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Link to publisher version: <https://doi.org/10.1016/j.jshs.2017.09.012>

Citation: Martin-Garcia M, Alegre Duran LM, Garcia-Cuartero B et al (2018) Effects of a 3-month vigorous physical activity intervention on eating behaviors and body composition in overweight and obese boys and girls. *Journal of Sport and Health Science*. Accepted for publication.

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Available online at www.sciencedirect.com

ScienceDirect

Journal of Sport and Health Science xx (2017) 1–7

www.jshs.org.cn

Original article

Effects of a 3-month vigorous physical activity intervention on eating behaviors and body composition in overweight and obese boys and girls

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Received 5 April 2017; revised 25 June 2017; accepted 21 July 2017

Available online

Abstract

Purpose: This study analyzes the effects of a 3-month vigorous physical activity (VPA) intervention on eating behavior and body composition in overweight and obese children and adolescents.

Methods: Forty-seven participants (7–16 years) took part in the study: 28 were assigned to the intervention group (IG) (10 boys and 18 girls) and 19 in a control group (CG) (8 boys and 11 girls). Body composition (dual-energy X-ray absorptiometry), anthropometrics (body mass, height, and body mass index (BMI)), and eating behavior traits (Three-Factor Eating Questionnaire-R21C) were determined before and after the VPA intervention.

Results: A decrease in the percentage of body fat and BMI (−2.8% and −1.8%, respectively), and an increase in most lean mass variables were found in the IG (all $p \leq 0.05$). In relation to the eating behavior traits, IG subjects showed a 14% reduction in the Emotional Eating score ($p = 0.04$), while Cognitive Restraint score did not change after the VPA intervention. The baseline factors of the questionnaire predicted changes in body mass and fat mass variables only in the CG.

Conclusion: A 3-month VPA intervention influenced eating behaviors of overweight or obese young, especially the Emotional Eating factor, in the presence of favorable body composition changes.

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Keywords: Appetite; Children; Exercise; Obesity; TFEQ-R21; Young

1. Introduction

Prevalence of childhood obesity has been on the increase since 1971 in developed countries.¹ Although published data suggest that this pattern might have slowed down in several countries as Spain, France, and USA,^{2,3} the prevalence of overweight and obesity in children remains very high. Several strategies recommend focusing on the increase of the vigorous physical activity (VPA) performed and not just on the reduction of the total caloric intake.^{4,5} However, no consensus about the

most successful intervention for weight control and body composition improvement in overweight or obese youth exists.

Moreover, the impact of physical activity (PA) in the treatment of excess body weight not only influences energy expenditure and reduces sedentary time, but also acts on the appetite system.⁶ The degree of compensation (replacing the energy expended during PA) can predict subsequent weight loss success.⁷ Compensation for the energy deficit caused by PA is more clearly seen in medium-term interventions (up to 14 days),⁷ suggesting that compensatory responses in adults may have a more important role in longer PA-based interventions.

There are few and inconsistent data about the effects of PA on dietary habits in children. Acute exercise (1–2 sessions) seems to differently influence energy intake as some studies have found that energy intake does not change,^{8,9} decreases,^{9–11}

Peer review under responsibility of Shanghai University of Sport.

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<https://doi.org/10.1016/j.jshs.2017.09.012>

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or increases.^{10,12} After a longer PA intervention (6 and 10 weeks, respectively) hunger increases and the feeling of fullness decreases,¹³ but energy intake is not modified¹⁴ in obese adolescents.

Some different questionnaires (Three-Factor Eating Questionnaire (TFEQ)¹⁵ or Dutch Eating Behavior Questionnaire) have been used in children to assess the eating behaviors. The research highlights that cognitive and restrained eating are positively related to body weight and body mass index (BMI) in children and adolescents regardless of the questionnaire used.¹⁶⁻¹⁹ However, emotional and external or uncontrolled eating does not have such a clear relationship with being overweight in children.²⁰

A previous study suggested that exercise-induced weight loss in response to a 3-month supervised exercise intervention is more marked in adults with high disinhibition scores,²¹ which suggests less compensation. In this study, those who decreased their disinhibition and hunger scores and increased their restraint, lost more weight.²¹ More recently, Danielsen et al.²² found similar results, which supports the importance of psychological eating behavior traits in exercise-induced weight loss. Most obesity treatments involve a multi-approach to modify exercise, nutrition, and lifestyle behaviors, so it is difficult to disentangle the real impact that PA has on eating behaviors of children and adults.

Thus, the purpose of the present study was to provide more information about the effects of a 3-month VPA intervention on eating behavior traits and body composition in girls and boys with excess body weight. Specifically, the first aim was to examine whether any change in eating behavior traits occurred following this type of intervention. The second aim was to determine any relationships between changes in body composition and eating behavior traits.

2. Methods

2.1. Participants

Sixty-one overweight or obese children (32 in the intervention group (IG) and 29 in the control group (CG)) took part in the study. After the training period, data from 28 children for the IG (10 boys and 18 girls) and 19 children for CG (8 boys and 11 girls) were included. Their physical characteristics before and after VPA intervention are presented in Table 1. The sample size was determined by an *a priori* power analysis, based on the time course of changes in body mass, BMI, and percentage of body fat (%BF) from a previous pilot study data. According to the power statistics of these variables ($\alpha = 0.05$, $1 - \beta = 0.95$, effect size f between 0.23 and 0.40), it was necessary to include 6–14 people in each group.

Participants were derived from the Severo Ochoa Hospital (Madrid, Spain). Both parents and children were informed about the aims and procedures of the study, as well as the possible risks and benefits. Children gave their verbal consent and written permission was obtained from their parents. The pubertal stage was self-assessed by the participants using Tanner's puberty rating, a method of recognized validity and reliability,²³ and when necessary it was confirmed by asking the parents to fill in the same test.

Children were eligible to participate if they met the following inclusion criteria: (a) aged 7–16 years and (b) overweight or obese according to the international cut-off points for BMI in children.²⁴ Participants were excluded from the research if (a) they had a disability or illness that prevented them from participating in the PA sessions; (b) if they took any medication that could affect their weight or body composition; or (c) if they did not have an attendance rate of at least 70% of the sessions.

Table 1
General physical characteristics and body composition variables before and after the vigorous physical activity intervention (mean \pm SD).

Variable	Intervention group ($n = 28$) (mean Tanner = 2.6)			Control group ($n = 19$) (mean Tanner = 2.6)			p	
	Pre	Post	Δ (%)	Pre	Post	Δ (%)	Time main effect (p)	Time \times group interaction (p)
Age (year)	11.5 \pm 2.4	11.7 \pm 2.4*	1.7	11.1 \pm 2.6	11.3 \pm 2.6*	1.8	<0.001	0.692
Body mass (kg)	67.1 \pm 6.5	66.9 \pm 16.0	-0.3	69.4 \pm 19.6	70.6 \pm 19.8	1.7	0.134	0.047
Height (cm)	153.4 \pm 12.9	154.7 \pm 12.5*	0.8	153.1 \pm 15.9	155.0 \pm 15.6*	1.2	<0.001	0.051
BMI (kg/m ²)	28.1 \pm 3.6	27.6 \pm 3.6*	-1.8	28.9 \pm 3.1	28.7 \pm 3.2	-0.7	0.017	0.239
%BF	43.4 \pm 4.5	42.2 \pm 5.0*	-2.8	44.6 \pm 5.2	44.4 \pm 5.3	-0.4	0.010	0.082
Fat mass								
FM whole body (kg)	29.0 \pm 8.5	28.1 \pm 8.3	-3.1	31.1 \pm 10.0	31.3 \pm 9.8	0.6	0.228	0.071
FM trunk (kg)	13.4 \pm 4.6	13.3 \pm 4.8	-0.7	14.7 \pm 4.9	14.8 \pm 4.6	0.7	0.884	0.339
FM lower extremities (kg)	11.8 \pm 3.3	11.4 \pm 3.2	-3.4	12.5 \pm 4.5	12.6 \pm 4.6	0.8	0.352	0.052
FM upper extremities (kg)	2.9 \pm 0.9	2.6 \pm 0.7*	-10.3	3.0 \pm 1.0	2.9 \pm 0.9*	-3.3	<0.001	0.015
Lean mass								
LM whole body (kg)	35.4 \pm 8.8	36.1 \pm 8.9*	2.0	36.0 \pm 10.5	36.7 \pm 10.8	1.9	0.001	0.864
LM trunk (kg)	16.1 \pm 4.0	16.5 \pm 4.2*	2.5	16.6 \pm 5.0	16.9 \pm 5.4	1.8	0.003	0.561
LM lower extremities (kg)	12.6 \pm 3.5	12.9 \pm 3.5*	2.4	12.7 \pm 4.0	13.0 \pm 4.0*	2.4	<0.001	0.810
LM upper extremities (kg)	3.6 \pm 1.2	3.6 \pm 1.1	0.0	3.9 \pm 1.3	3.9 \pm 1.3	0.0	0.457	0.490

* $p \leq 0.05$, compared with pre-intervention values.

Abbreviations: Δ = changes between pre- and post-intervention; %BF = percentage of body fat; BMI = body mass index; FM = fat mass; LM = lean mass.

2.2. Design of the study

Anthropometric, body composition, and eating behavior variables were tested before and after the 3-month VPA intervention in each participant. All these measurements were taken in the 10 days followed the last session of VPA. Children of the IG participated in a VPA intervention, which is described below. Participants received general dietary recommendations and were instructed to carry on with their usual daily routine, except those who belonged to IG that have to attend the VPA program. The study was performed in accordance with the Declaration of Helsinki of 1975 regarding the ethical principles for medical research involving human subjects and was approved by the Ethical Committee of Clinical Research of the University Hospital Complex of Albacete, Spain (CEIC 10/10).

2.3. Anthropometric and body composition assessment

Weight was measured using a balance with a 100-g precision (Detecto; Lafayette Instruments Company, Lafayette, IN, USA). Height was measured in the upright position to the nearest millimeter (Holtain Ltd., Crymych, UK). Both assessments were undertaken with children in underwear and barefoot. BMI was calculated as body mass (kg)/height (m²).

Dual-energy X-ray absorptiometry was used to measure fat and lean mass (GE Lunar Prodigy; GE, Madison, WI, USA). All scan analyses were analyzed using GE Encore 2002 software Version 6.10.029. Participants were scanned wearing light clothing with no metal and no shoes or jewelry. Whole body scans were made in a supine position and were submitted to a regional analysis as previously described.²⁵

2.4. Eating behaviors assessment

A validated Spanish version for children and adolescents of the 21-item TFEQ was used in this study (TFEQ-R21C).²⁶ Each child answered the items of TFEQ-R21C unassisted; however, they received help from the researchers for those questions where further clarification was needed. Their answers were coded following the instructions given by Cappelleri et al.,²⁷ where higher scores indicate more Cognitive Restraint (individuals' efforts to limit their food intake to control body weight or to promote weight loss), Uncontrolled Eating (tendency to overeat in response to loss of control over intake), and Emotional Eating (overeating in response to negative moods).

2.5. VPA intervention

The treatment lasted 12 weeks and consisted of 90 min of recreational games twice per week. These tasks, mainly based on aerobic games, and also some strength exercises, were adapted to the children's abilities by a trained physical education instructor in order to fulfill the following requirements: (a) each game lasted for a minimum of 10 min, (b) all participants were in movement throughout the game, (c) easy activities, such as jumping the rope, were proposed to the children for them to do during the pause periods through the activities (e.g., when a participant was out of a game before it had finished),

(d) small group games were organized to increase the active time, and (e) the resting periods between activities were short and included an active behavior (e.g., help to place and pick up the sport equipment). The dose of PA was similar to that used in previous studies that analyzed body composition changes.^{25,28} All children did the same recreational games, but to ensure that exercise was in accordance with their physical needs participants were divided into 2 groups according to Tanner status and motor development (pre-pubertal group Tanner I-II and pubertal group Tanner ≥ III).

The intensity of the activities in the IG was assessed with a heart rate (HR) monitor (Polar FT7; Polar, Kempele, Finland) in a subsample ($n = 3$) during all the training sessions. All participants wore the HR monitor for the same number of days, and all of them were encouraged to keep up VPA in each game, as Gutin suggested.⁴ The mean HR in our study was of 151 ± 13 beats per minute (bpm) during the games. Using a standardized maximal of 200 bpm for children, the average HR achieved during the intervention was 75.5% of predicted maximal heart rate (HR_{max}), which is classified as VPA (70%–89% of HR_{max}).²⁹ This cut-off point (approximately 150 bpm) also corresponds to the cut-off points used in previous studies that include VPA interventions with children and teenagers.^{30,31}

Throughout the PA program we carried out a motivational strategy with constant feedback in which we took into account the participants' attendance, good behavior, and effort (giving a positive score if they kept their HR above the set aim). At the end of the program, the children with better scores received a symbolic prize in order to increase the motivation of the participants. The mean attendance rate to the program was 89%. The VPA intervention was implemented in the sports facilities of a local school.

2.6. Statistical analysis

Statistical analyses were completed using SPSS Version 17.0 (SPSS Inc., Chicago, IL, USA). Results are presented as means \pm SD unless otherwise stated. The baseline differences between the IG and the CG were tested using Student's *t* tests. Changes over time and differences between genders and between intervention and control groups were assessed with a mixed-factorial analysis of variance (ANOVA) (Time as within-subject and Gender or Group as between-subject factor; 2 time points \times 2 groups). To follow up significant ANOVA results, Student's *t* tests were used.

To determine whether Cognitive Restraint, Uncontrolled Eating, and Emotional Eating were associated with changes in body composition at the baseline and after the intervention, a series of correlations and stepwise multiple regression analyses were performed on residualized variables. Residualized variables were used to reduce the impact of the baseline values on change variables. Correlations and regressions were performed using the baseline and residualized TFEQ-R21C predictor variables. In each regression model, the baseline age was entered at Step 1, followed by Cognitive Restraint, Uncontrolled Eating, and Emotional Eating factors in Step 2. For all statistical analyses, the level of significance was set at $\alpha = 0.05$.

3. Results

3.1. Physical characteristics and body composition

The age, physical characteristics (body mass, height, and BMI) and body composition variables (fat and lean masses) of both groups were compared both at the baseline and after the VPA intervention (Table 1).

When data were split by gender, a significant Time \times Group interaction for body mass ($F(1, 27) = 7.0, p = 0.04$) was found only in girls. A significant increase in body mass of the CG girls (from 70.3 ± 16.6 kg to 72.1 ± 16.6 kg, $p = 0.01$) was found. *Post hoc* tests showed that boys in the IG decreased significantly their whole body fat mass (FM) in kg (from 29.6 ± 7.3 kg to 27.9 ± 6.4 kg, $p = 0.04$) and their %BF (from $41.1\% \pm 3.7\%$ to $39.1\% \pm 4.2\%$, $p \leq 0.01$). In addition, whole body lean mass (LM) increased significantly only in the boys of the IG (from 40.6 ± 10.3 kg to 41.7 ± 10.6 kg, $p = 0.03$).

3.2. Eating behavior traits

Before the start of the VPA intervention, eating behaviors were similar in the IG and the CG participants. ANOVA showed significant main effects for Time in Emotional Eating ($F(1, 44) = 4.3, p = 0.04$). The 3 factors of the questionnaire remained unchanged in the CG after the 3-month period, while in the IG a significant reduction in Emotional Eating (14%, $p = 0.04$) and a non-significant reduction in Uncontrolled Eating (11.5%, n.s.) traits were found (Fig. 1). There were no significant Time \times Group interactions in any factors.

3.3. Relationships between the baseline and exercise-induced changes in TFEQ-R21C scores and body composition parameters

Significant correlations were observed between the baseline Uncontrolled Eating and the baseline % trunk FM ($r = 0.36, df = 50, p \leq 0.01$) and the baseline %BF ($r = 0.32, df = 50, p = 0.01$). Baseline Cognitive Restraint was associated with BMI loss ($r = -0.33, df = 26, p = 0.05$) in the IG. In the CG, a negative correlation was found between the baseline Emotional Eating and change in body mass ($r = -0.41, df = 16, p = 0.05$) and the baseline Uncontrolled Eating correlated positively with

change in whole body FM in percentage ($r = 0.42, df = 16, p = 0.04$) and with change in FM in the lower extremities ($r = 0.39, df = 16, p = 0.05$) (Appendix Tables S1 and S2).

We found significant associations between changes in TFEQ-R21C factors and changes in anthropometric or body composition only in the IG. Changes in Emotional Eating were significantly and positively correlated with changes in the % trunk of FM ($r = 0.34, df = 26, p = 0.04$). An increase in Cognitive Restraint was also significantly associated with reductions in LM in the lower extremities ($r = -0.32, df = 26, p = 0.05$) and the whole body LM ($r = -0.39, df = 26, p = 0.02$) (Appendix Table S3).

A stepwise multiple regression with data from all participants was carried out to determine whether the baseline TFEQ-R21C traits (Uncontrolled Eating, Cognitive Restraint, and Emotional Eating) could explain the baseline anthropometric and body composition variables. Only the baseline Uncontrolled Eating was found to account significantly in the baseline % trunk FM ($B = 3.60 \pm 1.44, \beta = 0.40, p = 0.02$), the baseline %BF ($B = 2.97 \pm 1.18, \beta = 0.40, p = 0.02$), and the baseline whole body LM ($B = -3.41 \pm 1.73, \beta = -0.22, p = 0.05$). In these variables, the model of the 3 TFEQ-R21C factors together predicted 15.7%, 16.3%, and 60.9% of the variance respectively in baseline % trunk FM, %BF, and whole body LM, respectively.

A stepwise regression examining whether residualized changes in anthropometric and body composition variables could be predicted by the baseline TFEQ-R21C factors revealed that the baseline TFEQ-R21C factors are significant predictors only in changes of body mass and FM variables in the CG (Table 2). The residualized changes in TFEQ-R21C factors were included into stepwise multiple regressions to determine their influence on residualized anthropometric and body composition changes and the analysis revealed no significant associations.

4. Discussion

The present study shows that in overweight or obese children and adolescents participation in a VPA program modifies eating behaviors, especially overeating in response to negative mood states (Emotional Eating) in the presence of positive body composition changes. This novel finding could be of great relevance

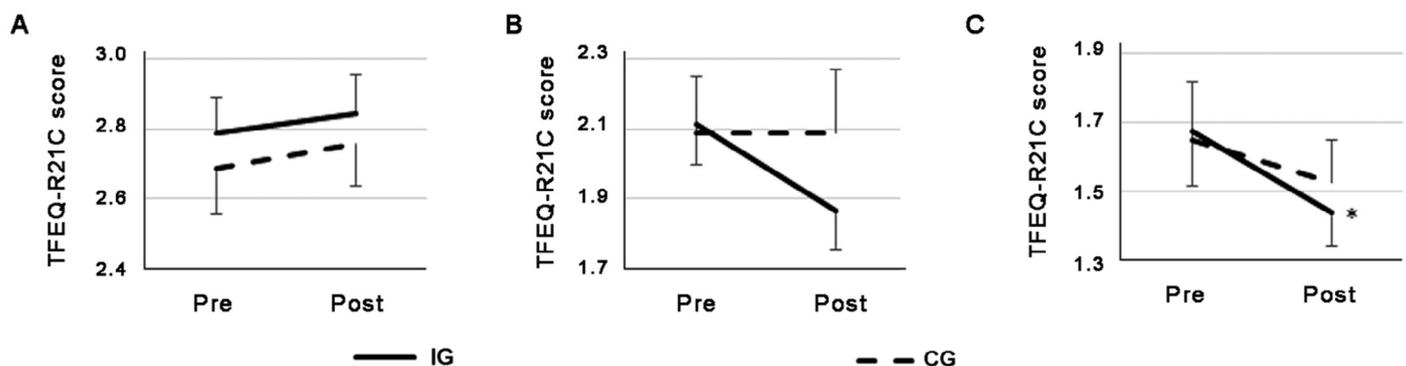


Fig. 1. Changes in Three-Factor Eating Questionnaire-R21 for children and adolescents (TFEQ-R21C) factors before (pre) and after (post) the 3-month physical activity intervention. Data split by groups of exercise (intervention group, IG) and non-exercise (control group, CG). (A) Cognitive Restraint; (B) Uncontrolled Eating; and (C) Emotional Eating. Data expressed as mean \pm SE to improve its legibility. * $p < 0.05$, compared with the post value in IG.

Table 2

Stepwise regression model predicting changes in weight and FM variables (residualized) with the baseline Three-Factor Eating Questionnaire-R21 for children and adolescents (TFEQ-R21C) factors.

Outcome	Predictor	Intervention group						Control group					
		Model	<i>B</i>	SE <i>B</i>	β	<i>R</i> ²	<i>p</i>	Model	<i>B</i>	SE <i>B</i>	β	<i>R</i> ²	<i>p</i>
Δ Body mass (%)	Baseline UE	1	-0.10	0.41	-0.06	0.09	0.802	1	0.77	0.27	0.63	0.54	0.013
	Baseline CR		-0.55	0.37	-0.30		0.151		0.82	0.30	0.54		0.016
	Baseline EE		-0.03	0.30	-0.03		0.897		-0.89	0.25	-0.75		0.003
Δ BMI (%)	Baseline UE	1	0.12	0.41	0.07	0.11	0.768	1	0.54	0.37	0.41	0.24	0.167
	Baseline CR		-0.58	0.37	-0.31		0.128		0.66	0.41	0.41		0.126
	Baseline EE		-0.08	0.30	-0.06		0.794		-0.59	0.35	-0.47		0.110
Δ FM whole body (%)	Baseline UE	2	-0.12	0.40	-0.07	0.23	0.770	1	0.91	0.27	0.79	0.46	0.005
	Baseline CR		-0.42	0.36	-0.22		0.256		0.53	0.30	0.37		0.102
	Baseline EE		0.11	0.30	0.09		0.703		-0.64	0.26	-0.58		0.026
Δ FM trunk (%)	Baseline UE	1	-0.13	0.42	-0.08	0.06	0.758	1	0.81	0.36	0.63	0.28	0.040
	Baseline CR		-0.46	0.38	-0.24		0.246		0.31	0.40	0.19		0.441
	Baseline EE		0.13	0.31	0.10		0.672		-0.59	0.34	-0.46		0.105
Δ FM lower extremities (%)	Baseline UE	2	0.04	0.39	0.02	0.28	0.913	1	0.93	0.26	0.82	0.53	0.003
	Baseline CR		-0.35	0.35	-0.18		0.331		0.70	0.28	0.49		0.026
	Baseline EE		0.03	0.29	0.02		0.914		-0.67	0.24	-0.61		0.014
Δ FM upper extremities (%)	Baseline UE	2	-0.29	0.43	-0.16	0.24	0.501	1	0.47	0.17	0.70	0.40	0.016
	Baseline CR		-0.38	0.38	-0.19		0.327		0.42	0.19	0.49		0.047
	Baseline EE		0.10	0.31	0.07		0.752		-0.31	0.16	-0.47		0.074

Note: Variables included in Model 1 are baseline UE, baseline CR, and baseline EE; variables included in Model 2 are baseline age, baseline UE, baseline CR, and baseline EE.

Abbreviations: BMI = body mass index; CR = cognitive restraint; EE = emotional eating; FM = fat mass; UE = uncontrolled eating.

as it determines the importance of changes in eating behavior traits during exercise interventions in young people. Additionally, it also proves a relationship between body composition and eating behavior traits (as measured by the TFEQ-R21C).

Our data are in line with previous studies^{14,32,33} that analyzed weight loss after a PA program without energy restriction in youngsters and adults. Although no significant weight loss in the IG was present, other positive body composition changes (decrease in %BF and increase in LM) were found only in the IG. Factors such as growth and maturation of the youths or individual differences in the compensatory responses to the negative energy balance induced by the exercise may explain this fact.^{14,34} Thus, as PA programs lead to positive changes in body composition, it is likely that body weight is not the best outcome to assess the health benefits of exercise interventions,³⁵ especially in the short-term programs.

Although there is no consensus yet as to whether the influence of exercise on body composition is gender-dependent,^{36,37} some evidence has shown that obesity prevention programs produced larger effects in females when compared to males.³⁷ In our study, whole body FM (kg) showed a significantly greater decrease after the exercise program (5.8% vs. 1.3%, IG and CG respectively) in boys while in the same intervention the girls of the IG maintained their fat and LMs similar to the baseline. Although both genders got benefits from the VPA intervention, the boys seemed to be better responders than the girls concerning their body composition changes. Thus, gender can be a potential factor to take into account. According to Doak et al.,³⁶ differences by gender may be related to the type of interventions, where boys respond better than girls to the programs focused mainly on PA, as in our study. Nonetheless, the different methodology used in our study (where the FM was assessed

by dual-energy X-ray absorptiometry) must be taken into account, compared to the methods used in most studies of the Doak³⁶ and Stice's³⁷ reviews (such as skin-folds or BMI) when the influence of exercise on body composition according to gender is compared.

Opposite to previous studies published with an obese population after a multicomponent program, in our study Emotional Eating trait decreased after our intervention while Sarvestani et al.³⁸ observed an increase in cognitive restraint, a decrease in hunger, and a higher reduction in disinhibition eating in obese adolescents girls. Similar results to the study by Sarvestani et al.³⁸ are found in adult populations.^{21,22} The fact that our study participants did not lose a significant amount of body weight might partly explain these differences. Overeating under stress and emotional situations is related to unhealthy food choices, high fat and sugar intake, eating in absence of hunger, and unbalanced eating patterns in obese young people.³⁹ The reduction of Emotional Eating scores after our VPA-intervention suggests that our participants did not use the food as a reward as much as they used to. All these results demonstrate that exercise in obese children may act as a regulatory mechanism over eating behaviors, which in turn could lead to improved weight management.⁴⁰

Contrary to previous evidence in children⁴¹ and obese adults,²¹ we found that only the baseline Cognitive Restraint correlated negatively with PA-induced BMI loss. It is possible that the methodological differences between the current study and the study by Goossens et al.⁴¹ (an in-patient obesity treatment program), could explain the discrepancies found. Interestingly, while no significant results were found in the IG, these TFEQ-R21C baseline eating behaviors were able to predict body composition changes in the CG, specifically Uncontrolled

Eating factor was associated with increases in all FM measures. This indicates that PA has the power to modify eating behavior traits (Uncontrolled Eating) and subsequent changes in body composition. The null findings for the relationships between changes in TFEQ-R21C factors and weight loss are inconsistent with the study of Danielsen et al.²² in an adult sample, where Cognitive Restraint changes were related to weight loss after a multicomponent intervention. Thus, it is possible that the effects of PA interventions on eating behaviors are different in children than in adults.

Finally, our results highlight the emergence of an interesting eating behavior trait, Uncontrolled Eating, which has been less investigated than the Cognitive Restraint trait, but has showed a strong relationship with the baseline body composition variables related to FM and LM in our study. Several previous studies have indicated that overeating in response to loss of control (Uncontrolled Eating or disinhibition) is the factor with the strongest relationship with BMI or body composition outcomes and should be seriously taken into account in obesity treatments.⁴²⁻⁴⁴

Despite the fact that all the participants had been asked to maintain their regular lifestyle (diet and PA levels) during the duration of the study, we cannot exclude the possibility that unintentional changes in their daily lives occurred in some of the participants as energy intake and PA outside the treatment were not assessed either before nor after the VPA intervention. Moreover, some authors⁴⁵ have shown that dietary recalls underestimated the real energy intake in obese adolescents. To our knowledge this is the largest study that investigates the changes in eating behaviors in growing boys and girls after a 3-month VPA intervention under stress and emotional situations.

5. Conclusion

A 3-month VPA intervention influences the eating behaviors in children and adolescents by decreasing overeating in response to stress caused by emotionally negative situations, as negative mood states (assessed by the Emotional Eating factor), in the presence of positive body composition changes. These eating behavior changes provide evidence that PA in treatments for childhood obesity have a greater role than just body composition improvements. To summarize, PA at this intensity level and over this duration of time has the potential to modulate eating behaviors as well as body composition variables.

Acknowledgments

This study was supported by the Consejo Superior de Deportes—High Council for Sports in Spain (CSD-089/UPB10/11). MMG has received a PhD. grant from the Ministerio de Educación, Cultura y Deporte, Spain (AP2010-5476). We owe special thanks to Rafael Gracia, Silvia Robledo, and Rafael Ibañez from the Department of Sport and Health (Council of Leganes, Madrid, Spain), to Amparo González from the Hospital Severo Ochoa (Leganes, Madrid, Spain), and to Javier Butragueño and Pedro J. Benito from the Laboratory of Exercise Physiology (INEF, Madrid, Spain).

Authors' contributions

IA conceptualized and designed the study, interpreted the data, and drafted the initial manuscript; BGC conceptualized and designed the study and was the coordinator of participates and coordinated the inclusion; LMA and EJB interpreted the data and advised on the analysis; BG conceptualized and designed the study and interpreted the data; MMG collected data, interpreted the data, carried out the analyses, and drafted the initial manuscript. All authors have read and approved the final version of the manuscript, and agree with the order of presentation of the authors.

Competing interests

The authors declare that they have no competing interests.

Appendix: Supplementary material

Supplementary data to this article can be found online at [doi:10.1016/j.jshs.2017.09.012](https://doi.org/10.1016/j.jshs.2017.09.012)

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