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EDUCATIONAL MEDIA INTERNATIONAL
2021, VOL. 58, NO. 4, 297–316
https://doi.org/10.1080/09523987.2021.1989765

Effects of a project based on mobile applications, exergames and a web 2.0 social learning platform on students' physical activity and nutritional criteria in the era of COVID 19

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ABSTRACT

The aim of this study was the investigation of the impact of a year-long, student-centered Physical Education (PE) project, in which mobile applications for Physical Activity (PA) and nutrition monitoring, exergames and an online social learning platform were utilized, on students' PA, sedentary behavior and food selection criteria. The study followed a pretest/posttest design involving 51 students (aged 15–16 years), split into two groups: the experimental group (n = 25), that participated in the project in parallel with attending the regular PE course, and the control group (n = 26), that only attended the regular PE course. The project lasted 7 months, two of which coincided with a quarantine because of COVID 19, during which, all project activities were coordinated through the online platform. The analysis of the data, which were collected through questionnaires, showed an increase in the experimental group students' use of mobile devices for PA and nutrition monitoring as well as a greater improvement of their perceived helpfulness of PA applications and food selection criteria, in relation to the control group. The quarantine did not significantly affect their levels of PA and sedentary behavior, although, in the control group, PA decreased significantly and sedentary time increased significantly. The students were highly satisfied with the project.

KEYWORDS
Mobile applications; exergames; social learning platform; physical education; project-based learning

Introduction

Despite the widely recognized need for a healthy lifestyle in adolescence, teenage obesity is increasing (Srivastav et al., 2020), and is linked to a growing tendency for teenagers not to exercise adequately (WHO, 2019). Thus, for school education, the question of devising ways of getting adolescents to become more physically active is very relevant.

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The Physical Education (PE) course can and should offer adolescents opportunities to include Physical Activity (PA) in their daily routine and to adopt a physically active lifestyle, in order for them to gain good health and wellness (Story et al., 2003). However, for PE to engage today's youth, a shift from traditional, teacher-centered educational approaches towards student-centered approaches that take into account students' interests (such as the project-based learning approach) is needed (Coyne et al., 2016). Project-based learning aims at actively engaging students in the investigation of topics through collaborative learning activities, within which students are offered opportunities to search for and analyze information, to experiment and to organize and share their findings and conclusions, thus constructing their own knowledge (Blumenfeld et al., 1991; Howard, 2002; Howell & Mordini, 2003). This approach can foster important student skills, such as decision-making, problem-solving, critical thinking, creativity, communication and collaboration skills (Howard, 2002; Treadwell, 2018). Information and Communication Technology (ICT) can be utilized in school projects in the area of PE to render such projects even more motivational and effective (Cox & Meaney, 2018).

ICT in Physical Activity and Healthy Eating Promotion

ICT tools, such as mobile applications (henceforth called "apps"), exergames and Web 2.0 platforms, may support adolescents in gaining knowledge on the improvement of their fitness and in becoming more physically active, both inside and outside school (Ahtinen et al., 2010; Consolvo et al., 2008; Lin et al., 2006; NASPE, 2009).

In recent years, smartphone use at a young age has become very common, with school students exhibiting great fluency in using smartphones and apps (Park, 2015). The variety of apps for PA monitoring, that can be found in online app stores, can potentially help young people incorporate PA into their daily routine (Davies et al., 2012). Such apps are generally user-friendly and provide instant feedback to the user, including summaries and estimations of the duration, intensity and energy expenditure of the user's exercise. They also offer the user opportunities to set goals and to share their activities and achievements through Web 2.0 platforms such as social networks (Lox et al., 2017; N. Martin et al., 2015). In addition, a plethora of apps for the promotion of healthy eating and weight loss, through daily personal monitoring of calorie intake, is available (Coughlin et al., 2015). Such apps may seem attractive to students, given that they can offer them possibilities to record the type and quantity of the food that they consume, to search for foods in food databases and to get detailed feedback regarding the food consumed (C. Martin et al., 2012). In fact, several studies in adolescents (e.g., Abraham & Michie, 2008; Duncan et al., 2014; Turner-mcgrievy et al., 2013) have shown that the adoption and use of appropriate apps can indeed be effective in increasing adolescents' levels of PA and exercise, and in improving their dietary habits.

As regards Web 2.0 platforms, online learning platforms, such as Edmodo (https://www.edmodo.com/), provide opportunities for social learning, combining features of social media platforms and functionalities of learning platforms with a user-friendly and safe environment. Thus, they could help with information sharing and communication (regarding PA and nutrition apps and their use) among students, teachers and even parents, extending learning, interaction and teamwork past the school day (Web 2.0 Tools for Teachers, 2012). What is more, exergames, namely physically interactive games (for mobile devices, computers or videogame consoles), such as Nintendo Wii Sports and Wii Fit games (https://en.wikipedia.org/wiki/Wii_Fit) or the exergames for Microsoft Xbox/Kinect (https://en.wikipedia.org/wiki/Kinect) and Sony Playstation VR (https://en.wikipedia.org/wiki/PlayStation_VR), can also constitute a useful and motivational tool when it comes to promoting PA in school students (Del Rio et al., 2018). In fact, in various studies (e.g., Garde et al., 2018; Schwarz et al., 2018) exergaming has proven to be effective in getting students to be more physically active, at least in the short-term, combining enjoyment of gaming with PA and exercise.

Rationale and Aim of the Study

Despite the afore-analyzed opportunities for PA and nutrition monitoring that are offered by ICT, the potential for the combination of ICT with the student-centered, project-based learning approach to PE still remains largely under-researched. Specifically, to the best of the authors' knowledge, no internationally published research study has investigated the utilization of mobile apps for PA and/or nutrition monitoring, combined with exergames and Web-based learning platforms, within the framework of project-based learning in school PE. The study presented in this paper attempts to fill in this gap in the research literature.

The aim of the study was the investigation of the impact of a year-long school project, based on apps for PA and nutrition monitoring, exergames and a Web 2.0 social learning platform, on secondary school students' PA, sedentary behavior and food selection criteria. The students' use of mobile devices for PA and nutrition monitoring, perceived helpfulness of PA monitoring apps and evaluation of the project were also studied.

Materials and methods

Sample

The year-long school project is part of the curriculum of the first and the second upper secondary ("lyceum") grades (ages 15–17) in Greece. In the first grade (ages 15–16), it occupies two hours a week. In the beginning of the school year, the teachers of each school propose various project topics and each student selects which topic they wish to work on. The specific project to which the present study refers was coordinated by a PE teacher and was targeted at introducing students to a healthy lifestyle and particularly, to PA, exercise and healthy eating.

The sample were 51 first grade students of a Greek public urban lyceum, 31 boys (60.8% of the sample) and 20 girls (39.2%), aged 15 to 16 years (M = 15.06, SD = 0.24), split into two groups. The experimental group (henceforth called 'Group 1′) consisted of the students from the school that had opted for the aforementioned project topic, whereas the control group (henceforth called "Group 2′) consisted of a cohort of classmates who had selected other projects. Group 1 comprised 25 students, 16 boys (64% of the group) and 9 girls (36%), who participated in the aforementioned project in addition to their regular PE course. Group 2 consisted of 26 students, 15 boys (57.7% of the group) and 11 girls (42.3%), who only participated in the regular PE course. Both groups were taught the regular PE course, two hours per week (according to the national official PE curriculum) by a PE teacher, who was not the same PE teacher that coordinated the project. The PE course was mainly focused on developing students" fitness and on engaging students in various team sport activities.

The Project

In the beginning of the school year, after discussion at the whole class level, the students themselves unanimously decided the precise topic of the project: the utilization of ICT for PA, exercise and nutrition monitoring. This topic was viewed by them as a contemporary, alternative mode of engaging in physical activities and maintaining a healthy diet. The coordinating teacher (henceforth called "the teacher") was also interested in utilizing digital technologies during the project, as a vehicle to enhance students' commitment in it and their motivation to eat healthily and to do physical activities inside and outside school.

The project sessions (2 hours a week) took place mainly in the classroom, where there was a projector connected to the teacher's laptop. Parts of the sessions were also held in the school yard, in order for the students to practice in the use of various mobile apps for PA monitoring, when needed. The classroom sessions were carried out mainly through presentations of the students' own work. The Edmodo online learning platform was also utilized for the purposes of the project. The teacher published educational material on the platform and the teams of students uploaded their "deliverables" to the platform. The students could utilize the published educational material, but were also required to search the Web for information relevant to the project. Students' parents were also granted access to the platform so that they could stay informed about the project and that knowledge could be disseminated to them as well.

The total duration of the project was 7 months. In the first project session, the 25 students formed 5 teams of 5 students each. The workflow of the project was organized as follows: each team collaboratively undertook one assignment (task) every week. Upon completion of the task, they uploaded the assignment to Edmodo so that the teacher and their peers could access it anytime. In the next project session, the members of each team jointly presented their work to the teacher and peers in the classroom. After the presentation, questions were put to the presenting students by their peers, and discussion took place. The teacher intervened when necessary. During the parts of the sessions that were held in the school yard, the teams of students engaged in exercise activities including brisk walking around the school, relay races, relaxed running and fast running. The equipment used were smartphones, smartwatches and cones for the demarcation of areas. The presenting teams led the activities and their peers followed so that the experience of using PA monitoring apps was diffused to all students. The data from the students' exercise activities were saved (the students themselves saved the data on their mobile devices) and, in the next project session, every team discussed the data with the teacher and peers. This was done with the ultimate goal of getting all students motivated in using PA apps.

During the *1st month of the project*, two of the teams (Team 1 and Team 2) dealt with nutritional issues and nutrition monitoring apps, two teams (Team 3 and Team 4) with PA issues and PA monitoring apps and one team (Team 5) with exergames. Specifically, Team 1 investigated meals, food groups and the capabilities of the Yazio and MyFitnessPal apps (see Appendix for a list of links to all the apps mentioned in this paper). Team 2 investigated teen and adult nutrition as well as the Titroo and Diet Coaching apps. Both teams also researched the functions of the hydration monitoring app Hydration Calculator. Team 3 investigated the capabilities of the Runtastic app and Team 4 did the same for the Endomondo app, while both teams researched how the human body responds to PA of varying intensity through using educational material from Edmodo and the Web (e.g., https://www.healthline.com/directory/human-body-maps). Team 5 investigated the capabilities of exergames and their impact on fitness through watching relevant videos on YouTube (e.g., https://www.youtube.com/watch?v=NBuN1iLafwU&t=165s, https://www.youtube.com/watch?v=LqjQY6kjXak) and through actually playing Nintendo

Wii Sports games (basketball, tennis, boxing, bowling, golf). A Nintendo Wii console and Wii Sports games (https://en.wikipedia.org/wiki/Wii_Sports) were made available to the team to this end.

From the *2nd month* to the end of *the 5th month of the project*, the teams rotated in successively dealing with PA, nutrition and exergame topics, on a per month basis, so that, by the end of the project, each team had acquired knowledge, skills and experience regarding all three topics. This was done as follows. During the 2nd month, Team 1 dealt with exergames, Team 2 with meals, food groups and nutrition monitoring apps, Team 3 with teen and adult nutrition as well as with nutrition monitoring apps, Team 4 with PA issues (e.g., impact of PA on heart rate) and the Runkeeper PA monitoring app, while Team 5 also dealt with PA issues (e.g., relationship between runner's speed and distance covered) and the Strava PA monitoring app. During the 3rd month, Team 1 dealt with PA monitoring apps, Team 2 with exergames, etc. The rotation involved a spiral process in the sense that, every month, Team *n* was asked to build on, deepen and extend what Team *n-1* had done during the previous month (e.g., finding and using other relevant apps, comparing or suggesting improvements to apps or exergames, using PA monitoring apps in combination with nutrition monitoring apps or using more generic health apps), with the ultimate goal that all students consolidate and expand their knowledge and skills.

The *5th month* and the *6th month* of the project coincided with the forced closure of all schools due to a nation-wide quarantine (because of COVID 19) and all project activities had to be transferred online (to the Edmodo platform) and to be adapted to the new reality, given the inability to conduct any face-to-face educational activities. Citizens were allowed out of their houses only for very specific purposes (e.g., to buy food, to help the elderly, to engage in outdoor PA), which were given "codes". For teenagers and other young individuals 'code 6' (i.e., PA) was the most plausible reason for going out. Furthermore, healthy eating and weight maintenance had suddenly become even more important, given the risk that "incarceration boredom" could lead to overeating. Thus, although the quarantine inevitably slowed down the course of the project, it was also seen by the authors as an opportunity for students to practically utilize the various PA and nutrition monitoring apps in their everyday lives. In particular, the members of each team were encouraged to record their nutrition during the week through a nutrition monitoring app and then, to upload their conclusions to Edmodo. In addition, when a team or a member of a team completed outdoor walking or running activities ('code 6') using some PA monitoring app, they were encouraged to post their conclusions to Edmodo for the teacher and peers to comment on.

During the *7th month*, the schools re-opened with half the students in one class going to school three days a week and the other half the remaining two days (to avoid overcrowding). Furthermore, many students were absent. Due to this "under-functioning" of the schools, it was decided that the project be continued online (through Edmodo) until the end of the month (which also coincided with the end of the school year). During that period, the teacher and the students summarized the activities of the project.

Instruments

The data of the study were collected through three anonymous questionnaires. The pretest questionnaire was identical for both groups and consisted of three parts.

The *first part* was constructed by the authors and was aimed at the collection of students' biographical data (gender, age) as well as of data regarding students' use of mobile devices for PA and nutrition monitoring. Specifically, through three closed questions, students were asked if they possessed a smartphone, and if they were wearing: a) a smartwatch, and b) a wrist activity tracker. Through a fourth, semi-closed question, they were asked if they were using any mobile apps for PA monitoring, and, in case their answer was positive, they were also asked to specify the frequency of use of such apps (daily, a few times a week, a few times a month, rarely), and to write the names of the apps. A similar, fifth, semi-closed question elicited students' use of apps for nutrition monitoring. A sixth closed question elicited students' perceptions regarding the helpfulness of apps for PA monitoring. It comprised the statement "*I believe that using apps for PA monitoring will help me . . .* " followed by ten 5-point Likert type items ("become more social and extroverted", "exercise in a pleasant and playful way", "share my athletic performance with others", "engage in organized sports activities", "improve my fitness", "improve my nutrition", "get hydrated more often", "walk more", "link nutrition to exercise", "control my weight") with possible answers ranging from 1 = 'Strongly disagree' to 5 = 'Strongly agree'. In the study, Cronbach's alpha coefficient of the ten-item question was 0.85 indicating good internal reliability.

The *second part* was aimed at assessing students' PA levels and sedentary behavior, and consisted of the 7 items of the short form of the well-established International Physical Activity Questionnaire (IPAQ, n.d.), as it has been adapted to Greek by Papathanasiou and colleagues (Papathanasiou et al., 2009). IPAQ-short has proven to be a reliable instrument for measuring PA in individuals between 15 and 69 years of age (Forde, n.d.; Papathanasiou et al., 2009). It consists of 6 items, through which a total PA score is calculated in MET (Metabolic Equivalent of Task) minutes per week, and of a seventh item, which measures sedentary time in hours per week.

The *third part* targeted students' food selection criteria. To elicit these criteria, a scale (henceforth called the Food Selection Criteria Scale – FSCS) was used. It was adapted from a relevant scale, which had been constructed in Greek and had already been used in students aged 13 to

18 years old by Papadimas (2017). The adapted scale consisted of the statement "*In order for me to consume food it is important for it . . .* ", and the following 7 items, each of which had to be rated on the 5-point range [1 = 'Strongly disagree', 5 = 'Strongly agree']: a) "to be healthy", b) "to be home-made", c) "to have a nice smell and appearance", d) "to be also consumed by my friends and peers", e) "to have high nutritional value", f) "to be known from advertising", and g) "to be fast to obtain". Items a), b) and e) are positive, while items c), d), f) and g) are negative, and should be reversed when calculating a subject's score on the FSCS scale. In the study, Cronbach's alpha coefficient of the scale was 0.77 indicating acceptable internal reliability.

The posttest questionnaire for Group 1 students consisted of the same three parts as the pretest questionnaire plus an additional fourth part, which was constructed by the authors. That *fourth part* was aimed at evaluating how students had experienced the project, and comprised one closed, two semi-closed, and one open-ended question. The closed question consisted of the statement "*I am satisfied with . . .* " followed by six items (e.g., "the way nutrition was approached during the project"), each of which had to be rated on the 5-point range [1 = 'Strongly disagree', 5 = 'Strongly agree']). The two semi-closed questions elicited (on the same 5-point range) the extent to which students agreed or disagreed that the knowledge that they had gained from the project regarding: a) PA and exercise, and b) nutrition helped them during the quarantine period. They were also asked to justify their responses. Finally, through an open-ended question, they were asked what was the most important thing that they had learned from the project.

The posttest questionnaire for Group 2 students was the same as the pretest questionnaire.

Procedure

Before the beginning of the project, all students completed the anonymous pretest questionnaire (which was paper-based). Then, the students of Group 1 engaged in the project for 7 months in addition to attending the regular PE course. During the same period, Group 2 students only attended the regular PE course. After the completion of the project (namely at the end of the school year), the students of both groups completed the respective anonymous posttest questionnaires, which were administered online. Pseudonyms that the students had been asked to remember and note on their questionnaires in the pretest and in the posttest were used for the matching of the questionnaires between the pretest and the posttest.

Data analysis

Data were analyzed by descriptive statistics (means, standard deviations, frequencies and percentages). For each student, the average of his/her ratings on the 10 items of the question that elicited their perceptions regarding the helpfulness of apps for PA monitoring was calculated (this was the "perceptions score" of the student). The IPAQ was scored according to the relevant instructions provided in (Forde, n.d.). As a result, for each student, a PA score was calculated (in MET minutes per week) and a sedentary time (in hours per week). Furthermore, for each student, a score on the FSCS scale was calculated (the average of his/her ratings on the 7 items of the scale, after reversion of items: c, d, f and g). Normality of the distribution of variables was assessed through Shapiro-Wilk's tests. Students' PA scores and sedentary times were found not to follow a normal distribution and were, thus, transformed using the square root transformation. Potential initial differences between the two groups (Group 1 and Group 2) as to perceptions scores, (transformed) PA scores, (transformed) sedentary time and FSCS scores were investigated through independent samples t-tests.

In order to compare the effectiveness of the two approaches (project combined with PE course versus PE course alone) to improve students' perceptions of the helpfulness of PA monitoring apps, a mixed between-within subjects ANOVA was conducted. In this analysis, pretest and posttest perceptions scores were the within-subjects variables, whereas group was the between-subjects factor. The analysis was also followed by an analysis of pairwise comparisons between the two different time periods (pretest and posttest perceptions scores) organized by group, with statistical significance receiving a Bonferroni adjustment. The same analyses were also performed on PA scores.

Given that a statistically significant difference between the two groups was detected in students' sedentary times in the pretest, a one-way between groups analysis of covariance (ANCOVA) was performed to compare the effectiveness of the two approaches (project combined with PE course versus PE course alone) to reduce sedentary time. In this analysis, group was the independent variable, and posttest sedentary time was the dependent variable, whereas pretest sedentary time was the covariate. Before conducting the analysis, preliminary checks were performed to ensure that the assumptions of linearity, homogeneity of variances and homogeneity of regression slopes were not violated (Pallant, 2001). The same analyses were performed on FSCS scores, given that a statistically significant difference between the two groups was detected in students' pretest FSCS scores.

All afore-mentioned analyses were conducted through the SPSS statistical package and level of statistical significance was set to 0.05. Finally, students' answers to the semi-closed and to the open questions were grouped into categories according to their common themes (Gall et al., 1996).

RESULTS

Students' Use of Mobile Devices for PA and Nutrition Monitoring

In the pretest, 24 students of Group 1 (96%) owned a smartphone and 3 (12%) were wearing a smartwatch, while in Group 2 the respective numbers were 26 (100%) and 4 (15.4%). These numbers remained unaltered in the posttest. As regards activity trackers, 3 students in Group 1 (12%) and 6 in Group 2 (23.1%) were wearing such a device in the pretest. In the posttest, the number had risen to 5 (20%) in Group 1, but had remained stable in Group 2.

Regarding use of apps for PA monitoring, 4 (16%) students of Group 1 were using such apps in the pretest (3 daily and one rarely), whereas in Group 2, 9 (34.6%) students did (6 daily, 2 a few times a week, 1 a few times a month). In the posttest, the number had increased by 10 in Group 1, namely 14 students (56%) were PA app users (4 daily, 6 a few times a week, 3 a few times a month, 1 rarely), but only by 2 in Group 2, in which 11 (42.3%) students did (6 daily, 5 a few times a week). In both groups, no student was using any app for nutrition monitoring in the pretest. In the posttest, 8 (32%) students of Group 1 did (4 daily, 2 a few times a week, 2 a few times a month), whereas in Group 2 only one boy did (daily). Table 1 shows the apps that students were using in the pretest and in the posttest (as mentioned by them).

For each group, Table 2 shows descriptive statistics of students' perceptions scores, in the pretest and in the posttest.

Table 1. PA and nutrition monitoring apps mentioned by students.

	Group 1		Group 2	
	Pretest	Posttest (*)	Pretest	Posttest (*)
Physical Activity (PA)	• Samsung Health • Apple Health • Sony Lifelog	• Runtastic Adidas Running • Endomondo	• Samsung Health • Apple Health • Google Health • Google Fit • Huami Mi Fit • Runtastic Adidas Running • Fitpal • Freeletics	-
Nutrition	-	• Yazio • MyFitnessPal	-	• Yazio

**: Only the apps that the students of the respective group had not mentioned in the pretest appear in this column*

Table 2. Descriptive statistics of students' perceived helpfulness of Physical Activity (PA) monitoring apps (N = 51).

	Group 1 (n = 25)				Group 2 (n = 26)			
	Pretest		Posttest		Pretest		Posttest	
	M	SD	M	SD	M	SD	M	SD
Perceived helpfulness of PA monitoring apps	3.28	0.73	4.09	0.42	3.27	0.65	3.83	0.39

M = Mean, SD = Standard Deviation

In the pretest, the two groups did not differ significantly as to their perceptions scores, as was inferred by the conducted independent samples t-test [t (49) = 0.04, p = 0.971]. The mixed between-within subjects ANOVA that was conducted showed a statistically significant main effect for time [Wilk's Lambda = 0.24, F(1, 49) = 155.68, p < 0.001]. The effect size was large (multivariate eta-squared = 0.76). The main effect for group was not statistically significant [F(1, 49) = 0.80, p = 0.377] and the relevant effect size was small (eta-squared = 0.02). However, a significant time x group interaction effect was obtained [Wilk's Lambda = 0.90, F(1, 49) = 5.18, p = 0.027], and the effect size was moderate (multivariate eta-squared = 0.10). The conducted pairwise comparisons revealed that within Group 1, there was a statistically significant increase in perceptions scores from pretest to posttest [Wilk's Lambda = 0.31, F(1, 49) = 106.73, p < 0.001], and the relevant effect size was large (multivariate eta-squared = 0.69). Within Group 2, there was also a statistically significant increase [Wilk's Lambda = 0.48, F(1, 49) = 53.08, p < 0.001] and the relevant effect size was large (multivariate eta-squared = 0.52), but smaller than the effect size for Group 1. Thus, both approaches were effective in improving students' perceptions of the helpfulness of PA monitoring apps, with the project combined with the PE course being more effective than the PE course alone.

Students' PA and Sedentary Behavior

For both groups, Table 3 shows descriptive statistics of students' PA scores and sedentary time in the pretest and in the posttest.

The independent samples t-test that compared pretest PA scores between the two groups showed no statistically significant difference [t (49) = −0.06, p = 0.952]. The conducted mixed between-within subjects ANOVA revealed a significant main effect for time [Wilk's Lambda = 0.59, F (1, 49) = 33.96, p < 0.001]. The effect size was large (multivariate eta-squared = 0.41). The main effect for group was marginally not statistically significant [F(1, 49) = 3.90, p = 0.054] and the relevant effect size was moderate (eta-squared = 0.07). However, a significant time x group interaction effect was obtained [Wilk's Lambda = 0.78, F(1, 49) = 13.98, p < 0.001], and the effect size was large (multivariate eta-squared = 0.22).

Table 3. Descriptive statistics of students' physical activity and sedentary time (N = 51).

	Group 1 (n = 25)					Group 2 (n = 26)				
	Pretest		Posttest			Pretest		Posttest		
	M	SD	M	SD	AM	M	SD	M	SD	AM
Physical activity	44.03	16.38	39.99	10.27	-	44.31	17.31	25.83	12.03	-
Sedentary time	3.07	0.38	3.09	0.18	3.15	3.38	0.29	3.50	0.20	3.45

M = Mean, SD = Standard Deviation, AM = Adjusted Mean

The conducted pairwise comparisons showed that within Group 1, the decrease in PA scores from pretest to posttest was not statistically significant [Wilk's Lambda = 0.96, $F(1, 49) = 2.14$, $p = 0.15$], and the relevant effect size was small (multivariate eta-squared = 0.04). However, within Group 2, the drop in PA scores across time was statistically significant [Wilk's Lambda = 0.51, $F(1, 49) = 46.67$, $p < 0.001$] and the relevant effect size was large (multivariate eta-squared = 0.49). Thus, although within both groups PA decreased over time (instead of increasing), for the students that participated in the project in addition to attending the PE course, the decrease was small and statistically insignificant. Conversely, for the students that only attended the PE course, the drop in PA scores was acute and statistically significant.

Regarding sedentary time, in the pretest, Group 2 was found to spend more time in sedentary activity than Group 1 and this difference was statistically significant, as revealed by the conducted independent samples t-test [$t(49) = -3.33$, $p = 0.002$]. Therefore, a one-way between groups ANCOVA was conducted. The independent variable, Group, included two levels: project combined with PE course (Group 1), PE course alone (Group 2). The dependent variable was students' sedentary time in the posttest and the covariate was students' sedentary time in the pretest. A preliminary analysis that evaluated the homogeneity of regression slopes assumption indicated that the relationship between the covariate and the dependent variable did not differ significantly as a function of the independent variable [$F(1, 47) = 0.149$, $MSE = 0.023$, $p = 0.701$, eta-squared = 0.003]. The ANCOVA was significant [$F(1, 48) = 40.22$, $MSE = 0.022$, $p < 0.001$]. The strength of the relationship between the Group factor and the dependent variable was very strong, as assessed by eta-squared, with the Group factor accounting for 46% of the variance of the dependent variable, holding constant students' sedentary time in the pretest.

The means of students' sedentary times adjusted for initial differences (See Table 3), were ordered as expected across the two groups. The control group (Group 2) had the largest adjusted mean (3.45) and the experimental group (Group 1) had a smaller adjusted mean (3.15). Follow-up tests were conducted to evaluate pairwise differences among these adjusted means. The Holm's sequential Bonferroni procedure was used to control for Type I error across the two pairwise comparisons. There were significant differences in the adjusted means between Group 1 and Group 2 (MD = −0.30; 95% CI: −0.39 to −0.20, $p < 0.001$). Thus, after having completed the project in parallel with attending the PE course, Group 1 students were significantly less sedentary than Group 2 students, who had only attended the PE course. As shown in Table 3, in Group 1, sedentary time remained quasi unaltered from pretest to posttest, whereas in Group 2, it increased over time.

Table 4. Descriptive statistics of students' scores on the FSCS – Food Selection Criteria Scale (N = 51).

	Group 1 (n = 25)					Group 2 (n = 26)				
	Pretest		Posttest			Pretest		Posttest		
	M	SD	M	SD	AM	M	SD	M	SD	AM
FSCS scores	3.59	0.70	4.03	0.41	3.91	3.20	0.59	3.54	0.44	3.65

M = Mean, SD = Standard Deviation, AM = Adjusted Mean

Students' Food Selection Criteria

For both groups, Table 4 shows descriptive statistics of students' scores on the FSCS in the pretest and in the posttest.

In the pretest, Group 1 students scored higher on the FSCS than Group 2 students and the difference was statistically significant, as was deduced from the conducted independent samples t-test [t(49) = 2.16, p = 0.036]. Therefore, a one-way between groups ANCOVA was conducted. The independent variable, Group, included two levels (experimental group, control group). The dependent variable was students' FSCS in the posttest and the covariate was students' FSCS in the pretest. A preliminary analysis that evaluated the homogeneity of regression slopes assumption indicated that the relationship between the covariate and the dependent variable did not differ significantly as a function of the independent variable [F(1, 47) = 1.36, MSE = 0.043, p = 0.249, eta-squared = 0.028]. The ANCOVA was significant [F(1, 48) = 18.36, MSE = 0.043, p < 0.001]. The strength of the relationship between the Group factor and the dependent variable was strong, as assessed by eta-squared, with the Group factor accounting for 28% of the variance of the dependent variable, holding constant students' FSCS in the pretest.

The means of students' FSCS scores adjusted for initial differences (see Table 4), were ordered as expected across the two groups. The experimental group had the largest adjusted mean (3.91) and the control group had a smaller adjusted mean (3.65). Follow-up tests were conducted to evaluate pairwise differences among these adjusted means. The Holm's sequential Bonferroni procedure was used to control for Type I error across the two pairwise comparisons. There were significant differences in the adjusted means between the experimental group and the control group (MD = 0.26; 95% CI: 0.14 to 0.38, p < 0.001). Thus, after having completed the project in parallel with attending the PE course, Group 1 students had more correct nutritional criteria than Group 2 students, who had only attended the PE course.

Table 5. Group 1 students' satisfaction from the project (N = 25).

I am satisfied with ...	M	SD
the topics that have been addressed during the project	4.28	0.54
the way nutrition was approached during the project	4.36	0.49
the way PA and exercise were approached during the project	4.64	0.49
the way ICT was used in the project	4.60	0.50
working with my teammates during the project	4.48	0.51
the way the teacher in charge coordinated the project	4.56	0.51

M = Mean, SD = Standard Deviation

Students' Evaluation of the Project

Table 5 shows descriptive statistics of the answers of Group 1 students to the six items of the question that elicited their satisfaction with the project, after having participated in it. As deduced from Table 5, the means of all items were well above 4, which suggests that the students were highly satisfied with the project. As inferred from Table 5, they particularly appreciated the ways in which: PA and exercise were approached, ICT was used, and the teacher in charge had coordinated the project (given that all respective means exceeded 4.5). As the coordinating teacher observed, the students showed great enthusiasm, interest in and satisfaction with competition while interacting with the various exergames or while using PA monitoring apps in the yard.

Table 6 shows descriptive statistics of Group 1 students' answers to the two questions regarding the helpfulness of the knowledge that they had acquired within the framework of the project during the quarantine period. Specifically, Table 6 shows the frequencies and percentages of the students who answered: a) "strongly agree" or "agree" (collectively presented in column "Agreement" of Table 6), b) neutral (column "Neutral answer"), and c)"strongly disagree" or "disagree" (collectively presented in column "Disagreement"), as well as the means and standard deviations of the answers. As inferred from Table 6, most students consider that what they had learned regarding PA and exercise helped them during the quarantine. The helpfulness of the nutritional knowledge that they had gained from the project was perceived to be less. Nevertheless, more students agreed than disagreed that it helped them during the quarantine.

Table 6. Group 1 students' perceived helpfulness of the knowledge gained from the project during the quarantine (N = 25).

	Agreement		Neutralanswer		Disagreement			
What I had learned within the framework of the project ...	f	%	f	%	f	%	M	SD
regarding PA and exercise helped me during the quarantine	16	64	6	24	3	12	3.68	1.03
regarding nutrition helped me during the quarantine	10	40	9	36	6	24	3.16	0.94

f = Frequency, M = Mean, SD = Standard Deviation

Of the 16 students that expressed agreement in the first semi-closed question (that addressed PA and exercise), 13 justified their ratings, as follows: 8 stated that they had the chance to use or to experiment with what they had learned in the project (e.g., "*Experimentation with what I had been taught*", "*The apps helped me quite a lot and I am still using them now"*), while 5 focused on walking (e.g., "*I walked more*", "*I combined walking (code 6) with the app on my smartphone*", "*I made many steps during the quarantine*"). Of the 6 students that gave a neutral rating, only 2 justified their rating giving answers such as "*I was home all day*", as did the 2 students that justified their disagreement (e.g., "*I didn't get out of the house*").

Of the 10 students that expressed agreement in the second semi-closed question (that addressed nutrition), 9 justified their ratings, as follows: 4 stated that they had used or were still using the Yazio app (e.g., "*I am still learning Yazio together with my mother*"), 4 answered that they paid attention to their nutrition (e.g., "*I paid attention to my diet and calories*", "*I consumed less unhealthy food*"), whereas a girl admitted that "*I paid more attention to my diet during the quarantine than I do now*". Of the 9 students that gave a neutral response, only 3 justified their responses, however showing that the project did have some impact on them too (e.g., "*I experimented with Yazio*", "*I paid more attention to what I was eating*"). Of the 6 students that expressed disagreement, only 3 justified their ratings giving answers such as: "*I didn't want to deal with anything during the quarantine*".

The responses of the 23 students that answered the open-ended question (regarding the most important thing that they had learned from the project) were as follows. Seven students referred to nutrition: of them, 4 mentioned the apps for nutrition monitoring (e.g., "*That there are apps for nutrition*") and 3 the fact that they had learned to eat right (e.g., *"Eat right and count my calories"*). Five students focused on PA and/or exercise: of them, 3 mentioning the PA apps (e.g., "*That exercise and diet were combined in PA apps*") and 2 the fact that they had learned to walk (e.g., "*To walk*"). Five students mentioned exergames (e.g., "*To combine playing games with exercise*"). Another 6 students referred to various aspects of the project that had seemed novel to them (e.g., "*To do a course through the computer with Edmodo*", "*That a course can be done in a pleasant way*", "*To collaborate*").

Discussion and Conclusions

This study was aimed at the investigation of the impact of a year-long, school student-centered PE project, in which apps for PA and nutrition monitoring, exergames and the Edmodo online social learning platform were utilized, on secondary school students' PA, sedentary behavior and food selection criteria. Students' use of mobile devices for PA and nutrition monitoring, perceived helpfulness of PA monitoring apps and evaluation of the project were also studied. The study followed a pretest/posttest design involving an experimental group of students that participated in the project in parallel to attending the regular PE course and a control group of students that only attended the regular PE course. During a two-month quarantine, because of the COVID 19 epidemic, all project activities were coordinated through the aforementioned online platform.

As deduced from the results of the study, the project had a positive impact on students' use of mobile devices for PA and nutrition monitoring. Specifically, although in both groups of students, the quasi-universal use of smartphones and the rather limited used of smartwatches remained stable over the duration of the study, the use of wrist-worn activity trackers as well as the use of apps for PA monitoring and for nutrition monitoring increased more in the experimental group than in the control group. Furthermore, after the completion of the project, the perceptions that PA monitoring apps can help them get more physically active were strengthened more in the experimental group students than in the control group students. Thus, the project combined with the PE course was more successful than the PE course alone in fortifying students' beliefs that PA monitoring apps are useful and relevant to them. These encouraging findings corroborate the assertion previously expressed by various researchers (e.g., Martin at al., 2012; Abraham & Michie, 2008; Duncan et al., 2014; Turner-mcgrievy et al., 2013) that young people in general and adolescents in particular are generally positive towards PA and nutrition monitoring apps and willing to utilize them. Furthermore, the findings allow the assumption that the students that participated in the year-long project will continue to use such apps in their everyday lives.

The quarantine did not significantly affect the PA levels and sedentary behavior of the experimental group, although it did yield a significant decrease in PA accompanied by a significant increase in sedentary time in the control group. Thus, although the project did not manage to significantly increase PA and decrease sedentary time in the experimental group (which is not surprising, given that the posttest took place after two months of quarantine and one month of under-functioning of the schools because of COVID 19), nevertheless, it did have a positive impact on the experimental group students, who had they not participated in it, would probably have been less physically active and more sedentary. These findings seem to support those of prior studies (e.g., Ahtinen et al., 2010; Consolvo et al., 2008; Lin et al., 2006), which have suggested that the use of PA monitoring apps can motivate adolescents to remain physically active inside and outside school.

As far as students' nutritional criteria are concerned, the results suggest that the project combined with the PE course was more successful than the PE course alone in improving these criteria towards eating more healthily. This finding corroborates the important role that the use of nutrition monitoring apps can play in forging users' nutritional criteria, which has already been highlighted in the research literature (e.g., Paramastri et al., 2020), and which has been attributed to the fact that nutrition monitoring apps offer continuous, detailed feedback to the user regarding the nutrients and the caloric value of foods.

The experimental group students were highly satisfied with the project and especially appreciated the innovative way in which PA and exercise were approached during it as well as the way in which ICT was utilized. They also considered that what they had learned during the project about nutrition and especially about PA and exercise helped them during the quarantine. These findings indicate that student-centered, ICT-based PE projects, such as the one presented in this study, are well-received and appreciated by students, and should, thus, be more often incorporated into PE curricula.

This study had certain limitations, that should be mentioned and which require that the results of the study be interpreted with caution. Firstly, the sample was rather small and the experimental group consisted of students who were already interested in PA and dietary issues given that they had already opted for the relevant, aforementioned school project. Secondly, measurements were based only on self-report instruments. Although self-reported data about PA cannot be used to accurately quantify absolute amounts of PA, they can serve to evaluate relative differences in PA levels over time and among subgroups (Colley et al., 2019). Thirdly, there was an interruption in the face-to-face project sessions and in the regular PE course because of the quarantine, during which all organized, group exercise activities had to be suspended and to be transferred online. Daum (2020) argues that online PE bears the same responsibilities as traditional programs with respect to delivering equitable, developmentally appropriate, and equally accessible learning experiences. However, web-based PE is still far from satisfactory. Thus, the results obtained would probably have been different, if the quarantine had not occurred.

The above-mentioned limitations should be addressed in future research endeavors. Specifically, a similar study in a larger sample of randomly selected students, using both self-report and objective instruments (e.g., measurements of students' PA levels through accelerometers), is a prominent topic in the authors' research agenda. Furthermore, the extent to which students continue to use PA and nutrition monitoring apps in their everyday lives after having participated in such a project deserves to be studied too.

This study has provided a concrete example of how the active, student-centered approach of project-based learning coupled with ICT (mobile applications, a social learning platform and exergames) can serve the purposes of the PE course towards motivating students to engage in PA and healthy nutrition, both inside and outside school. The study can offer useful guidance to researchers in the areas of PE and ICT in education as well as to PE educators and school administrators.

Disclosure statement

No potential conflict of interest was reported by the author(s).

References

Abraham, C., & Michie, S. (2008). A taxonomy of behavior change techniques used in interventions. *American Psychological Association*, *27*(3), 379–387. https://doi.org/10.1037/0278-6133.27.3.379 .

Ahtinen, A., Huuskonen, P., & Häkkilä, J. (2010). Let's all get up and walk to the North Pole. In *Proceedings of the 6th Nordic Conference on Human-Computer Interaction "Extending Boundaries" – NordiCHI'10* (3–12). New York: ACM Press.

Blumenfeld, P., Soloway, E., Marx, R., Krajcik, J., Guzdial, M., & Palincsar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational Psychologist*, *26*(3/4), 369–398. https://doi.org/10.1080/00461520.1991.9653139

Colley, R. C., Butler, G., Garriguet, D., Prince, S. A., & Roberts, K. C. (2019). Comparison of self-reported and accelerometer-measured physical activity among Canadian youth. *Health Reports*, *30*(7), 3–12. https://doi.org/10.25318/82-003-x201900700001-eng

Consolvo, S., Klasnja, P., McDonald, D., Avrahami, D., Froehlich, J., LeGrand, L., Libby, R., Mosher, K., & Landay, J. (2008). Flowers or a robot army? Encouraging awareness & activity with personal, mobile displays. In *Proceedings of the 10th International Conference on Ubiquitous Computing – UbiComp '08* (54–63). New York: ACM Press.

Coughlin, S. S., Whitehead, M., Sheats, J. Q., Mastromonico, J., Hardy, D., & Smith, S. (2015). Smartphone Applications for Promoting Healthy Diet and Nutrition: A Literature Review. *Jacobs Journal of Food and Nutrition*, *2*(3), 021. https://pubmed.ncbi.nlm.nih.gov/26819969/

Cox, D., & Meaney, K. S. (2018). Lights, camera, project-based learning! *Strategies*, *31*(1), 23–29. https://doi.org/10.1080/08924562.2017.1394240

Coyne, J., Hollas, T., & Potter, J. (2016). Jumping in: Redefining teaching and learning in physical education through project-based learning. *Strategies*, *29*(1), 43–46. https://doi.org/10.1080/08924562.2016.1113910

Daum, D. N. (2020). Thinking about hybrid or online learning in physical education? Start here! *Journal of Physical Education, Recreation & Dance*, *91*(1), 42–44. https://doi.org/10.1080/07303084.2020.1683387

Davies, C. A., Spence, J. C., Vandelanotte, C., Caperchione, C., & Mummery, K. (2012). Meta-analysis of Internet-delivered interventions to increase physical activity levels. *International Journal of Behavioral Nutrition and Physical Activity*, 9(52). https://doi.org/10.1186/1479-5868-9-52

Del Rio, N., Gonzalez, C. S. G., Gonzalez, R. M., Adelantado, V. N., Delgado, P. T., & Fleitas, Y. B. (2018). Gamified educational programme for childhood obesity. In *Proceedings of IEEE Global Engineering Education Conference (EDUCON)* IEEE & Curran Associates Inc (pp. 1962–1968). Santa Cruz de Tenerife, Spain.

Duncan, M., Vandelanotte, C., Kolt, G., Rosenkranz, R., Caperchione, C., George, E., Ding, H., Hooker, C., Karunanithi, M., Maeder, A., Noakes, M., Taque, R., Taylor, P., Viljoen, P., & Mummery, K. (2014). Effectiveness of a web- and mobile phone-based intervention to promote physical activity and healthy eating in middle-aged males: Randomized controlled trial of the ManUp study. *Journal of Medical Internet Research*, *16*(6), e136. https://doi.org/10.2196/jmir.3107

Forde, C. (n.d.). Scoring the International Physical Activity Questionnaire (IPAQ).Trinity College Dublin. https://ugc.futurelearn.com/uploads/files/bc/c5/bcc53b14-ec1e-4d90-88e3-1568682f32ae/IPAQ_PDF.pdf

Gall, M., Borg, W., & Gall, J. (1996). *Educational research*. Longman.

Garde, A., Chowdhury, M., Rollinson, A., Johnson, M., Prescod, P., Chanoine, J. P., Ansermino, J. M., & Dumont, G. A. (2018). A multi-week assessment of a mobile exergame intervention in an elementary school. *Games for Health Journal*, *7*(1), 43–50. https://doi.org/10.1089/g4h.2017.0023

Howard, J. (2002). Technology-enhanced project-based learning in teacher education: Addressing the goals of transfer. *Journal of Technology and Teacher Education*, *10*(3), 343–364. https://www.learntechlib.org/primary/p/15139/

Howell, R., & Mordini, R. (2003). The project method increases student learning and interest. *Tech Directions*, *62*(8), 31–34.

IPAQ (n.d.). International Physical Activity Questionnaire. https://sites.google.com/site/theipaq/questionnaire_links

Lin, J., Mamykina, L., Lindtner, S., Delajoux, G., & Strub, H. (2006). 4206 (UbiComp 2006: Ubiquitous Computing), Fish'n'Steps: Encouraging physical activity with an interactive computer game. Dourish , P., &Friday, A.(Eds.). In *Lecture Notes in Computer Science* (pp. 261–278). Springer.

Lox, C., Ginis, K., & Petruzzello, S. (2017). *The psychology of exercise: Integrating theory and practice* (4th Ed. ed.). Holcomb Hathaway Publishers.

Martin, C., Correa, J., Han, H., Allen, R., Rood, J., Champagne, C., Gunturk, B., & Bray, G. (2012). Validity of the Remote Food Photography Method (RFPM) for estimating energy and nutrient intake in near real-time. *Obesity (Silver Spring)*, *20*(4), 891–899. https://doi.org/10.1038/oby.2011.344

Martin, N., Ameluxen-Coleman, E., & Heinrichs, D. (2015). Innovative ways to use modern technology to enhance, rather than hinder, physical activity among youth. *Journal of Physical Education, Recreation & Dance*, *86*(4), 46–53. https://doi.org/10.1080/07303084.2015.1009205

NASPE. (2009). *Appropriate use of instructional technology in physical education*. National Association for Sport and Physical Education. http://getfitarkansas.pbworks.com/w/file/fetch/62316594/Appropriate-Use-of-Instructional-Technology-in-PE-2009-2.pdf

Pallant, J. (2001). *SPSS survival manual*. Open University Press.

Papadimas, A. (2017). *Eating habits, knowledge and behavior of secondary school students towards healthy eating and exercise in the region of Epirus*. University of Peloponnese. (in Greek.

Papathanasiou, G., Georgoudis, G., Papandreou, M., Spyropoulos, P., Georgakopoulos, D., Kalfakakou, V., & Evangelou, A. (2009). Reliability measures of the short International Physical Activity Questionnaire (IPAQ) in Greek young adults. *Hellenic Journal of Cardiology*, *50*(4), 283–294. https://www.hellenicjcardiol.org/archive/full_text/2009/4/2009_4_283.pdf

Paramastri, R., Pratama, S. A., Ho, D. K. N., Purnamsari, S. D., Mohamed, A. Z., & Galvin, C. J. (2020). Use of mobile applications to improve nutrition behaviour: A systematic review. *Computer Methods and Programs in Biomedicine*, *192* (105459), 2020. https://doi.org/10.1016/j.cmpb.2020.105459

Park, Y. (2015). My whole world's in my palm! The second-level divide of teenagers' mobile use and skill. *New Media & Society*, *17*(6), 977–995. https://doi.org/10.1177/1461444813520302

Schwarz, A., DeSmet, A., Cardon, G., Chastin, S., Costa, R., Grilo, A., Ferri, J., Domenech, J., & Stragier, J. (2018). Mobile exergaming in adolescents' everyday life - contextual design of where, when, with whom, and how: The SmartLife case. *International Journal of Environmental Research and Public Health*, *15*(5), 5. https://doi.org/10.3390/ijerph15050835

Srivastav, P., Broadbent, S., Vaishali, K., Nayak, B., & Bhat, H. V. (2020). Prevention of adolescent obesity: The global picture and an Indian perspective. *Diabetes and Metabolic Syndrome: Clinical Research and Reviews*, *14*(5), 1195–1204. https://doi.org/10.1016/j.dsx.2020.06.039

Story, M., Sherwood, N., Himes, J., Davis, M., Jacobs, D., Cartwright, Y., Smyth, M., & Rochon, J. (2003). An after-school obesity prevention program for African-American girls: The Minnesota GEMS pilot study. *Ethnicity & Disease*, *13*(1 Suppl.1), 54–64. https://pubmed.ncbi.nlm.nih.gov/12713211/

Treadwell, S. (2018). Making the case for project-based learning (PBL) in physical education. *Journal of Physical Education, Recreation & Dance*, *89*(1), 5–6. https://doi.org/10.1080/07303084.2018.1393225

Turner-mcgrievy, G., Beets, M., Moore, J., Barr-Anderson, D., & Tate, D. (2013). Comparison of traditional versus mobile app self-monitoring of physical activity and dietary intake among overweight adults participating in an mHealth weight loss program. *Journal of the American Medical Informatics Association*, *20*(3), 513–518. https://doi.org/10.1136/amiajnl-2012-001510

Web 2.0 Tools for Teachers (2012). Edmodo. https://sites.google.com/site/kratzwilkesfinalproject/home/edmondo

WHO. (2019). *The challenge of obesity: Quick statistics*. World Health Organization. https://www.euro.who.int/en/health-topics/noncommunicable-diseases/obesity/data-and-statistics

APPENDIX: MOBILE APPLICATIONS

(1) Apple Health (https://www.apple.com/ios/health/)
(2) Endomondo (https://www.endomondo.com/)
(3) Fitpal (https://play.google.com/store/apps/details?id=com.sanyi.fitness,https://apps.apple.com/us/app/fitpal-gym-home-workout/id1297133978)
(4) Freeletics (https://www.freeletics.com/en/)
(5) Google Fit (https://www.google.com/fit/)
(6) Google Health (https://health.google/)
(7) Huami Mi Fit (https://play.google.com/store/apps/details?id=com.xiaomi.hm.health&hl, https://apps.apple.com/gr/app/mi-fit/id938688461?l)
(8) MyFitnessPal (https://www.myfitnesspal.com/)
(9) Runtastic Adidas Running (https://www.runtastic.com/)
(10) Samsung Health (https://www.samsung.com/gr/apps/samsung-health/)
(11) Sony Lifelog (https://sonyreconsidered.com/sony-mobile-lifelog-app-redesigned-with-new-ui-3-0-a-0-12-e368d1f6f9c2)
(12) Strava (https://www.strava.com/)
(13) Yazio (https://play.google.com/store/apps/details?id=com.yazio.android&hl=el, https://apps.apple.com/gr/app/yazio-θερμιδομετρητής/id946099227?l=el)
(14) Titroo (https://www.titroo.gr/)
(15) Diet Coaching (http://diet-coaching.gr/index-gr.html)
(16) Hydration Calculator (https://play.google.com/store/apps/details?id=com.uk.orsapp, https://apps.apple.com/us/app/o-r-s-hydration-calculator/id1092077898)
(17) Runkeeper (https://play.google.com/store/apps/details?id=com.fitnesskeeper.runkeeper.pro, https://apps.apple.com/us/app/runkeeper-gps-running-tracker/id300235330)