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# Pilot evaluation of an interactive multimedia platform to provide nutrition education to Portuguese adolescents

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Background: Obesity prevalence has been rising worldwide and currently is one of the most serious public health problems. Nutrition literacy is important to the development of healthier habits that could help prevent and stem obesity and overweight. The aim of this study was to evaluate the impact of using a multimedia web platform to provide nutrition education to Portuguese adolescents. Methods: The intervention consisted in a two-week period in which students ( $n = 1291$ ) had access to an interactive multimedia web platform with nutritional content, and designed for a self-paced learning experience. Students completed a knowledge questionnaire at baseline and immediately after the end of the intervention. Results: The results obtained revealed that 85.8% of the students increased their nutrition knowledge. No gender differences were observed post-intervention. There were significant differences in the knowledge acquisition regarding age ( $P < 0.001$ ). The baseline knowledge seemed to influence the learning process. Conclusions: Overall, the intervention had a positive impact. The preliminary results observed will be important for the improvement of the intervention, though they need to be confirmed by further research. Nevertheless, it is safe to say that technology-based assets can be important tools to incorporate and complement health-related interventions in schools.  
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## Introduction

Obesity has been rising worldwide, and according to that, it is considered as one of the most serious health problems of the 21st century. Globally, in the last three decades, the number of overweight and obese individuals has increased from 921 million to 2.1 billion;<sup>1</sup> of those, it is estimated that 170 million are children (<18 years).<sup>2</sup>

The National Food, Nutrition and Physical Activity Survey, 2015–2016, revealed that 8.7% of Portuguese adolescents (10–17 years old) are obese and 23.6% are in a pre-obesity stage. Also, it showed that the obesity prevalence is age-related, with the lowest prevalence in children and the highest in the elderly (7.7 and 39.2%, respectively),<sup>3</sup> reinforcing the idea that prevention strategies at younger ages are extremely important and can be crucial to reduce the future obesity prevalence. Due to the huge importance of food in our lives, and its strong connection with overweight and obesity prevalence, with other diseases, and with environmental issues too, it is fundamental to increase nutrition education and teach children to eat better and in a sustainable way.

School is an important setting to promote a healthy lifestyle. Interventions focused on the whole school community can be very effective to improve dietary and physical activity patterns both inside and outside school. These interventions should be prioritized since most children attend school daily, and they easily spread the message to other segments of the population.<sup>4,5</sup> Several studies show the difficulty to engage children into health-related activities effectively, essentially because of the absence of interest for such subjects. Thus, one of the challenges is the development of complementary tools to lure their attention to these topics.<sup>6</sup> The incorporation of technological assets in traditional education represents a potential benefit in the improvement of the education quality, by improving students' attention and perception skills, and also by increasing their organization and strategic thinking competences.<sup>7</sup> Several studies regarding technology-based approaches to prevent obesity in children suggest that it can have a positive influence in the development of healthy behaviors,<sup>8–11</sup> though it is difficult to assess the real impact of such programs, due to the vast diversity in protocol, content, approach, duration, outcomes and other supplemental components. Furthermore, to the best of our knowledge,<sup>12</sup> there are only four published studies<sup>13–16</sup> reporting effects on nutritional knowledge arising from school-based interventions (with adolescent participants) that used Information and Communication Technology (ICT). Again studies differ in methods, but results are encouraging about the effectiveness of using ICT in nutritional education and in changing eating habits. However, only one study was conducted in Europe (Finland),<sup>16</sup> with particularities regarding the educational, social and economic context. In addition, most studies have a very small sample size and are restricted to isolated school contexts,<sup>14–16</sup> with only one study reporting feedback based on individuals' self-reported intake of target foods.<sup>14</sup>

Hence, the aim of this pilot study was to evaluate the impact of using an interactive educational multimedia web platform to teach basic nutritional contents to Portuguese school-aged adolescents.

## Methods

### Sample

The study was conducted in six random Portuguese schools that agreed to collaborate, after the approval of its administration board. In the absence of population-based information (pupils enrolled in public secondary education in Portugal), the sample design was not the result of a simple random sampling process: (i) we randomly invited a set of 10 public schools; (ii) the experimental design was presented to 6 school principals who showed interest in participating; (iii) each school board randomly selected the

Table 1 Description of the sample: number of participants and percentages by gender, grade and school

	n (%)
Gender	
Male	584 (45.2)
Female	707 (54.8)
Grade	
9th	255 (19.8)
10th	415 (32.1)
11th	337 (26.1)
12th	284 (22.0)
School	
A	297 (23.0)
B	326 (25.3)
C	108 (8.4)
D	35 (2.7)
E	281 (21.8)
F	244 (18.9)

participating classes and (iv) students from participating classes were invited to take part in the study. Then, a written informed consent was obtained from the students' legal guardians, and verbal consent was obtained from the adolescents before the study was initiated. Ethical approval was granted by the Ethical Committee of the Centro Hospitalar da Cova do Beira (Covilhã, Portugal).

A total of 1291 students, aged 15–23 years, participated in this study and all completed the pre-test and post-test assessments. Participants were excluded from the study if they were undergoing nutritional counseling. Table 1 gives an overview of the baseline distribution of the individuals.

### Nutrition education intervention

A detailed explanation about the study design and the web platform functioning was provided to all the students by the research team before the start of study. Then the implementation of the intervention was managed by the assigned teachers (one science teacher from each class), according to the guidelines given by the research team.

The web platform was designed as an educational tool with nutritional content for self-paced learning, and comprised three sections. The first section was introductory to the study and to the web platform functioning. The second section required the introduction of data regarding gender, age, weight and height. The third section was educational and covered the following topics: (i) body mass index and metabolism, (ii) historical context, (iii) food and nutrients, (iv) the digestive process, (v) diet balance and (vi) eating disorders. The web platform has a presentation in hypertext (with information grouped in different icons) and in hypermedia (different media supporting information), with videos, photos, music, audiovisual narrative and written narrative. The platform produced a report on each participant's BMI, theoretical basal metabolism and diet, comparing the values with references from the literature. It was also possible to consult the nutritional composition of several foods (calories and amount of macronutrients). Thus, it was possible to combine different diet options, which is a feature of interactive multimedia games, applied here to discover new eating styles.

During the two weeks of the intervention, students managed freely the time spent using the web platform. Discussion of the contents among the students was encouraged. The assigned teacher was also available throughout the intervention for any content questions (in person or by email).

It is important to state that, in a preliminary phase, a group of 20 students used the web platform during a week to evaluate their perception and interpretation of its content. After meeting with

this group of students, changes were made to the usefulness and intuitive mode of the commands and the clarity of the educational content for self-learning. The web platform content was also reviewed by two nutrition experts.

A nutrition knowledge questionnaire was answered twice: at the baseline and post-intervention, 2 weeks later, during the school year of 2016/2017. The questions covered the same educational content provided for self-learning. The instrument was analyzed regarding the content validity through the judgment of a team of three nutrition experts and two high school teachers (all with more 5 five years of experience). For the content validation, the experts had to verify the following items: objectivity, relevance, clarity, suitability of the language and degree of difficulty. All questions with a concordance level below 80% or a score below three (considered reasonable, poor or very poor) for any of the above items were discarded from the assessment instrument. Furthermore, two teenage students were asked to read the questions and point out any reading comprehension problems. The final questionnaire consisted of 35 multiple-choice questions, to be answered during a normal class period. The questionnaire was answered in the classroom; each participant answered it individually, and no consultation was allowed. The scores ranged from 0 to 96 points, with the highest scores representing a higher knowledge level. The overall performance at the baseline knowledge test was reported immediately by the software; in addition, specific performance feedback was given for each question.

### Data analysis

Data were analyzed using XLSTAT 2018. Summary statistics were obtained to characterize the statistical distribution of the nutrition knowledge scores at baseline and post-intervention. Additionally, a conditional frequency table was constructed to study the performance's evolution under different degree of initial knowledge using order statistics (quartiles). *t*-Tests were conducted to investigate the statistical significance of the evolution of knowledge along the learning process, ventilated by each surveyed school and in the context of two age groups. Furthermore, a paired samples *t*-test was applied to compare the nutrition knowledge mean values obtained at baseline and at post-intervention.

## Results

The global results of the intervention ventilated by school are presented in table 2. All schools presented an improvement in nutrition knowledge; the greater impact of the intervention was observed in school C, which was the school that presented the lower score at the baseline. Overall, the intervention had a positive impact in student's nutrition knowledge ( $P < 0.001$ ), with 85.8% of the students increasing their score after the intervention.

Students were also grouped into four categories regarding their nutrition knowledge at baseline: category 1 comprised the students that had a nutrition knowledge below the first quartile, category 2 included the students, with scores ranged from the first quartile to the median, category 3 included the students, which scored between the median and the third quartile and category 4 was composed of the students with the highest scores, above the third quartile. Table 3 shows the percentages of students comprising each category of post-intervention scores, grouped by their baseline results. In the lowest knowledge category (Cat. 1), 52.4% of the students improved their performance in the post-test; of those, 21.3% even scored higher than the median value. In category 4, 57.3% of the students maintained it, but 42.7% decreased their results.

Knowledge acquisition considering the gender of the students was explored, and results are presented in table 4. At the baseline, nutrition knowledge was significantly different between genders ( $P = 0.001$ ), with

Table 2 Results of the pre-test and post-test ventilated by school

	Baseline		Post-intervention		Mean evolution %
	M	SD	M	SD	
School A	38.2	11.2	50.4	18.4	32.0
School B	35.2	9.6	46.7	15.6	32.7
School C	30.6	8.1	46.0	18.4	50.3
School D	42.3	14.9	53.7	15.3	27.0
School E	38.6	12.0	51.1	16.9	32.2
School F	38.5	10.4	50.8	14.5	31.9
Total	37.1	11.0	49.4	15.9	33.2

Notes: M, mean; SD, standard deviation.

Table 3 Knowledge category grouped by students' baseline knowledge

Baseline	Post-intervention			
	Cat. 1	Cat. 2	Cat. 3	Cat. 4
Cat. 1	47.5	31.1	14.4	6.9
Cat. 2	22.0	41.4	16.1	20.4
Cat. 3	18.4	28.7	25.5	27.4
Cat. 4	0.08	14.4	27.4	57.3

Notes: Cat. 1, <first quartile; Cat. 2, first quartile-median; Cat. 3, median-third quartile; Cat. 4, >third quartile.

Table 4 Initial and post-intervention nutrition knowledge scores regarding gender

Gender	Nutrition knowledge (0–96 points)		<i>P</i> value
	Baseline	Post-intervention	
Female ( $n = 707$ )	38.0	50.1	<0.001 <sup>a</sup>
Male ( $n = 585$ )	36.0	48.6	<0.001 <sup>a</sup>
<i>P</i> value	0.001 <sup>b</sup>	0.078 <sup>b</sup>	–
Total ( $n = 1291$ )	37.1	49.4	<0.001 <sup>a</sup>

<sup>a</sup>Paired *t*-test.

<sup>b</sup>Independent *t*-test.

girls exhibiting more knowledge. However, at the end of the intervention the gender difference was not significant ( $P = 0.078$ ).

To examine whether age influenced or not, the sample was divided into two groups: G1 (15–18 years) and G2 (19–23 years). The results obtained revealed that the students who increased their knowledge from G1 presented a higher evolution than the ones from G2 after the intervention (87.1 and 82.9%, respectively,  $P < 0.001$ ).

## Discussion

This pilot study aimed to assess the possibility to use a technological asset to provide nutrition education to the Portuguese adolescents. Adolescence is a critical period of life characterized by biological, physiological and social changes. It is considered to be the most propitious life period to engage in risky behaviors with lifelong consequences,<sup>17,18</sup> but it can also be an opportunity to shape healthy behaviors. Adolescents begin to make their own lifestyle choices and to establish habits that affect their current and future health, so it is important to guarantee that they have the basic knowledge to make mindful decisions.

The scores obtained pre-intervention are concerning since all schools achieved results below the median possible score. This suggests that students do not have the appropriate nutrition knowledge, in order to satisfy their daily nutritional requirements, if their nutrition relies exclusively on their own. Post-intervention, the students exhibited significant improvement in their nutrition knowledge, confirming the positive impact of this intervention.

Similarly, other studies have documented the positive impact of technology-based interventions in the increasing of nutrition knowledge.<sup>14–16</sup> In addition, adolescents find these types of interventions more motivating and pleasant than the conventionally used,<sup>13,19</sup> and they seem to be particularly responsive to them, as they exhibit high levels of technology usage.<sup>20,21</sup> Therefore, it seems that the incorporation of ICTs, in health-related interventions, can be beneficial.

Our study reported that the baseline knowledge was higher in females. Literature shows that adolescent girls are more preoccupied with body size and physical appearance,<sup>22–24</sup> which can influence their interest in nutrition-related subjects. Therefore, this can result in a higher degree of knowledge and awareness regarding nutrition. However, the post-intervention results revealed that when there is an intervention, it is possible to captivate males' attention as well.

Associations with age were explored and suggest that it could be easier to captivate the Portuguese adolescents to nutrition-related subjects at younger ages. Although deeper research is needed to confirm it, this can be an interesting information for the development of future interventions.

The observed findings of this study also showed that basic nutritional knowledge could be acquired in a short period, though the contact period with the web platform was probably not long enough to solidify it. Nevertheless, this is an exploratory study and its results must be analyzed with cautions; further controlled tests are necessary to assess the permanence of the knowledge, and to improve the intervention.

Our web platform followed the principles of multimedia learning; thus its exploration was imminently interactive and non-linear. However, we believe the added value of our approach stems not only from the student's ability to manage their learning, but above all because the software encourages learning in two ways: it informs the user about the nutritional areas where he has less knowledge; it allows to self-report dietary intake, giving immediate feedback on the calories ingested and their distribution in macronutrients, which could provide a motivation to adopt healthier and more balanced eating habits.

The conclusions regarding the influence of knowledge are widely different across studies. There are some studies reporting that nutrition knowledge influences the food choices and the preferences of the individuals, but its effects are relatively modest and last for short periods.<sup>25–27</sup> Some others mention that adolescents with good nutrition knowledge do not necessarily make proper dietary choices,<sup>28</sup> and that food choices are more influenced by social features than by health consequences.<sup>29</sup>

This study was not without limitations. The sample was not representative of the entire Portuguese adolescent population, and this was due to the low rate response from the contacted schools. Additionally, the duration of the study was short as it is difficult to promote long-term school interventions, since they interfere with the schedule for the official curricula. A longer intervention will undoubtedly contribute to solidify the knowledge. Lastly, an assessment of the impact of the intervention on the eating patterns should have been done in order to evaluate the real impact of nutrition knowledge, and it should be included in a future intervention.

In conclusion, even though the relationship between dietary knowledge and dietary behavior is very complex, there is no doubt that knowledge influences decisions, and the more people know about the food they eat,<sup>30</sup> the higher is the probability of making healthier dietary choices and fulfill the dietary guidelines.

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*Conflicts of interest:* None declared.

## Key points

- Technology-based tools are feasible to provide nutrition education to adolescents, and thus should be integrated in interventions focused on healthy lifestyle behaviors.
- Technology is easy to adapt to each one learning necessities, it can have several approaches to the same subjects, and can be used to complement other methods.
- These tools still have a lot of potential to explore and research studies, in this direction, will be very important.
- Due to the huge importance of food in our lives and its massive cultural relation, nutrition education is fundamental to the development and maintenance of healthy habits within the population.

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