

## **A school educational intervention based on a serious game to promote a healthy lifestyle**

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### **Abstract**

*Background:* Maintaining a healthy lifestyle is a basic aspect of well-being. Since public health surveillance systems underlie high prevalence of obesity and diet-related ill health, efforts to provide effective intervention to prevent these conditions are of primary importance. The present study aims to test and validate a school intervention based on a serious game (SG) directed to empower a healthy lifestyle in children, actively involving their parents and teachers.

*Methods:* A quantitative, pre/post-test study design assessed effects of a healthy lifestyle intervention on healthy food knowledge, food consumption frequency and level of interest. Participants were 79 children attending primary school and lower secondary school in the Chieti-Pescara urban and rural areas of Italy. Measures were collected during two supervised steps of assessment (T1 and T2).

*Results:* Sixty-seven children completed the intervention. After playing the SG, participants reported higher levels of knowledge on healthy diet. Children also showed significant improvement in healthy eating habits. Moreover, high rates of endorsement about fun, playability, learning perception and goodness of characteristics emerged.

*Conclusion:* This study, targeted children, but directly involving families, shows the effectiveness of a school educational intervention based on a SG, an innovative tool with potential benefits for preventive purposes, despite the short term of intervention. Issues related to the implementation of a method for prevention tailored for children are discussed.

Key words: Healthy behavior promotion, Obesity and diabetes prevention, Serious games, Children, parents

## Introduction

The health implications of unhealthy lifestyle habits among children and young people are increasingly evident with the high prevalence of obesity and diet-related ill health (e.g. diabetes). The World Health Organization (WHO) estimates that 41 million children in the world have an excessive ponderal status (World Health Organization, 2016). More than one-third of children and adolescents are reportedly at risk of being overweight or obese in many countries of Europe (Kotaniidou et al., 2013; Miqueleiz et al., 2014; Schönbeck et al., 2011) and in Italy

(Turchetta et al., 2012). The Italian national lifestyle surveillance system of primary school children, performed in 2014 (alla SALUTE, 2014) showed that 20.9% of children were overweight, and 9.8% were obese. In Italy unhealthy dietary habits are frequent among children with predisposing chronic diseases such as diabetes future public health problems (Lauria et al., 2015). An unhealthy lifestyle involving bad eating habits and physical inactivity predisposes to chronic diseases such as diabetes. In the last decade, Type 2 Diabetes (T2DM) has emerged as an increasingly common pediatric disease in Europe (Marcovecchio & Chiarelli, 2012; Tamayo, 2014). This condition usually begins between 10-14 years of age, with a prevalence in the female gender, and specific ethnic groups (e.g. Central America, South-East Asia, the Pacific Ocean, and the Arabian Peninsula) some of which are present in Italy (Tumini et al, 2014). In our country, the prevalence of Type 2 diabetes among children and adolescents is around 0,5%. (Marcovecchio & Chiarelli, 2012).

A public health challenge is to reduce intakes of processed foods and saturated fat, which are often appetizing, attractive, and strongly advertised. A recent review highlighted that studies among children clearly point out that the largest part of this population poorly adheres to the Mediterranean diet also in the Mediterranean region (Naska & Trichopoulou, 2014). Despite health concerns about dietary habits among young people, at the time of this study few interventions made positive changes on children's knowledge and behavior. To be effective, such interventions should attract the participants' attention and motivation to learn and to change dietary habits. Interactive multimedia provides tremendous potential to develop and deliver school-based, health promotion/education tools, which can be designed around effective models of behavior change (Goran & Reynolds, 2005). Digital Games represent an innovative tool that overcomes many barriers, for promoting healthy behaviors (Boyle et al., 2016; Parisod et al., 2014). Furthermore,

videogames seem to be more effective in producing changes in a child's behavior compared to traditional media (Hieftje, Edelman, Camenga, & Fiellin, 2013).

In the last years, the growing use of technology among kids influenced the kind of child's favorite game. In 2011, the Italian National Statistical System (ISTAT) published data about "Childhood and Everyday Life". It shows an increase of children (aged 6-10 years) of both sexes (M=65.8%, F=47.5%) that prefer playing video games, compared to 1998 (M=60.4%, F=28.8%) (ISTAT, 2011). It is likely that the increased use of creative and interactive multimedia tools will lead to a stronger impact on children's knowledge about healthy foods and their motivation to change related unhealthy behaviors. Computer or video games encourage active engagement, processing of information and learning by fun. Thus, an educational use of such tools may be more effective in producing improvement and awareness of healthy lifestyle importance.

For this reason, our multidisciplinary teamwork designed, developed, and evaluated a game for health called "Gustavo in Gnam's Planet", aimed to increase knowledge and to improve a healthy lifestyle in Italian adolescents. We conducted studies in school settings, because school is regarded as a health-promoting environment and it is a key link with families. This assumption in accordance with WHO's Health Promoting Schools (HPS) framework supports the reciprocal relationship between concepts of "health" and "education" and it underlines the central role of school to promote health as well as to sustain and reach students (Langford et al., 2015).

The pilot intervention study represented, to our knowledge, the first study in Italy aimed at testing a game-based intervention for prevention programs for youth. It demonstrated that after playing "Gustavo in Gnam's Planet" for one week, participants increased awareness and consumption of healthy foods, and decreased intake of unhealthy foods. Therefore, it is an important didactic resource, whose effectiveness has resulted in a measurable change (Marchetti et al., 2015). A second

study was conducted aimed to test the adolescents' improvement of knowledge about healthy nutrition and to analyze participants' enjoyment in playing "Gustavo in Gnam's Planet", in comparison with an entertaining web game. In accordance with the pilot study, we confirmed the efficacy of our web game to improve participants' nutritional knowledge; we also found a comparable level of fun expressed by participants between the educational and the recreational games. Therefore, "Gustavo in Gnam's Planet" represents a fun resource to promote a healthy lifestyle among adolescents by teaching nutrition notions (Fratlicelli et al., 2016).

Since the prevalence of obesity and T2DM among children is increasing, evaluating the effectiveness of our educational web game to improve knowledge and awareness related to healthy habits in this population is a very important means. The basis for health and a healthy lifestyle is developed in childhood. During this life stage, adults (family and teachers) play a critical role in children's acquisition of knowledge, skills, behaviors and habits (Yoshikawa, 2010).

The objective of this study was to assess the effectiveness of a school educational intervention based on a serious game (SG) and an active involvement of parents and teachers: 1) to improve children's healthy eating knowledge; 2) to empower healthy nutrition related behaviors.

## Methods

### Participants and procedure

A sample of children attending primary school and lower secondary school in the Chieti-Pescara urban and rural areas (Italy) were invited to participate in the study. Parents were informed about the object of the project and the content and method of the study with a written communication. Their involvement was asked also to

provide supervision on the children during activity expected at home. After the informed consent was obtained from children and their parents, participants attended a meeting at school with an expert in nutrition and metabolic diseases. During the meeting “Gustavo in Gnam’s Planet” was presented, and the steps of the research were explained. All the participants were asked to complete on-line questionnaires before starting the use of the web game (Time 1). Assessment at T1 provided the participants' level of knowledge of healthy foods and their habits regarding weekly food consumption. The on-line questionnaires were developed and delivered through LimeSurvey, an open source tool for online surveys. Participants were asked to play the game at school during a dedicated time, under the supervision of two research members, and at home for at least half an hour per day during the following week, under the supervision of their parents. After that, at Time 2, post-test questionnaires were administered to all participants. At the beginning of T1, children were provided with personal credentials to access the reserved Web area, where they could find all the contents of the research. The reserved Web area displayed the instructions of the research, the links to LimeSurvey pages for the two times of assessment, and the link to the Unity page of the web game “Gustavo in Gnam’s Planet”.

### Measures

The on-line assessment included a brief initial section about demographic information (gender and age), followed by two self-report measures: the healthy food knowledge questionnaire - children version, and the food frequency questionnaire - children version. The healthy food knowledge questionnaire - children version, was a modified version of a measure used with adolescents in previous studies (Fratlicelli *et al.*, 2016; Marchetti *et al.*, 2015) and evaluated the knowledge of participants about healthy foods. The literature related to children’s evaluation in survey research underlies how questionnaires must be specially developed for this group taking into account the stage of cognitive development

reached (e.g., Borgers, de Leeuw, & Hox, 2000). Moreover, researchers in Child Computer Interaction (CCI) applied different survey methods like “yes/no” questions (Read & MacFarlane, 2006). According to the field, we changed the type of response from Likert type Scale to Agree-Disagree Response Scale in order to provide a very simple answer method. The measure asks participants to indicate for 22 kinds of food if each one should be recommended in a healthy diet. Scores ranged from 0 to 22, a higher score indicating a better knowledge about healthy foods. Kuder Richardson 20 coefficients for pre-test (T1) and post-test (T2) showed an acceptable reliability of the measure (respectively 0.72 and 0.79).

The food frequency questionnaire - children version assessed instead the consumption frequency of common foods in the previous week. Participants were asked to indicate on a 5-point Likert-type scale their consumption in the previous week of 33 foods. Scores for each food could range from 0 (none of the days of the week) to 4 (every day of the week). Each single score was used for data analysis.

Subjects who played “Gustavo in Gnam’s Planet” also completed an interest questionnaire in the post-test session. The measure included 5 items, on an Agree-Disagree Response, investigating participants opinion about the game’s characteristics such as structural features (i.e. graphic and sound), enjoyment and playability of the game, clarity of information presented during the game, self perception about learning through the game.

#### Statistical Analysis

Kuder- Richardson 20 coefficient was used to estimate the reliability of the healthy food knowledge questionnaire - children version at T1 and T2.

Information about the effectiveness of the web game to improve knowledge on healthy diet and to change eating habits were tested. T1 to T2 difference about participants’ level of knowledge on healthy diet and about weekly food

consumption frequency were calculated using Wilcoxon signed rank sum test. Frequencies of the interest questionnaire responses were provided in order to account participants' opinion about the game's playability.

Statistical analysis was carried out with SPSS statistical package version 17.0.

## Results

A sample of 79 children (53.2% males) was involved, ranged from 9 to 13 years ( $Mage = 10.54$  years,  $SD = 0.78$ ). Of these 67 children (52.2% females), ranged from 10 to 13 years ( $Mage = 10.58$  years,  $SD = 0.74$ ), had available complete information on T1 and T2 questionnaires.

The children's' level of knowledge on healthy diets was significantly higher after playing "Gustavo in Gnam's Planet" (T2,  $Mdn = 21.00$ ) than before that (T1,  $Mdn = 20.00$ ),  $Z = -4.03$ ,  $p < .001$ ,  $r = -.35$ .

Comparisons of food consumption frequency revealed that participants showed significant higher consumption frequency of white meat ( $p = 0.03$ ), and lower consumption of sugar-containing packaged snacks ( $p = 0.04$ ), soft drink ( $p = 0.002$ ) and sauces ( $p = 0.03$ ) after having played "Gustavo in Gnam's Planet" for one week (see Table 1).

Table 1

*Pre-test and post-test differences in food consumption*

Food	Pre-Game <sup>a</sup>	Post-Game <sup>a</sup>	Z	$p^b$
Pasta, rice, other cereals	2 (1-4)	2 (1-4)	-1.93	0.05
Bread	3 (2-4)	3 (2-4)	-0.60	0.55
Potato	1 (1-2)	1 (1-2)	-0.18	0.80
Milk, yogurt	3 (1-4)	3 (1-4)	-1.937	0.05
Croissant, brioche	1 (0-1)	1 (0-1)	-0.18	0.90
Sugar-containing packaged snacks	1 (1-2)	1 (0-2)	-2.05	<b>0.04</b>
Homemade cake	1 (1-2)	1 (1-2)	-1.18	0.26



Biscuit	2 (1-4)	2 (1-3)	-1.36	0.19
Spreadable cream	0 (0-1)	1 (0-1)	-0.27	0.81
Breakfast cereals	2 (0-2)	2 (1-4)	-1.70	0.09
Crackers, salty snack	1 (1-2)	1 (1-2)	-1.55	0.13
Chips	1 (0-1)	1 (0-1)	-2.13	0.05
Pizza	1 (1-2)	1 (1-1)	-1.67	0.10
Hamburger, hot-dog	0 (0-1)	1 (0-1)	-0.23	0.83
Sandwich, toast	1 (1-2)	1 (1-2)	-1.09	0.31
Red meat	1 (1-2)	1 (1-2)	-1.89	0.06
White meat	1 (1-2)	2 (1-2)	-2.18	<b>0.03</b>
Fish	1 (1-1)	1 (1-2)	-1.49	0.16
Fresh cheese	1 (0-2)	1 (1-3)	-0.47	0.65
Cheese	1 (0-2)	1 (0-2)	-1.51	0.14
Eggs	1 (1-1)	1 (1-2)	-1.00	0.35
Cold cuts	2 (1-2)	1 (1-2)	-1.98	0.06
Legumes	1 (1-2)	1 (1-2)	-1.44	0.16
Vegetables	2 (1-4)	2 (1-4)	-1.55	0.12
Fresh fruit	3 (2-4)	3 (2-4)	-0.45	0.68
Dried fruit	0 (0-1)	1 (0-1)	-0.02	1.00
Fruit juice	2 (1-3)	2 (1-3)	-1.08	0.28
Soft drink	1 (0-2)	1 (0-1)	-3.08	<b>0.002</b>
Slice of cake, dessert	1 (0-2)	1 (0-1)	-2.03	0.05
Extra virgin olive oil	3 (1-4)	3 (2-4)	-1.01	0.33
Sauces (mayonnaise, ketchup)	1 (0-1)	1 (0-1)	-2.23	<b>0.03</b>
Butter, margarine, heavy cream	1 (0-1)	1 (0-1)	-0.67	0.55
Precooked food	1 (0-1)	1 (0-1)	-1.78	0.08

<sup>a</sup>Data are expressed as median (interquartile range).

<sup>b</sup>A  $p$  value  $< 0.05$  was considered for statistical significance. Comparisons were calculated by using Wilcoxon signed rank sum test.

Bold values indicate statistical significance.

According to the interest questionnaire results, all participants ( $n = 67$ ) agreed the web game is funny (item 1). Moreover, 85.1% of the participants ( $n = 57$ ) agreed the game is well designed (item 2), it is easy to use (item 3) and they had a

perception of their own learning while playing Gustavo in Gnam's Planet (item 5). Finally, 97% of the sample ( $n = 65$ ) thinks the messages presented during the game are clear (item 4).

## Discussion

The results of this research in accordance with our previous studies (Fratlicelli *et al.*, 2016; Marchetti *et al.*, 2015) showed the efficacy of our G4H "Gustavo in Gnam's Planet" in a school-based education program to promote healthy behavior in Italian children. As expected participants showed higher knowledge of nutrition notions and awareness in the choice and consumption frequency of healthy and unhealthy foods.

The most important result is the participants' evaluation of game interest because we believe that the combination of an effective methodology with an interest and pleasure evaluation is the core of preventive programs for children. We consider that the effectiveness of the intervention is also due to parental involvement. Parents' influence is vital for establishing healthy lifestyle behaviors in children (Gibson *et al.*, 2012). It occurs mostly because parents have higher control over children's actions and habits at this stage of the life span. Therefore, it is not appropriate to provide healthy lifestyle principles and foster related behaviors without parental support.

The study had also some limitations: the small sample size, the lack of a control group, and the lack of a follow-up measure. Although these limitations, our study addresses important issues highlighted in literature as significant factors to consider in studies on the benefits of SGs for the promotion of healthy habits in children. Specifically, a recent review (Mack *et al.*, 2017) concluded that from the studies published to test the effectiveness of SGs aimed at improving knowledge and change behavior in nutrition and physical activity, only a very limited number of

studies provided a direct evaluation of the acceptance of the game and reported parental involvement in the intervention process.

The findings of our game-based intervention study could be used to help the implementation of a method for prevention tailored for children. We discuss some issues of implementation. The first issue focuses on the relevance of parents' involvement about the objective of the action, their active role both in the supervision of child's activity at home, and in the process of restitution and reinforcement of the intervention results and implications. The second aspect is more directly related to the process of persuasion of children knowledge and behavior. It considers the school as the ideal environment in which to perform most of the activity under expert supervision. Moreover, it implies at least two times of assessment to retrieve changes. The third issue regards the technology used to modify knowledge and behavior. "Gustavo in Gnam's Planet", like other web games developed for serious purposes (Boyle et al., 2016; DeSmet et al., 2014; Parisod et al., 2014; Sharma et al., 2015; Turnin et al., 2001), provides an interesting, funning and reusable means to catch children's attention and intention on healthy lifestyle choices and habits. According to Baranowski et al. (2003) games delivered via internet (as opposed to other delivery systems) have the benefit to reach large numbers of individuals minimizing costs per new participants. The proposed method for prevention is a good starting point in working effectively with children and their parents with the awareness that further meetings and reinforcement are probably required to get a permanent change in behavior.

In a literature review, Guy and colleagues (2011) said that children education about healthy eating provides health benefits both in the short and long-term. In this area of study, a long-term goal could be the influence of web games such as "Gustavo in Gnam's Planet" on the "Healthcare Marketing", making healthy choices more attractive for youths and their families. If children learn to make healthier

nutritional choices, they can influence family food purchases and so the “Diet Industry”.

In conclusion, our study showed the potential effectiveness of a school intervention based on an educational game to improve health behavior knowledge in children, despite the short term of intervention. Moreover, it suggested that parents and teachers’ active involvement is essential to empower health behaviors in children and keep them in their family's daily routine.

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