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V-care: An Application to Support Lifestyle Improvement in Children with Obesity

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Abstract. Obesity is increasing in the pediatric population and it represents an important risk factor for the life-long development of several diseases. The aim of this work is to reduce children obesity through an educational program delivered through a mobile application. Novelties of our approach are the involvement of the families in the program and a design inspired to psychological/behavioral change theories, with the aim of maximizing the chance of patients' compliance to the program. A pilot usability and acceptability study has been performed on ten children aged 6-12 years using a questionnaire to evaluate eight system features on a Likert scale from 1 to 5. Encouraging results were obtained: mean scores were all above 3.

Keywords. Mobile application, Mobile health, Chatbot, Pediatric obesity

1. Introduction

Overweight and obesity impair health, leading to increased morbidity, premature mortality and economic burden for health and social system. Over the past 40 years, prevalence of overweight and obesity increased in many countries, in both children and adults [1]. Childhood obesity is estimated to increase by 60% over the next decade, reaching 250 million by 2030. This dramatic trend brings out the urgency for health promotion from childhood, before a pathology sets in.
Lifestyle modification, including diet and exercise, continues to be the mainstay of obesity prevention and treatment; unfortunately, lifestyle modification programs are often unsuccessful [2]. Reasons could be: lack of results in a short time, bad family habits, lack of motivation, low frequency of check-ups (often only every six months or more) that put the treatment burden mainly on the family and on the child himself.

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All these findings suggested the development of a mHealth platform supporting both children and their families in following a treatment program and help physicians in monitoring goals achievements. As reported in the literature, mHealth has the potential for improving patient management when compared with standard care [3]. However, data on the usefulness of mHealth in pediatric obesity management are limited [4-7].

This paper presents V-care, an app purposely developed to offer effective interaction with young subjects, and the results of a pilot study conducted in 10 children.

2. Requirement Analysis and Design

2.1. Target population

When developing an application for young patients, it's crucial to decide the target age range. In fact, although pediatric age is broadly defined as 0-18 years, it is clear that, in that range, cognitive abilities change a lot over years, so that technological solutions can address only parents (for very young children), only children (for adolescents) or both. Since one-fits-all solution does not work, we decided to develop an app for children aged 6-12 years, i.e. very young but able to understand some basic lifestyle principles. This age requires two precautions: using a captivating and intuitive language appropriated for very young patients and involving their parents. The latter is mandatory because of two reasons, first family-based behavioral treatment is an evidence-based intervention for childhood obesity [8] and second the children may not have a personal mobile device yet, and/or could be unable to interact appropriately (reading/writing) with the app.

2.2. Basic requirements of the application

The review of the above-cited literature on systems designed to support young people in overcoming their state of obesity has guided us in defining the basic requirements to be included in V-Care. They are summarized in Table 1 and elaborated below.

Table 1. Basic requirements

1. Provide physicians with a monitoring dashboard	5. Monitoring both behavior and engagement
2. Involve the entire family	6. Tailoring the app to specific situations
3. Provide education on healthy lifestyle	7. Promote motivation and avoid drop-outs
4. Provide behavioral goals to the user	8. Allow different modalities of interaction

1. Physicians will see the data through their dashboard, in particular they will monitor BMI, the objective measure used to evaluate the children's compliance to the program. Periodical update of height and weight will be performed by parents.
2. Given the age range 6-12yrs, parents play an indispensable role in the success of the treatment. The system requires them to register the children, provide an initial profile for them, and regularly visualize the trends of the data managed by the app. This is the way to involve the family in their children's journey against obesity.
3. The app includes an educational section that, besides reporting certified information about the best dietary behaviors, is made more appealing by a set of success stories. A story can also be the experience of an app users himself, and this can both motivate the children to improve their health status and the future users to engage.

4. The app is compliant with the latest guidelines on children obesity, providing general goals that every patient should achieve regarding nutrition, physical activity and sleep, e.g., they suggest the correct number of portions for vegetables, glasses of water, fruit.
5. Since face-to-face visits are only one or twice a year, for a tighter monitoring the app administers monthly questionnaires providing validated behavioral scores, and also provides a light diary to collect information about the child's habits daily or weekly.
6. The app is conceived as a virtual coach that reacts appropriately according to the patient's performance by providing some feedback. Good child performance is rewarded, while failures trigger encouragement to the child to do better in the future.
7. To face drop-out for loss of motivation, we must strengthen subjects' engagement with effective strategies. First, at registration the child may choose his preferred avatar (a pet). Moreover, the app implements gamification, e.g., a quiz section that gives medals or rewards if the child provides correct answers. This strategy allows to enjoy learning the fundamentals of healthy eating and the importance of physical activity.
8. To make the app usage more friendly, the innovative technique of conversational agents (chatbot) has been exploited. It is used to collect responses to questionnaires and quizzes, to give specific "practical advice" about healthy cooking, or correct behavior. The language and the kind of interaction of the chatbot with children is designed to mimic a mate who addresses them in a friendly tone and tries to encourage them.

2.3. Functional and technical Architecture

Figure 1 shows the architecture of V-Care, which can be used on IOS and Android operative systems. Three user categories exist: children/parents who will use a smartphone, doctors and administrators who access the web application from a PC, each of them accessing different features. Parents register their children in the app and provide short demographics, height, weight and one or more referral doctors. Furthermore, each child is associated with his parent's account, but he could use his personal smartphone, if he has one, and choose his favorite avatar. Subjects are then asked to periodically fill in questionnaires for lifestyle monitoring. All features in section 2.2 are implemented.

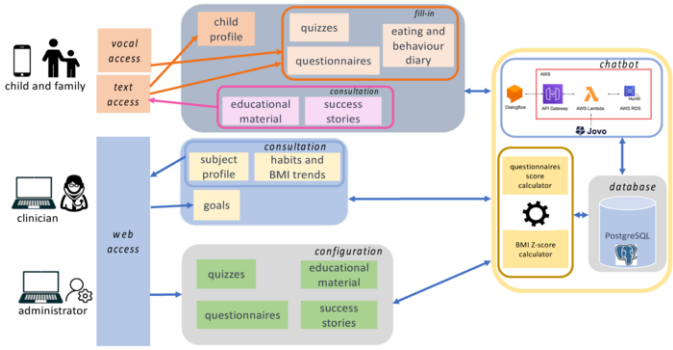

Figure 1. The App architecture. Technical details in the right: the chatbot is implemented using Dialogflow and AWS services: API Gateway to route the chatbot request to the correct Lambda function (written in Jovo) that will prepare the answer to the user. The Lambda function accesses the RDS (database) to get the necessary information and fulfill the request. The same mechanism is used both to manage the text and the voice based interaction.

The chatbot module provides new means for interacting with some parts of the application, through vocal commands or keyboard. The bot acts a child's friend, maintaining an informal and engaging language, and entertaining the user, even while completing a questionnaire; e.g., it encourages the child to continue filling in by indicating how many questions are missing, or if he reached halfway through the questionnaire, and at the end of the compilation, the score is calculated and a feedback is given based on the comparison with previous scores (if any). As for the "practical advice" part, different conversation flows between the chatbot and the user have been developed. The user can ask the chatbot for advice on some topics that will be presented by the chatbot itself. Those concern nutrition, physical activity and cooking, which expand into sports, a sedentary lifestyle, healthy cooking methods, "special recipes" and foods that the user does not like. The idea is to give simple explanations and provide practical and qualitative advices. Moreover, intolerances and disliked foods and sports are stored in the DB in order to personalize the conversation.

Doctors have access to a dashboard showing the BMI trend of the subjects, the data entered daily or weekly in the personal diary and the questionnaire answers and scores.

Administrators can manage: the registration of the doctors and of the admin in the back office, the questionnaires and quizzes to be proposed to users, with the related scores, educational material and curiosities, success stories and the guidelines to follow in terms of nutrition and behavior.

3. The Developed Application and the Validation Study

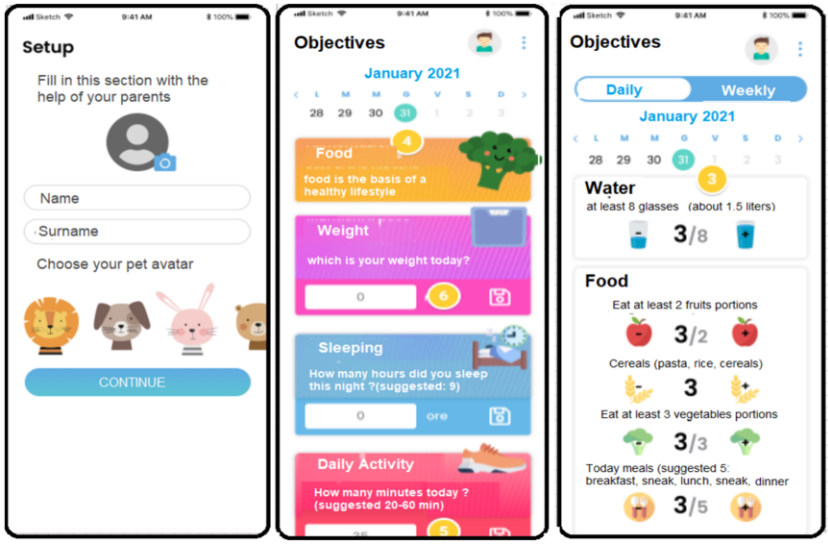

Figure 2. A Three screenshots of the children's and their parents' GUI.

Figure 2 shows the graphical interface of the app used by children and their parents. Ten children (6M/4F, 9.5±1.3 yrs) with obesity (BMI ε2) have been enrolled in the usability study. The parents gave consent to participate (protocol number 2020/ST/298, approval date 01/12/20). After an initial training by the doctors, they utilized the app at home for a period of two weeks, at the end of which they were required to fill in an anonymous

evaluation questionnaire. For each question they had to provide a score from 1 to 5, where 1 is the worst rating. Figure 3 shows the results.
The app resulted in a very good overall friendliness and perceived usefulness, even if some criticalities emerged particularly for the curiosity section and the chatbot.

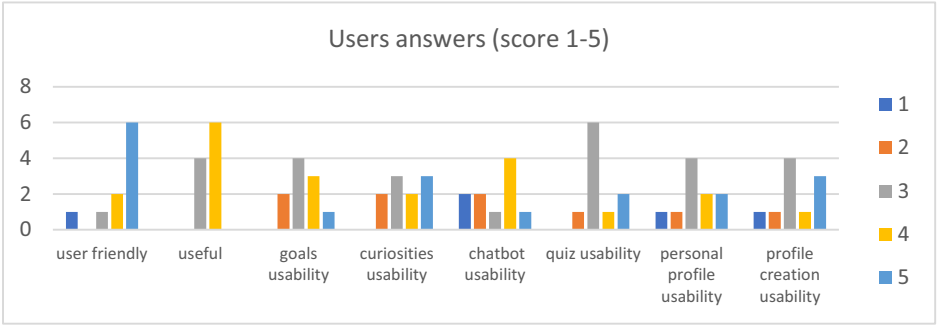

Figure 3. Results of the usability evaluation study: number of patients assigning the different scores for each feature

4. Conclusion and Future Work

V-care has been created by a multidisciplinary team with expertise in pediatric obesity and home-monitoring apps, and offers a dedicated and easy tool to improve pediatric patients management. A usability study provided encouraging results. Limitations of the study are the small sample size, the short time evaluation and the limited exploitation of the vocal interaction, until now performed only at experimental level. Validated instruments will be used in further evaluation studies.

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