

Exercise addiction risk and health in male and female amateur endurance cyclists

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Background and aims: To determine the relationship between the risk of exercise addiction (REA) and health status in amateur endurance cyclists. **Methods:** In 859 (751 men and 108 women) cyclists and 718 inactive subjects (307 men and 411 women), we examined the REA (Exercise Addiction Inventory), training status (volume, frequency, experience, and performance), socioeconomic status, quality of life (QoL) (SF-12), quality of sleep (Pittsburgh Sleep Quality Index), anxiety and depression (Hospital Anxiety and Depression Scale), and cardiometabolic risk: body mass index, physical activity (International Physical Activity Questionnaire), physical condition (International Fitness Scale), adherence to the Mediterranean diet (Mediterranean Diet Adherence Screener), alcohol and tobacco consumption. **Results:** In total, 17% of the cyclists showed evidence of REA and 83% showed low REA. REA occurred independent of age, sex, training, and socioeconomic status (all $ps > .05$). Regardless of REA, the cyclists displayed a better physical QoL and a lower cardiometabolic risk than the inactive subjects (all $ps < .05$). The cyclists with REA displayed worse values of mental QoL, quality of sleep, and anxiety than cyclists with low REA (all $ps < .05$). The REA group had better values of mental QoL and anxiety and similar values of quality of sleep than the inactive subjects. The differences in mental QoL between the REA and low REA groups were significantly greater in women ($p = .013$). There was no Addiction \times Sex interaction in the other analyzed variables. **Conclusion:** Our results suggest that an increased prevalence of REA limits the benefits that amateur endurance cycling has on mental health and quality of sleep.

Keywords: risk of exercise addiction, endurance training, physical activity, health, quality of life, quality of sleep

INTRODUCTION

Scientific evidence shows that the beneficial effect of exercise on physical and mental health is indisputable (Allegre, Therme, & Griffiths, 2007). However, it has been suggested that there can be a limit in the exercise volume that results in negative health effects, such as the risk of exercise addiction (REA) (Szabo, Griffiths, de La Vega, Mervó, & Demetrovics, 2015). Exercise addiction has been described as a morbid pattern of behavior in which the habitually exercising individual loses control over his or her exercise habits and acts compulsively, exhibits dependence and experiences negative consequences to health as well as in his or her social and professional life (Szabo et al., 2015).

Research on exercise addiction is relatively new, and the subsequent results are unclear. A significant limitation is the use of multiple terminologies to describe the same phenomenon, such as exercise addiction, exercise dependence, obligatory exercise, compulsive exercise, and excessive exercise (Berczik et al., 2012). In this research, the term addiction is considered to be the most appropriate because it incorporates both dependence and compulsion (Berczik et al., 2012). Research is primarily based on self-reports

obtained from questionnaires, such as the Compulsive Exercise Test (CET) (Tarani, Touyz, & Meyer, 2011), the Exercise Dependence Scale (EDS) (Hausenblas & Downs, 2002), and the Exercise Addiction Inventory (EAI) (Terry, Szabo, & Griffiths, 2004), that provide a range or risk scores instead of a diagnosis (Szabo et al., 2015).

The review of the extant models specifically utilized for the explanation of exercise addiction clearly revealed that there was inconsistency in the research perspectives from which this behavioral addiction was examined (Egorov & Szabo, 2013). Indeed, exercise addiction falls within the field of behavioral addictions, but because of the lack of sustained and methodologically rigorous evidence for exercise addiction as a morbidity, the disorder is not listed as a mental dysfunction in the latest (fifth) edition of the *Diagnostic and Statistical Manual of Mental Disorders, DSM-5* (American Psychiatric Association, 2013). To advance knowledge regarding the process of exercise addiction,

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we must identify the factors that determine a greater REA and establish the negative consequences of this addiction on health.

There is large variability among studies on the prevalence of REA (Szabo et al., 2015). Excessive training volume has been highlighted among the numerous objective and subjective factors that could explain this variability. Thus, although the prevalence of REA established by the EAI in general exercisers is 3.2% (Mónok et al., 2012), much higher values have been observed in endurance athletes (17%–20%) (Szabo, De la Vega, Ruiz-Barquín, & Rivera, 2013; Youngman & Simpson, 2014). Currently, studies with endurance athletes are scarce, and the relationship between REA and training volume is contradictory (Cook, Karr, et al., 2013; Szabo et al., 2013). The relationship between REA and other variables associated with training, such as weekly frequency, years of sports practice, physical condition, and sports performance, is also confusing or unknown (Freimuth, Moniz, & Kim, 2011; Youngman & Simpson, 2014). The influence of sex and age is controversial (Bruno et al., 2014; Griffiths et al., 2015), and numerous sociodemographic factors have not been studied.

Cycling is one of the most common sport/exercise activities, and its practice has been associated with a significant reduction in all-cause mortality (Oja et al., 2016). However, similar to other modalities, such as running and triathlon, many cycling practitioners are currently motivated to participate in road cycling and all-terrain biking events of high physical and psychological demand. Thus, it is typical for these amateur cycling events to have a level of demand (e.g., distance and accumulated unevenness) higher than that required in professional day cycling events. To meet such demands, these athletes require frequent and high-volume training that is likely associated with a high REA. In some of these cyclists, the REA may be increased by negative perfectionistic behavior, such as unrealistic self-expectations, a strong goal focus, and compensation for a fear of not trying hard enough or being dedicated enough to a chosen sport event (Macfarlane, Owens, & Cruz, 2016). Despite this, to date, the literature has not addressed REA in the amateur cycling community. Some amateur cyclists may benefit from clinical sport psychology interventions. However, for clinical sport psychologists to provide diagnosis and treatment for amateur cyclists, they must be aware of the prevalence and risk factors associated with exercise addiction specific to amateur cyclists.

The consequences of exercise addiction on health are not clearly defined. In fact, to our knowledge, no study with endurance athletes has established this relationship. In other athletic populations, the few studies that have compared athletes with and without addiction or dependence to exercise did not observe significant differences in global indicators of quality of life (QoL) associated with health (Lichtenstein, Christiansen, Bilenberg, & Støving, 2014; Modolo et al., 2011). It has also been suggested that athletes with REA would have a worse quality of sleep, but this aspect has not been clearly confirmed (Modolo et al., 2011). The relationship between exercise addiction and anxiety and depression symptoms is also controversial (Antunes, Andersen, Tufik, & DeMello, 2006; Maraz, Urbán, Griffiths, & Demetrovics, 2015). Contrarily, it has

also been suggested that the obsession for exercise could induce exercise-addicted athletes to acquire healthy habits associated with better physical health and lower cardiometabolic risk, such as lower tobacco and alcohol consumption and a more balanced diet (Lejoyeux, Avril, Richoux, Embouazza, & Nivoli, 2008). However, no study has established the relationship between REA and cardiometabolic risk, and very few studies have tested its relationship with other addictions (Di Nicola et al., 2015; Lejoyeux et al., 2008).

Indeed, unlike other addictions, the study of the consequences of exercise addiction on health is complex because of the simultaneously converging positive effects inherent to exercise and the negative effects inherent to addiction. From this perspective, although comparing athletes with REA to inactive subjects can be particularly interesting for establishing clinical diagnostic criteria, the scientific community has still not addressed this issue. Therefore, the objective of this study was to compare parameters associated with the physical and mental health of cyclists with REA, those with a low REA and inactive subjects; we also aimed to determine the factors associated with an increased REA. Our hypothesis was that cyclists with a high REA will have worse indices of QoL, quality of sleep, anxiety and depression than cyclists without the risk of addiction and inactive subjects. We do not expect differences among cyclists regarding factors of cardiometabolic risk, such as the level of physical activity, physical condition, body mass index (BMI), adherence to the Mediterranean diet, and tobacco and alcohol consumption. We also hypothesized that the REA would be higher in younger subjects with less training experience and who perform a higher training volume.

METHODS

Participants

An invitation to participate in the study was sent via e-mail to the representatives of the 3,426 cycling clubs that were integrated into the Royal Spanish Cycling Federation in 2016. The invitation included a brief introduction to the study, an explanation of the anonymous and voluntary nature of participation in the study, a link to the online survey, and a request for the information to be distributed to the 62,856 male and 2,483 female amateur cyclists officially registered in Spain. In total, 1,023 potentially eligible Spanish cyclists responded and sought more information. Finally, 859 amateur cyclists (751 men and 108 women) whose objective was to participate in May–June road cycling events (>100 km, $n = 403$) or mountain biking (MTB) events (>45 km, $n = 456$) were recruited. A total of 164 cyclists were excluded from the study for not meeting these criteria. Each cyclist was instructed to invite inactive subjects with similar sociodemographic status to participate in the study. Of a total of 1,527 subjects, 718 age-controlled subjects (307 men and 411 women) were classified as inactive based on the short International Physical Activity Questionnaire (IPAQ) form (Craig et al., 2003) and were included as the control group.

Materials

REA. The Spanish version of the EAI has shown satisfactory psychometric properties (α value = .70 and ICC = .92) (Sicilia, Alfas-García, Ferriz, & Moreno-Murcia, 2013); thus, this self-administered questionnaire was used to establish the REA. The EAI consists of six questions based on six general components of addiction: salience, mood modification, tolerance, withdrawal symptoms, social conflict, and relapse (Griffiths, 1996). The responses are rated on a 5-point Likert scale. The EAI classifies subjects as having a high REA (score: 24–30) or a low REA (score: 0–23).

Sociodemographic status. In addition to sex and age, a questionnaire was designed to evaluate the main sociodemographic variables that may condition the balance of training with family, social, and work obligations: size of municipality of residence, education level, marital status, number of children, type of occupation, and income level.

Training, athletic performance, and cycling event distance. A questionnaire was designed to evaluate the volume (hr/week in the last month), frequency (days/week in the last month) and training experience (years participating in amateur endurance cycling events and federated sports practice during adolescence) of the participants. The competition distance was also recorded. In 100 road cyclists (83 men and 17 women) who participated in the same cycling event (198 km and 3,500 m of positive slope), the average speed was recorded. This analysis was also performed for 60 male cyclists of MTB (163 km and 4,700 m positive slope).

Health status. The generic self-report short form 12-item Short Form Survey version 2.0 (SF-12v2) showed good psychometric properties (Vilagut et al., 2008) and was used to assess health-related QoL. Self-reporting of QoL has been found to be a good predictor of illness and well-being. This survey consists of 12 questions related to 8 sub-scales distributed into two components: physical health (QoL physical-12) and mental health (QoL mental-12). Higher scores indicate better functioning. Quality of sleep was evaluated with the Spanish version (Macías-Fernández & Royuela-Rico, 1996) of the Pittsburgh Sleep Quality Index (PSQI) (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989). The Spanish version of the PSQI has shown satisfactory psychometric properties (Hita-Contreras et al., 2014). It consists of 19 self-rating questions combined into seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleeping medications, and daytime dysfunction. These component scores are then summed to yield a global PSQI score, which has a range of 0–21, with higher scores indicating worse sleep quality. We used the Spanish version (Herrero et al., 2003) of the Hospital Anxiety and Depression Scale (HADS) (Zigmond & Snaith, 1983) to determine the levels of anxiety and depression. The Spanish version of the HADS has shown satisfactory psychometric properties (Herrero et al., 2003). This questionnaire consists of 7 items related to anxiety and 7 items related to depression. Each item on the questionnaire is scored from 0 to 3, indicating that a person can score between 0 and 21 for either anxiety or depression.

Based on the World Health Organization (2015), we established physical inactivity, unhealthy diet, and tobacco

and alcohol consumption as behavioral cardiometabolic risk factors. These factors are associated with the main causes of morbidity and mortality (Noble, Paul, Turon, & Oldmeadow, 2015). In addition, we measured BMI and physical condition. BMI was calculated based on self-reported values of weight and height. The level of physical activity was established by the Spanish version (Mantilla-Toloza & Gómez-Conesa, 2007) of the short IPAQ form (Craig et al., 2003), which has shown acceptable measurement properties. This questionnaire classifies subjects as having low, moderate, or vigorous physical activity levels. We evaluated cardiorespiratory fitness, muscular fitness, speed-agility, flexibility, and overall fitness using the International Fitness Scale (IFIS) questionnaire (Ortega et al., 2011), which has shown satisfactory psychometric properties in Spanish adults (Ortega et al., 2013). This instrument stratifies subjects according to their level of physical condition and predicts the risk of cardiovascular disease. We used the Mediterranean Diet Adherence Screener (MEDAS) questionnaire (Schröder et al., 2011) which has been shown to be a valid instrument to evaluate adherence to the Mediterranean diet. This instrument establishes a scoring range of 0–14 that differentiates subjects according to their adherence. Adherence to the Mediterranean diet has been associated with a lower cardiometabolic risk (Estruch et al., 2013). Consumption of and dependence on tobacco was evaluated by the Spanish version (Becona & Vázquez, 1998) of the Fagerström Test for Nicotine Dependence (Korte, Capron, Zvolensky, & Schmidt, 2013), which has shown good psychometric properties. Alcohol consumption was evaluated by calculating the standard alcohol units (Guardia-Serecigni, Jiménez-Arriero, Pascual, Flórez, & Contel, 2007).

Procedure

The participants answered an online survey with questions regarding age, height, and weight and answered the questionnaires described above that included questions about REA, sociodemographic status, training and athletic performance, and health status. The questionnaires took an average of 40 min to complete, and the Internet design prevented missing data. The cyclists were classified into two groups according to the REA (Terry et al., 2004). The data collection was completed on the last week of May.

Statistical analysis

The statistical analyses were performed using the IBM Statistical Package for the Social Sciences (IBM SPSS Statistics, v. 20.0 for WINDOWS). The cohort data are presented as the mean \pm standard deviation unless otherwise stated. Kolmogorov–Smirnov tests were used to check for normal distributions. To measure differences in the variables of interest between the groups of cyclists (with high and low REA) and the control group, we used ANOVA. Bonferroni correction was used to adjust the calculated p values to prevent type I error caused by the multiple comparisons. Therefore, to aid interpretation, we calculated effect sizes (Cohen's d) for the significant pairwise comparisons. We also performed two-way ANOVA to establish whether there

was an Addiction × Sex interaction in the various health parameters. We applied the chi-square (χ^2) test to check whether there were differences in REA depending on sex and depending on whether the federated sport was practiced during adolescence. The values were considered to be significant if $p < .05$.

Ethics

The participants gave their informed consent for the scientific use of the data. All participants were volunteers and received no incentive for taking part. The Committee on Biomedical Ethics of the Aragon Government approved this study.

RESULTS

The EAI value was slightly higher in men than in women (19.2 vs. 18.3; $p = .046$, $d = .20$), with a similar percentage of cyclists with REA (17% vs. 16%). In both sexes, there were no significant age differences between the REA and low REA groups (Table 1). There were no significant differences in the percentage of REA cyclists in subjects <35 years (19%), 35–50 years (15%), and >50 years (16%) ($p = .192$). REA was also not associated with training, competition distance, competition performance, or socio-demographic status (all $ps > .05$).

In both sexes, there were no significant differences between the REA group and the low REA group in physical QoL (men: $p = .117$, $d = .20$; women: $p = .590$, $d = .13$) and in variables associated with cardiometabolic risk. In both sexes, worse indices of mental QoL [men: $F(1, 749) = 7.561$, $p = .006$; women: $F(1, 106) = 11,330$, $p = .001$] were observed in the REA group than in the low REA group. In men, the REA group had worse indices of quality of sleep [$F(1, 749) = 3,904$, $p = .049$] and anxiety than the low REA group [$F(1, 749) = 10,685$, $p = .001$]. There were no differences in the values of depression between the REA and low REA groups ($p > .05$) (Table 2). The differences in mental QoL between the REA and low REA groups were significantly greater in women, $p = .013$ for the Addiction × Sex interaction. There was no Addiction × Sex interaction in the other analyzed variables.

In men, compared with the control group, the REA and low REA groups had better indicator of physical QoL, mental QoL, anxiety and cardiometabolic risk. Similar results were observed in women. In both sexes, the control group and the REA group had comparable values of quality of sleep. In men, compared with the control group, the REA group had worse indices of depression; no differences were observed between the groups in the sample of women (Table 2). No result varied significantly as a function of road cycling practice or MTB.

DISCUSSION

This is the first study to analyze the relationship between REA and various health-related parameters in a large sample of amateur endurance cyclists. The main findings were

Table 1. Differences of exercise addiction score, age, training, competition distance, and competition performance among cyclists with and without a risk of exercise addiction

	Men						Women							
	REA, n = 125	Low REA, n = 626	p	Cohen's d	r	Skew	Kurtosis	REA, n = 17	Low REA, n = 91	p	Cohen's d	r	Skew	Kurtosis
EAI score	25.9 ± 1.6	17.9 ± 3.4	<.001	3.01	.83	-0.04	-0.29	25.2 ± 1.3	17.0 ± 4.1	<.001	2.70	.80	-0.30	-0.50
Age (years)	37.2 ± 8.8	38.4 ± 8.4	.635	-0.14	-0.07	0.24	0.05	34.4 ± 10.0	37.4 ± 7.4	.455	-0.34	-0.17	-0.11	-0.67
Training														
Frequency last month (days/week)	3.9 ± 1.4	3.8 ± 1.3	.240	0.07	.04	0.16	-0.44	3.7 ± 1.6	3.6 ± 1.5	.914	0.06	.03	0.07	-0.87
Volume last month (hr/week)	11.3 ± 4.9	11.1 ± 4.8	.618	0.04	.02	1.29	2.44	10.7 ± 4.2	10.3 ± 4.4	.785	0.09	.05	1.01	1.16
Experience in cycling events (years)	4.2 ± 4.4	4.9 ± 4.8	.454	-0.15	-0.07	2.35	6.90	3.9 ± 3.2	2.8 ± 2.8	.147	0.37	.18	1.57	2.75
Sports experience in adolescence (percentage of subjects)	42.4	45.2	.742					35.3	29.7	.094				
Competition distance														
Road cycling (km)	162 ± 44	169 ± 44	.638	-0.16	-0.08	0.03	0.93	150.1 ± 47.4	139.7 ± 55.3	.816	0.22	.11	-0.25	-1.31
MTB (km)	121 ± 91	130 ± 108	.839	-0.09	-0.05	4.40	23.6	73.7 ± 24.1	90.9 ± 46.3	.144	-0.47	-0.23	1.79	4.29
Competition performance														
Road cycling (km/hr)	25.9 ± 4.7	26.6 ± 4.1	.687	-0.16	-0.08	-0.58	-0.63	28.6 ± 6.6	24.4 ± 5.6	.212	0.69	.32	1.12	1.03
MTB (km/hr)	13.9 ± 2.1	14.8 ± 2.9	.624	-0.36	-0.17	0.97	0.70							

Note. Values are the mean ± SD or percentage. REA: risk of exercise addiction group; EAI: Exercise Addiction Inventory; MTB: mountain biking. The analysis of competition performance was conducted for road cycling in a sample of 83 men (REA: n = 13; low REA: n = 70) and 17 women (REA: n = 5; low REA: n = 12) who participated in the same event (198 km, 3,500 m positive slope). This analysis was performed for MTB in a sample of 60 male cyclists (REA: n = 11; low REA: n = 49) who participated in a 163-km event with a 4,700-m positive slope.

Table 2. Differences in health status between cyclists with high and low risk of exercise addiction and inactive subjects (control group)

	Men				Women						
	REA, n = 125	Low REA, n = 626	Inactive, n = 307	p	p REA vs. low REA	REA, n = 17	Low REA, n = 91	Inactive, n = 411	p	p REA vs. low REA	p REA vs. inactive
Physical QoL	58.4 ± 6.1	57.5 ± 5.5	51.8 ± 8.5	<.001	.117	58.3 ± 6.8	57.5 ± 5.6	51.1 ± 10.6	<.001	.590	<.05
Mental QoL	48.2 ± 11.0	50.8 ± 9.4	43.2 ± 15.4	<.001	<.01	41.3 ± 12.8	50.8 ± 10.2	39.4 ± 17.3	<.001	.001	.304
Sleep	4.9 ± 2.5	4.4 ± 2.4	5.2 ± 2.8	<.005	<.05	5.2 ± 2.6	3.9 ± 2.6	5.2 ± 3.1	.001	.120	1.000
Anxiety	8.6 ± 2.1	7.9 ± 1.8	9.2 ± 2.4	<.001	≤.001	8.3 ± 1.6	7.7 ± 1.7	9.3 ± 2.4	.001	.663	1.000
Depression	10.0 ± 1.6	9.8 ± 1.5	9.3 ± 1.9	<.05	.653	9.5 ± 1.9	9.9 ± 1.7	9.5 ± 1.9	.124	.408	.809
Cardiometabolic risk											
BMI (kg/m ²)	24.5 ± 2.8	24.3 ± 2.5	26.3 ± 4.5	<.001	1.000	21.7 ± 2.8	22.2 ± 2.8	24.1 ± 4.2	<.001	1.000	.308
PA (MET-min/week)	7,576 ± 4,138	7,102 ± 4,445	1,065 ± 906	<.001	.711	7,103 ± 3,877	6,037 ± 3,946	923 ± 751	<.001	1.000	<.001
PC	4.1 ± 0.7	4.0 ± 0.7	2.8 ± 0.6	<.001	.614	4.2 ± 0.8	4.1 ± 0.7	2.7 ± 0.6	<.001	1.000	<.001
AMD	8.0 ± 2.3	8.3 ± 2.1	7.1 ± 2.0	<.001	.387	8.6 ± 2.3	9.1 ± 1.9	7.8 ± 1.9	<.001	.732	.530
Tobacco	0.1 ± 0.4	0.25 ± 1.2	1.8 ± 3.1	<.001	.282	0.1 ± 0.2	0.0 ± 0.0	0.9 ± 2.2	<.005	1.000	.246
SAU	6.2 ± 0.4	5.8 ± 7.9	8.3 ± 9.5	.081	1.000	1.5 ± 2.5	2.2 ± 4.7	3.2 ± 4.7	.069	1.000	.383

Note. Values are the mean ± SD. REA: risk of exercise addiction group; QoL: quality of life; BMI: body mass index; PA: physical activity; PC: physical condition; AMD: adherence to the Mediterranean diet; SAU: standard alcohol units. p values (ANOVA) between the three groups; post-hoc Bonferroni test between REA and low REA, and between REA and inactive group.

as follows: (a) 17% of subjects had REA; (b) REA was independent of sex, age, sociodemographic status, current and past training, competition distance, and competition performance; (c) REA negatively influences mental QoL, anxiety, and quality of sleep; and (d) REA does not influence indicators of cardiovascular risk and physical QoL.

REA, prevalence, and determinants

Our results extend to amateur endurance cyclists, with previous findings in ultramarathoners (Szabo et al., 2013), and triathletes (Youngman & Simpson, 2014), highlighting that according to EAI criteria, approximately 17%–20% of endurance athletes experience REA. This percentage is much higher than that observed in general exercisers (Mónok et al., 2012). However, we did not identify training volume as a susceptible index of exercise addiction, despite the high variability observed among our cyclists. These results are consistent with observations in ultramarathoners (Szabo et al., 2013). Interestingly, it is observed higher EAI values in half-Ironman (1.9 km swim/90 km cycle/21 km run) triathletes compared with Sprint (0.75 km swim/20 km cycle/5 km run) and Olympic (1.5 km swim/40 km cycle/10 km run) triathletes, without differences with respect to the values observed in Ironman (3.8 km swim/180 km cycle/42 km run) triathletes (Youngman & Simpson, 2014). Studies that have observed the relationship between training volume and indicators of the risk of addiction or dependence to exercise is characterized by samples that perform a relatively low training volume (Lejoyeux et al., 2008; Ruiz-Juan & Zarauz Sancho, 2012; Szabo et al., 2013). Overall, this analysis suggests that there may be a threshold from which training volume does not influence REA. It is also suggested that in long-distance sports, REA is not determined by training but rather by how athletes face and adapt the training to their lives. This hypothesis also has support from the absence of the relationship between exercise addiction and training frequency, training experience, and sports performance. The study of REA based on usual variations in training during the season of long-distance amateur athletes may be an area of interest for future studies.

Reviewers summarizing the research show that the literature currently lacks a clear consensus on differences and/or the moderating effect of sex in REA (Cook, Hausenblas, & Rossi, 2013; Weik & Hale, 2009). According to authors, among other factors, this controversy could be explained by differences between the sexes in the motivation to perform physical exercise and their associated factors, such as personality, body image, weight perception, eating disorders, narcissism, and self-esteem (Modolo et al., 2011). Thus, for example, it has been suggested that the different prevalence of alterations in eating behavior between men and women could significantly affect the results obtained in different studies (Lichtenstein, Christiansen, Elklit, Bilenberg, & Støving, 2014). However, even this aspect lacks clear evidence. In fact, in a large sample of runners, sex has not been shown to modulate the relationship between REA and altered eating behavior (Cook, Karr, et al., 2013). Studies also suggest that the different questionnaires used likely measure different aspects of REA that would favor each sex

differently (Cook, Karr, et al., 2013; Weik & Hale, 2009). There are also differences in the meaningful interpretation of EAI (Griffiths et al., 2015). The results observed in the literature according to sex in endurance athletes are also controversial, although sex differences are small or insignificant on a global scale. Thus, through EAI, a higher REA was found in a large sample of female triathletes (22%) than in male triathletes (18%) (Youngman & Simpson, 2014), whereas REA was higher in male marathoners (19%) than in female marathoners (15%) (Szabo et al., 2013). The results are also controversial with the use of other questionnaires in long-distance runners, with no sex differences in REA in several studies that used the Running Addiction Scale (Ruiz-Juan & Zarauz Sancho, 2012; Ruiz-Juan, Zarauz Sancho, & Flores-Allende, 2016; Zarauz Sancho & Ruiz-Juan, 2011). However, in another study using EDS, REA was slightly higher in women (Cook, Karr, et al., 2013). Overall, both our results and the analysis of the literature suggest that in endurance sports, sex is not a determinant factor of REA, and both sexes have a high percentage of REA. In this context, it should be considered that in all studies with endurance athletes, both men and women have the common motivation to participate in endurance events characterized by high physical and psychological demands. The analysis of possible differences in REA between men and women who differ in terms of exercise motivation is an area of interest for future studies. Likewise, our results suggest a greater impact of REA on women's mental health, but this should be tested with larger samples.

Younger subjects with less training experience might perform more compulsive sports practice than older subjects with more sports experience. However, the influence of age and sports experience on REA has rarely been studied. Studies that do not include long-distance endurance athletes have shown that the exercisers categorized as REA according to the EAI criteria were slightly younger than the exercisers categorized as low REA (Bruno et al., 2014; Lichtenstein, Christiansen, Elklit, et al., 2014). By contrast, in our study with a more heterogeneous aged sample, we did not observe age or training experience differences between REA and low REA groups. Specifically, our study revealed that REA is comparable among subjects with marked differences in age and training experience, which agrees with the results observed in large and heterogeneous samples of marathon runners and triathletes (Ruiz-Juan & Zarauz Sancho, 2012; Youngman & Simpson, 2014; Zarauz Sancho & Ruiz-Juan, 2011). In this regard, it should be considered that the incentive or motive for fulfilling planned exercise and exercise identity are important distinguishing characteristics between addicted and non-addicted exercisers (Berczik et al., 2012; Cook et al., 2015). In a manner equivalent to that established for sex, our results suggest that age and training experience are not particularly determinant factors of REA in subjects who have the common motivation to participate in high-endurance sports challenges. However, it is plausible to think that age as a possible differential factor of motivation toward the practice of exercise modulates the REA in other types of populations, although this requires empirical support. In line with previous studies with long-distance athletes (Allegre et al., 2007; Ruiz-Juan & Zarauz Sancho, 2012; Mónok et al., 2012), we

also did not observe a relationship between exercise addiction and other sociodemographic factors that could be associated with a more stressful lifestyle with a larger number of obligations. Overall, these results again suggest that extrinsic factors have little influence on REA.

REA on health

Currently, it is unknown whether greater health benefits are obtained at higher exercise volumes (Garber et al., 2011). Although this was not our objective of study, our results provide evidence that in both sexes, the practice of amateur long-distance cycling induces a better profile of physical and mental health than that observed in healthy inactive subjects.

To our knowledge, there are no previous studies that have related REA to parameters associated with health in exclusive samples of amateur long-distance athletes. Our results with cyclists suggest that REA has an influence on mental health but not on physical health. Our results on physical QoL agree with those observed in previous studies with heterogeneous samples of athletes (Lichtenstein, Christiansen, Bilenberg, et al., 2014; Modolo et al., 2011). In this regard, one study evaluated a sample that included footballers and observed that subjects with REA only had worse values in the bodily pain scale than subjects without exercise addiction (Lichtenstein, Christiansen, Bilenberg, et al., 2014). The authors linked their results to a greater incidence of injuries as a result of overtraining in athletes with REA. The absence of differences in the bodily pain scale between our cyclists with and without REA is consistent with the low incidence of injuries in cycling, the fact that no cyclists were injured, the fact that the cyclists were in the period of greatest benefit of the season and the fact that both groups performed the same training volume. Furthermore, in both sexes, addicted and non-addicted cyclists showed a better score on the bodily pain scale than inactive subjects.

According to previous studies (Allegre et al., 2007; Lejoyeux et al., 2008; Ruiz-Juan & Zarauz Sancho, 2012), it might be expected that exercise obsession could induce better values in determined physical parameters in athletes with REA. However, our results with amateur endurance athletes do not confirm this hypothesis. Thus, similar to competition performance, the perception of physical condition was also comparable between cyclists with REA and those with low REA. These results are logical considering the similarity between the groups in training volume and in other aspects related to the physical condition, such as diet, BMI, and tobacco and alcohol consumption. It can be suggested that cyclists smoke less, consume less alcohol, and have a greater adherence to the Mediterranean diet because they are more preoccupied with their physical health and their sportive performances than controls, which confirms the relationship observed in previous studies between physical activity and these health-related parameters (Loprinzi & Walker, 2015; Sánchez-Benito, Sánchez-Soriano, Martín, & Preedy, 2015). The relationship between exercise addiction and BMI is controversial (Allegre et al., 2007; Ruiz-Juan & Zarauz Sancho, 2012). The absence in our sample of differences in BMI values

between exercise addicts and non-addicts is consistent when both groups have comparable values of training and adherence to the Mediterranean diet. Together, our results suggest that regardless of the REA, the practice of amateur endurance cycling induces optimal physical health and reduced cardiovascular risk.

Our results suggest that in both sexes, REA negatively influences quality of sleep. Previously, this relationship has been observed in women but not in men (Modolo et al., 2011). The inconsistencies between studies can be associated with differences in the type of sports practice, training volume, and sample size. The worse quality of sleep in subjects with REA can be related to symptoms of exercise abstinence and anxiety. In fact, levels of anxiety were significantly higher in cyclists with REA. In our sample, these levels of anxiety were not associated with worse indices of depression. In previous studies, the relationship between addiction or dependence to exercise and anxiety and depression is controversial (Bamber, Cockerill, & Carroll, 2000; Maraz et al., 2015; Modolo et al., 2011; Weinstein, Maayan, & Weinstein, 2015). Based on our results on quality of sleep, anxiety, and depression, cyclists with REA showed a worse mental QoL than subjects with low REA. Previously, in a sample of women, it was also observed that subjects with a risk of addiction had worse indices of mental QoL than subjects without a risk of addiction (Lichtenstein, Christiansen, Bilenberg, et al., 2014; Modolo et al., 2011), although likely because of the sample size, the differences were not significant. Certainly, the observed differences in this and in other studies (Bamber et al., 2000; Lichtenstein, Christiansen, Bilenberg, et al., 2014) in the absolute values of quality of sleep, anxiety, and mental QoL among subjects with and without REA are small. In this sense, the positive aspects that exercise has on these parameters should be considered (Garber et al., 2011).

Based on the results of this study, trainers and professionals in the clinical field should understand that the practice of amateur endurance cycling has positive effects on health, and therefore, excessive exercise itself is not necessarily maladaptive. However, this study contributes to the existing literature by applying the concept of exercise addiction in a previously unseen population. Approximately one-fifth of the sample was identified with REA that was associated with poor quality of sleep and mental health. This information is important for cyclists and clinicians because it provides a warning about REA. At-risk cyclists require greater clinical attention and should be subjected to a specific clinical study with the aim of diagnosing a true addiction to exercise and establishing treatments that reverse this problem. Diagnosis and treatment should consider, in addition to finding a balance between exercise practice and family and social life, establishing whether mental health problems are a consequence of exercise addiction or, conversely, whether exercise addiction is concomitant to mental health problems or personality traits (Berczik et al., 2012). Therefore, clinical sports psychologists should carefully listen to the signal of exercise addiction to further investigate and accurately diagnose this condition. The results of this study justify the need to develop future research to further explore REA among resistance cyclists to better

understand their complex nature and the factors that mitigate the risk within this specific population.

There are some limitations to this study. First, because the study information was sent to the representatives of each club, it was not possible to control whether this information reached all the cyclists under study. Regardless, the heterogeneity of our sample in age, BMI, and training is likely representative of the globality of amateur cyclists who participate in endurance cycling events, though we cannot rule out that non-responders might differ from responders. Second, the cycling sample was very biased toward males, although this represents the current differences in Spain in the proportion of men and women participating in endurance cycling events. Third, our study was based on self-report data, which are vulnerable to response bias, inaccurate reporting and denial. However, we have used validated questionnaires for epidemiological studies that have been sensitive enough to differentiate the health status between groups. It is also important to stress that REA is not a diagnosis (Berczik et al., 2012). According to other investigators (Müller et al., 2014; Szabo et al., 2015; Youngman & Simpson, 2014), devotion for the sport can inflate EAI scores by the infiltration of concepts linked to commitment, resulting in false positives. Finally, our cross-sectional design precludes any causal inferences concerning the development of exercise addiction and its symptomatology. Future longitudinal studies could help identify cause-effect patterns between exercise addiction, abstinence from exercise, and health-related parameters.

CONCLUSION

In conclusion, the practice of amateur endurance cycling has beneficial effects for health. The benefits on quality of sleep and mental health are limited in approximately 20% of subjects with REA. Our results also suggest that the REA in amateur endurance cycling is not significantly influenced by extrinsic factors, such as age, sex, sociodemographic factors, and training, suggesting that to accurately diagnose and establish appropriate treatment, clinical sports psychologists should focus their attention on the intrinsic factors in each subject that can induce the addiction to exercise.

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