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CoviHealth: A pilot study with teenagers in schools of Centre of Portugal

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Abstract. Obesity is one of the most common problem that can be avoid with the correct education of the teenagers. There are different methods, but the use of the mobile devices to promote the creation of social challenges is important, because the teenagers act mainly in groups. The use of questionnaires, challenges and gamification purposes may promote the use of this type of mobile applications by teenagers. It is a special population that needs the adoption of different interactive technologies. The studies available are not validated by healthcare professionals. First of all, we started to analyze the related work of obesity problem, mobile applications, and different methodologies adopted with teenagers. By the end, seven students participated in the study with the performance of visualization of daily tips and curiosities, answering questionnaires, monitoring of physical activity and gamification. The teenagers were satisfied with the strategies adopted, but this study was affected by the pandemic situation around the world. In general, the participants were satisfied with the use of the mobile, and they would like to use it in the future for the improvement of their nutrition and physical activity habits.

Keywords: teenagers, mobile application, nutrition, physical activity, health, education.

1 Introduction

Nowadays, it was verified that the teenagers have an inadequate and little knowledge about healthy nutrition and physical activity. They spend a lot of time with technological equipment and did not practice physical activity [1, 2]. It causes different healthcare

problems in the teenagers, including the obesity [3–5]. One of the factors for the poor habits of the teenagers are socioeconomic factors [6]. Still, the reduces physical activity and the energy intake is other important factor in this type of population [5].

The obesity is caused by the excessive body fat with the difference between energy expenditure and calories intake [7]. It caused the development of several diseases, including hyperglycemia, dyslipidemia, hypertriglyceridemia, low levels of High-Density Lipoprotein, and hypertension [8]. However, the performance of physical activity is the best method to spend calories and control the weight [9].

The prevalence and incidence of obesity and overweight in teenagers was proposed in the National Health Plan - Review and Extension to 2020 [10]. Portugal is not exception, and the National Program for the Promotion of Healthy Eating was created to promote the combat of the obesity. One of the strategies that Portugal adopted was to attempt to increase the levels of physical activity in young people and teenagers [11].

A Body Mass Index (BMI) for age with more than a typical deviation above the median established in child growth patterns and obesity as being higher than two standard deviations above the norm established in child growth patterns was created by the World Health Organization (WHO) for individuals aged between 5 and 19 years old [7]. This population is considered as overweight between the 85th and 95th percentile, and obese above the 95th percentile [12]. Thus, the WHO verified, in 2016, that the number of teenagers that are overweight or obese exceeded 340 millions of individuals [7].

The purpose of this study is to use a mobile application for the promotion of healthy nutrition and physical activity habits by teenagers during a trial of five weeks. During the time of the study, different tips, curiosities, challenges, and questionnaires were proposed for the seven teenagers that participated in the study. The teenagers were aged between 13 and 16 years old, and they are students in the public schools in the Covilhã, and Fundão municipalities (Portugal) [14]. The mobile application includes different methodologies to captivate the attention of the teenagers, and it also includes methods to stimulate the physical activity. The gamification, personalized messages, and medical control are some of the methodologies implemented. The teenagers answered different questionnaires about physical activity and nutrition during the study. The analysis of the different answers was performed to evaluate the knowledge level of the teenagers.

This study revealed that the use of a mobile application is a good method to promote health nutrition and physical activity habits in teenagers. It was also verified that these population valued gamification techniques and the medical control. The effects of the use of mobile application should be reevaluated after the pandemic situation.

This paragraph and the introductory section. Section 2 presents the related work about the obesity, mobile applications for nutrition and physical activity and different methodologies used with this population. The methodology of CoviHealth project is presented in Section 3. Next, Section 4 presented the analysis of the initial questionnaire, the answers in the questionnaires about nutrition and physical activity, and the feedback questionnaire. The discussion of this study, and comparison with other studies are presented in Section 5. The conclusions are presented in Section 6.

2 Related Work

Obesity is considered a chronic, complex and multifactorial disease that is unfavorable for health, being characterized by an excessive increase in body fat that results from the imbalance of caloric expenditure and energy intake [7]. This imbalance is favorable to the development of several metabolic complications, namely insulin resistance, which leads to hyperglycemia, dyslipidemia, namely hypertriglyceridemia and low levels of High Density Lipoprotein (HDL), and arterial hypertension [8], also affecting the intestinal microbiota [15] that results from the interaction of several genetic, environmental and lifestyle factors [16].

The reduction and control of the incidence and prevalence of overweight and obesity in the child and school population is one of the goals proposed for 2020 in the National Health Plan - Review and Extension to 2020 [10]. Thus, in Portugal, the Directorate-General for Health created the National Program for the Promotion of Healthy Eating, in which public health strategies for combating obesity are addressed and created.

For children, adolescents and young adults between 5 and 19 years old, the World Health Organization (WHO) defines excess weight as the Body Mass Index (BMI) for age with more than a typical deviation above the median established in HDL child growth patterns. In turn, obesity is defined as being greater than 2 typical deviations above the median established in child growth patterns [7]. Thus, children, adolescents and young adults aged 13 to 19 between the 85th and 95th percentiles are overweight. It is further mentioned that with a percentile higher than the 95th percentile, they are classified as obese [12].

In 2018, the study [17], which presents data collected between 2015 and 2016 in Portugal, concludes that the prevalence of obesity increases with increasing age, being less prevalent in children and higher in the elderly. There are 3 inflection points in the prevalence of obesity throughout life, being them at 5, at 15 and, finally, at 75 years old. This study resulted in approximately 17.3% of children, under the age of 10 years, having pre-obesity and 23.6% of adolescents, aged between 10 and 18 years, having pre-obesity. 7.7% of children and 8.7% of adolescents were obese.

In 2017, the WHO estimates that, as adolescents are older, the level of physical activity decreases [18]. However, when analyzing the answers related to the question related to the accomplishment of "at least one hour of moderate to vigorous activity every day", this was performed by 25% of the children of 11 years, but for those of 15 years, the number drops to 16% [18]. The authors also conclude that the probability of sedentary behavior increases with age, with only 50% of 11-year-old children reporting watching 2 or more hours of television during the week, against 63% of those who are older [18].

In order to understand what type of functionalities are the most frequently present in mobile applications aimed at nutrition, physical activity and health, in the general population, a search was carried out in the Google Play Store, since the mobile application would be developed for the Android operating system [19]. The following keywords "nutrition", "diet", "calories", "health", "exercise" and "weight" were used for this search. 250 applications resulted from this search [19]. Thus, only 73 were analyzed,

where the remaining were excluded by previously defined criteria [19]. The 73 applications were classified, verifying that most of them corresponds to applications related to "diet and nutrition" (52%) [19]. The remaining mobile applications are distributed by "health" (25%), "physical activity" (12%) and education (11%) [19]. We also analyzed and categorized the different functionalities, including "diet", "anthropometric parameters", "social", "physical activity", "medical parameters", and, "vital parameters" [19]. From the study of the 73 mobile applications, we verified that the most features encountered in the mobile applications were weight, height, age, gender, objectives, calculation of calories needed, diet diary, database of food and calories, calories burned and calculation of intake of calories [19].

Finally, in order to discover the most used methodologies to obtain the participation and attention of young people with the use of mobile applications to improve health, a search for different studies was made. A search was made in different digital libraries, such as Springer, IEEE Xplore, and PubMed. Initially, we found 13,218 articles, where, after the exclusions, 9 articles were remaining due to the criteria that we established previously. These studies indicate the different techniques to attract the attention of young people, where, generally, it includes questionnaires and gamification techniques. The different features used in the different studies include the paper diary, the digital diet diary, the digital exercise diary, the use of notifications, the diet plan, the record of physical activity, the use of photos, the use of games, and the use of SMS.

3 Methods

Before this study, a methodology was proposed with the use of a mobile application [14], which was built with the aim of monitoring, advising and educating young people about health. This mobile application was named as CoviHealth, where young people could register their diet, physical activity, medication plans, anthropometric data, alerts and objectives. In addition, the teenagers could accept the challenges related to physical activity and fill the weekly questionnaires. The main screen will show a daily curiosity/suggestion related to nutrition and physical activity, and their effects on health.

As the project was developed in Covilhã, Portugal, two schools were proposed to collaborate, such as Escola Quinta das Palmeiras (Covilhã), and Escola Secundária com 3º Ciclo Ensino Básico do Fundão (Fundão). The selected students were aged between 13 and 18 years old, where 68 were selected from Fundão, and 105 were selected from Covilhã.

Between the 173 students, only 155 of them were validated, because the remaining reported an invalid email or they do not have a smartphone with Android operating system. During the study 28 students downloaded the mobile application from Google Play Store, where one was excluded by age range and execution of the questionnaires in the mobile application.

All validated students used the mobile application for 5 weeks, where 18 curiosities and 10 suggestions related to nutrition or physical activity were presented. In addition, 6 challenges in relation to the number of steps and calories were provided. Thus, 4

questionnaires related to the curiosities and suggestions provided were presented to the teenager.

At the end of the first five weeks, the mobile application was evaluated by the teenager with a questionnaire. All questionnaires were statistically analyzed by quantitative and qualitative variables. Finally, the analysis was performed by groups, applying the Chi-square test with the contingency tables.

4 Results

4.1 Sample Analysis

The population included in the study tries to have equivalent number of people from different genders, where the population has 14 of female gender, and 12 of male gender. In addition, the individuals are distributed by different ages, *i.e.,* between 13 and 18 years old.

In this study is also studied the presence of pathologies in the different subjects, where only 19% of teenagers reported that have some diseases, but only 8% reported that are taking some medication.

The different teenagers have between 1.43m and 1.87m of height, but they have major incidence between 1.60m and 1.70m of height. Related to the weight, they reported that have between 35kg and 80kg, but they have major incidence between 40kg and 50kg. Thus, it is possible to calculate the Body Mass Index (BMI) with these values, reporting that 67% reported the normal level of BMI, *i.e.,* between 18.5 and 24.9.

4.2 Analysis of population habits

In relation to the sleeping habits, most of the students are sleeping between 8 and 9 hours per night, and the majority is not consuming alcoholic beverages. Fortunately, 65% of analyzed teenagers practice sports, but only 62% are frequenting the gymnasium, where also 62% of teenagers practice exercise during 1 or 2 hours for each day. Regarding the sports played, 39% of the teenagers play football, and 23% of the teenagers play basketball. Regarding the group sports, 35% of students prefer individual sports, and 31% of teenagers prefer team sports.

In general, the teenagers involved in the study did not have specific diet, where only 62% of individuals are consuming one or two pieces of fruit per day. However, only 4% are consuming candies between 5 to 6 times a week. In contrast, 54% of teenagers are drinking only between 0.5L and 1L of water per day.

4.3 Analysis of weekly questionnaires

The participants had available in the mobile application 4 weekly questionnaires, answered by the end of each week of the study and they are related to the different tips and curiosities presented during each week. Table 1 shows the answers on the different questionnaires. The correct answers are highlighted in Table 1.

Regarding the different questionnaires, in average, 54% of the answers of the questionnaire 1 are correct, 39.75% of the answers in the questionnaire 2 are correct, 73%

of the answers in the questionnaire 3 are correct, and 50% of the answers in the questionnaire 4 are correct.

Table 1. Different Answers of the different questionnaires.

Questionnaires	Questions	Answer 1	Answer 2	Answer 3	Answer 4
1	1	13%	20%	47%	20%
	2	13%	7%	7%	73%
	3	60%	40%	-	-
	4	60%	13%	7%	20%
2	1	42%	17%	8%	33%
	2	25%	42%	17%	17%
	3	58%	42%	-	-
	4	25%	8%	42%	25%
3	1	8%	92%	0%	0%
	2	0%	17%	17%	67%
	3	17%	8%	75%	0%
	4	0%	58%	25%	17%
4	1	14%	43%	0%	43%
	2	43%	0%	57%	0%
	3	29%	29%	29%	14%
	4	14%	14%	0%	71%

4.4 Analysis of feedback questionnaire

Related to the monitoring of physical activity components of the mobile application, the users are mainly satisfied with the different functionalities, but most of the students that answered the questionnaire said that they maintained the level of physical activity during the study. In addition, most of the teenagers are satisfied with the use of the training plan functionality. Related to the food, most of the students maintained their food habits.

Related to the educational features, the use of tips and curiosities are useful for most of the students, and the use of questionnaires are mainly reasonably useful to the improvement of the knowledge about education of nutrition and physical activity. In general, most of the students answered that the use of gamification motivated the use of the mobile application. The mobile application also allows the medical control, where most of the teenagers said that it is important.

In general, people are reasonably satisfied with the mobile application, and a large part of the students involved in the study said that will use the proposed mobile application.

5 Discussion

Due to the presence of similar studies in the literature, the results obtained by our study can be discussed with them. The CoviHealth project was implemented for 5 weeks, and only one study found was implemented in the same number of weeks and a similar

number of teenagers [20]. *Spook et al.* [21] and Reid *et al.* [22] are two studies implemented during only one week. In [23], a larger number of teenagers participated in the study during only 4 weeks. Finally, Lee *et al.* [24] performed a study with a similar number of teenagers than CoviHealth project for 12 weeks.

It was verified that one study improved the diet of the teenagers with mobile applications [20]. Still, the dietary habits did not changed in the study [23]. The satisfaction with the methodology implemented was higher in the study [25]. However, in the study [24], the teenagers are clearly satisfied, and, in study [23], the teenagers are not satisfied. Regarding our study, the majority of the teenagers agreed to the use of mobile applications. Thus, similarly to our study, in [21], the teenagers said that they would continue using the mobile application.

Therefore, the use of mobile applications by teenagers is not recommended until between 14 and 16 years old [26], and we need to act in earlier age to promote healthier habits. The technological equipment, chu as mobile devices, is a good manner to prometon good habits in the different communities of teenagers.

The technology allows the healthcare professionals to monitor the teenagers anywhere, and it can be explained to the teenager in a consultation. Different validated methods are important to captivate the attention of the teenagers, including the pedometer, and the measurement of the energy expenditure [27–30].

Finally, CoviHealth project demonstrated that the use of a mobile application increases the good habits for physical activity and nutrition. However, this study was implemented in a pandemic situation and it affected the results obtained as well as the low number of teenagers that completed the study. The main limitation was that the mobile application was only focused in nutrition and physical activity. The technologies captivate this type of population.

6 Conclusions

The CoviHealth application intends to educate the teenagers about physical activity and nutrition with daily tips and curiosities, questionnaires, gamification, challenges, and other functionalities. The teenagers win points with the use of the mobile application to earn discounts in different stores.

At the beginning this study involved 26 teenagers, but we only analyzed the seven teenagers that finalized the study. The analyzed teenagers are aged between 13 and 16 years old, and they answered the feedback questionnaire. The study has the duration of five weeks with the availability of four weekly questionnaires about the tips and curiosities provided by the mobile application.

Regarding the different functionalities of the mobile application, the teenagers are mainly satisfied with the physical activity monitoring, tips and curiosities, and questionnaires. By the way, they choose the medical control as a relevant feature, and they indicated that the gamification functionalities motivated the use of the mobile application.

It was concluded that the use of the mobile application for the promotion of healthy nutrition and physical activity habits is reliable. However, due to the pandemic situation, this study should be performed with a more diverse population and an larger samples in the analysis.

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