

A New mHealth App for Monitoring and Awareness of Healthy Eating: Development and User Evaluation by Spanish Users

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Abstract Modern-day society has moved towards a more sedentary lifestyle. Advances in technology and changes in habits in our daily lives have led a large part of the population towards a spiralling sedentary lifestyle and obesity. The main objective of this work is to develop and subsequently assess a mobile app, named DietApp, that provides advice about obtaining a healthy diet according to age, clinical history

and physical condition. DietApp has been developed for iOS and Android systems, and a survey comprising 7 simple questions enabled the app to be evaluated on a user level by taking into account aspects such as its usefulness and ease of use. DietApp was assessed by 150 Spanish individuals between 18 and 69 years of age, and 84% of them thought it was easy to use. 80% of users also considered the dietary suggestions provided by the app to be very useful while 62% were of the opinion that it is very useful in general. All of them would recommend the app to other users. During the six months when the app was used, any dietary excess or shortcomings were corrected in 72% of those interviewed. A mobile app has been created that is easy to use and attractive, providing personalised suggestions according to illness that are useful for the individual.

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Background

Despite all the advantages offered by evolution in technology, there are still a number of disadvantages, one of the most important ones being the fact that the lifestyle of a large part of the population is changing towards more sedentary attitudes [1, 2]. In evolutionary terms, humans are not ready to spend much of their daily lives seated in front of a computer or TV, although technical advances are leading humanity towards this scenario. Large amounts of our daily time (e.g. remaining seated for hours) are examples of how human customs have adapted to modern physical and social environments [3]. In contemporary society, it is very common for people to be seated when they are having fun or to work, which implies most of the time. Moreover, people tend to be

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seated when travelling to places of work or leisure by car or train – a great many workers spend much of their time performing the duties required from their seat, specifically in telecommunications-related jobs. Therefore, most individuals tend to be sedentary over a large part of their lives [1, 4–6].

In addition, society itself places great importance on time. Individuals are becoming increasingly less interested in cooking or setting aside a lengthy period of time for meals. This leads directly to increased access to fast and pre-cooked food, characterised by being dense in energy. A sedentary life and dietary shortcomings combined are very harmful, and to a large extent contribute to the appearance of excess body weight and obesity, which are major risk factors in producing illnesses such as diabetes, vascular diseases and cancer [6–8].

Overeating combined with a sedentary lifestyle offset the daily energy balance that the individual needs to survive. Generally speaking, the energy consumed should be similar to that ingested, and so any imbalance means that surplus calories are stored in the form of fats that will only be used when the organism has no other source of food. Developed countries currently find themselves in a residual situation, whereby the food that is converted into fats is not often used and remains stored for an indefinite period of time. It is therefore important to maintain a balanced calorie intake [7].

Physical inactivity contributes to premature death and morbidity and has a direct influence on the increase in excess weight and obesity in developed countries. There are different activities that encourage sedentary behaviour, with the most common ones being passive leisure activities (watching TV, reading, etc.) and work. The *World Health Organization (WHO)* and other international bodies (as *World Heart Federation*, *Diabetes International Federation*, among others) are currently pursuing certain strategies to try and contain high levels of obesity and physical inactivity. The general

guidelines they set out are based on a change in the type of food in order to reduce fat consumption and the ingestion of calories, and to increase physical activity in the individual [8, 9]. At the 57th World Heart Assembly, the WHO approved the Global Strategy on Diet, Physical and Health which proposed national plans of action to prevent the epidemic, since which time prevention strategies have been steadily applied on a national level. In short, experts, academics and politicians all coincide in that the best way of reducing sedentary lifestyles and obesity in the world is to educate and warn about healthy living habits [7–10].

Within another context is the rise of Smartphones and the great variety of applications available of all types. Approximately 22% of the world's population owns at least one Smartphone, and these figures increase especially in Europe and North America where percentages rise to nearly 50%. It is precisely in these parts of the world where above-average obesity levels are evident. Thus, the use of mobile applications is a channel of paramount importance in raising the population's awareness about the harm caused by a sedentary lifestyle [11–14].

In this sense, the aim of this research work is to provide a mobile application that may attempt to raise people's awareness and guide them about healthy living habits – especially in cases of patients with diet-related illnesses– despite the fact that there are a great many mobile applications related to weight loss on the market, as has been shown following a state-of-the-art review. An exhaustive search was conducted at Apple [15] and Google virtual stores [16], and Table 1 shows the features of some of the apps analysed in this work. Ten were selected that were considered the most interesting from the functional standpoint. Most focus on trying to ensure the user loses weight quickly without dealing with the nutritional shortcomings or excesses in individuals – an aspect that

Table 1 Main features and operative systems supported for several mhealth apps

Name	Operative systems supported	Features
Calorie Counter - My Fitness Pal	Android and iOS	Enables the food consumed and calories ingested to be controlled
Diet Point · Weight Loss	Android and iOS	Mainly focuses on diet planning
Fat Secret	Android and iOS	Enables the user to record what they eat, what exercise they do and their daily energy balance according to the data inserted
Jefit Workout Exercise Trainer	Android and iOS	Provides different physical routines to develop the body muscles chosen by the user
Cardio Trainer	Android	Geared to burning calories, and focuses on doing aerobics-type exercises such as walking, running, swimming and skiing, etc.
Lifesum	Android and iOS	Advises the user to record what they eat and the exercise they do every day
My Diet Diary Calorie Counter	Android and iOS	Tracks the food, calories, exercise, weight, cholesterol, carbohydrates and calories burned, among other nutrition-related data
Calorie Counter PRO MyNetDiary	Android and iOS	Analyses the diary and guides via personalised dietary tips
Calorie Counter & Diet Tracker	Android and iOS	Enable nutritional breakdowns for individual meals, and uses hash tags
Lose It!	Android and iOS	Helps the user lose weight quickly

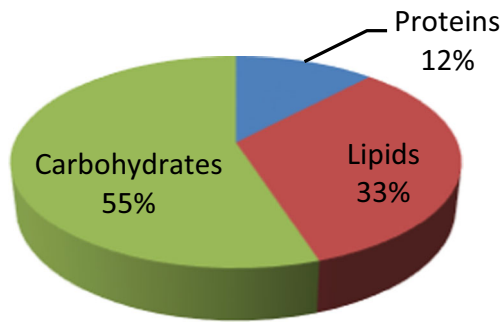


Fig. 1 Percentage of calories in a balanced diet

will try to be covered by the app developed in this work, named DietApp. The main contributions of this research work are to develop and assess a new health app to help people with nutritional problems. The results of this work can serve as basis to other communities about the importance of nutrition and how mobile apps can contribute in this aim.

An attempt is made below to lay the foundations for what are understood to be healthy living habits. The methods used to develop the DietApp application will then be described followed by subsequent user evaluation. The results obtained from this research will then be shown and lastly, these will be discussed and the conclusions explained.

Healthy living habits

A healthy living habit can be said to be based on a general factor known as RDI (Recommended Daily Intake), which includes the basic nutrients a person need to consume to maintain their state of health. The RDI is a good method to use if the aim is to maintain a balanced diet and if the person’s physical features correspond to those of an average user. However, each individual is different and, therefore, so is their appropriate lifestyle.

Given the impossibility of assigning a nutritionist to every individual, certain heuristic features have been established in

order to gauge a healthy living habit approach for different people [12, 14].

Each individual needs a certain amount of energy to keep their vital functions in working order, i.e. what is known as basal metabolism. This includes activity carried out by the external organs and maintaining body temperature, etc. Basal metabolism depends on weight, size, build (the muscle consumes more energy than the fat even when in a state of rest), gender (less in women) and age (decreases with age). Basal metabolism is divided into different factors, from which we will focus on three for the purpose of carrying out this project: basic energy expenditure, physical activity and growth of the individual.

Basal metabolic expenditure is essential for ensuring that the vital functions work properly without putting one’s health at risk. Although 24 kcal/kg/day is accepted internationally as a basic energy need [12], this figure can be personalised for a specific individual according to Eq. 1. In this equation, *P* represents the individual’s weight in kg, *A* their height in cm and *E* their age in years [12].

$$\begin{aligned}
 \text{Women} &= 65.5 + (9.6 \times P) + (1.7 \times A) - (4.7 \times E) \\
 \text{Men} &= 66 + (13.7 \times P) + (5 \times A) - (6.8 \times E)
 \end{aligned}
 \tag{1}$$

In Eq. 1, the most modifiable factor of basal metabolism is left out. It is the physical activity. The energy requirements of basal metabolism increase considerably depending on the type of physical activity undertaken and its duration.

Taking into account the body mass index (BMI), there is another parameter of great interest regarding healthy living habits which is the Recommended Daily Intake (RDI). The RDI measures the nutrients and kilocalories a specific individual needs to consume to maintain a balanced diet and healthy weight [17–19].

Guaranteeing an appropriate ingestion of calories is not enough to maintain a healthy diet – relatively, this must also be together with the types of nutrient. Figure 1 shows the

Fig. 2 DietApp structure

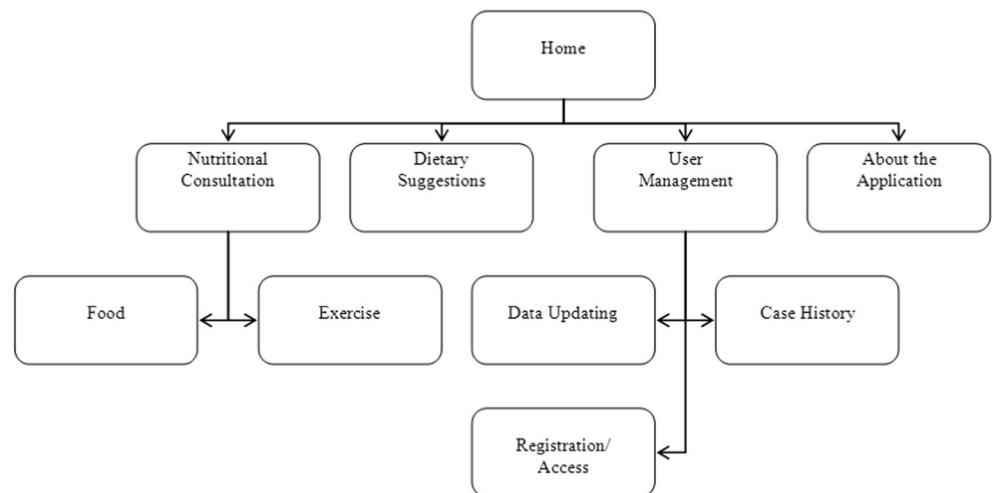


Table 2 Survey about DietApp

Question	Evaluation				
Using the app has been	Very easy	Easy	Average	Difficult	Very difficult
Have the dietary suggestions proved useful?	Very little	Little	Somewhat	Average	A lot
Have you managed to lose weight while using it?	No	Yes			
I think it is attractively designed	Very little	Little	Somewhat	Average	A lot
You have found it useful	Very little	Little	Somewhat	Average	A lot
Do you think this app has resolved your dietary shortcomings or excesses?	Very little	Little	Somewhat	Average	A lot
Would you recommend this app?	No	Yes			

proportion of nutrients to be ingested according to the WHO for an adult of average who is in a normal physical condition [18].

In this paper, a mobile app will be developed and subsequently assessed. This app, named DietApp, provides advice about obtaining a healthy diet according to different parameters such as clinical history, age and physical condition.

Methods

Used software and app structure

Android Studio and the *SDK Android (Software Development Kit Android)* have been used to develop the application, which includes a set of tools for native *Android* applications.

The version used to develop the application is the 4.0 *Ice Cream Sandwich*, whereby the application will function for 81% of devices equipped with the *Google* operative system, and takes up 20 MB of internal memory space – meaning it is considered to be light. The version of the application has also been developed in *iOS* [20], and been optimised from version 3.2. In Fig. 2 can be clearly seen the structure of the DietApp application, which consists of four modules that we will explain in the results section.

User survey

One of the most important aspects to be taken into account when developing an application is the opinion users have of it – usability is one of the most important factors to be taken into consideration in rating the quality of an application [21]. The following criteria have been taken into account to evaluate the DietApp: Content: the information included in the application according to its objectives. Dynamics: how users move and interact with information-based elements and components. Structure: how the content of the application is organised. Interaction: how the dynamic components are used. Presentation: how the content and functions of the application are shown to users.

A survey with 7 questions that is accessible via mobile was developed in this case, the contents of which can be seen in Table 2.

Results

DietApp

The application comprises 4 modules. The details of which are provided below:

Home This module is the first to be displayed when the application is started, and its design is therefore vital to ensure the user feels comfortable when using the application. The user can access any section of the application from this module, which makes it easy to use. If the user has opened a session, a summary showing the



Fig. 3 Home

Alimentos				
gr	Artículo	Cal/uni	Cal/tot	
33	Cerveza rubia	0.45	14.85	
Añadir alimento				
Ejercicios				
min	Tipo	Cal/uni	Cal/tot	
15	Caminar 2Km/H	4.0	60.0	
Añadir ejercicio				
Resumen				
Calorías ingeridas	Calorías consumidas	Balance		
14.85	60.0	-45.15		

Fig. 4 Nutritional consultation

user features will be displayed on the screen (see email, age, weight, height and gender), as well as any other relevant aspects such as BMI, RDI and any advice or specific risk depending on their condition. Figure 3 shows an image of the screen for this section.

User management This module stores all the information about the user as name, password, email, weight, height, gender and any illnesses that the user may suffer from. This module manages everything related to the user’s registration and session and within it can be found the user’s case history containing their energy balance. The user may also add various foods to their case history via the Foods/Exercises module. According to the amount and size of the portion chosen by the user, an energy balance is implemented which indicates the total energy balance and also warns the user if the balance is either extremely positive or negative (with a margin of 500 Kcal).

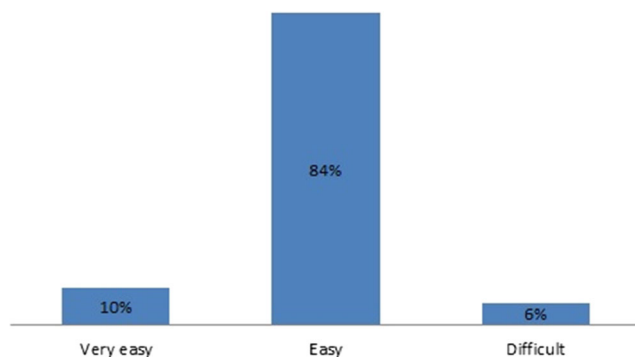


Fig. 5 Use of DietApp

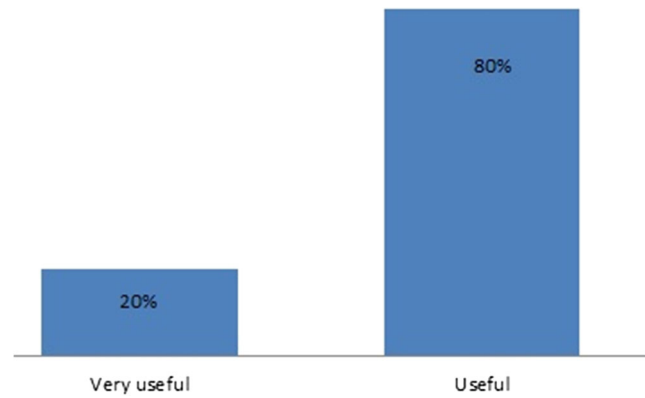


Fig. 6 Usefulness of dietary suggestions

Nutritional consultation This section shows the information about listed foods and exercises (see Fig. 4). Some aspects are described in detail such as the calories contained in a specific food or those burned when performing a specific exercise, whether a type of food may be harmful or beneficial to the user depending on its features, or when a type of food or exercise is added to the user’s case history.

For instance, when the user has selected a category, they are shown the corresponding foods with a photo of the type of food in question, name, number of calories and two notices indicating whether the food is harmful to or recommended for the user in case they decide to proceed.

Dietary suggestions With this module, the user can receive personalised suggestions via this section, whereby any illnesses they may suffer from are gathered and used to define certain advice for their physical condition. These suggestions are classified according to the user in such a way as to provide them with more detailed information. Thanks to these suggestions, the end user may have at their disposal sufficient data to help them pursue a sufficiently healthy diet. Many suggestions are done according to the food pyramid.

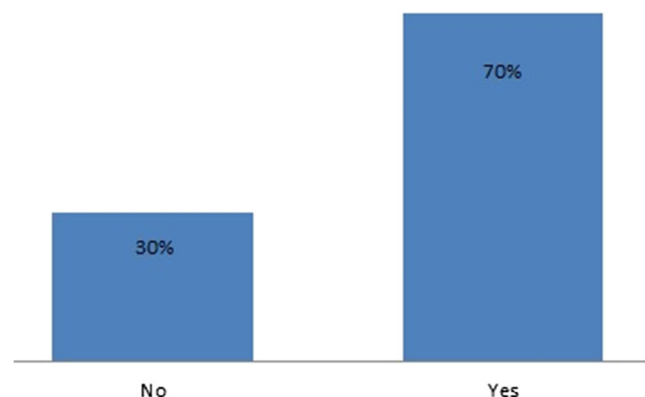


Fig. 7 Have you managed to lose weight?

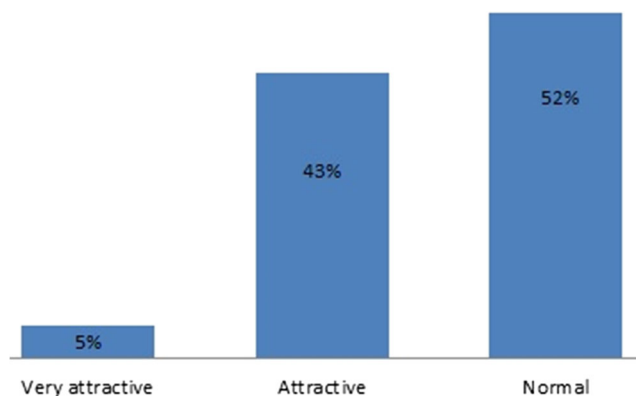


Fig. 8 Attractive design

User evaluation

The DietApp app was evaluated by 150 Spanish users of between 18 and 69 years of age. All live in rural areas from Zamora and Valladolid, Spain. 84% of users were of the opinion that the app was easy to use, 6% found it difficult and 10% very easy, as can be seen in Fig. 5. 20% of users found the nutritional suggestions very useful and the remaining 80% useful, as can be noted in Fig. 6. 30% of users managed to lose weight over the 6-months period as shown in Fig. 7. In all cases, the percentage weight loss was less than 5 kg. 100% of users would recommend using the app and in terms of design, 42% thought the DietApp was attractively designed,

Five percent found this very attractive and the remaining 53% thought it was average (see Fig. 8). 62% of users found the app useful while 38% thought it very useful, as can be seen in Fig. 9. As for the matter of whether the app can resolve dietary problems as is the case with individuals who experience dietary excess or shortcomings, 72% of those interviewed answered yes, as shown in Fig. 10. 100% of users would recommend the app to others.

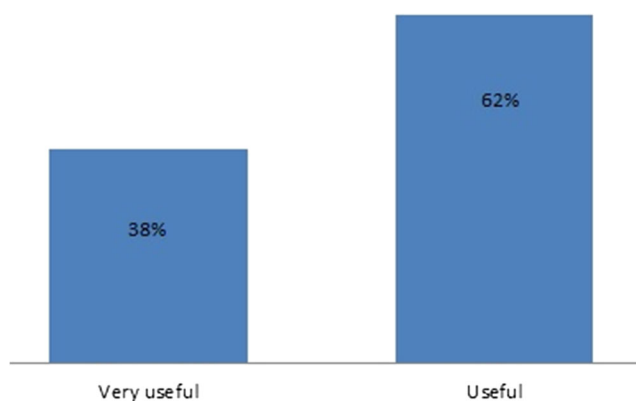


Fig. 9 Usefulness of DietApp

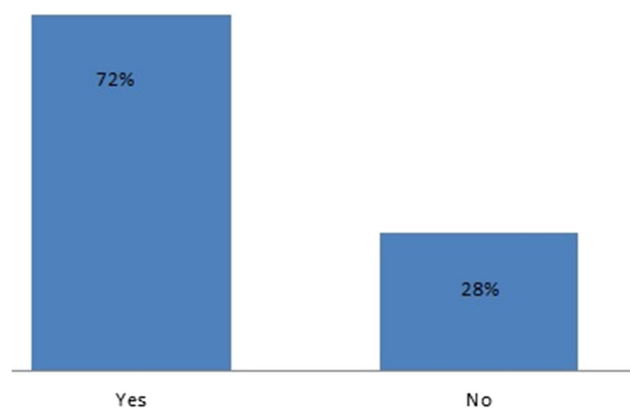


Fig. 10 Has DietApp resolved your dietary problems?

Discussion and conclusion

The main purpose of this paper has been to provide users who have nutritional or dietary problems with a mobile application that may be used as a guide them or nutritional support to those already existing on the market. DietApp was created by highlighting its design and ease of use. A home page was in turn created from where any section of the app can be accessed in order to optimise its intuitiveness.

DietApp covers the most common foods and exercises, lending support to a large percentage of target users. Secondly, it provides personalised suggestions according to illness which are useful for the individual, and also constitutes an easy application to use that is attractively designed and can run completely transparently for the user. The app can be used by adults who want dietetic tips, mainly people with nutritional problems. Due to its ease of installation and use can be used by all type of public (experts and non-expert in mobile technologies and applications).

One of the major limitations of this application is that advice about living habits or nutritional suggestions are too generalised. An interesting aspect to be covered would be to be able to put nutritionists or endocrinologists in contact with patients of a certain type to ensure the latter receive even more personalised care.

Comparing with apps shown in Table 1, DietApp treats more about nutritional shortcomings or excesses in people. For example, other apps such as My Diet Diary Calorie Counter tracks calories, exercise, cholesterol, etc. DietApp has been developed in Android and iOS as many other apps (see Table 1).

In this work, DietApp is done in Spanish and English language. All users in this work have used the Spanish version. As future lines of work on the application, the function of implementing nutritional information about the type of food in question might be added using the Spanish Agency for Food Safety and Nutrition database.

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Compliance with ethical standards

Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval The ethics board approval was obtained of the “Ethical Committee of Clinical Research of Clinic Hospital of Valladolid, Spain”.

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