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Original Article

"STAR WARS: The first Jedi" Gamification Program: Use of a Mobile App to Improve Body Composition in College Students

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Abstract

Background: There is a need to promote initiatives toward reaching more active and healthier lifestyles. Gamification has emerged among teachers as a powerful teaching strategy that favors students' motivation and behavioral change by applying game elements in nongame contexts.
Purpose: To examine the effects of a 14-week gamification-based teaching program, including the use of a game-based mobile app on body composition in college students.
Materials and Methods: One hundred twelve college students (21.22 ± 2.55 years) were assigned to a gamification-based group or a control group. College students from the intervention group participated in a gamification program under the narrative of ''STAR WARS'' and had a mobile app with a countdown timer. They had to meet physical activity recommendations to gain lifetime (i.e., sum time to the countdown). A portable eight-polar bioelectrical impedance analysis was used to obtain body composition outcomes; height (cm) was measured with a stadiometer; and waist circumference (cm) was measured using a metric tape. Body mass index (BMI), muscle mass index, fat mass index, and body fat percentage were computed.
Results: Participants from the gamification program reported a significantly lower BMI, waist circumference, fat mass index and body fat percentage after the intervention, in comparison with the control group, indicated by an effect size ranging from –0.23 to –0.11 (all $P \leq 0.043$).
Conclusion: Gamification and the use of interactive mobile app are powerful teaching strategies in higher education to motivate students toward healthier lifestyles that lead to body composition benefits.

Keywords: Fatness, Gamification, Innovation, Mobile app, Motivation, University

Introduction

Physical inactivity figures are alarming worldwide.[1] More than a quarter of the world's adult population (28%; 1.4 billion adults) do not meet the public health guidelines for recommended levels of health-related physical activity.[2] Increasing physical activity levels could be essential to prevent from several health diseases, for instance from those related to excess fat mass accumulation.[3,4] A steady increase in fat mass levels from 22% to 35% has been documented during the transition period between adolescence and adulthood (i.e., 18 and 25 years).[5,6] During the university stage of education, significant lifestyle changes appear that may lead to the acquisition of unhealthy habits among students: more academic stress and pressure, longer times sitting and studying, insufficient sleep times, or lack of motivation to exercise.[7,8] Given the negative impact on health, societal, and economical systems of increased levels of physical inactivity, there is an urgent need to promote initiatives among young adults toward reaching more active and healthier lifestyles.

Education is a powerful tool to promote healthier lifestyle behaviors among students. The use of specific teaching

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methodologies has a differential impact on students' emotions and cognitive compromise, both crucial for their engagement and participation.[9] Particularly, motivation and compromise are two main factors that any teacher should take into consideration for the completion of tasks and for the promotion of a specific behavioral change (e.g., a more physically active lifestyle) among their students.[10] A powerful way of promoting physical activity is through motivational teaching methodologies that fight back the lack of implication among students, making them protagonist of their learning process. In line with this, gamification[11] has gained interest among teachers as a powerful pedagogical strategy that favors students' motivation and engagement by applying game mechanics and dynamics in nongame contexts such as the educational.[12,13]

Findings from recent lifestyle interventions emphasize the potential to implement these gamification-based methodologies through mobile phone applications (apps) because of their attractiveness, wide accessibility, and potential to increase physical activity levels.[14,15] Also, mobile phone apps allow to take any game beyond someone's home into his or her everyday life, becoming therefore a powerful tool to modify lifestyle behaviors.[16] Therefore, implementing game-based elements in the educational setting using gamification and mobile phone apps can be very powerful to promote lifestyle behaviors related to physical activity practice among students.

Gamification's main characteristic resides in designing a narrative that can be created from the beginning or adapted from an existing one (e.g., STAR WARS), as well as in making students the protagonists of this narrative.[17,18] Thus, every educational challenge is built under the narrative (e.g., to do *interplanetary trips*: students had to run or cycle a specific number of days). Overall, any gamification program should meet the following aspects[18]: (1) to intrigue the student, generating curiosity before and during the experience[19,20]; (2) to immerse the students in the adventure and take them out of their comfort zone[21]; (3) to fulfil an ambitioned and long-term objective (e.g., to improve body composition) by influencing students' intrinsic motivation[17,22]; (4) to generate an attractive, challenging objective that moves students to action[19]; (5) to propose educational challenges adapted to students' competences[17,23]; (6) to act as a guide, making students the real protagonists of the adventure[21]; and (7) to take care of small details in the narrative so that it has internal credibility for the students and they feel coherently integrated into it.[17,21]

While several gamification-based programs have been implemented in elementary and high schools with a significant impact on students' body composition,[24,25] there is, to the best of our knowledge, no study addressing this specific issue in higher education. Even college students from university degrees related with Physical Education have presented certain prevalence of fat mass accumulation. Considering their academic profile and professional future, they should care even more about having a healthier body composition. Therefore, the aim of the present study was to analyze the effects of a 14-week gamification-based teaching program, under a narrative based on ''STAR WARS'' saga of movies, on body composition in college students from the degree in Physical Education and Sport Sciences.

Materials and Methods

Study design and participants

The ''STAR WARS: The first Jedi'' program was a 14-week gamification-based teaching intervention carried out in college students to test its effect on body composition. A total of 112 college students (21.22 ± 2.55 years old; 74% males) participated as convenience sample of the present quasi-experimental cluster randomized controlled trial. The sample was distributed among two different class groups that participated in the same academic course from the degree of Physical Education and Sport Sciences at the University of Granada (Granada, Spain). Two different teachers were randomly assigned to each group (i.e., intervention and control group). The groups were formed each by 56 college students; college students from the intervention group (20.69 ± 1.41 years old; 71% males) participated in the ''STAR WARS: The first Jedi'' gamification-based teaching program, while college students from the control group (21.75 ± 3.25 years old; 77% males) followed a traditional teaching methodology.

Study purpose and main characteristics were informed to all participants and a written informed consent was signed by them to participate. The study protocol was approved by the Human Research Ethics Committee of the University of Granada (approval number: 421/CEIH/2017).

The "STAR WARS: The first Jedi" gamification-based intervention

''STAR WARS: The first Jedi'' program was set in the ''STAR WARS'' saga of films. The narrative of the program set the students under the role of *padawans*, who had to overcome several physical and learning challenges during 14 weeks to demonstrate that they were prepared to become *Jedi* and take part in the *Rebel Alliance* (i.e., become future Physical Education teachers). In the narrative, *Jedi Master Yoda* is kidnapped by the *Galactic Empire*, so the *padawans* are recruited by the *Jedi Council* as the only ones capable to liberate *Master Yoda* and the *galaxy*. The teacher played the role of *Master Guidoogway* (an old friend of *Yoda*) and had the responsibility to provide guidance to all college students (*padawans*) throughout their *Jedi* training (i.e., physical activity and learning challenges). For that purpose, all students (*padawans*) were installed a mobile phone app (Fig. 1) described in detail elsewhere[26] and designed for the present study under ''STAR WARS'' atmosphere. This app included a countdown timer that determined how well the *padawans* managed their time during their *Jedi* training (as future Physical Education teachers). Thus, the students had to avoid that their counter reached zero.

In those cases when the counter reached 0, the *padawans* did not complete their training successfully, succumbing therefore to the *dark side of the Force* (i.e., representing the comfort, apathy, and conformism of teachers). At the end of the 14-week program, when the *padawans* (students) had completed their training, they obtained the rank of *Jedi* and took part in the *Rebel Alliance* that liberated *Yoda*.

During the 14 weeks that the program lasted, the *padawans* had to complete their training to become those to whom ''*the Force is strong with*.'' To motivate them, we set a competitive atmosphere by the implementation of

FIG. 1. Visual interface and menu with the life countdown of ''STAR WARS: The first Jedi'' app. ''*Dias*'' = Days; ''*Horas*'' = Hours; ''*Minutos*'' = Minutes; ''*Segundos*'' = Seconds; ''*Viajes*'' = Travels; ''*Reto Ciclismo*'' = Cycling challenge; ''*Reto Running*'' = Running challenge; ''*Velocidad*'' = Speed; ''*Ritmo*'' = Pace; ''*Duración*'' = Duration; ''*Rango*'' = Rank/Category; ''*Clasificación Mensual Individual*'' = Monthly individual ranking.

midiclorianos as the points they could get when they overcome their physical activity and learning challenges. The gamification strategy used under the ''STAR WARS'' atmosphere and the system of points had the aim of increasing motivation among students toward a change in their usual physical activity patterns. The *padawans*, with the aim of convincing other *planets* to join the *Rebel Alliance* and build a better and healthier future, had to do *interplanetary trips*. In other words, to do these *interplanetary trips* they could choose between running or cycling 3–5 days/week during at least 150 min/week or 75 min/week to meet the moderate or vigorous physical activity intensity recommendations.[2] They were asked to upload their daily running or cycling physical activity registers into Runtastic app (www.runtastic.com)[27] to sum time to their countdown timer and get closer to the *bright side of the Force.*

As we can see in Figure 1, *padawans* were asked to upload their Runtastic registers into the app under the ''*Interplanetary trips*'' section (see ''*Viajes*'' in the figure). To meet the physical activity recommendations previously described, running pace had to be >5 to 8.4 min/km and cycling pace had to be >16 to 25.6 km/h as previously stablished.[28] Therefore, at the end of every week, *padawans* who did 3 to 5 *interplanetary trips* (i.e., registered 3 to 5 valid physical activity sessions into the app) were awarded with a lifetime bonus of 2 days and a half summing up to their countdown timer. Another motivational resource from the gamification-based approach was the classification established among students. All *padawans* were able to check their rank (i.e., *Padawan*, *Jedi Knight*, *Commander of the Rebel Alliance*, and *Jedi Master*) based on their *midiclorianos* level and the number of physical activity and learning challenges overcome (see ''*Rank*'' in Fig. 1). The top 10 *padawans* of the ranking had a protagonist role on the final battle against the *Siths* (*dark side of the Force*) already as *Jedi Masters*.

The control group participated in a traditional methodology course group without the gamification and motivational approach and without the requirement of meeting physical activity recommendations. This group was asked to keep their usual lifestyle during the 14 weeks of the program.

Body composition

Body weight (kg), muscle mass (kg), fat mass (kg), and body fat percentage (%) were determined by a portable eight-polar bioelectrical impedance analysis (InBody R20, Biospace, Seoul, Korea). Previous research has reported accurate estimates of total and appendicular body composition from this bioelectrical impedance analysis.[29] Height (cm) was measured with a stadiometer (Seca 22, Hamburg, Germany). Waist circumference (cm) was measured twice using a metric tape (Harpenden anthropometric tape; Holtain Ltd, Wales, United Kingdom) at the middle point between the ribs and iliac crest and the average of both measures was computed. All body composition measurements were performed always by the same trained evaluator and with participants barefoot and wearing light underwear. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). Muscle mass index was computed as muscle mass (kg) divided by height squared (m^2), and fat mass index by dividing participant's fat mass (kg) by their height squared (m^2).

Statistical analyses

The characteristics of the study sample are presented as mean and standard deviation (SD) for continuous variables, and frequency and percentage for categorical variables. To analyze the differences at baseline between the intervention and control groups, we used one-way analysis of variance (ANOVA) for continuous variables and chi-squared test for categorical variables. SPSS software (version 25.0; IBM Corporation) was used for the performance of statistical analyses and Prism (version 7.0, GraphPad, San Diego, CA, USA) for the graphs design.

To study the effects of the ''STAR WARS: The first Jedi'' program on body composition outcomes, we used analysis of covariance (ANCOVA), and each model included: the group (i.e., intervention vs. control) as fixed factor, the post-intervention body composition outcome as dependent variable, and the baseline body composition outcome as covariate. To compare the effects of the program on outcomes of different nature (e.g., BMI, muscle mass index, waist circumference, etc.), we computed the *z*-score of each body composition outcome at baseline using the following equation: (*individual raw value at baseline – baseline mean*)/ *baseline SD*; and at postintervention (i.e., also called *z*-score of change) using the following equation: *(postintervention individual raw value – baseline mean)/baseline SD*. To compute and interpret the *z*-score of change, we based on a major randomized controlled trial that also used this score to represent the effects of a program.[30] The computation of the *z*-score of change indicates how many SDs the outcomes at postintervention changed with respect to the baseline mean and SD, reflecting therefore the standardized effect size (i.e., threshold *z*-score of 0.2, 0.5, and 0.8 as small, medium, and large effect sizes, respectively).[30]

For example, a –0.23 *z*-score in waist circumference for the intervention group means that the waist circumference was 0.23 SDs lower at postintervention than at baseline for this group (i.e., positive intervention effect). The ANCOVA analyses reported herein include both raw and *z*-score outcomes. Although we used the classic *P*-value threshold <0.05 to report significant effects, we also performed multiple comparison corrections using the Benjamini–Hochberg method ($q < 0.05$)[31] to investigate whether the effects remained significant after the adjustment.

An exploratory analysis was performed to analyze the moderating role of sex on the effects of the intervention. For this purpose, we ran the same ANCOVA analysis described before but, in this case, we stratified the analyses by subgroups of populations according to sex (males vs. females). First, we visually inspected the effect sizes by sex and determined whether the gamification program influenced males and females differently. Second, we run ANCOVA models to test whether the interaction term *sex* × *group* was significant.

Results

The intervention and control group showed significant differences at baseline mean for age (–1.06 years; $P = 0.028$), BMI (–0.93 kg/m^2; $P = 0.048$), and waist circumference (–2.72 cm; $P = 0.042$) (Table 1). However, these baseline differences did not remain significant after correction for multiple comparisons.

Figure 2 shows the main effects of the ''STAR WARS: The first Jedi'' program on *z*-score postintervention body composition outcomes. Also, Table 2 presents the effects of the program on both raw and *z*-score postintervention outcomes for the intervention and control group, separately. The ''STAR WARS: The first Jedi'' program had a higher significant positive effect on BMI, waist circumference, fat mass index, and body fat percentage for the intervention group in comparison with the control group (all $P < 0.05$; Table 2 and Fig. 2). The largest effect size from baseline to postintervention was observed on waist circumference, with the intervention group showing a waist circumference –0.23 SDs ($P < 0.001$) lower than the control group at post-intervention. The intervention group, in comparison with the control group, also presented significantly lower BMI (–0.11 SDs, $P = 0.043$), fat mass index (–0.18 SDs, $P = 0.008$), and body fat percentage (–0.20 SDs, $P = 0.005$) at postintervention with respect to the baseline value. No significant effect was observed for muscle mass index (0.08 SDs, $P = 0.282$). After correction for multiple comparisons, all positive effects observed on body composition outcomes for the intervention group remained significant.

In exploratory analyses (Supplementary Fig. S1), we tested the moderator role of sex over the effects of the intervention and observed that the ''STAR WARS: The first Jedi'' program was more effective in males than females for fat mass index and body fat percentage (–0.26 and –0.23 SDs

Table 1. Descriptive Baseline Characteristics of the Participants of the STAR WARS Program

	All		Intervention group		Control group		
	N	Mean ± SD	N	Mean ± SD	N	Mean ± SD	P
Age (years)	112	21.22 ± 2.55	56	20.69 ± 1.41	56	21.75 ± 3.25	**0.028**
Sex	112		56		56		0.667
Boys (*n* %)	83	74%	40	71%	43	77%	
Girls (*n* %)	29	26%	16	29%	13	23%	
Weight (kg)	112	70.57 ± 10.84	56	68.7 ± 10.78	56	72.44 ± 10.67	0.068
Height (cm)	112	172.95 ± 8.89	56	172.23 ± 9.41	56	173.66 ± 8.35	0.394
BMI (kg/m^2)	112	23.50 ± 2.48	56	23.04 ± 2.14	56	23.97 ± 2.72	**0.048**
Waist circumference (cm)	112	75.61 ± 7.03	56	74.23 ± 6.43	56	76.95 ± 7.37	**0.042**
Muscle mass (kg)	112	31.22 ± 6.12	56	30.4 ± 6.42	56	32.03 ± 5.74	0.158
Muscle mass index (kg/m^2)	112	10.34 ± 1.32	56	10.14 ± 1.35	56	10.54 ± 1.28	0.104
Fat mass (kg)	111	15.10 ± 5.26	56	14.32 ± 4.2	55	15.89 ± 6.09	0.117
Fat mass index (kg/m^2)	111	5.11 ± 1.92	56	4.89 ± 1.58	55	5.35 ± 2.21	0.210
Body fat percentage (%)	112	21.25 ± 6.87	56	20.92 ± 6.12	56	21.58 ± 7.58	0.616

Values are expressed as means ± SDs, unless otherwise indicated. Baseline differences between intervention and control groups were analyzed by one-way analysis of variance (ANOVA) for continuous variables and by chi-squared tests for categorical variables. Statistically significant baseline differences between intervention and control group at $P < 0.05$ are shown in bold. However, significant differences dissapeared after correction for multiple comparisons using the Benjamini and Hochberg[31] method ($q < 0.05$).

BMI, body mass index; SD, standard deviation.

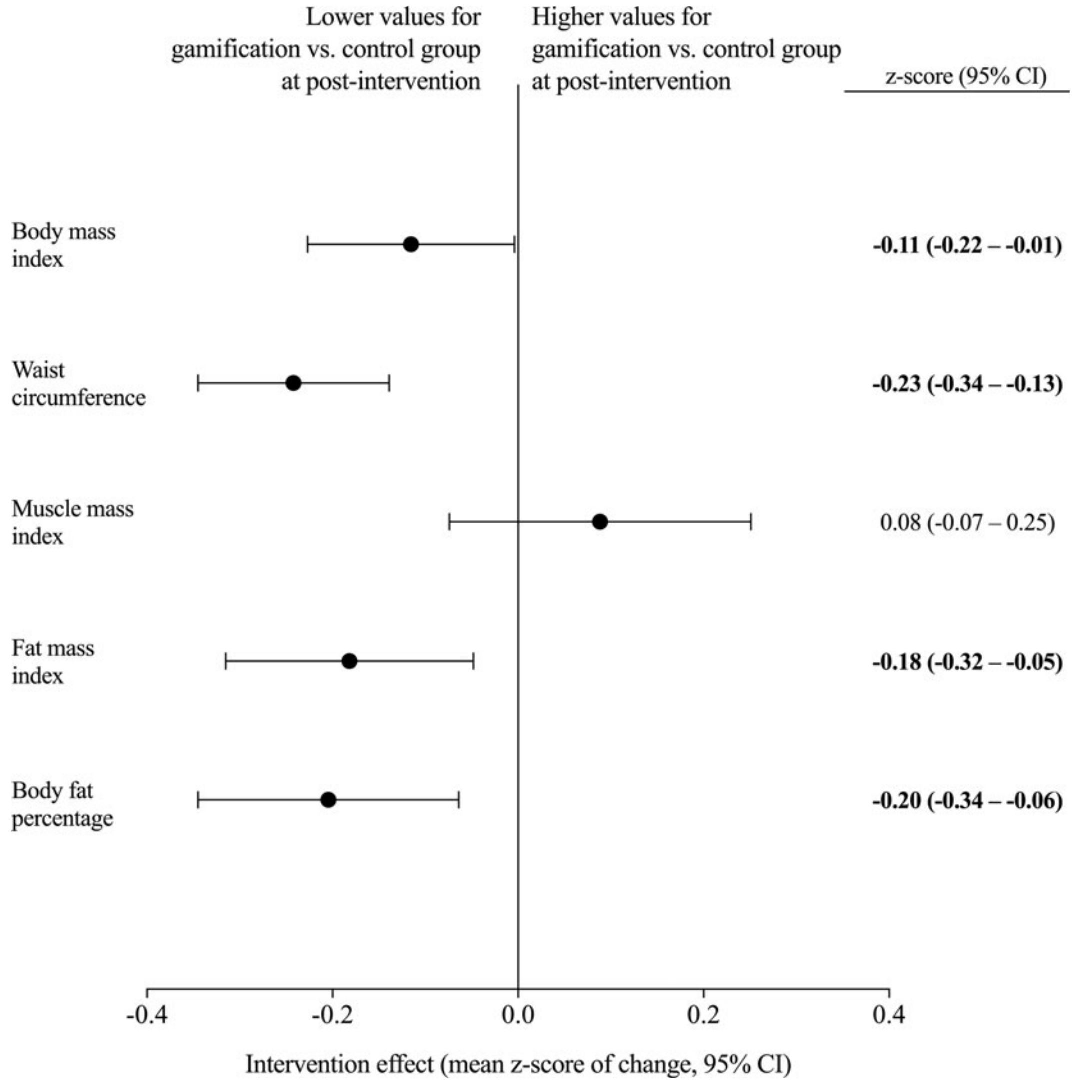

FIG. 2. Effects of the ''STAR WARS: The first Jedi'' program on body composition outcomes. ANCOVA to test the effect of the STAR WARS program on the *z*-score postintervention body composition outcomes were adjusted for the outcome of interest at baseline. ''*Spaceships*'' represent the between-group difference (intervention vs. control) in *z*-score values of change (black dots), that is, change of each postintervention outcome with respect to the baseline mean and SD. For example, the between-group difference of –0.23 *z*-score of change observed in waist circumference means that the postintervention waist circumference mean values is 0.23 SDs lower for the gamification group than for the control group with respect to baseline values. Bars of the ''*spaceships*'' represent 95% CIs. Bold font indicates significant effect at $P < 0.05$ (or by the 95% CI not including zero) after correction for multiple comparisons following Benjamini and Hochberg[31] method. ANCOVA, analysis of covariance; CI, confidence interval; SD, standard deviation.

difference between intervention and control group, respectively, $P \leq 0.018$). No interaction effect of $sex \times group$ on any of the outcomes was observed ($P \geq 0.05$).

Discussion

The findings of the present study reveal a positive effect of the ''STAR WARS: The first Jedi'' gamification-based teaching program, including the use of a mobile app, on body composition of college students. Specifically, college students participating in the gamification program and using the app to manage their own lifetime and meet physical activity recommendations, presented a significant reduction after the program of BMI, waist circumference, fat mass index, and body fat percentage, in comparison with the control group. Although all college students participating in the present study belonged to the degree in Physical Education and Sport Sciences and, therefore, have practical and active subjects that may influence their physical activity levels, both groups (control and intervention) had the same subjects along the career and, regardless of this, we still observed a significant benefit of gamification in body composition only in the intervention group. Therefore, we believe that the findings observed herein were not directly affected by the fact that they were students of a sport degree but by the power of gamification, as the intervention group improved their body composition significantly more than the control group.

This is, to the best of our knowledge, the first study that analyzes the influence of a gamification-based approach as a motivational teaching tool to increase physical activity levels

Table 2. Effects of the ''STAR WARS: The First Jedi'' Program on Raw and Z-Score Postintervention (i.e., Z-Score of Change from Baseline) Body Composition Outcomes

			Mean (95% CI)				
	N_{all}	N	*Intervention group*	N	*Control group*	*Difference between groups*	P
BMI	112	56		56			
Raw score (kg/m^2)			23.39 (23.20 to 23.59)		23.68 (23.49 to 23.87)	–0.29 (–0.56 to –0.01)	**0.043***
z-Score			–0.04 (–0.12 to 0.03)		0.07 (–0.00 to 0.15)	–0.11 (–0.22 to –0.01)	
Waist circumference	110	54		56			
Raw score (cm)			74.00 (73.49 to 74.51)		75.70 (75.20 to 76.20)	–1.70 (–2.42 to –0.98)	**<0.001***
z-Score			–0.23 (–0.31 to –0.16)		0.00 (–0.06 to 0.07)	–0.23 (–0.34 to –0.13)	
Muscle mass index	112	56		56			
Raw score (kg/m^2)			10.65 (10.50 to 10.79)		10.53 (10.39 to 10.68)	0.11 (–0.09 to 0.32)	0.282
z-Score			0.04 (–0.07 to 0.16)		–0.04 (–0.16 to 0.07)	0.08 (–0.07 to 0.25)	
Fat mass index	111	56		55			
Raw score (kg/m^2)			4.60 (4.42 to 4.79)		4.96 (4.77 to 5.15)	–0.35 (–0.62 to –0.09)	**0.008***
z-Score			–0.09 (–0.18 to 0.00)		0.09 (–0.00 to 0.19)	–0.18 (–0.31 to –0.04)	
Body fat percentage	112	56		56			
Raw score (%)			19.15 (18.47 to 19.84)		20.56 (19.87 to 21.24)	–1.41 (–2.36 to –0.43)	**0.005***
z-Score			–0.30 (–0.40 to –0.20)		–0.10 (–0.19 to –0.00)	–0.20 (–0.34 to –0.06)	

ANCOVA was used to test the effect of the ''STAR WARS: The first Jedi'' program on the outcomes. ANCOVA models included: the postintervention body composition outcome as dependent variable, group (i.e., intervention vs. control) as fixed factor, and the baseline body composition outcome as a covariate. Bold font indicates significant effect at $P < 0.05$ (or by the 95% CI not including zero) and an asterisk (*) indicates whether the significant effect persisted after multiple comparisons correction [31]. *z*-Score data show how many SDs have the postintervention values changed with respect to the mean and SD at baseline. For example, a –0.23 *z*-score value in waist circumference for the intervention group means that the postintervention waist circumference mean value is 0.23 SDs lower than the mean value at baseline for this group (i.e., positive intervention effect).

ANCOVA, analysis of covariance; CI, confidence interval; SD, standard deviation.

and benefit body composition in higher education. However, our findings in a sample of college students confirm and extend prior research in children and adolescents[24,25,32] on the positive effect that a gamification-based teaching approach can have for body composition in different educational levels. For instance, a previous 7-month intervention that consisted of a game system of internal and external motivators, healthy challenges, and fun activity rewards, demonstrated a reduction of BMI, but not waist circumference, in children from elementary educational level.[25] Another study in the same age group demonstrated the potential of an ''exergame'' (i.e., active videogames to exercise indoor) to prevent from obesity during childhood, as they found a reduction of body weight in the gamification-based group and an increase of this variable in the control group.[24]

However, they did not observe changes in BMI. This could be due to the fact that ''exergames'' limit the practice of physical activity only to the moment when the videogame is played, and may, therefore, fail to transfer physical activity to daily life. To avoid this limitation, we made use of a mobile phone app that allows to take any game beyond someone's home into his or her everyday life. A recent systematic review also concluded that gamification captivates children and adolescent students to use mobile phone apps toward acquiring healthier lifestyle behaviors.[32] All this evidence together confirms the potential of gamification and mobile apps as motivational techniques to promote health benefits in higher education.

The ''STAR WARS: The first Jedi'' gamification-based program emerged to fight back the general unhealthy habits derived from the university way of live.[5,33] But, *what has gamification that is so powerful?* When educational programs aim to promote behavioral changes, the key aspect to focus on should be students' motivation.[34,35] The inclusion of game elements through gamification in the students' contexts (e.g., in the university) and routines can influence students' motivational aspects toward changes in their attitudes and behaviors. When the activities performed in an educational context cause satisfaction or happiness, students feel more motivated, predisposed, and compromised toward the performance of any demanded task by the teacher.[36] Another factor that increases motivation is the implementation of roles, scores, and/or levels, as we implemented in the ''STAR WARS: The first Jedi'' program. Therefore, gamification has the potential to make students attend to courses highly motivated as a consequence of the game atmosphere generated and the narrative where they are set,[37] favoring their predisposition to acquire healthier habits.

The narrative used in the present program is, with no doubt, the most innovative and differential element of this study. There are evidences of the efficacy of including story-tools/narratives to promote positive emotions and self-regulation among students against specific unhealthy habits.[38,39] The use of ''STAR WARS,'' a ''universally'' known saga of films and books, set students as main protagonist of their own educational and fantastical adventure. We believe that what immerses the student in the proposal was the design of a narrative adapted from a known saga and the fact that we made students the protagonists of this narrative/adventure.[17,18] Some examples of the activities that they had to do to fulfil their training as *padawans* and become *Jedi* were: (1) to follow *Jedi Masters* on *Twitter*, that is, to follow relevant people from the field of education, in general, and physical education, in particular. For example, they could save *tweets* on new educational interactive materials that could be helpful for their future own sessions; (2) to buy ''groceries'' to sum up time to their countdowns and, therefore, increase their level of *midiclorianos*.

For example, the food was represented by any formative and educational project they worked on and submitted, and the water was represented by any creative challenge; iii) to do *interplanetary travels* to make inhabitants aware of the need to join the *Rebel Alliance* and build a hopeful future in the educational galaxy. To do this, they had to fulfil running or biking challenges in a weekly basis. All these, together with the inclusion of game-based elements, such as rankings, levels, scores, lives, missions, or challenges, were factors that involved the students in the proposal and motivated them toward the proposed health aims.

Besides the use of a narrative, several investigations have suggested that using electronic devices, and particularly physical activity-related mobile apps, increase motivation toward more active lifestyles.[40,41] Given that the lack of time has been reported by college students as one of the main barriers to practice physical activity,[8,42] we designed an app that included a countdown timer. By including a countdown timer in our app, we wanted students give to the ''time'' the value it has for their life. Furthermore, the teaching strategy used herein aimed to help students in the management of their own time, what we hypothesized would derive in health improvements. For instance, the app allowed students to check their lifetime's countdown and thus make the decision to practice more physical activity to gain time that was directly added to the timer. Therefore, interactive digital devices designed to allow physical activity tracking can be valuable tools for the implementation of gamification and for encouraging behavioral changes, helping to increase physical activity levels among adults and prevent from unhealthy body composition.[43]

Interestingly, we observed a larger effect of the gamification-based intervention on fat mass index and body fat percentage in males than in females, although no interaction by sex was found. This may be explained by the fact that the gamification-based program had a higher influence in physical activity levels of males and, therefore, a higher improvement of their body composition. This concurs with recent evidence showing that, in general, females are less active than males.[44] Also, a recent meta-analysis[45] showed greater effects of physical activity interventions on males than females, concluding that sex could be an important moderator and suggesting that the larger effects in males could be due to greater engagement in the intervention and, therefore, in meeting physical activity guidelines. However, evidence demonstrating this is still lacking and further studies must confirm this issue.

Several limitations must be acknowledged: (1) participants were not randomly distributed to each group but they chose their group according to their schedule's preferences; (2) the sample size can be considered relatively small, limiting therefore the statistical power; and (3) we did not count with an objective measurement of participants' physical activity during the program (e.g., accelerometers). Despite these limitations, we can also acknowledge several strengths. To the best of our knowledge, this is the first study investigating the effects of a gamification-based teaching program under a narrative of ''STAR WARS'' on body composition outcomes in college students. Another strength is the inclusion of objective and standardized assessments of body composition outcomes by bioelectrical impedance.

Conclusions

The use of gamification and a game-based mobile app in higher education increase motivation of college students toward meeting physical activity recommendation and having, therefore, benefits on BMI, waist circumference, fat mass index and body fat percentage. Innovative and active teaching strategies, such as gamification, are powerful tools to increase students' motivation and implication and, consequently, favor the acquisition of physically active lifestyle habits that lead to body composition improvements. Future studies should analyze whether the effects observed herein are also found in other educational age groups (i.e., children and adolescents) after applying a gamification-based program that uses a science fiction narrative as a motivational resource for students. Also, future studies should incorporate, not only quantitative, but also qualitative measurements to shed light on the most subjective aspects that lead to increase students' motivation toward a specific objective.

Authors' Contributions

I.J.P.-L.: study design, study implementation, and critical revision. C.N.-M.: study design, study implementation, and critical revision. J.M.-G.: study design, data analysis, data interpretation, drafting, and critical revision. All authors were accountable for the final version of the article.

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Supplementary Material

Supplementary Figure S1

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