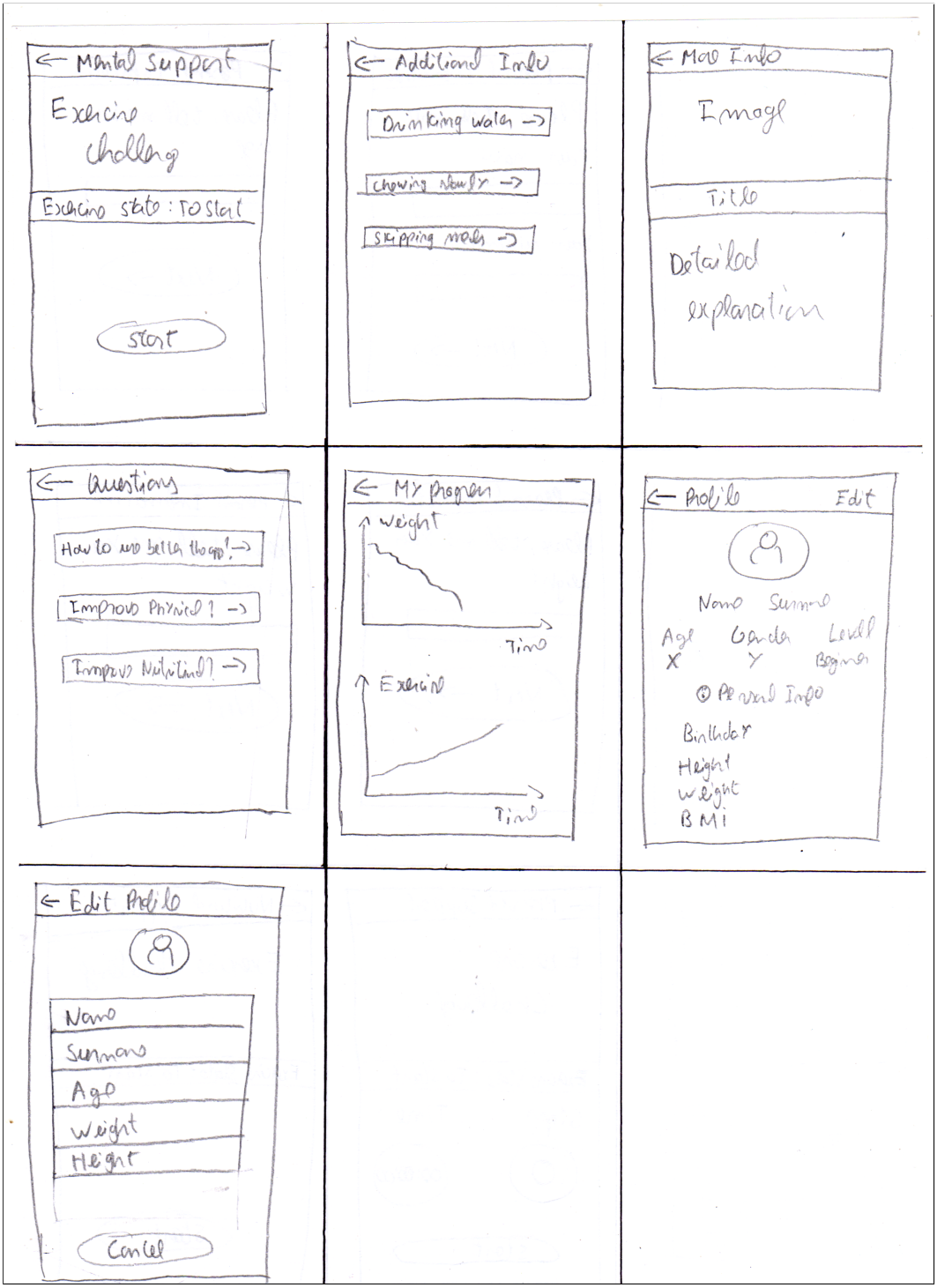


Figure 4.5: Second paper prototype back page.

4.3.3 Stakeholders Feedback

After the design of the second paper prototype, just like the first paper prototype, it was then evaluated for the same stakeholders.

Although this paper prototype being more appreciated and more relevant to obese users,

it received as well constructive reviews. To begin with, words that could be too specific in some sentences should be removed, such as "Hello, I am ObeOne, (...) in your obesity treatment". The word "obesity" should be removed and the sentence should be improved to a more contextual one.

Then, stakeholders related to HCI, mobile application development and informatics engineering noticed that there was no interaction method with the clinician, without being just the Statistical Module, in which users could only show their statistics only if they wanted to.

On its turn, the psychology professional and the HCI stakeholder, reported that forcing users to fill their personal information in the system at the beginning, could let them think that this was similar to a fitness application, and could make obese users to do not want to use the system. Therefore, these stakeholders suggested that users should introduce their information in the system when it was required or when they update their profile. For example, information like user's age, gender, height and weight are useful to trace a physical profile in order to the system trace physical exercises suited for each user.

Also, about the physical support, the psychology professional reported that users should not be able to visualize the number of steps and the exercise time duration while a physical challenge is being performed. This is related to the fact, that obese users could easily quit the exercise, when they thought they already had walked too much or for a long time.

Another suggestion that stakeholders made, was that the progress bars in Home screen should be divided in at least three levels for each dimension. They also reported, that the top right rounded questions button should be removed, and it should be inserted as an option in the buttons menu.

Finally, at the Profile screen, the user's level should be removed, since hey could now follow their evolution in each dimension through the progress bars presented at the Home screen.

All of these reviews were accepted and implemented, in section 4.4.

4.4 First Functional Prototype

Here it will be described the process of development and testing of this first functional prototype. It will be possible to see the requirements that were needed to take into account in order to develop the prototype. Then, it will be possible to see in detail the application's representative screens that were evaluated in an Heuristic Evaluation and consequently its results. Finally, it will also be possible to observe in detail the screens of a clinician's system

prototype to interact with *ObeOne*.

4.4.1 Requirements

After the design and validation of the two paper prototypes referred above in 4.2.2 and 4.3.2, the next step consisted in implement with modifications the system designed in the second paper prototype taking into account the stakeholders feedback in 4.3.3. Therefore, this first functional prototype implemented the modifications suggested by them.

Lastly, the system should be easy to navigate, minimalist, attractive, and inform users of what is happening when they perform certain tasks.

4.4.2 Representative Screens

Here it is possible to see some of the representative screens of the proposed system for this first functional prototype. In Appendix A.3 is possible to see all the designed screens. The presented screens are horizontally grouped, however the order in which they appear should not be considered relevant, since it is intended to only be illustrative in order to clarify better the reader.

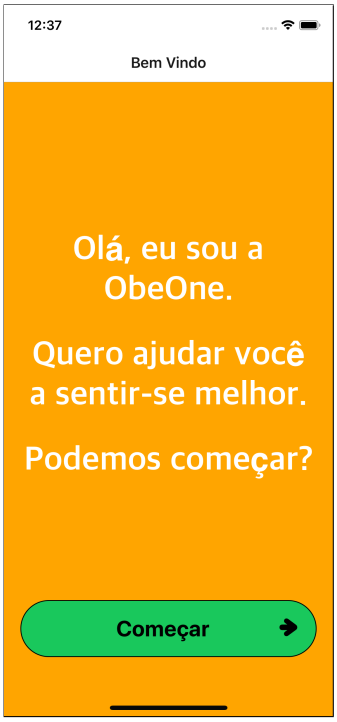


Figure 4.6: First screen of the application when is used for the first time.

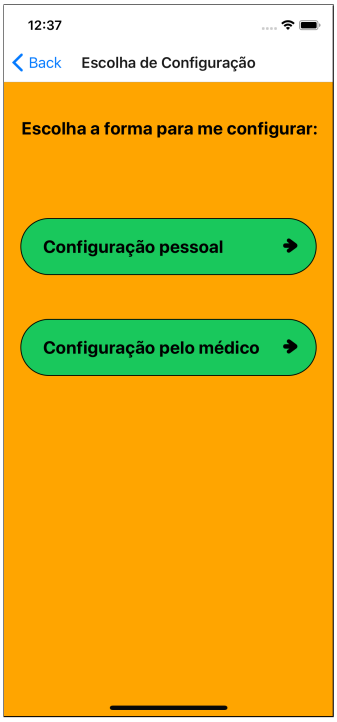


Figure 4.7: Screen to choose between personal or medical configuration.

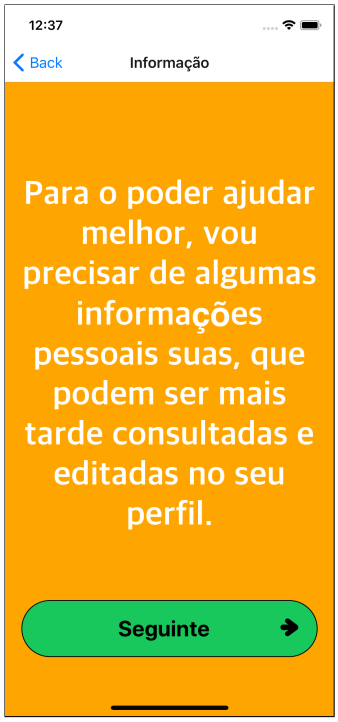


Figure 4.8: Screen informing users that personal info is going to be asked.

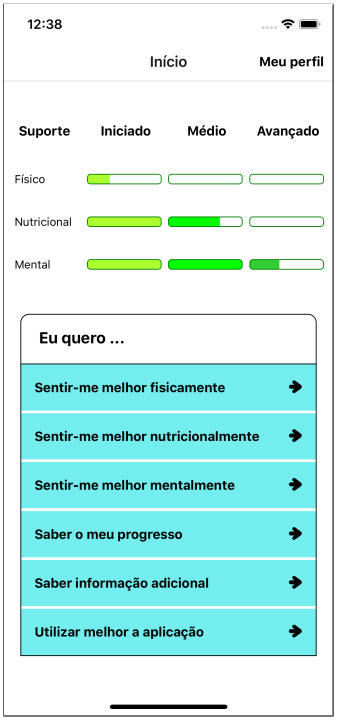


Figure 4.9: Home screen with menu options.

Figure 4.10: Users profile screen.

Figure 4.11: Update users information screen.

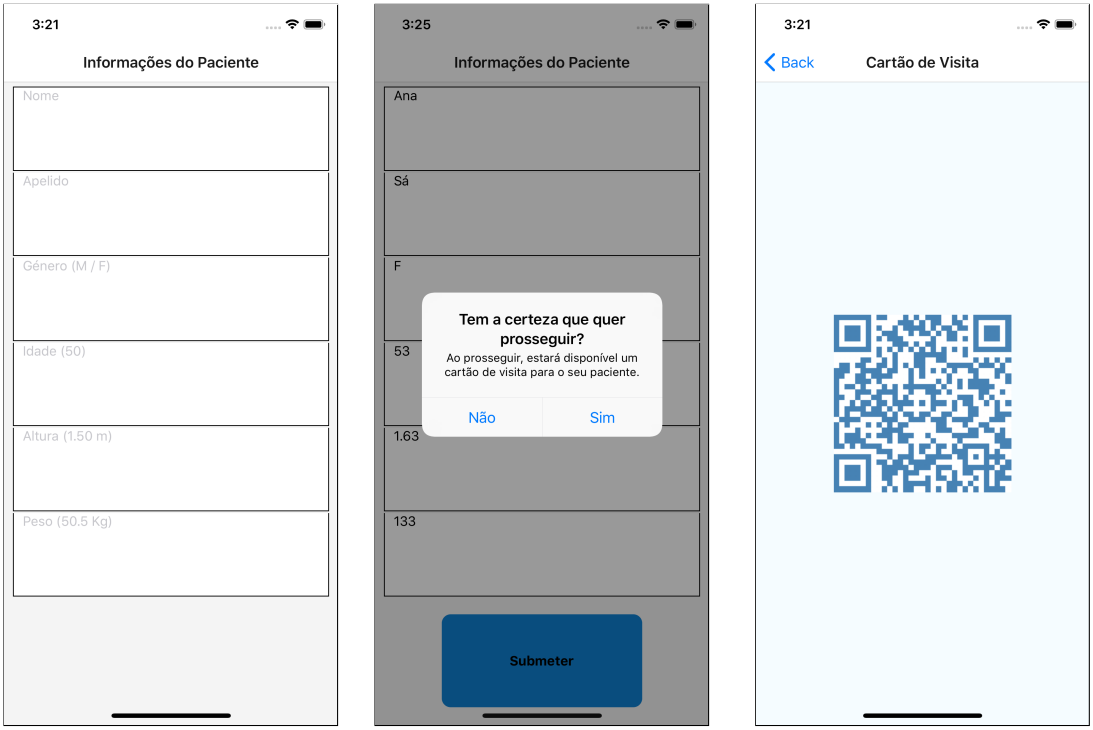
4.4.3 Clinician's System Representative Screens

Here it is possible to visualize a system design for clinicians. Since this system is a illustrative prototype, it was not evaluated with an Heuristic Evaluation neither with an Usability Evaluation.

This system allows clinicians to introduce their patients personal information such as their name, age, gender, height and weight, as it is possible to see in Figure 4.12a, in order to illustrate an interaction between the *ObeOne* system and a system that doctors use to trace their patient's profile.

Then, clinicians hit the *Submit* button and they are alerted that by proceeding, a visit card (QR Code), will be available for their patients to read with the *ObeOne* system, as demonstrated in Figure 4.12b.

Lastly, the visit card is displayed in Figure 4.12c, enabling this way a very simple interaction between these two systems.



(a) Screen for doctor fill patient's personal information.

(b) Alerts the clinician if he wants to proceed to the QR Code generation.

(c) Screen showing the generated QR code.

Figure 4.12: Clinician's mobile application screens.

4.4.4 Heuristic Evaluation

In order to identify usability issues in this first functional prototype, it was asked to four different evaluators to conduct a heuristic evaluation, using the Nielsen Heuristics. The evaluators consisted in three elements of the male gender and 1 element of the female gender. Also, evaluators, students of Informatics Engineering and Computer and Telematics Engineering, about 22-23 years old and with knowledge of how to perform a heuristic evaluation.

Therefore, during each evaluation, each examiner marked usability issues according to a severity scale in a range of 0 to 4, in which zero consisted in a no usability problem at all and 4 consisted in a very severe usability issue. The used severity scale and an explanation of each heuristic for each examiner can be seen in detail in Appendix A.1.

Lastly, the results of each evaluator were gathered and resulted in a list of major usability issues identified, which can be seen below.

4.4.5 Results

After all the heuristic evaluations being made by all examiners, their evaluations were gathered in order to understand the usability issues found. Therefore, in Table 4.1 is possible to see each heuristic rated with a severity scale degree.

Examiners	Heuristics									
	1	2	3	4	5	6	7	8	9	10
Examiner 1	0	0	2	0	0	0	0	1, 2	0	0
Examiner 2	0	0	1	0	1	2	0	2	0	0
Examiner 3	1	1, 2	0	1, 2, 3	0	0	0	0	0	0
Examiner 4	1, 2	0	3	1, 2	3	2	0	0	2	0

Table 4.1: Severity rating of each examiner in the respective heuristics

By the analysis of the table, is possible to understand that almost of the heuristics were rated with a severity degree different from zero. Below, it is possible to see all the usability issues found by all examiners:

1. The colors in some application's screens should change;
2. The *Cancel* button in *Edit Profile* screen does not work;
3. The hardware back button of Android device should be disabled in some screens;
4. The progress bars in Home screen should be displayed as long as the dimensions exercises are completed in the first time they were performed;
5. The removal of the annoying alert every time users makes a mistake when introducing their personal information;
6. The information icon should be changed to a different one, since users could confuse it with a button;
7. The input field for inserting user's information should be pressed at any of it's defined area, and not only at its beginning;
8. The screen in which users can choose the configuration of the application should change to the first screen;
9. The Home screen should change and some information should also be removed;
10. The progress bars of the different dimensions should change from the *Home* screen to the *Statistics* screen;
11. The application should have more icons, avoiding the use of textual information;
12. After a physical challenge, the results of it should be immediately displayed and not asked if users want to verify them;
13. The *Congratulations* text after a physical challenge can be easily confused with a button;
14. The search bar in both *Frequently asked questions* and *Additional Information* screens does not work correctly;
15. When users are performing a physical challenge, the number of walked steps should be displayed while the challenge is being performed;

16. An alert indicating that the physical challenge will end should be displayed, when the users hit the hardware back button or the back navigation button;
17. When users want to update their profile, the input fields should be filled with the existent current information about them;
18. When the device's keyboard is prompted, it should be displayed accordingly with the type of information that is required for user to insert;
19. The feedback for users should be improved when not allowed characters are introduced in input fields;

4.5 Second Functional Prototype

This second functional prototype appears after the evaluations and results made for the previous prototype. Here, it will be explained in detail the requirements needed to take into account in its development in. Additionally, it will be possible to see in detail the representative screens of this prototype, evaluated then by users who had to complete typical tasks in real life-situations. Lastly, it is also possible to see the results of the performed Users Evaluation.

4.5.1 Requirements

After the implementation and validation of the first prototype, some modifications were made for the implementation of this second functional prototype.

To begin with, some of the usability issues found in the heuristic evaluation were firstly solved. However, some of those issues remained unsolved, since they were in disagreement with stakeholders feedback. In Table 4.2 is possible to see if the usability issues found during the Heuristic Evaluation were solved or not, so as the reason for not being fixed. Lastly, another requirement for this prototype was the inclusion of a fully working dimension. So, the Physical Support module had to be implemented with user's suited challenges, in order to evaluate this second functional prototype.

Heuristic issue number	Solved	Reason to do not solve
1	No	It was not a critical issue to solve, in order to, develop the second functional prototype
2	Yes	—
3	Yes	—
4	No	It was not a critical issue to solve, in order to, develop the second functional prototype
5	Yes	—
6	Yes	—
7	Yes	—
8	Yes	—
9	Yes	—
10	Yes	—
11	Yes	—
12	No	Violates stakeholders feedback
13	Yes	—
14	Yes	—
15	No	Violates stakeholders feedback
16	Yes	—
17	Yes	—
18	Yes	—
19	Yes	—

Table 4.2: Association between usability issues number, its solution and reason for not being solved .

4.5.2 Representative Screens

Here it is possible to see some of the designed screens for this second functional prototype. In Appendix A.4 is possible to see all the designed screens. The presented screens are horizontally grouped, however the order in which they appear should not be considered relevant, since it is intended to be only illustrative in order to clarify better the reader.

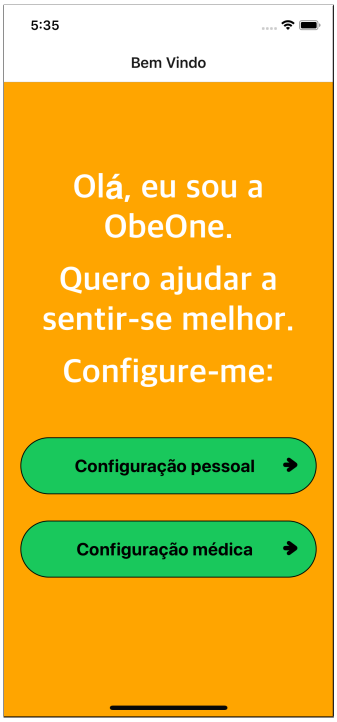


Figure 4.13: First screen of the application when is used for the first time.

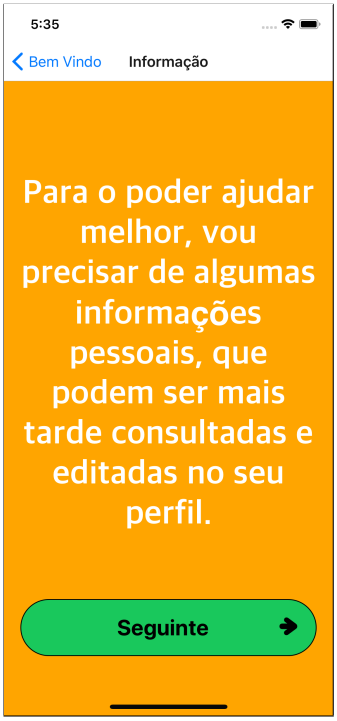


Figure 4.14: Screen informing users that personal information is going to be asked.

Figure 4.15: Screen for users introduce their name and surname.

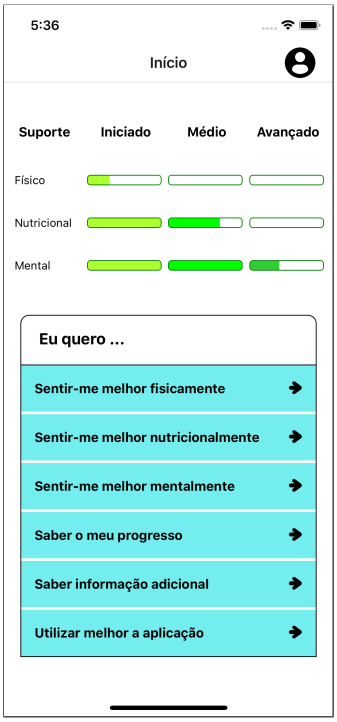


Figure 4.16: Home screen of the application.

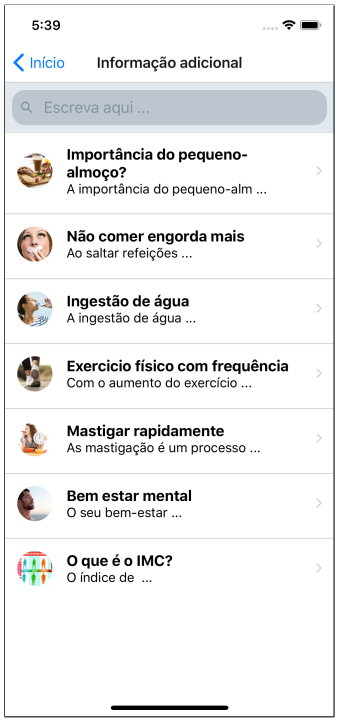


Figure 4.17: Educational Support screen.

Figure 4.18: Screen showing additional information of a educational tip.

4.5.3 Users Evaluation

Due to the fact that access to obese patients depends on proper authorizations by the Ethics Committee and other limitations not clarified in this document, and in order to understand the ability of user's learning and the achievement of a given goal, as well as to detect additional usability issues five participants between 22-23 years old were recruited to participate in a Users Evaluation test. Participants consisted in three elements of male gender and two elements of female gender, being participants students of Informatics Engineering and Computer and Telematics Engineering. In Table 4.3 is possible to see the eight defined tasks that participants had to accomplish.

Task	Description
1	Initiate the application with a personal configuration.
2	Use the system to perform a physical challenge and walk 50 steps.
3	Finish the exercise and do not verify its results.
4	Check the information on how the BMI is calculated.
5	Check information on how to improve the nutrition.
6	Repeat a physical exercise, walking 70 or more steps and verify its results after finishing it.
7	Check the dimension which has more progress.
8	View the profile and edit weight.

Table 4.3: List of tasks performed by users during the usability evaluation sessions.

At the end of each task, metrics were measured, such as:

- Successful task completion;
- The time that each task took to be completed;
- Non-critical errors;
- Error-free rate;
- Critical errors;
- Ease of use: scale within a range of 1 to 5, being 1 very difficult and 5 very easy;

Also, some recommendations that participants would like to say were noted, [47]. The observation grid used for this evaluation can be found in Appendix A.2.

4.5.4 Results

To begin with, all the evaluations made by participants were carefully performed, so that, the results achieved by each evaluation could be trustworthy. Each participant could complete all the tasks with or without external help.

Below, it is possible to see charts indicating the percentage of: task completion chart, time spent by participants in each task, non-critical and critical errors, error-free rate and finally the ease of each task considered by each participant, in Figures 4.19, 4.20, 4.21, 4.22, 4.23 and 4.24.

Figure 4.19: Chart indicating the percentage of task successfully accomplished by participants.

By evaluation of the Figure 4.19 is possible to conclude that all the tasks defined, with exception of task number 5, were successfully accomplished by all participants. On the fifth task, about 80% of participants were able to finish it by themselves, with another 20% of participants not being able to finish this task without any kind of help and within the time stipulated.

This can be considered as a minor problem, [48], since some users can be annoyed from not completing the task. However, for the same task some users recommended to change the Home screen layout, since it could lead in error when performing a similar task.

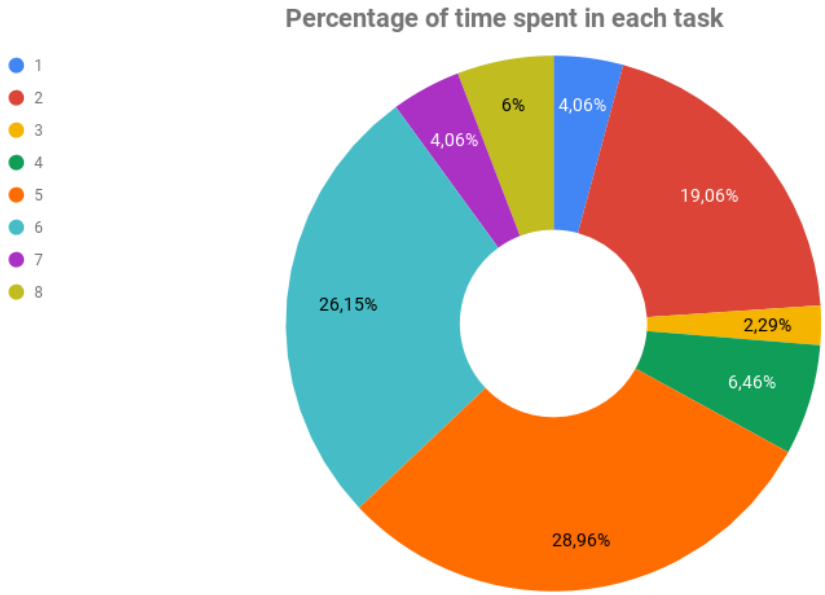


Figure 4.20: Chart indicating the percentage of time spent by participants in each task.

Each task had a two minutes maximum time to be performed. In Figure 4.20, the tasks that took more time to be accomplished were the third, the fifth and the sixth, since they require very different efforts.

However, the second and sixth tasks were expected to take longer than the remaining, but the fifth task took more time, since users committed some mistakes when trying to reach its goal.

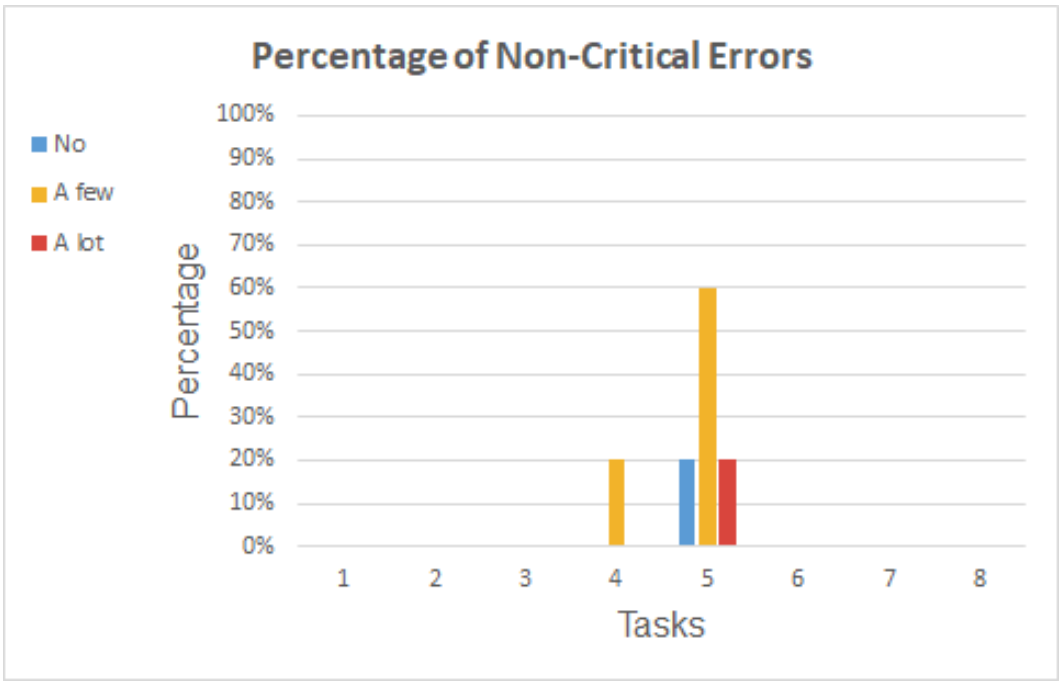


Figure 4.21: Chart indicating the percentage of Non-Critical errors made in each task by participants.

Analysing now the chart in Figure 4.21, to understand the percentage of participants who were able recover from errors that did not result in the failure of task completion, is possible to see that participants made some errors in task four and five. In the fourth task, about 20% of participants could reach the proposed goal with some errors. However, in the fifth task, 60% of participants committed a few mistakes and 20% of participants made lots of errors. Since the fourth and the fifth task consisted in "Check the information on how the BMI is calculated" and "Check information on how to improve nutritionally" respectively, these tasks consisted in verify information in the two different parts of the Educational module, with users misunderstanding each of this module's part.

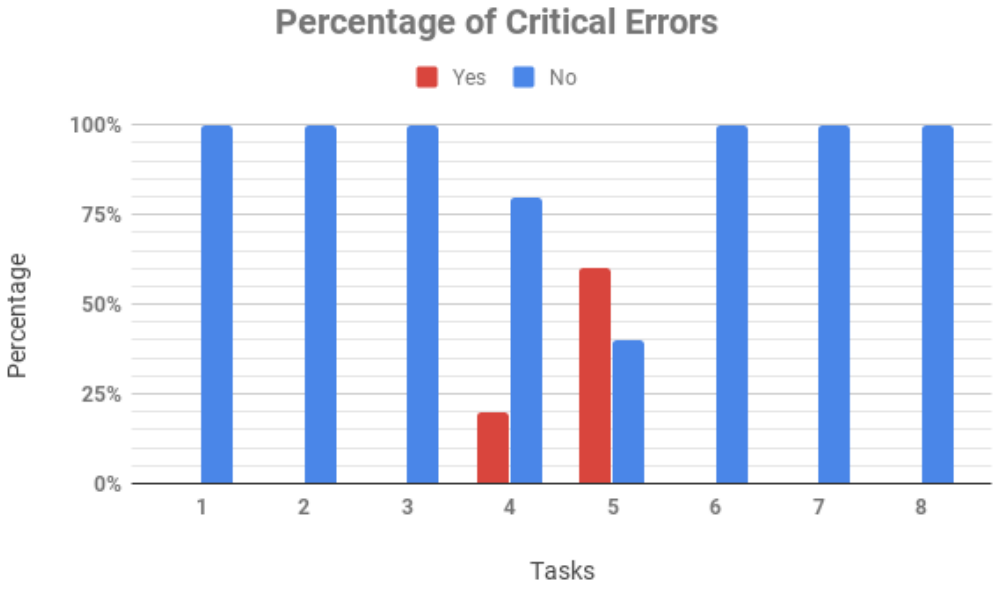


Figure 4.22: Chart indicating the percentage of Critical errors made by participants.

In order to understand if participants were aware if the task goal was incorrect or incomplete, in Figure 4.22, is possible to see that the tasks which only had critical errors were only the number 4 and 5. This is due to the fact these tasks were almost similar, however the configuration of the Home Screen layout induced participants in error. Is also possible to note, that the percentage of critical errors in task number five, is critical, with 60% of participants making several mistakes until reaching the task's goal.

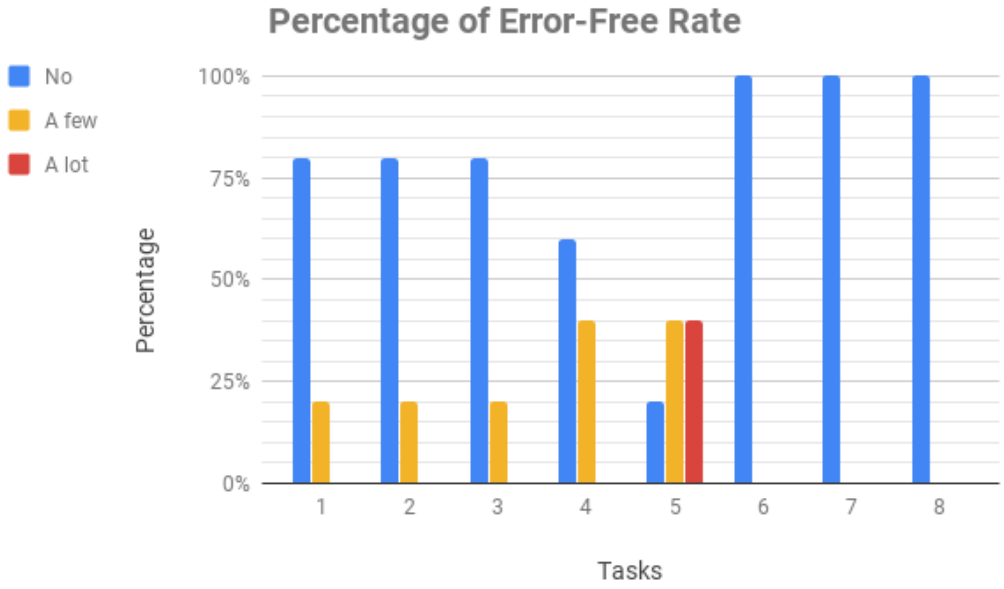


Figure 4.23: Chart indicating the percentage of Error-Free rate made by participants.

To understand the percentage of participants who completed tasks without any errors, the chart in Figure 4.23 can depict such percentage. Here, is possible to see that the only tasks in which participants did not commit any mistakes were the last three. On the other hand, in the first three tasks, 20% of participants made a few mistakes in each. However, is notable that in both tasks 4 and 5, 40% of participants made a few mistakes, being also the fifth task, the one in which most participants made a lot of mistakes.

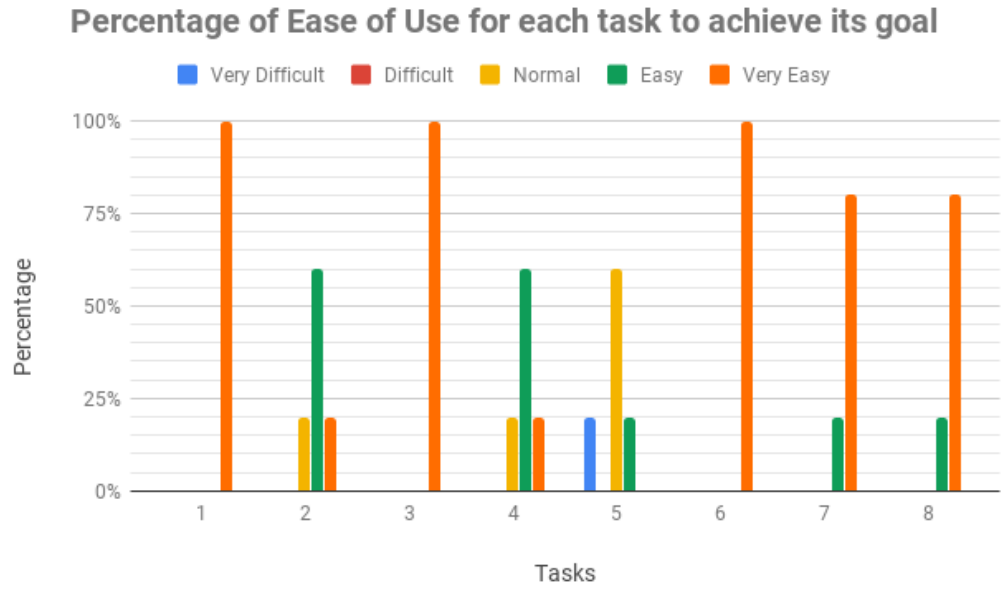


Figure 4.24: Chart showing the percentage of ease of achieving the objective for each task.

Finally, in the chart in Figure 4.24, is possible to see the most voted answers for classifying the ease of use of the system, when participants had to reach the goal of a given task. Here it is possible to verify that participants found the objectives of each task easy or very easy to achieve, with the exception of the fifth task in which 60% participants considered it as a degree of normal ease. Also, 20% of participants considered it as a very difficult task to accomplish.

SUS Score	Grade	Adjective Rating
> 80.3	A	Excellent
68 – 80.3	B	Good
68	C	Okay
51 – 68	D	Poor
< 51	F	Awful

Figure 4.25: SUS Score guideline interpretation, [49].

In Table 4.4 is possible to see the the score and rating of each participant after completing the tasks that they were intended to.

The average score of the SUS is 84. With this result, we can notice that this system has a very good score, according to the Figure 4.25, and can be considered as a system with excellent usability.

However, some participants reported the fact that some aspects should be improved in the system, such as the Home screen, since it could confuse users with the frequently asked questions and the educational support. On the other hand, they also reported that the progress bars for each dimension should be moved to the Statistical support.

Finally, when they were performing a physical challenge, it should display a progress bar that fills up as it approaches of the proposed goal, so that, users can know when the given challenge is accomplished. They also reported that the alert for displaying results should not be dismissed when clicking outside of its defined area.

Participant	SUS score	SUS Rating
1	82.5	A
2	70	B
3	100	A
4	92.5	A
5	85	A

Table 4.4: Score and rating of each SUS questionnaire.

4.6 Current Functional Prototype

After all the evaluations made in each functional prototype, appeared the need for some more refinements in the system, which, is possible to see the modifications made for this new prototype below.

4.6.1 Requirements

Since some suggestions were given after the Users Evaluation and some of the encountered issues in the Heuristic Evaluation were not solved, this prototype implemented the solutions for some of the reported gaps. Thus, it was required to fix those issues, so as the deployment of the screens for modules that were not yet developed, like the *Nutritional*, *Mental* and *Statistical* support screens.

4.6.2 Modifications

The first modifications being made were some of the issues found in the Heuristic Evaluation that were not fixed for the second functional prototype. Therefore, the colors in some system's screens were then changed, in order make a more pleasant and elegant application. The *Home* screen was redesigned too, by removing the progress bars for each dimension and adding more icons, making this screen more intuitive.

As for the progress bars, they were moved to the *Statistical* screen. Also, at this screen is possible to navigate to other screens, to show charts about the performed exercises in *Nutritional*, *Mental*, *Physical* modules, among other possibilities.

At the moment, this system is ready to be evaluated in a pilot test, used by end-users and clinicians, in order to understand its action plan in real-life circumstances and its effects in obesity treatment, so that, the feasibility and efficiency can be measured.

4.6.3 Representative Screens

Here it is possible to see some of the designed screens for the actual version of the proposed system. In Appendix A.5 is possible to see all the designed screens. The presented screens

are horizontally grouped, however the order in which they appear should not be considered relevant, since it is intended to only be illustrative in order to clarify better the reader.

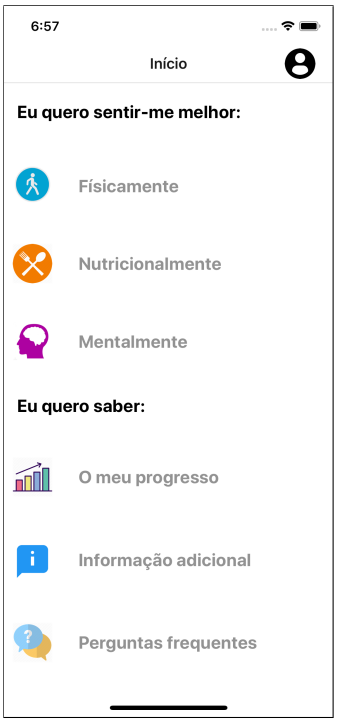


Figure 4.26: Home screen of the application.

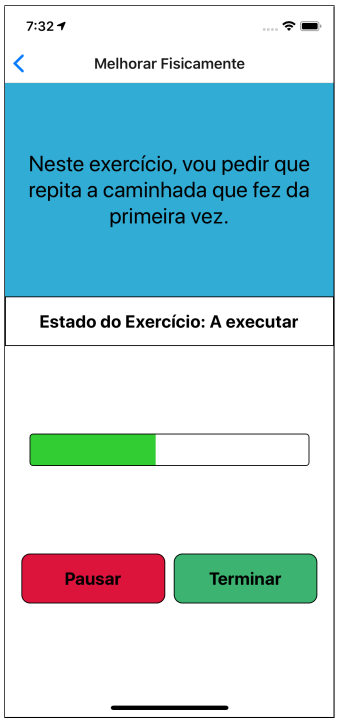


Figure 4.27: Physical challenge in progress.

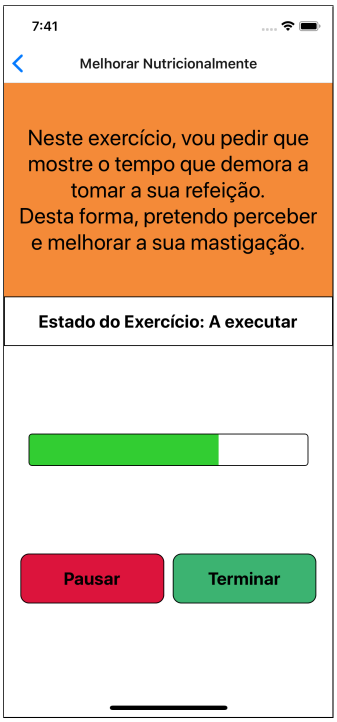


Figure 4.28: Nutritional challenge in progress.

Figure 4.29: Statistical support screen.

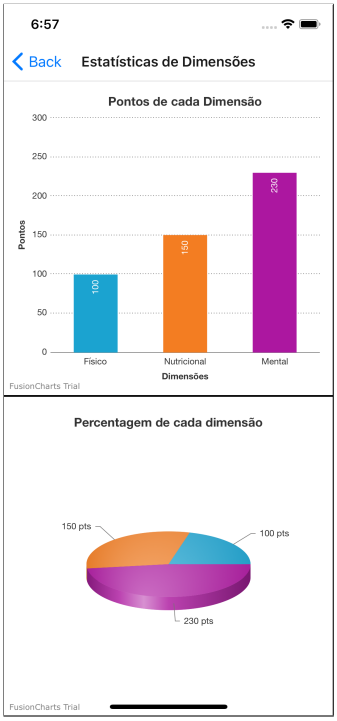


Figure 4.30: Punctuation charts about each dimension.

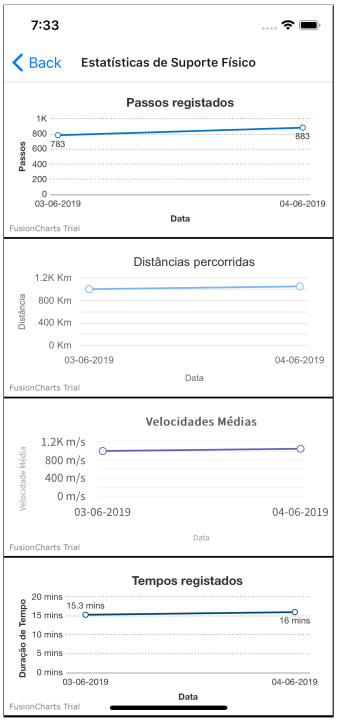


Figure 4.31: Physical Support charts.

CHAPTER 5

Conclusions

5.1 Evaluation of the work

The present work aimed at proposing ways of supporting obese patients and their clinicians in improving the patients quality of life and prognosis.

Based on the overview of existing mobile applications targeting weight loss and corresponding RCT studies in which these applications were tested, it was possible to understand their scope, context of use, feasibility and gaps through their assessment. Additionally, based in the analysis of reviews of several mobile applications, not fully presented in this document, due to its extent, it was possible to understand the main failures in existing systems promoting weight loss.

As a result, we present a system that aims to enhance the support to obese patients in their obesity's treatment, through a mobile application. This application was developed considering an iterative UCD approach, through the analysis of relevant issues not covered by other weight loss applications and through the establishment of requirements based on user needs, as well as the design and evaluation of prototypes until reaching the current functional prototype. As it is possible to see in Appendix A.5, the conceptualization of the system's design and functionalities considered the Portuguese language.

For the evaluation of the different prototypes, the considered options enabled solving several usability issues and also to achieve a system that is focused in user needs. In both paper prototypes, it was possible to improve some aspects that could lead to immediate disuse of the proposed system. As for the first two functional prototypes, it enabled solving several usability issues.

At is current development stage, *ObeOne* can be a valuable tool to support obesity treatment, since it gradually presents techniques suited for each user in nutritional and physical aspects, in order to provide personalized goals that they can reach. It also tries to be an educational tool since it focuses in related aspects that can lead to weight loss / gain. It is important to mention that *ObeOne* also focuses in its users mental health, for instance, by promoting a gradual setting of exercise goals, personalized to each patient, based on their

capabilities. Lastly, clinicians as well as obese users can track the evolution in the system with a statistical module that can be used to improve information sharing during doctor-patient sessions.

Nevertheless, this tool needs to be evaluated in a pilot test, by clinicians and end-users, in order to understand its action plan in real circumstances and its effects in weight loss, so that, feasibility and efficiency can be measured.

In conclusion, the work made can be positively evaluated. The defined objectives in section 1.3 were successfully accomplished. As for the requirements defined in section 3.3, the major part of them were fulfilled. However, it is important to note that the system is not yet defined to be multi-language, since its conceptualization was made in the Portuguese language, in order to be firstly tested by Portuguese end-users, however in a further development stage, is intended that the system can support other languages.

Thus, with the realization of the present work, it is possible to say that several things were learned. To begin with, obesity is not just a weight issue that can be treated with a restrictive diet and a lot of physical exercise, rather with several types of support, mainly with psychological counselling. Therefore it is necessary to make more efforts to provide better and more effective treatments to obese people.

5.2 Future Work

In order to continue the effort of evolving ObeOne towards our goals of a more complete, multidimensional support to obese patients, several points of the system should be improved and other functionalities should also be added. As for the evaluation of the system, the following topics should be implemented:

- The current prototype of the system should be evaluated by end-users and clinicians, so that, certain aspects that may be considered relevant for obesity's treatment can be improved;
- A pilot study, for example, enabling patients to use the application by themselves, over a period of time, should be made, in order to evaluate the suitability and acceptability of ObeOne;

Regarding the improvement of system features, the following topics should be considered, so that, system quality can be enhanced:

- The introduction of user's information should cover more than just personal aspects. Data such as the number of sleeping hours, food patterns, among others should be input in the system, in order to establish a more concrete user's profile. This also stands for the clinician's system;
- When users are inputting some of their personal information, they should be able to configure the modules they would like feel supported. For example, if users do not want a system intervention with nutritional support, they should be able to disable such component;

- The clinician's system should be able to better configure the *ObeOne* system. Therefore, during doctor-patient times, if clinicians think that the user's system should focus more in nutritional support, clinicians, with their system, should be able to configure *ObeOne* to focus more in the aspect they want to;
- Based on user's profile, support modules like mental, physical and nutritional, should be automatically adapted to each user, so that, users can get a more personalized intervention. This can enable the system to deliver a more suited intervention based in user's needs;
- Also, based in user's profile, physical challenges present to users should have in consideration data such as age and gender. Therefore, more specific exercises can be delivered to users;
- As the user uses the physical support module, more diverse challenges than just normal walking should be included, seeking to promote more intense activity exercises suited for each user;
- Although the integration with wearable devices was not defined in the 3.3, it should be considered at a further stage of development in order to obtain data, such as the number of steps, in a more more reliably way.
- Referring also the physical support module, the given punctuation should be adapted to the type of exercise. If users can fulfill some aspects such as for one hundred steps for minute, they should be awarded with more punctuation. It is important to note that, even if a given challenge can not be fulfilled, users should get a symbolic punctuation for their attempt;
- In order to improve the nutritional support module, other aspects should also be covered. Therefore, the total amount of daily ingested water could be an aspect to improve;
- The mental health support should be improved in several ways and to be more personalized. As well, more diverse exercises should be included, in order to improve users mental well-being. For example, at the end of certain mental exercises, a survey could be displayed asking how users are feeling with the intervention proposed for them;
- More educational tips related with obesity that can lead to weight loss / gain should be displayed. It is important to make users aware about the importance of certain aspects about obesity, so that, they can play a more active role in their obesity treatment;
- If for some reason, the user's device is replaced by a different one, is necessary to assure that the user's data stored in the old device does not get lost. Therefore, a solution can go through the remotely data storage, however, it is necessary to guarantee the safety and protection of this sensitive data;

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APPENDIX A

Appendices

A.1 Heuristics Grid

Escala de Classificação

A seguinte escala pode ser utilizada para classificar a severidade de problemas de usabilidade:

0 = Não concordo que que seja um problema de usabilidade no geral;

1 = Apenas problema cosmético: não precisa ser corrigido a menos que haja tempo extra disponível no projeto;

2 = Problema de usabilidade menor: resolver isto deve receber baixa prioridade;

3 = Problema de usabilidade maior: importante corrigir, portanto deve ser dada alta prioridade;

4 = Catástrofe de usabilidade: imperativo corrigir antes que o produto possa ser lançado;

Avaliação de Heurísticas

As seguintes heurísticas, devidamente explicadas, permitem classificar a *interface* e experiência de uso da aplicação. Seguidamente, pode deixar um comentário que pense ser necessário e classificar cada heurística com a escala apresentada anteriormente. Nielsen

1 Visibilidade do estado do sistema

Explicação: Esta heurística permite classificar o conhecimento do utilizador em relação à sua posição dentro do sistema, ou seja, informar o utilizador sobre o ambiente em qual ele estava, no qual ele está e que outros ambientes pode alcançar a partir da sua localização.

2 Compatibilidade entre o sistema e o mundo real

Explicação: O sistema apresenta a mesma linguagem do utilizador, não apenas no idioma em si, mas também linguagem que o utilizador utiliza diariamente.

3 Liberdade e controlo do utilizador

Explicação: Esta heurística permite avaliar se o sistema permite apresentar uma *saída de emergência* ao utilizador caso este realize ações por engano. Um exemplo comum quando o utilizador apaga por engano um *e-mail*, mas pode recuperá-lo facilmente quando acede ao Lixo.

4 Consistência e padrões

Explicação: A manutenção da consistência entre os vários ecrãs da aplicação é essencial para que não seja necessário o entendimento de vários padrões e formas de interação diferente para cada ecrã, sendo que uma vez aprendido, é algo replicável noutros contextos.

5 Prevenção de erros

Explicação: Esta heurística permite avaliar se o utilizador antes de realizar alguma ação no sistema, previne que o utilizador não cometa esse erro. Um exemplo comumente utilizado são as caixas de confirmação como as que aparecem quando o utilizador quer apagar um ficheiro do sistema.

6 Reconhecimento em vez de memorização

Explicação: O cérebro é muito bom em reconhecer padrões e na medida em que objetos, ações e opções ficam expostos ao utilizador, mais dicas chegam ao cérebro, permitindo tornar certas ações familiares. Deste modo, é preferível dar ao utilizador formas de reconhecer padrões do que obrigá-lo a memorizar várias informações à medida que ele navega pela aplicação.

7 Eficiência e flexibilidade de uso

Explicação: Esta heurística permite avaliar se a *interface* da aplicação é útil tanto para utilizadores avançados como também para utilizadores mais inexperientes.

8 Estética e *design* minimalista

Explicação: Quanto maior a quantidade de informação, maior será a quantidade de informações que serão analisadas, e decisões que o utilizador necessitará de tomar. Esta heurística avalia se as informações mostradas são realmente as necessárias.

9 Ajudar utilizadores a reconhecer, diagnosticar e recuperar de erros

Explicação: Esta heurística permite avaliar se o sistema ajuda o utilizador a recuperar de um erro. Um exemplo simples são os formulários em que campos obrigatórios que não foram preenchidos corretamente indicam o erro cometido pelo utilizador.

10 Ajuda e documentação

Explicação: Permite avaliar se o sistema fornece ajuda caso o utilizador precisa de alguma. Pode ser entendida como uma forma de “faça você mesmo” do utilizador para resolver as suas dúvidas de quais ações tomar dentro da aplicação, tornando o utilizador mais independente do suporte.

Heurística	Comentário	Classificação

Heurística	Comentário	Classificação

A.2 Observation Grid

Nº T.	Descrição	Completou Tarefa?	Tempo Máx. Tempo obs. (mm:ss)	Cometeu erros?	Sent. Perdido?	Pediu ajuda?	Grau de facilidade 1 - Muito difícil 5 - Muito fácil
1	Iniciar a aplicação com configuração pessoal.	Sim ☐ Não ☐	2m __:__	Não ☐ Poucos ☐ Muitos ☐	Não ☐ Pouco ☐ Muito ☐	Sim ☐ Não ☐ Qual?	1 2 3 4 5
2	Utilizar a aplicação para realizar um desafio físico e caminhar 50 passos.	Sim ☐ Não ☐	2m __:__	Não ☐ Poucos ☐ Muitos ☐	Não ☐ Pouco ☐ Muito ☐	Sim ☐ Não ☐ Qual?	1 2 3 4 5
3	Terminar o exercício e não verificar os resultados.	Sim ☐ Não ☐	2m __:__	Não ☐ Poucos ☐ Muitos ☐	Não ☐ Pouco ☐ Muito ☐	Sim ☐ Não ☐ Qual?	1 2 3 4 5
4	Verificar a informação de como se calcula o IMC.	Sim ☐ Não ☐	2m __:__	Não ☐ Poucos ☐ Muitos ☐	Não ☐ Pouco ☐ Muito ☐	Sim ☐ Não ☐ Qual?	1 2 3 4 5
5	Verificar a informação de como se pode melhorar nutricionalmente.	Sim ☐ Não ☐	2m __:__	Não ☐ Poucos	Não ☐ Pouco ☐ Muito ☐	Sim ☐ Não ☐ Qual?	1 2 3 4 5
6	Voltar a fazer um exercício físico, caminhar 70 ou mais passos, e verificar os resultados do exercício efectuado.	Sim ☐ Não ☐	2m __:__	Não ☐ Poucos ☐ Muitos ☐	Não ☐ Pouco ☐ Muito ☐	Sim ☐ Não ☐ Qual?	1 2 3 4 5
7	Verifique qual a dimensão de actuação em que está mais avançado.	Sim ☐ Não ☐	2m __:__	Não ☐ Poucos ☐ Muitos ☐	Não ☐ Pouco ☐ Muito ☐	Sim ☐ Não ☐ Qual?	1 2 3 4 5
8	Consultar o perfil e editar o peso.	Sim ☐ Não ☐	2m __:__	Não ☐ Poucos ☐ Muitos ☐	Não ☐ Pouco ☐ Muito ☐	Sim ☐ Não ☐ Qual?	1 2 3 4 5

A.3 First Functional Prototype Representative Screens

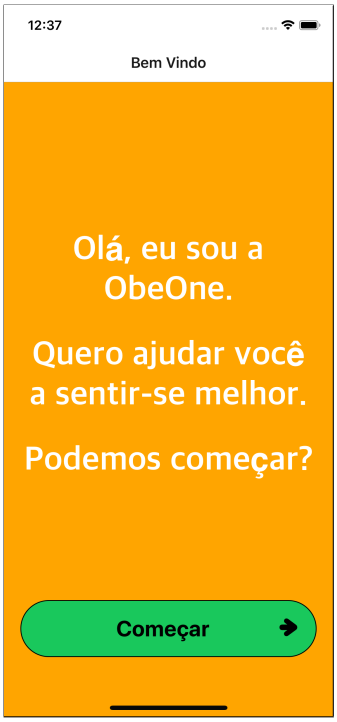

Figure A.1: First screen of the application when is used for the first time.

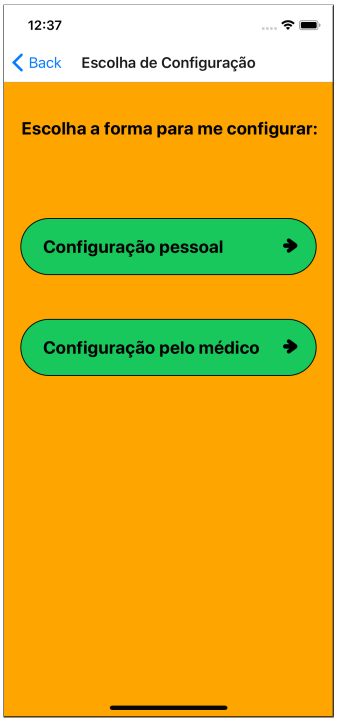

Figure A.2: Screen to choose between personal or medical configuration.

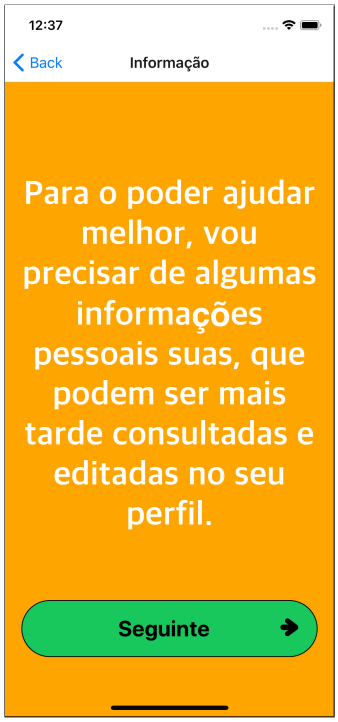

Figure A.3: Screen informing users that personal info is going to be asked.

Figure A.4: Screen for users introduce their name and surname.

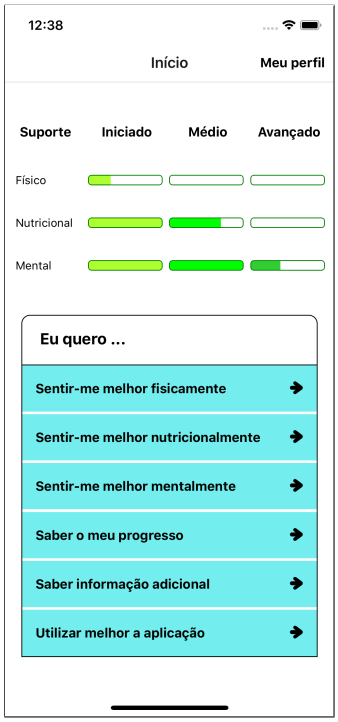

Figure A.5: Application's home screen with menu options.

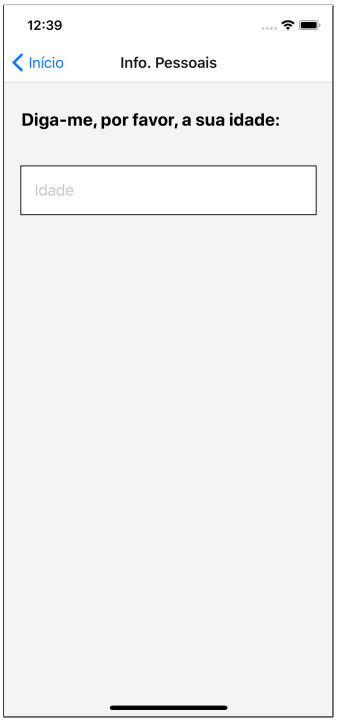

Figure A.6: Screen for users introduce their age.

Figure A.7: Screen for users introduce their gender.

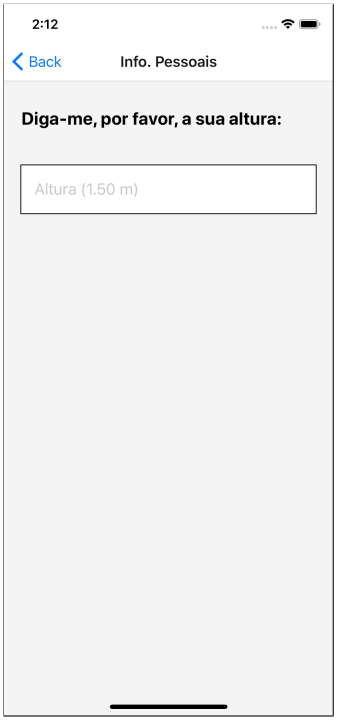

Figure A.8: Screen for users introduce their height.

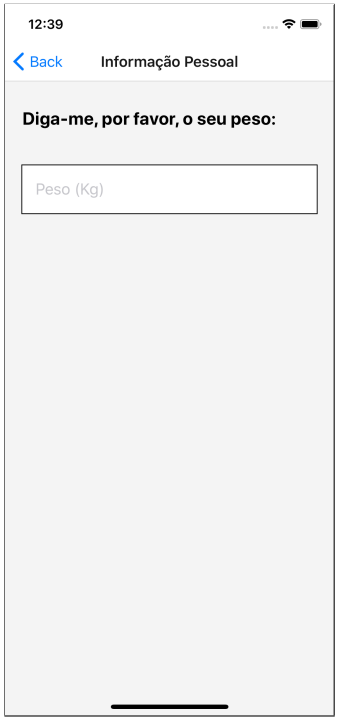

Figure A.9: Screen for users introduce their weight.

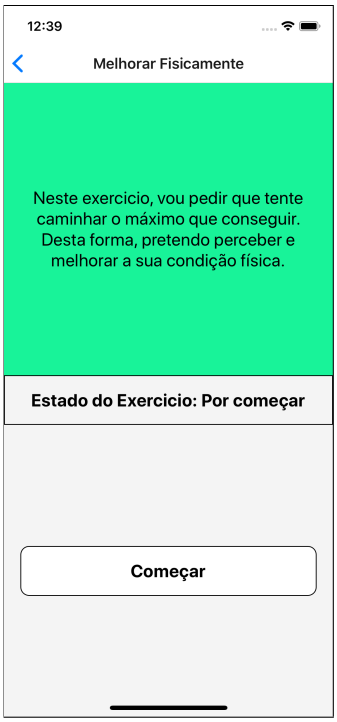

Figure A.10: Physical Support screen.

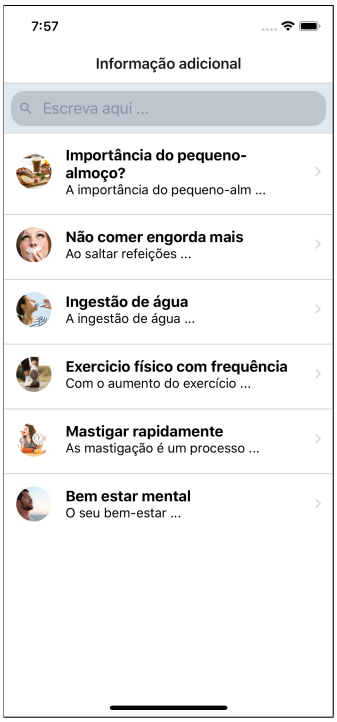

Figure A.11: Tips in educational support screen.

Figure A.12: Additional information a tip.

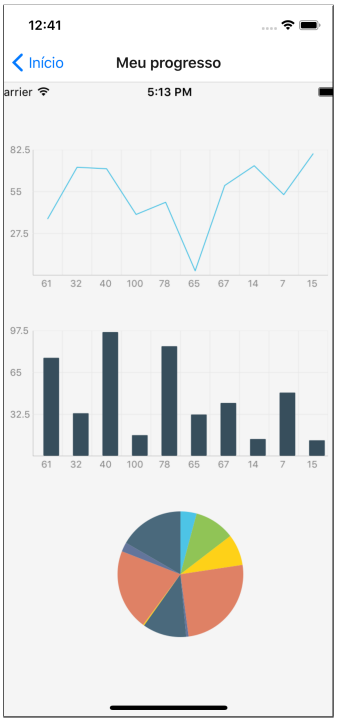

Figure A.13: Statistical support screen.

Figure A.14: Questions screen.

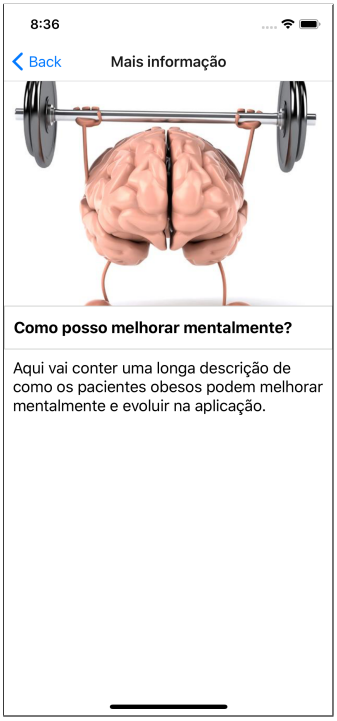

Figure A.15: Additional information about a question.

Figure A.16: Users profile screen.

Figure A.17: Update users information screen.

A.4 Second Functional Prototype Representative Screens

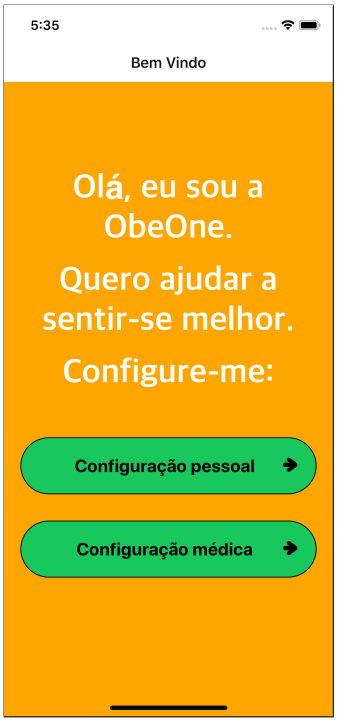

Figure A.18: First screen of the application when is used for the first time.

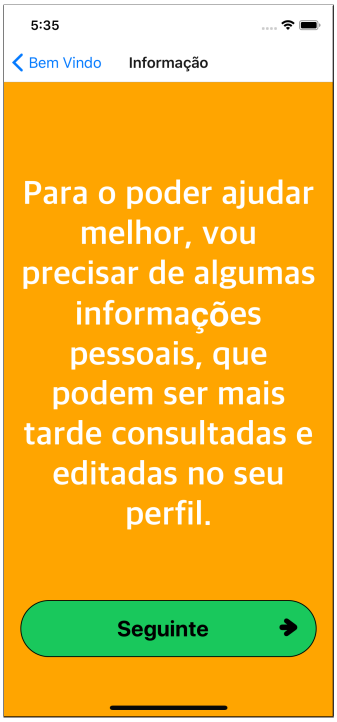

Figure A.19: Screen informing users that personal information is going to be asked.

Figure A.20: Screen for users introduce their name and surname.

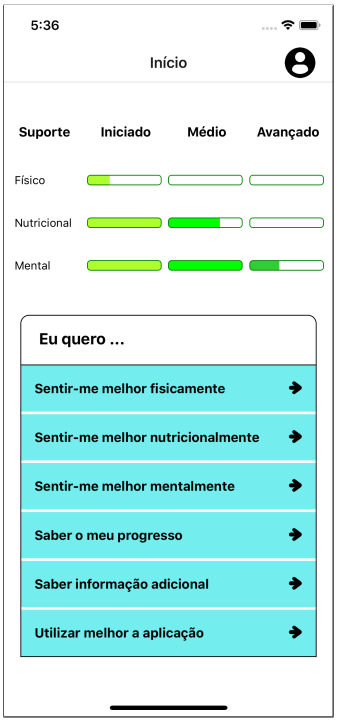

Figure A.21: Home screen of the application.

Figure A.22: Profile screen with options to edit it.

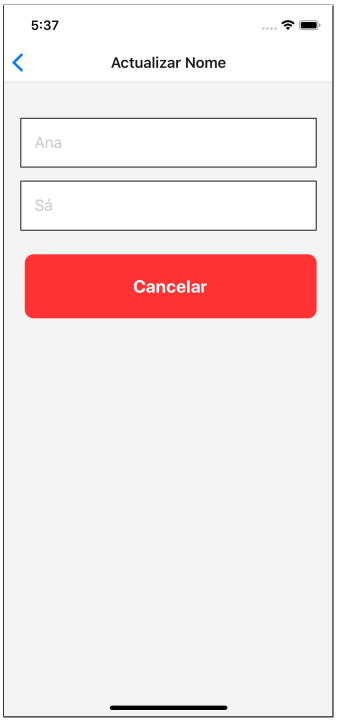

Figure A.23: Edit name screen.

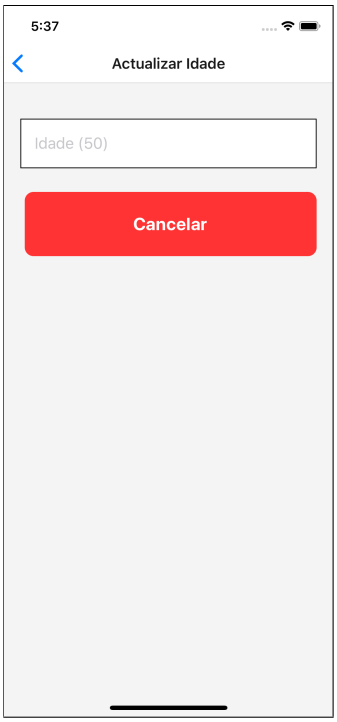

Figure A.24: Edit age screen.

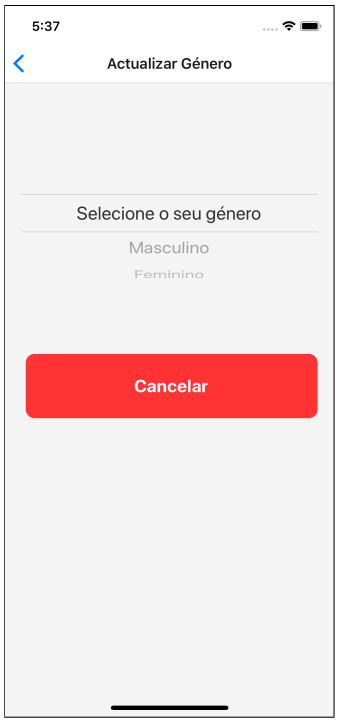

Figure A.25: Edit gender screen.

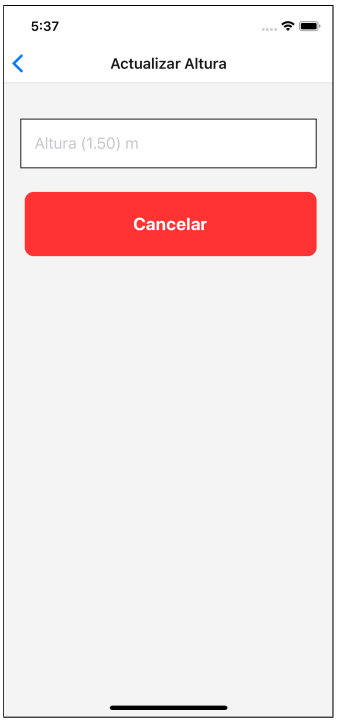

Figure A.26: Edit height screen.

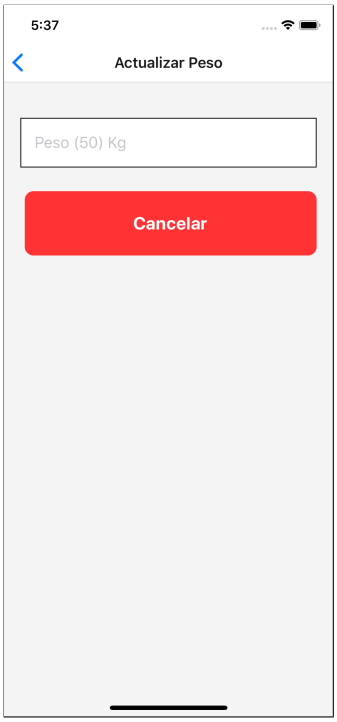

Figure A.27: Edit weight screen.

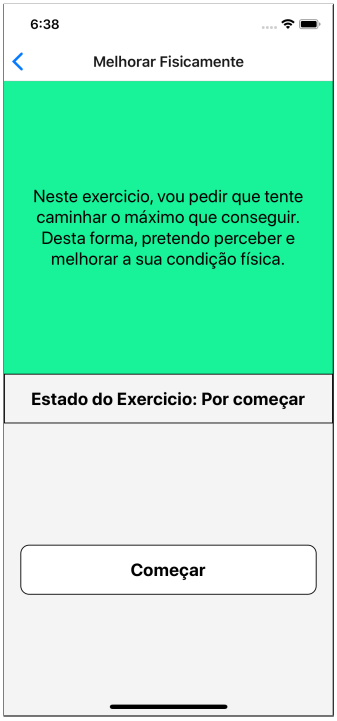

Figure A.28: Physical Support screen.

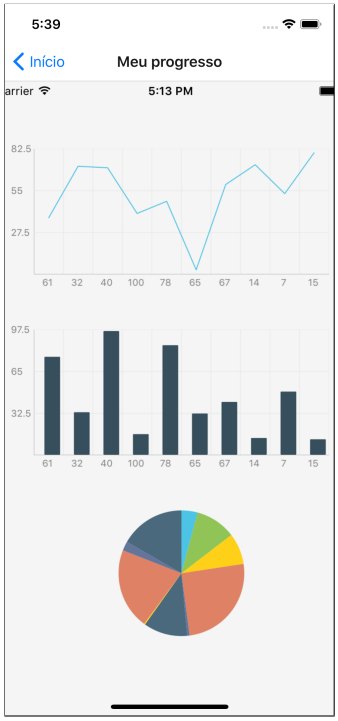

Figure A.29: Statistical Support screen.

Figure A.30: Screen with some frequently asked questions.

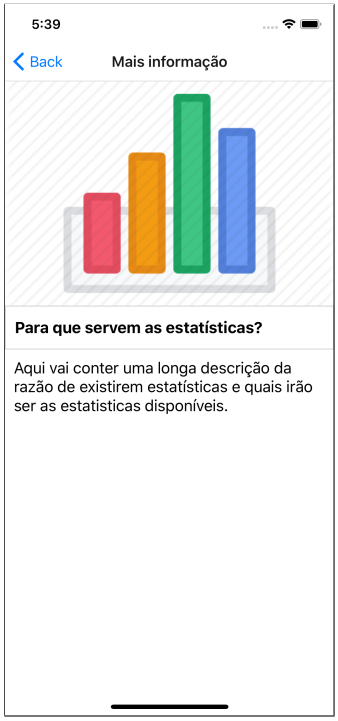

Figure A.31: Screen showing additional information of a question.

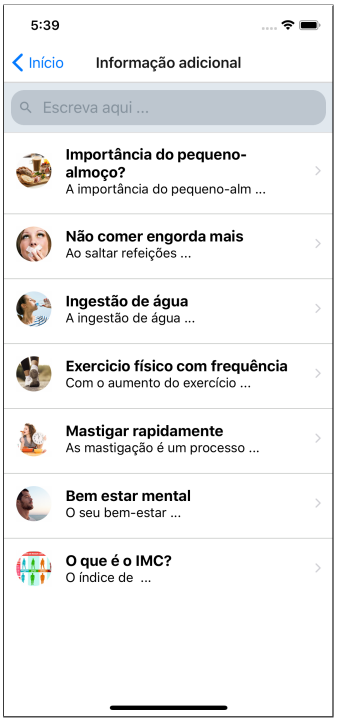

Figure A.32: Educational Support screen.

Figure A.33: Screen showing additional information of a educational tip.

A.5 Current Functional Prototype Representative Screens

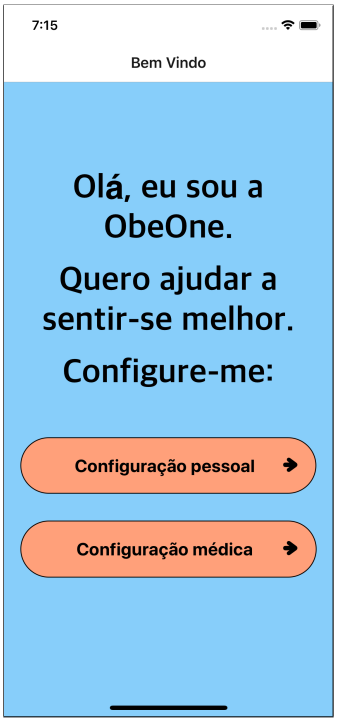

Figure A.34: First screen of the application when is used for the first time.

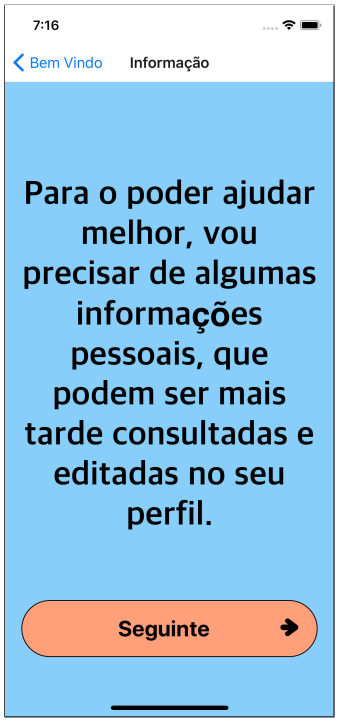

Figure A.35: Screen informing users that personal information is going to be asked.

Figure A.36: Screen for users introduce their name and surname.

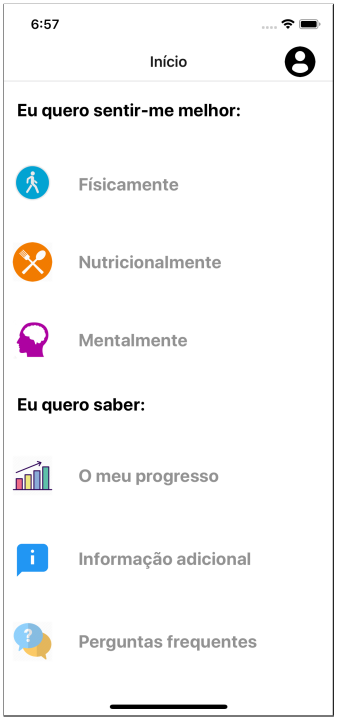

Figure A.37: Home screen of the application.

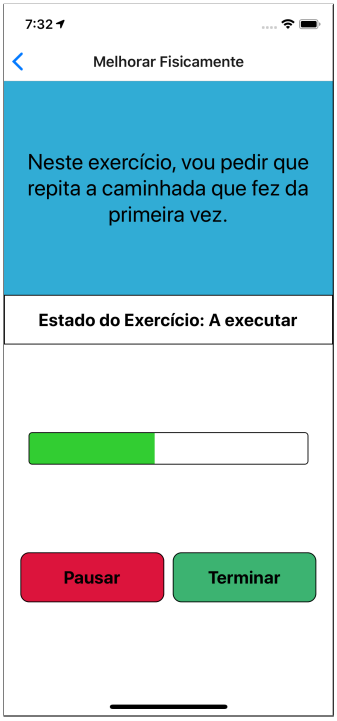

Figure A.38: Physical challenge in progress.

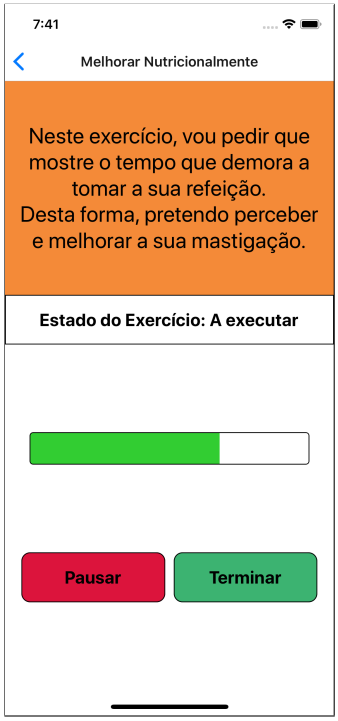

Figure A.39: Nutritional challenge in progress.

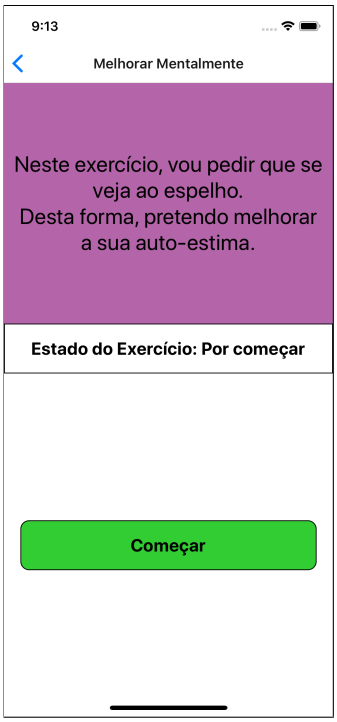

Figure A.40: Mental support screen.

Figure A.41: Statistical support screen.

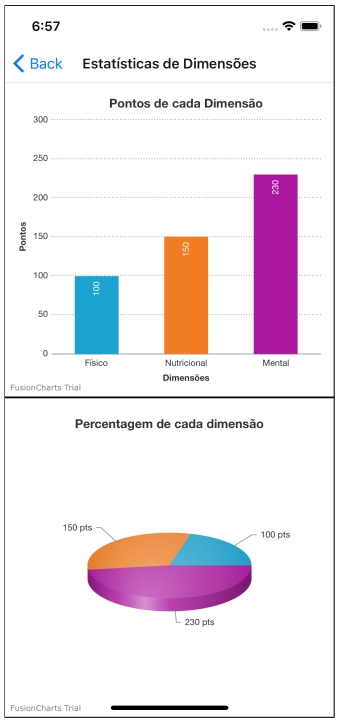

Figure A.42: Punctuation charts about each dimension.

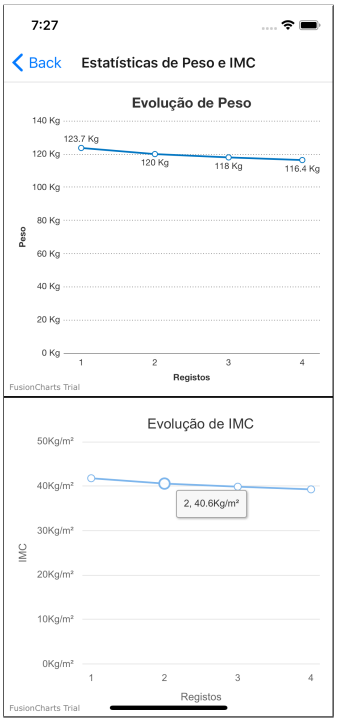

Figure A.43: Weight and BMI charts.

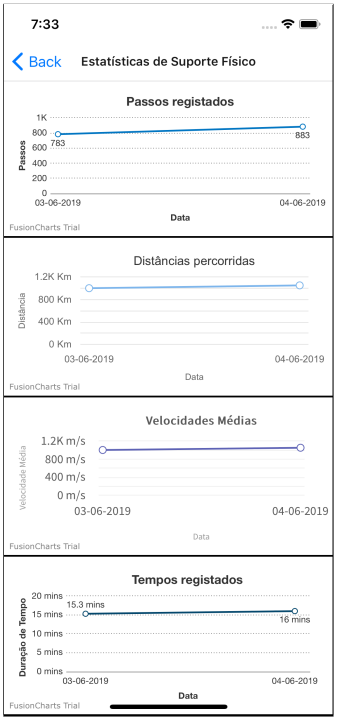

Figure A.44: Physical Support charts.

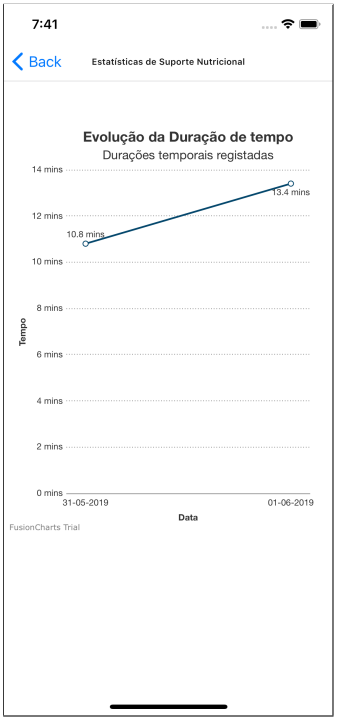

Figure A.45: Nutritional Support chart.

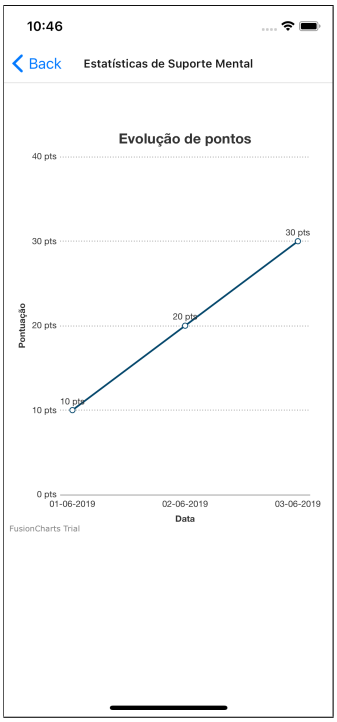

Figure A.46: Mental Support chart.

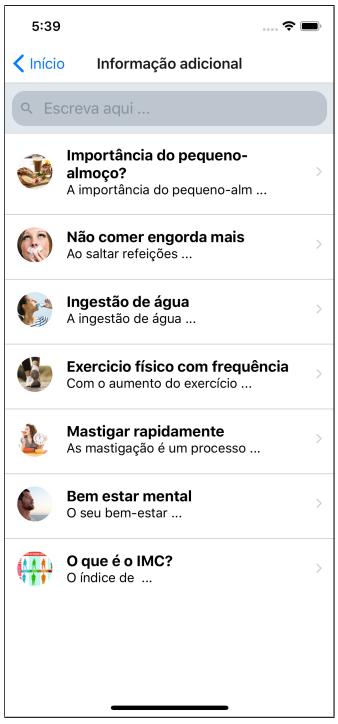

Figure A.47: Educational Support screen.

Figure A.48: Additional information about a tip.

Figure A.49: Screen with some frequently asked questions.

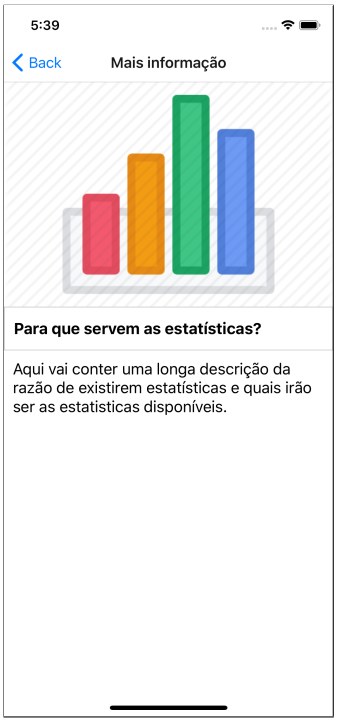

Figure A.50: Additional information about a question.

Figure A.51: Profile screen.

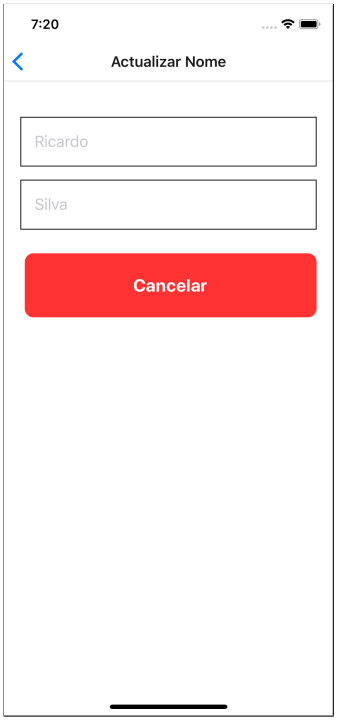

Figure A.52: Edit name and surname screen.

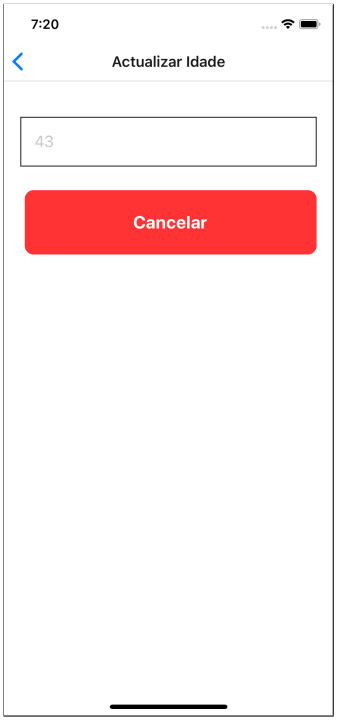

Figure A.53: Edit age screen.

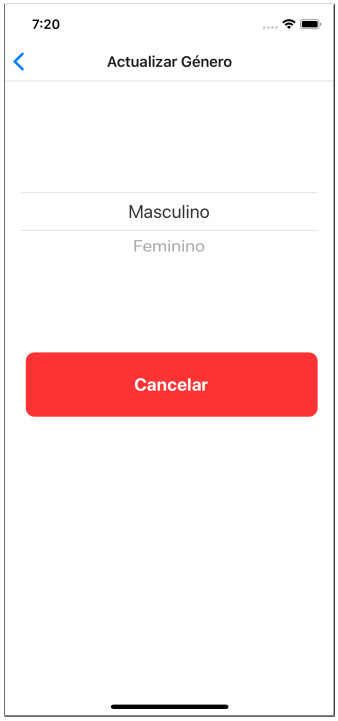

Figure A.54: Edit gender screen.

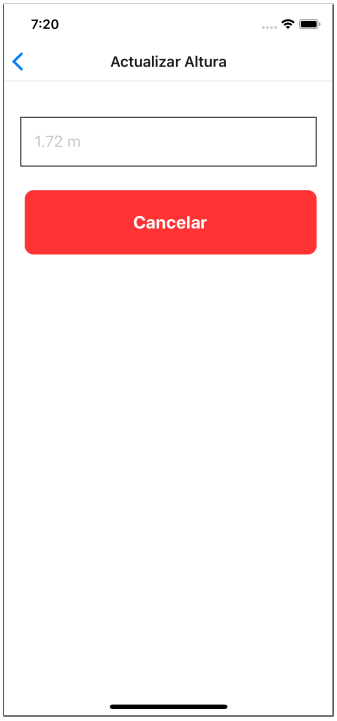

Figure A.55: Edit height screen.

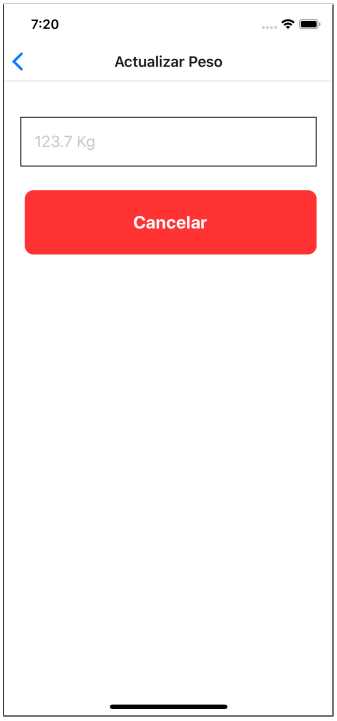

Figure A.56: Edit weight screen.