Exploring the direct or inverse association of physical activity with behavioral addictions and other self-regulation problems

¿Protege o predispone la actividad física a las adicciones conductuales y otros problemas de autorregulación?

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Abstract

This cross-sectional survey study had the aim of clarifying the relationships between leisure time physical activity (LTPA) and non-drug-related self-regulation problems (non-drug-related SRPs), including behavioral addictions, and the role of impulsive personality traits therein. Spanish university students (N = 329; M_{age} = 21.20) completed questionnaires for each of these constructs.

Fitness and Bodybuilding LTPA was negatively associated with video gaming-related SRPs, r = -.13, p = .019, 95% CI (bootstrapped) [-.23, -.02], and positively associated with sex-related SRPs, r = .16, p = .005, 95% CI (bootstrapped) [.04, .30]. Endurance LTPA was associated with higher scores in eating-related SRPs, r = .17, p = .003, 95% CI (bootstrapped) [.02, .31]. The proportion of participants presenting scores above the clinically significant threshold in eating-related SRPs was 2.64 times higher for respondents in an Excessive Endurance LTPA cluster compared to the other respondents, Fisher's exact test, p = .017, OR = 3.10, 95% CI [1.26, 7.63], and the proportion of participants reporting vomiting to control weight was 2.12 times higher, Fisher's exact test, p = .040, OR = 2.43, 95% CI [1.06, 5.57]. The associations were largely independent of impulsive personality traits.

We identified an elevated risk of eating pathology in a subgroup of participants with anomalously high participation in endurance physical activity. This overlap is consistent with the *secondary dependence* hypothesis of exercise addiction.

Keywords: Leisure time physical activity; Physical exercise; Exercise addiction; Self-regulation; Behavioral addiction; Impulsivity; Impulsive personality traits.

Resumen

Este estudio tuvo como objetivo aclarar las relaciones entre la actividad física de ocio (AFO) y los problemas de autorregulación (PARs) no relacionados con drogas, incluyendo las adicciones conductuales, y el papel de los rasgos de personalidad impulsiva. Estudiantes universitarios españoles (N = 329, M_{age} = 21,20) completaron cuestionarios para cada uno de estos constructos.

La AFO de gimnasio y musculación se asoció negativamente con los PARs relacionados con videojuegos, r = -0,13, p = 0,019, 95% CI (*bootstrapped*) [-0,23, -0,02], y positivamente con los PARs relacionados con sexo, r = 0,16, p = 0,005, 95% CI (*bootstrapped*) [0,04, -0,30]. La AFO de resistencia se asoció positivamente con los PARs relacionados con la alimentación, r = 0,17, p = 0,003, 95% CI (*bootstrapped*) [0,02, 0,31]. La probabilidad de presentar puntuaciones potencialmente clínicas en PARs de alimentación fue 2,64 veces mayor para los encuestados en un grupo de AFO de resistencia excesiva en comparación con los otros encuestados, prueba exacta de Fisher, p = 0,017, OR = 3,10, 95% CI [1,26, 7,63], y la probabilidad de vomitar para controlar el peso fue 2,12 veces mayor en ese mismo grupo, prueba exacta de Fisher, p = 0,040, OR = 2,43, 95% CI [1,06, 5,57]. Las asociaciones fueron en gran medida independientes de los rasgos de personalidad impulsiva.

Identificamos un riesgo elevado de patología alimentaria potencialmente clínica en un subgrupo de participantes con niveles anormalmente altos de actividad física de resistencia. Esta superposición es consistente con la hipótesis de *dependencia secundaria* en la adicción al ejercicio.

Palabras clave: Actividad física de ocio; Ejercicio físico; Adicción al ejercicio; Autorregulación; Adicción conductual; Impulsividad; Rasgos de personalidad impulsiva.

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Physical activity (PA) is widely acknowledged as beneficial for mental and physical health. However, a long-lasting debate has been going on with regard to the potentially risky correlates of participation in sports. More specifically, abnormally intense or frequent PA shows parallelisms with self-regulation problems (SRPs; Bratland-Sanda et al., 2011). Self-regulation requires the control of habits, urges, and cravings, so that poorly self-regulated behaviors may interfere with well-being (Vohs & Baumeister, 2011). Some of these SRPs, including excessive PA, have been conceptualized as behavioral addictions (e.g. Grant, Potenza, Weinstein, & Gorelick, 2010).

Thus PA may be used as a strategy to address mental health issues, but, at the same time, certain PA patterns could overlap with or be a precursor of self-regulation problems. With this two-sided prospect in mind, we explored the potential relationships between amounts of leisure time physical activity (LTPA) and subjective complaints associated with non-drug-related self-regulation problems (SRPs), as well as the possible involvement of impulsive personality traits in such relationships.

Most SRPs as well as certain PA patterns have been found to be associated with impulsive personality traits (Evenden, 1999; Joseph, Alonso-Alonso, Bond, Pascual-Leone, & Blackburn, 2011; Knezevic-Budisin, Pedden, White, Miller, & Hoaken, 2015; Lejoyeux, Tassain, Solomon, & Adès, 1997; Perry & Carroll, 2008; Raymond, Coleman, & Miner, 2003; Verdejo-García, Lawrence, & Clark, 2008). In accordance with the "Urgency, Premeditation, Perseverance, Sensation Seeking" model (UPPS-P; Whiteside & Lynam, 2001), impulsivity comprises: (a) negative urgency, i.e., the tendency to experience strong reactions under conditions of negative affect; (b) positive urgency, i.e., the proneness to act rashly under intense positive affect; (c) sensation seeking, i.e., the tendency to pursue new and exciting activities; (d) lack of premeditation, i.e., the tendency to not think of the consequences of an action before engaging in it; and (e) lack of perseverance, i.e., the inability to stay focused on attention-demanding tasks (Cyders et al., 2007).

Impulsive personality traits can play different hypothetical roles in the relationships between LTPA and non-drug-related SRPs. On the one hand, the *strength model of self-control*[1] predicts that the availability of self-control resources underlies low levels of impulsive personality traits, facilitates self-regulation, and prevents self-regulation problems (Baumeister & Tierney, 2011; Baumeister, Vohs, & Tice, 2007). In accordance with this prediction, individuals with reduced self-control resources are more prone to impulsive acts and SRPs (Billieux, Gay, Rochat, & Van der Linden, 2010; Verdejo-García et al., 2008; Wills & Dishion, 2004; Wills, Iasi, Don Mendoza, & Ainette, 2007). Concurrently, high self-control is associated with a low level of sedentary behavior and increased levels of participation and performance in PA, via a higher tolerance to fatigue and an orientation toward long-term benefits (Dorris, Power, & Kenefick, 2012; Joseph et al., 2011; Wills et al., 2004; Wills et al., 2007). In other words, high levels of self-control (manifested in low impulsive personality traits) could predict both engagement in LTPA and decreased risk of non-drug-related SRPs.

On the other hand, the *PA dependence hypotheses* conceive some cases of anomalously high participation in sports as instances of a specific type of SRP, so-called *primary PA dependence* (i.e., exercise addiction). Alternatively, PA can be a strategy to deal with the consequences of other clinical or subclinical primary problems, so-called *secondary PA dependence* (de Coverley Veale, 1987; Landolfi, 2013). Accordingly, PA-dependent individuals would exercise routinely to excess[2], often ignoring injury and neglecting work, family, and friends (de Coverley Veale, 1987). This condition is frequently reported among runners and other endurance sports people (Allegre, Souville, Therme, & Griffiths, 2006; Breuer & Kleinert, 2009). Assuming it could be regarded as a primary SRP, excessive PA would be expected to present some level of co-occurrence with other problematic behaviors in this category. This type of overlap is observed, for example, between substance abuse and problem gambling (Navas, Torres, Vilar, et al., 2014; Petry, Stinson, & Grant, 2005), or between harmful alcohol consumption and excessive internet use (Navas, Torres, Cándido, & Perales, 2014; Yen, Ko, Yen, Chen, & Chen, 2009). Extending the parallelism, at least some excessive exercisers (in whom excessive exercise tends to an addictive pattern) would be expected to present impulsivity characteristics similar to the ones observed in other addictive behaviors, with sensation seeking signaling early exposure, and negative urgency as a predictor of disordered behavior (Billieux et al., 2007; Dick et al., 2010; Navas, Torres, Cándido, & Perales, 2014; Navas, Torres, Vilar, et al., 2014).

Of particular interest is the specific relationship between dysregulated eating behavior and excessive endurance LTPA (Grandi, Clementi, Guidi, Benassi, & Tossani, 2011; Lichtenstein, Christiansen, Elklit, Bilenberg, & Støv-

1 Self-control is a component of self-regulation (the ability to regulate behavior at the service of longer-term goals), namely the top-down cognitive mechanism by means of which drives, habits, and urges are inhibited.

2 There is no consensus on the existence of PA dependence. Therefore, no diagnostic category exists in the Diagnostic and Statistical Manual of Mental Disorders (5th ed.; DSM–5; American Psychiatric Association, 2013). Actually, the DSM–5 only recognizes gambling disorder as a behavioral (non-substance) addiction. In order to avoid controversy, we use the term "excessive LTPA" for cases reporting very high levels of LTPA participation compared to mean LTPA values, in a purely descriptive fashion and without any clinical connotations.

ing, 2014). In putative cases of primary PA dependence, dieting and weight loss would be expected to be strategies to increase performance, whereas secondary PA dependence can occur among people with eating disorders, where PA is a means to lose weight (Adams & Kirkby, 2001; de Coverley Veale, 1987).

Our overarching research aim was thus to explore the potential relationships between practice patterns of different forms of LTPA and non-drug-related SRPs (including behavioral addictions), and the role impulsive personality traits play in these relationships. Few studies exist about the relationships between LTPA and SRPs, apart from substance abuse (e.g. Lisha & Sussman, 2010). Furthermore, the importance of PA modalities has not yet been exhaustively considered (Allegre et al., 2006; Breuer et al., 2009; Ziemainz et al., 2013). However, athletes practicing distinct types of LTPA mostly differ in their personal exercise motivation and aims (Ford, 2007; Kondric et al., 2013; NIH, 2011), and it has been found that these underlying motives may influence the associations with drug-related SRPs (Kondric et al., 2011). Considering the absence of direct evidence, our expectation about the direction of relationships remains open. An association in which low impulsive personality trait scores contribute simultaneously to a higher likelihood of participation in LTPAs and to a lower probability of presenting non-drug-related SRPs would be in line with the strength model of self-control (Baumeister et al., 2011; Baumeister et al., 2007). On the contrary, a direct positive relationship of endurance LTPA with non-drug-related SRPs as well as with impulsive personality traits would support the PA dependence hypothesis. More specifically, an association between potentially clinical eating-related SRPs and excessive LTPA would support the secondary PA dependence hypotheses (de Coverley Veale, 1987).

Methods

Participants

Participants were students at the University of Granada, Spain. Being a university student was the only inclusion criterion. Meeting the intended sample size required for the statistical analyses, the final sample consisted of 329 students with ages between 18 and 41 years (M_{age} = 21.20; *SD* = 3.50). The sample consisted of 183 female and 146 male students. Participants were following degrees in Sports Sciences (n = 125), Psychology (n = 116), Sociology (n = 42), Speech-Language Therapy (n = 18), a Master's degree (n = 4) or others (n = 22). Most participants (n = 227) were in the first year of their degree.

Design and Procedure

For the cross-sectional survey study we recruited the participants through convenience sampling at various departments of the University of Granada, without compensation. All participants received information about the aims of the study and gave their informed consent prior to participation. The participants completed a set of paper-and-pencil self-report questionnaires in class. Instructions were given by members of the research team. The procedure was approved by the Ethics Committee of the University of Granada (*Vicerrectorado de Política Científica e Investigación*) with reference number 2014-901.

Measures

We measured LTPA by means of the *Cuestionario sobre la Participación en Actividades Deportivas por Tipo* (Questionnaire of Participation in Sports Activities per Type; CPAD-T). We adapted the Global Physical Activity Questionnaire (GPAQ) of the World Health Organization to measure the patterns of participation in LTPA (Armstrong & Bull, 2006; Bull, Maslin, & Armstrong, 2009), specified by type of sport. The scale contains the forty most practiced LTPAs in Spain according to results from a survey carried out by the Supreme Council for Sports of the Spanish Government (García & Llopis, 2011), and the option "other physical activity, namely…". Based on the measurement system of the GPAQ, respondents were asked to indicate which of the LTPAs they presently practiced, how many days a week they practiced this activity during a typical week, and how many hours and minutes on a typical day—a day on which they practiced a certain LTPA. Students from the Sports Sciences faculty filled out the questionnaire twice, in order to separate academic PAs from activities practiced in their leisure time. Here, only the latter were used for the analyses, since our focus was on leisure time practice, and mandatory PA could distort the results. The GPAQ is used extensively in the scientific field and has good psychometric properties (Armstrong et al., 2006).

In order to boil down the number of LTPAs assessed with the CPAD-T questionnaire to a manageable set of dimensions, we extracted the combination of dimensions that best accounted for correlations among different LTPAs with a principal component analysis (PCA; see Appendix A for a detailed description of the analysis). Table 1 shows the factor loadings after rotation. Based on literature (Ford, 2007; García et al., 2011; Kondric et al., 2013; NIH, 2011) we identified the components as Opposition LTPA (Factor 1); Ski, Skate, and Board LTPA (Factor 2); Non-Intrusive Endurance LTPA[3] (Factor 3); Fitness and Bodybuilding LTPA (Factor 4); Aerobics LTPA (Factor 5); Competitive Individual LTPA (Factor 6); and Swimming LTPA (Factor 7).

Subsequently, we carried out a k-means cluster analysis with Euclidean distance measure on the Non-Intrusive Endurance LTPA factor scores, in order to discriminate a

3 With Non-Intrusive Endurance LTPA we refer to PAs that are usually practiced to sustain physical condition and supposed to minimally interfere with daily life.

Table 1. *Factor Loadings From Principal Component Analysis With Varimax Rotation for Leisure Time Physical Activities (LTPA) of the Questionnaire of Participation in Sports Activities per Type* (N = *329)*

	Rotated factor loading						
LTPA	1	2	3	4	5	6	7
Padel tennis	**.73**	.04	-.02	-.00	.01	.17	.14
Tennis	**.66**	-.16	-.00	-.07	.08	.13	.20
Soccer	**.60**	.19	.02	.16	-.16	-.27	-.20
Winter sports	.00	**.76**	.08	-.03	.08	.10	.25
Skating	.01	**.73**	-.08	.01	-.07	-.05	-.21
Fitness at home	.02	-.20	**.73**	-.17	.08	-.06	-.21
Running	.05	.07	**.61**	.36	-.23	.06	.08
Hiking	-.17	.32	**.58**	-.03	.06	.04	.46
Bodybuilding	.00	-.13	.00	**.79**	-.13	.06	-.02
Fitness at gym	-.12	.18	-.01	**.63**	.42	-.12	.03
Aerobics	-.16	-.11	-.09	.11	**.72**	-.02	.10
Basketball	-.18	-.09	-.06	.13	**-.59**	-.01	.16
Athletics	.05	-.06	-.12	.05	-.10	**.82**	.07
Cycling	.16	.24	.29	-.06	.12	**.58**	-.22
Swimming	.28	-.03	-.06	.01	-.07	-.05	**.75**
Initial eigenvalue	1.75	1.60	1.30	1.24	1.15	1.05	1.03
% of variance	11.68	10.65	8.64	8.24	7.66	6.98	6.87

Note. Boldface indicates highest factor loadings. Factor 1 = Opposition LTPA; Factor 2 = Ski, Skate, and Board LTPA; Factor 3 = Non-Intrusive Endurance LTPA; Factor 4 = Fitness and Bodybuilding LTPA; Factor 5 = Aerobics LTPA; Factor 6 = Competitive Individual LTPA; Factor 7 = Swimming LTPA.

Table 2. *Demographic Characteristics per Cluster Distinguished on Endurance Leisure Time Physical Activity (LTPA;* N = *329)*

	Cluster 1: Low–Normal Endurance LTPA (*n* = 287)				Cluster 2: Excessive Endurance LTPA (*n* = 42)			
Characteristic	%	*M*	*SD*	*Mdn*	%	*M*	*SD*	*Mdn*
Age (years)		21.25	3.60	2.17		21.01	2.68	20.17
Gender (female)	55.7				54.8			
Degree (Sports Sciences)	39.0				31.0			
Years of education attendance		14.27[a]	2.82[a]	14.00[a]		13.88	2.97	13.50
Education level mother		1.75[b]	0.95[b]	2.00[b]		1.81	1.04	2.00
Education level father		1.82[c]	0.99[c]	2.00[c]		1.83	0.99	2.00

Note. [a]*n* = 278. [b]*n* = 285. [c]*n* = 284.

group of participants who practiced endurance LTPA at very high to excessive levels compared to the rest of the sample. We labeled the clusters Low–Normal Endurance LTPA (Cluster 1; $n = 287$) and Excessive Endurance LTPA (Cluster 2; $n = 42$). Demographic characteristics per cluster are shown in Table 2. In Appendix B, we explain the analysis in more detail. Table B.1 displays intercluster differences in participation in each LTPA.

For the measurement of the non-drug-related SRPs we used the questionnaire MULTICAGE CAD-4 (Pedrero Pérez et al., 2007). The questionnaire consists of 32 items assessing alcohol-, drug-, video gaming-, sex-, eating-, gambling-, internet-, and spending-related SRPs. Here, we only used the non-drug-related variables. All items are dichotomous (yes/no). In each SRP subscale, zero or one affirmative answers indicate non-existence of a clinically relevant problem, two affirmatives indicate a possible existence of a problem, three a very probable, and four an almost definite existence of a problem (a score of 2 or higher is considered clinically significant). The questionnaire is easily applicable and presents adequate psychometric and discriminative properties (Pedrero Pérez et al., 2007).

In order to test the incidence of problematic eating behavior as a function of LTPA participation, we identified individuals with eating-related SRP scores above a clinically significant threshold: We divided scores on the eating-related SRP variable into 0–1 indicating a low probability, and 3–4 indicating a high probability of clinical problems.

Participants who scored 2 were not included, in order to diminish the possibility of false positives.

Impulsivity was assessed with the Spanish brief UPPS-P Impulsive Behavior Scale (Cándido, Orduña, Perales, Verdejo-García, & Billieux, 2012; Whiteside, Lynam, Miller, & Reynolds, 2005), based on the model explained above. Each trait is measured by four items, scored on a four-point Likert scale ranging from 1 (*strongly agree*) to 4 (*strongly disagree*). Psychometric properties are satisfactory and can be found in Cándido et al. (2012).

Statistical Analyses

For the first hypothesis regarding the relationships between LTPA and non-drug-related SRPs, we conducted a partial correlation analysis including LTPA factors, non-drug-related SRP scores, and impulsive personality traits. Demographic variables (gender, age, years of education attendance, and education level completed by the mother) entered the analysis as control variables. These variables have been previously found to be associated with drug-related SRPs (Gardner, 1994; Lamptey, 2005), and, in the present study, correlated either with LTPA or with non-drug-related SRP scores. Whether a participant studied at the faculty of Sports Sciences or not also entered the analysis as a covariate (for a detailed description of the analyses see Appendix C).

For the second set of hypotheses we explored the potential clinical correlates of the different LTPA patterns showed by the Low–Normal Endurance LTPA and Excessive Endurance LTPA clusters three-way. First, we compared the proportion of individuals who presented clinically significant scores on the eating-related SRPs across the two endurance LPTA groups with the use of a Fisher's exact test. Second, we analyzed differences between groups per MULTICAGE CAD-4 eating-related SRP item, again using Fisher's exact tests. Finally, we compared the two groups on each of the impulsive personality traits by conducting independent samples *t* tests.

We performed all analyses using IBM SPSS Statistics 20, and applied a .05 significance criterion.

Results

Sample characteristics

The most popular LTPAs, practiced by at least 15 participants, both female and male students, from the faculty of Sports Sciences as well as other faculties, were running (36.4%, including jogging and trail running), soccer (23.7%), bodybuilding (21.9%, including weight lifting), aerobics (17.9%, including corporal expression, dancing, steps, pilates, yoga, acrobatics, pole dance, spinning, and similar guided LTPAs), fitness at home (17.6%), cycling (16.4%), fitness at gym (14.0%), padel tennis (13.7%), hiking (13.7%, including trekking and mountaineering), swimming (8.5%), winter sports (7.6%), basketball (7.3%), tennis (7.0%), athletics (4.6%), and skating (4.6%). Some participants practiced more than one activity, while some others ($n = 54$) did not practice any LTPA. The mean time spent in LTPA was 8.08 h/week ($SD = 8.13$). The sample median was 6 hours and the middle 50% of the respondents spent between 1.5 and 12 hours in LTPA. The frequencies categorized by gender and faculty are shown in Table 3.

Table 4 displays the frequency distributions of non-drug-related SRPs in the sample (according to the

Table 3. *Practiced Leisure Time Physical Activity in Hours per Week (*N *= 329)*

	Faculty of Sports Sciences						Other faculties					
Gender	*n*	%	*M*	*SD*	*Mdn*	*IQR*	*n*	%	*M*	*SD*	*Mdn*	*IQR*
Female	39	11.9	8.92	7.00	6.25	14.00–4.50	144	43.8	4.73	5.45	3.00	7.19–0.06
Male	86	26.1	12.63	9.02	11.21	16.00–6.38	60	18.2	9.06	7.10	7.00	14.77–1.50

Table 4. *Non-Drug-Related Self-Regulation Problem (SRP) Scores of MULTICAGE CAD-4 Questionnaire (*N *= 329)*

	Video gaming		Sex		Eating		Gambling		Internet		Spending	
SRP score	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
0	281	85.4	267	81.2	191	58.1	311	94.5	124	37.7	246	74.8
1	28	8.5	39	11.9	76	23.1	11	3.3	90	27.4	48	14.6
2	15	4.6	16	4.9	31	9.4	4	1.2	64	19.5	23	7.0
3	2	0.6	4	1.2	18	5.5	2	0.6	30	9.1	9	2.7
4	2	0.6	2	0.6	12	3.6	0	0.0	20	6.1	2	0.6
Missing	1	0.3	1	0.3	1	0.3	1	0.3	1	0.3	1	0.3
M (SD)	0.22 (0.36)		0.28 (0.67)		0.73 (1.08)		0.08 (0.36)		1.18 (1.21)		0.39 (0.79)	

MULTICAGE CAD-4 questionnaire). All distributions were positively skewed: The majority of the sample reported low scores on the non-drug-related SRP variables. As mentioned above, a score of 2 or higher indicates the possible existence of a non-drug-related SRP. As shown by the means and the relatively large number of risk scores of 2 or higher, quite some respondents showed potential eating- (18.5%) and internet-related (34.7%) SRPs, of whom a large part very probably presented those problems (score of 3 or 4): respectively 9.1% and 15.2%.

Impulsive personality traits measured with the UPPS-P range between 1 (*low impulsive personality traits*) to 4 (*high impulsive personality traits*). The mean scores were: negative urgency, $M = 2.38$ ($SD = 0.74$); positive urgency, $M = 2.47$ ($SD = 0.61$); sensation seeking, $M = 2.58$ ($SD = 0.75$); lack of premeditation, $M = 1.98$ ($SD = 0.56$); lack of perseverance, $M = 1.77$ ($SD = 0.59$). The overall mean was 2.24 ($SD = 0.42$). One participant did not fill in the scale.

Relationships between variables of interest

We used partial correlations to explore the associations between the variables of interest. The possible confounders described in Appendix C (gender, age, studying at the faculty of Sports Sciences or not, years of education attendance, and education level completed by the mother) were entered in the analyses as control variables. The correlations are shown in Table 5, with hypotheses-relevant associations presented in bold. An inverse relationship between LTPA and non-drug-related SRPs appeared only for Fitness and Bodybuilding LTPA and video gaming-related SRPs. We found a positive relationship for the same factor Fitness and Bodybuilding LTPA and sex-related SRPs. Finally, as predicted, a positive correlation emerged for Non-Intrusive Endurance LTPA and eating-related SRPs.

In these associations between LTPA and non-drug-related SRPs we found a possible involvement or moderating effect of impulsive personality traits only for sensation seek-

Table 5. *Partial Intercorrelations Among Measures of Leisure Time Physical Activity (LTPA), Non-Drug-Related Self-Regulation Problems (SRPs), and Impulsive Personality Traits* (N = *329)*

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1. Opposition LTPA	—																	
2. Ski, Skate, & Board LTPA	-.07	—																
3. Non-Intrusive Endurance LTPA	.02	.03	—															
4. Fitness & Bodybuilding LTPA	-.13*	-.02	.01	—														
5. Aerobics LTPA	.11°	.04	.00	.08	—													
6. Competitive Individual LTPA	-.03	.00	.01	-.02	.00	—												
7. Swimming LTPA	.01	.10°	-.01	-.01	-.02	-.02	—											
8. Video gaming-related SRPs	.01	-.02	.02	**-.13***	-.06	.06	.02	—										
9. Sex-related SRPs	-.06	.06	-.02	**.16****	-.02	-.04	-.01	.09	—									
10. Eating-related SRPs	-.06	-.01	**.17****	.04	**.10°**	.07	-.02	-.01	.07	—								
11. Gambling-related SRPs	.05	-.09	-.03	.09	.06	-.01	-.03	.06	.18**	.07	—							
12. Internet-related SRPs	.03	-.03	.06	.04	-.04	.01	-.03	.16**	.17**	.17**	.06	—						
13. Spending-related SRPs	-.02	-.01	-.01	.06	.00	-.06	-.03	.12*	.32**	.16**	.06	.22**	—					
14. Negative urgency	-.02	.00	.00	.03	.00	.02	-.07	.06	.19**	.21**	.10°	.15**	.18**	—				
15. Positive urgency	-.08	.08	.04	.09	-.01	.03	-.02	.03	.23**	.15**	.15*	.15**	.24**	.50**	—			
16. Sensation seeking	.00	.17**	-.01	**.17****	-.03	.17**	.00	-.06	**.26****	.07	.11*	.11°	.12*	.19**	.41**	—		
17. Lack of premeditation	-.05	.09	-.02	.07	.04	-.04	.02	.07	.19**	-.01	.00	.11°	.08	.23**	.33**	.29**	—	
18. Lack of perseverance	.01	-.12*	-.05	-.04	-.04	-.04	-.05	.12*	.15**	.05	.20**	.21**	.18**	.11°	.25**	.05	.27**	—

Note. Boldface indicates highest hypotheses-related correlations. Control variables were age, gender, studying at the faculty of Sports Sciences or not, years of education attendance, and education level completed by the mother. ° $p < .10$. * $p < .05$. ** $p < .01$.

ing in the positive relationship between Fitness and Bodybuilding LTPA and sex-related SRPs. As shown in Table 5, sensation seeking correlated both with Fitness and Bodybuilding LTPA and with sex-related SRPs.

Eating-related SRPs in Excessive Endurance LTPA practitioners

In the Low–Normal Endurance LTPA cluster (n = 287) 7.7% showed a score of 3 or higher on eating-related SRPs, versus 19.0% of the Excessive Endurance LTPA cluster (n = 42). An analysis of the data with a Fisher's exact test, in which we excluded individuals who scored 2 on the eating-related SRP subscale, as explained above, yielded a significant association between endurance LTPA cluster and eating-related SRPs, p = .017, OR = 3.10, 95% CI [1.26, 7.63]. Supporting the hypothesis, the proportion of respondents presenting scores above the clinically significant threshold in eating-related SRPs (3-4 MULTICAGE scores in the eating disorders subscale, as opposed to individuals with 0-1 scores) was 2.64 times higher in the Excessive Endurance LTPA cluster.

Fisher's exact tests carried out with the whole sample (N = 329) showed that the clusters significantly differed in affirmative answers only on the first item of the eating-related SRP variable, "Have you ever provoked vomiting to avoid weight gain?", p = .040, OR = 2.43, 95% CI [1.06, 5.57].The proportion of individuals indicating "yes" was 2.12 times higher for the Excessive Endurance LTPA cluster. Confirming the previously reported partial correlations (Table 5), t tests showed no significant intercluster differences with regard to the impulsive personality traits: The lowest p-value was p = .201.

Discussion

Summarizing the main results, data unveiled a very limited number of associations between LTPA and non-drug-related SRPs and behavioral addictions in a community sample of university students. The higher an individual's practice levels of Fitness and Bodybuilding LTPA, the lesser video gaming-related and the more sex-related SRPs were reported. High participation in endurance LTPAs was associated with more eating-related SRPs, and specifically with vomiting as a strategy to control weight. Furthermore, a considerable amount of positive relationships supported the hypothesized association between impulsive personality traits and non-drug-related SRPs. However, we did not find clear associations between impulsive personality traits and LTPAs that could, in turn, be responsible for a relationship between LTPAs and non-drug-related SRPs.

The strength model of self-control (Baumeister et al., 2011; Baumeister et al., 2007) predicts inverse relationships between LTPA participation and non-drug-related SRPs. In partial accordance with this model, we found lower levels of Fitness and Bodybuilding LTPA participation to correlate with higher levels of video gaming-related SRPs. However, although the model proposes availability of self-control resources to be at the core of SRPs and regular engagement in effortful activities (Dorris et al., 2012; Joseph et al., 2011), in our study we did not find any indications of impulsive personality traits being responsible for the association. Alternatively, the *displacement* hypothesis could account for the inverse association between Fitness and Bodybuilding LTPA and video gaming-related SRPs. This proposition states that time spent in sedentary behaviors displaces time that could be spent in PA (Ballard, Gray, Reilly, & Noggle, 2009; Mansoubi, Pearson, Biddle, & Clemes, 2014). Consistent with our results, Ballard and colleagues (2009) found a negative relationship between time dedicated to video gaming and PA levels.

The Fitness and Bodybuilding LTPA factor was positively related to sex-related SRPs, with high sensation seeking simultaneously correlating with both constructs. To our knowledge, a relationship between PA and excessive sexual behavior has never been directly analyzed. However, previous research suggests (1) an association between bodybuilding (Litt & Dodge, 2008; McCreary & Sasse, 2000), even to excess (Hale, Roth, DeLong, & Briggs, 2010; Hurst, Hale, Smith, & Collins, 2000), and drive for muscularity, especially reported among men (McCreary, 2012; McCreary et al., 2000); (2) associations of muscularity (in men) and thinness (in women) with ideals of attractiveness (Murnen & Don, 2012; Murray, Rieger, Touyz, & De la Garza García, 2010); and (3) an association between drive for attractiveness and frequency of sexual intercourse (Brody, 2004; Filiault, 2007; Swami, Diwell, & McCreary, 2014). Our results suggest the possibility that Fitness and Bodybuilding LTPA practice can be associated with not only an enhanced sexuality, but also with its potential negative consequences in the form of SRP symptoms of hypersexuality.

Besides drive for attractiveness, an alternative (not necessarily incompatible) explanation comprises the existence of a common personality factor associated with both behaviors. In accordance with that possibility we found sensation seeking to correlate with both Fitness and Bodybuilding LTPA and sex-related SRPs. Higher levels of sensation seeking have been found before among fitness club members (Lichtenstein et al., 2014), and sensation seeking has been reported as a robust predictor of risky sexual behavior (e.g., Hoyle, Fejfar, & Miller, 2000; Zapolski, Cyders, & Smith, 2009).

The primary PA dependence hypothesis was not confirmed: We did not find impulsive personality trait markers (which were expected to be mainly negative urgency and sensation seeking; Billieux et al., 2007; Dick et al., 2010; Navas, Torres, Cándido, & Perales, 2014; Navas, Torres, Vilar, et al., 2014) to potentially underlie positive associations between excessive endurance LTPA measures and non-drug-related SRPs. However, in accordance with the

secondary PA dependence hypothesis (de Coverley Veale, 1987), higher scores on the Non-Intrusive Endurance LTPA factor (containing running, fitness at home, and hiking) correlated with signs of eating-related SRPs. Moreover, belonging to a cluster of individuals showing very high practice patterns of this type of LTPA (labeled here as Excessive Endurance LTPA) more than doubled the probability of presenting symptoms of eating-related SRPs above the clinically significant threshold, compared to Low–Normal Endurance LTPA participants. This is consistent with prior research, indicating that excessive endurance PA participation and disordered eating patterns often go hand in hand (Allegre et al., 2006; Grandi et al., 2011; Lichtenstein et al., 2014). Moreover, as a novel result, we found that vomiting as a weight-control strategy distinguished between Low–Normal Endurance LTPA and Excessive Endurance LTPA participants.

The impulsive personality trait negative urgency correlated with eating-related SRPs. This result is consistent with reports of negative urgency as a strong predictor of psychopathology, especially in the realm of SRPs (Billieux et al., 2007; Dick et al., 2010). The potential association of eating-related SRPs and sensation seeking, proposed by previous researchers as a signal of early exposure to potentially addictive substances (e.g., Cyders, Flory, Rainer, & Smith, 2009), as well as with overeating and obesity (e.g. Schag, Schönleber, Teufel, Zipfel, & Giel, 2013), has not been found here. This suggests that the type of eating-related SRPs detected in the current sample and found to be related to excessive LTPA is not the type that has been described as food addiction (e.g. Lerma-Cabrera, Carvajal, & Lopez-Legarrea, 2016), but is more closely linked to clinical or subclinical forms of anorexia and bulimia. The relationship between excessive LTPA and vomiting also points in that direction.

Strengths and Limitations

The conclusions presented are potentially affected by a number of limitations. Foremost, future (longitudinal) research is needed in order to examine directions of the correlational findings in our cross-sectional self-report study. Another limitation is the fact that, given the exploratory nature of the study, some hypotheses were rather open. Because we used no methods for alpha adjustment, this could be deemed fishing. Even so, this does not apply to the remarkable association found between endurance LTPA and eating-related SRPs, which we expected based on a very specific hypothesis.

Furthermore, we based the hypotheses in part on PA dependence models (e.g., de Coverley Veale, 1987), although, for PA, characteristics of addiction have not been measured: Purely behavioral measures are not necessarily associated with PA dependence attitudes (Adkins & Keel, 2005; Mond, Hay, Rodgers, & Owen, 2006). A mayor strength is the adaptation of the GPAQ (Armstrong et al., 2006) without altering its measurement system, which allowed us to assess sport modalities: The importance of sport types in relation to self-regulation issues has scarcely been paid any attention to in prior research.

The generalizability of the results is supported by the most practiced LTPAs being very comparable to the most practiced sports in Spain (García et al., 2011). Moreover, in a study with a population of all ages (Rodríguez Monje, Pedrero Pérez, Fernández Girón, Gallardo Alonso, & Sanz Cuesta, 2009) very similar–heavily skewed–distributions of non-drug-related SRP were found. A larger sample size in our study may have yielded more respondents with potentially clinical problem scores and thereby resulted in a greater statistical power. Furthermore, the questionnaire may be oversensitive regarding internet abuse (Billieux, Schimmenti, Khazaal, Maurage, & Heeren, 2015), for which a high percentage of the sample scored above the risk threshold for clinical problems. However, the plausible prevalence rates found for the other non-drug-related SRPs still show substantial percentages of potentially clinical addictive behaviors among university students. This supports the relevance of early recognition and intervention, especially since people showing addictive behaviors often experience comorbid psychopathological symptoms and even suicidal ideation (Bousoño et al., 2017; Martín-Fernández et al., 2017). Correctly assessing individual profiles of potentially clinical problematic behaviors, including non-drug-related SCPs and LTPA practice patterns, helps the identification of people at risk, contributes to prevention, and helps to establish treatment plans adapted to the profile of a person (Martín-Fernández et al., 2017). The study has major strengths regarding eating-related SRPs. The possibility that we actually measured clinical eating-related self-regulation pathology is high, given multiple indicators. Negative urgency was associated with eating-related SRPs, and substantial evidence has shown that this impulsive personality trait is an indicator of clinical pathology (Billieux et al., 2007; Dick et al., 2010). Furthermore, Pedrero Pérez et al. (2007) found a diagnostic sensibility for the cut-off point of two or more affirmative answers indicating a clinical problem above 90% for substance abuse: In the present study, we used an even more conservative cut-off point of three or four affirmative answers to indicate clinical eating-related SRPs. Finally, the difference in eating-related SRPs between the Low–Normal Endurance LTPA and Excessive Endurance LTPA participants seemed to be especially true for the use of vomiting as a strategy to avoid weight gain: This MULTICAGE CAD-4 questionnaire item was previously found to be related to diagnosed anorexia and bulimia (Rodríguez Monje et al., 2009), and thus could be considered as a sign of clinical eating pathology.

Finally, the powerful outcomes of the endurance LTPA cluster comparisons strongly suggest that associations between LTPA and SRPs occur only on very high (that is, ex-

cessive or clinically significant) levels of both constructs. This may be an explanation for the small effects between the continuous variables when measured in the full range, and requires further examination.

Conclusions

In order to develop effective intervention and treatment plans for SRPs and behavioral addictions, the understanding of the at-risk population is imperative. The present study has aided in the identification of LTPA practice patterns and impulsive personality traits as risk and protective factors for non-drug-related SRPs, and is of added value due to explorations per LTPA modality. Main novel findings were an inverse relationship between Fitness and Bodybuilding LTPA and video gaming-related SRPs; a triangle of positive associations between Fitness and Bodybuilding LTPA, sex-related SRPs, and sensation seeking; and, most important, a positive relationship of running, fitness at home, hiking, and similar endurance LTPAs with eating-related SRPs, with the eating disorder symptom vomiting more often shown in people presenting very high participation in those activities. This result is of particular importance, since the use of vomiting as a weight loss strategy is highly indicative of eating pathology.

The results of our study suggest a substantial prevalence of potentially clinical non-drug-related SRPs and behavioral addictions among university students, supporting that possibilities to recognize, intervene on or prevent those are relevant to address. Therefore, it is recommended that well-designed future research extends the evidence for the role of LTPA as both a risk behavior and a non-pharmaceutical intervention strategy for self-regulation issues in various populations, and further detects psychological antecedents of those associations. This can aid in further elucidation of warning signs and treatment possibilities for risky and unhealthy behaviors regarding self-regulation.

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Conflicts of interest

None of the authors declare competing financial interests.

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Appendix A
Factor Analysis for Leisure Time Physical Activities

In order to boil down the number of LTPAs assessed with the CPAD-T questionnaire to a manageable set of dimensions, we extracted the combination of dimensions that best accounted for correlations among different LTPAs with a principal component analysis (PCA). Because scores on the variables of interest significantly differed depending on gender and faculty, we only included activities practiced by both female and male students, from the faculty of Sports Sciences as well as other faculties. These were running, soccer, bodybuilding, aerobics, fitness at home, cycling, fitness at gym, padel tennis, hiking, swimming, winter sports, basketball, tennis, athletics, and skating. The minimum amount of cases for factor analysis was satisfied (MacCallum, Widaman, Zhang, & Hong, 1999), with at least 15 respondents in each LTPA category. We analyzed the intercorrelations among the variables, showing that all items significantly correlated up to .14–.33 (one-tailed) with at least one other item. The only exception was basketball, although the data showed a trend to significance with aerobics, $r = -.07$, $p = .116$. This indicated reasonable factorability and the absence of multicollinearity. Bartlett's test of sphericity was significant, $\chi^2(105) = 283.17$, $p < .001$, and the communalities were all (except basketball, .43) above .50, with an average communality of .61. This confirmed that each item shared some variance with other variables, thus that the relations between the variables were sufficiently large for PCA. Given these indicators, we carried out the factor analysis with all 15 items.

The analysis resulted in seven components, with eigenvalues over Kaiser's criterion of 1. In combination, the components explained 60.7% of the variance. There was little difference between the Varimax and Oblimin solutions: For the final model we chose the Varimax rotation. Table 1 shows the factor loadings after rotation. Based on literature (Ford, 2007; García et al., 2011; Kondric et al., 2013; NIH, 2011) we identified the components as Opposition LTPA (Factor 1); Ski, Skate, and Board LTPA (Factor 2); Non-Intrusive Endurance LTPA (Factor 3); Fitness and Bodybuilding LTPA (Factor 4); Aerobics LTPA (Factor 5); Competitive Individual LTPA (Factor 6); and Swimming LTPA (Factor 7).

Appendix B
Cluster Analysis for Endurance LTPA

We carried out a k-means cluster analysis with Euclidean distance measure on the Non-Intrusive Endurance LTPA and Aerobics LTPA factors, in order to discriminate a group of participants who practiced endurance LTPA at very high levels compared to the rest of the sample. The Aerobics LTPA factor did not discriminate between the clusters, $F(2, 326) = .11$, $p = .738$, so we made the decision to carry out the cluster analysis only with the Non-Intrusive Endurance LTPA factor.

We labeled the clusters Low–Normal Endurance LTPA (Cluster 1; $n = 287$) and Excessive Endurance LTPA (Cluster 2; $n = 42$). The small size of the Excessive Endurance LTPA cluster is an indication of the statistical anomaly of this group: As aimed for, the clusters separated the individuals who practiced excessive levels of endurance LTPA from the rest of the sample. In Table 2, demographic characteristics per cluster are shown. There were no significant intercluster differences as examined using chi-square and *t* tests: The lowest *p*-value was $p = .320$. Table B.1 displays intercluster differences in participation in each LTPA.

Table B.1 *Practiced Leisure Time Physical Activity (LTPA) in Hours per Week per Cluster Distinguished on Endurance LTPA* (N = *329)*

	Cluster 1: Low–Normal Endurance LTPA (*n* = 287)				Cluster 2: Excessive Endurance LTPA (*n* = 42)			
LTPA	*n*	%	*Mdn*	*IQR*	*n*	%	*Mdn*	*IQR*
Running	90	31.4	1.50	2.00–1.00	30	71.4	4.00	6.00–2.00
Soccer	67	23.3	2.00	5.00–1.00	11	26.2	2.00	3.00–1.00
Bodybuilding	64	22.3	5.00	7.50–3.00	8	19.0	4.92	7.13–3.13
Aerobics	52	18.1	3.00	5.00–2.00	7	16.7	2.00	4.00–1.67
Fitness at home	33	11.5	1.00	1.50–0.58	25	59.5	3.00	4.75–2.67
Cycling	43	15.0	2.00	3.00–1.00	11	26.2	4.50	9.67–3.00
Fitness at gym	40	13.9	3.00	7.40–1.75	6	14.3	5.25	6.50–2.50
Padel tennis	38	13.2	1.50	2.50–1.00	7	16.7	1.00	1.50–1.00
Hiking	27	9.4	2.00	3.00–1.50	18	42.9	6.00	10.13–3.00
Swimming	24	8.4	2.00	4.50–1.13	4	9.5	3.00	4.00–0.64
Winter sports	19	6.6	3.50	8.00–2.00	6	14.3	5.38	9.00–2.19
Basketball	20	7.0	3.50	4.50–1.50	4	9.5	2.75	4.00–0.75
Tennis	20	7.0	2.00	3.75–1.00	3	7.1	1.50	––1.00[a]
Athletics	14	4.9	1.63	2.63–1.00	1	2.4	2.50	–––[a]
Skating	11	3.8	4.00	10.50–1.00	4	9.5	1.00	3.25–0.63

Note. [a]No upper and/or lower quartile exists due to small *n*.

Appendix C
Preliminary Analyses for Demographic Confounders

We used a correlation analysis to identify potential demographic confounders. Age significantly correlated with internet-related SRPs, r = -.15, p = .007. Years of education attendance presented significant associations with leisure time practice of soccer, r = -.12, p = .032, fitness at gym, r = .12, p = .028, as well as with eating-related SRPs, r = .11, p = .045. The education level completed by the mother was correlated with leisure time practice of cycling, r = .12, p = .029, and winter sports, r = .11, p = .048.

Variance analyses showed significant differences between students of the faculty of Sports Sciences (n = 125) and other faculties (n = 204). The students of the faculty of Sports Sciences showed higher means on leisure time practice of soccer, $F(1, 326) = 26.13$, $p < .001$, bodybuilding, $F(1, 326) = 29.45$, $p < .001$, padel tennis, $F(1, 326) = 27.23$, $p < .001$, swimming, $F(1, 326) = 6.68$, $p = .010$, basketball, $F(1, 326) = 7.43$, $p = .007$, tennis, $F(1, 326) = 15.30$, $p < .001$, athletics, $F(1, 326) = 3.93$, $p = .048$, and lower means on eating-related SRPs, $F(1, 326) = 5.72$, $p = .017$. We also found significant differences between male (n = 183) and female students (n = 146). Confirming previous reports, male students showed higher means on leisure time practice of soccer, $F(1, 326) = 30.40$, $p < .001$, bodybuilding, $F(1, 326) = 50.08$, $p < .001$, aerobics, $F(1, 326) = 11.43$, $p = .001$, padel tennis, $F(1, 326) = 12.49$, $p < .001$, basketball, $F(1, 326) = 5.43$, $p = .020$, winter sports, $F(1, 326) = 4.74$, $p = .030$, tennis, $F(1, 326) = 7.48$, $p = .007$, and skating, $F(1, 326) = 5.21$, $p = .023$, as well as in video gaming-, $F(1, 326) = 30.71$, $p < .001$, sex-, $F(1, 326) = 15.00$, $p < .001$, and gambling-related SRPs, $F(1, 326) = 4.58$, $p = .033$, and lower means on eating-related SRPs, $F(1, 326) = 8.01$, $p = .005$.

Based on these results, in the final analyses we set control measures for the variables age, gender, studying at the faculty of Sports Sciences or not, years of education attendance, and education level completed by the mother, but not for education level completed by the father.