

## Exercise dependence among customers from a Parisian sport shop

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*Aim of the study:* We assessed exercise dependence (ED), alcohol and nicotine use disorders, eating disorders, hypochondria and compulsive buying and in a population of customers of a Parisian sport shop. *Methods:* Five hundred consecutive customers of a sport shop were invited to participate. Diagnostic of exercise dependence was made with the Exercise Addiction Inventory and a specific questionnaire checking all diagnostic criteria. The DSM-IV-TR criteria for bulimia, alcohol and nicotine use disorders were checked and all subjects answered the CAGE and Fagerström questionnaires. Hypochondria was assessed with the DSM-IV-TR criteria and the Whiteley Index of Health Anxiety. For all parameters, customers with (ED+) and without (ED-) exercise dependence were compared. *Results:* The prevalence of exercise dependence was 29.6%. Subjects from the ED+ group were younger than in the ED- group (27.1 vs 29.8 years) and there were more women. They were more dependent on alcohol, had higher scores at the CAGE questionnaire. ED+ subjects more often presented hypochondria (23 vs 15%), bulimia and binge eating and they more often made gifts to themselves and to others. *Conclusions:* Exercise dependence appears as a frequent and almost always unrecognized form of behavioral dependence in non clinical population frequenting sport shops. It is frequently associated to chemical dependence and eating disorders.

**Keywords:** exercise dependence, alcohol dependence, alcohol abuse, behavioral addiction, bulimia, addiction, sport

### INTRODUCTION

Regular physical activity has many physical and psychological benefits (Ogden, 2004). Excessive physical activity, however, may have negative consequences and results in exercise dependence when it becomes an all-consuming activity. Exercise dependence can be included in the spectrum of behavior addictions due to its clinical characteristics in common with classical addictive disorders. Exercise addicts experiment all signs characteristics of dependence (Hausenblas & Symons Downs, 2002). They overdose in the sense that they over-train and this leads them to experience chronic fatigue (Veale, 1995). A syndrome of primary exercise dependence has however not been still recognized as a diagnostic category in either ICD-10 or DSM-IV-R. Exercise dependence also appears closely related to bulimia since bulimics often use physical exercise to compensate the effect of food intake (Blaydon & Lindner, 2002). Exercise dependence is often associated to a high level of anxiety about the shape of their body and their physical health and a low level of self-esteem (Hausenblas & Giacobbi, 2004).

Exercise dependence is defined by the presence of a craving for physical activity resulting in extreme exercising and generating negative physiological consequences (over-exert injuries). An equivalent of withdrawal can be identified when exercise dependents experiment anxiety and negative feelings if they cannot practice sport or exercise as much as they need. Hausenblas and Giacobbi (2004) proposed diagnostic criteria to distinguish exercise dependence from normal physical activity. They described exercise dependence as an inadequate pattern of exercise leading to clinically significant impairment or distress, as manifested by three or more of the following: (1) *tolerance*, which is defined as either a need for significantly increasing amounts of exercise to achieve the desired effect or a diminished effect

with the continued practice of the same amount of exercise; (2) *withdrawal* as manifested by anxiety and tiredness when the amount of exercise decreases; (3) *excessive exercise*, exercise is often taken in larger amounts or over a longer period than intended; (4) *loss of control* of the sportive or physical activity; (5) *excessive time* spent in activities necessary to prepare for exercise; (6) *conflicts*, social, occupational, or recreational activities are given up because of exercise; and (7) *continuity*, exercise is continued despite knowledge of a physical problem caused by exercise. Exercise deprivation sensations (also referred to as exercise withdrawal symptoms) are the cardinal identifying components of exercise dependence. These sensations represent the psychological effects that occur during periods of no exercise and are manifested by either withdrawal symptoms (e.g. anxiety, tiredness) or the fact that the same (or closely related) amount of exercise is taken to relieve or avoid withdrawal.

#### Prevalence

Blaydon and Lindner (2002) found that 28% of nonprofessional athletes presented exercise dependence. Other studies conducted in college-aged populations found that 21.8% of participants displayed compulsary or dysfunctional activity patterns (Garman, Hayduk, Crider & Hodel, 2004) and 18.1% reported compulsive exercising (Guidi et al., 2009). A prevalence rate of 42% was found for exercise dependence among customers of a Parisian fitness center

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(Lejoyeux, Avril, Richoux, Embouazza & Nivoli, 2008), whereas in a study on occurrence of exercise dependence among college students a prevalence of 45.9% was found (Zmijewski & Howard, 2003).

#### *Comorbidity and psychological characteristics of exercise addicts*

Exercise dependence is frequent among patients presenting eating disorders. Bulimics use physical exercise to compensate the effects of excessive food intake (Blaydon & Lindner, 2002). In these cases, individuals are extrinsically motivated to exercise in attempt to control their body size and shape. Excessive exercise is so frequent among bulimics that it is part of the DSM diagnostic criteria for bulimia. In case of exercise dependence and eating disorders, exercise dependence is described as a secondary dependence (Veale, 1995). Zmijewski and Howard (2003) studied exercise dependence among 237 college undergraduates; 45.9% of them presented 3 or more symptoms of exercise dependence. The number of exercise-dependence symptoms was significantly positively correlated with problematic attitudes toward eating (i.e., bulimia or anorexia). Anorectic patients continue to exercise to lose weight even when they are pathologically thin. Women with clinical and subclinical eating disorders are also at high risk for the development of exercise-dependence symptoms.

Exercise dependents regularly show lower levels of self-esteem than controls (Grandi, Clementi, Guidi, Benassi & Tossani, 2011). They are more passive, insecure and prone to experience high levels of anxiety, hostility or depression when exposed to stressful events (De Moor, Beem, Stubbe, Boomsma & De Geus, 2006). As suggested by Hausenblas and Giacobbi (2004), some individuals with personality disorders or chronic anxiety use physical exercise as a coping strategy which over time becomes dysfunctional and leads to an increase of their distress or their anxiety. A study of hypochondria among exercise dependents showed that higher scores of the hypochondriasis among exercise addicts (Lejoyeux et al., 2008). The same study tried to identify a correlation with other forms of behavior and chemical addictions. Exercise addicts had higher score of compulsive buying. Their prevalence rate of alcohol and nicotine dependence was not higher than in controls.

#### *Exercise dependence and body dissatisfaction*

Relation between exercise dependence and body dissatisfaction has first been showed among bodybuilders. These subjects practice more than ten hours per day and experiment withdrawal symptoms when they cannot go to their preferred fitness or exercise room. They need to modify the shape of their body to accept it more easily (Mc Cabe & Ricciardelli, 2004). Weightlifters and runners also have a high level of body dissatisfaction (Hausenblas & Symons Downs, 2002). Excessive physical activity may develop the belief that increased investment in exercise will eliminate anxiety, anger, or worries about appearance (Bamber, Cockerill, Rodgers & Carroll, 2000).

#### *Aim of the study*

Our study tried to determine prevalence and clinical characteristics of exercise addiction among a population of cus-

tomers from a Parisian sport shop. We addressed the following questions:

- What is the prevalence of exercise dependence among customers of a sport shop who are interested by physical activity and buy sport items?
- Is there a difference in prevalence rate of exercise dependence according to the type of items they buy in the sport shop?
- Can we confirm an association between eating disorders and exercise dependence by demonstrating a higher level of bulimia in customers presenting exercise addiction?
- Do exercise addicts present a higher prevalence of hypochondria and of health anxiety?
- Is exercise dependence associated to more “classical” forms of dependence like alcohol or nicotine dependence and/or to a behavioral addiction like compulsive buying? Considering that exercise dependence is like a behavioral or non-drug addiction, we raised the hypothesis that this dependence could be associated to more classical forms of dependence to alcohol or nicotine.

## METHODS

#### *Selection of the population*

The study was reviewed and approved by the department ethical review board. We proposed our questionnaire to all consecutive customers of a Parisian sport shop. This shop, open every day of the week, offers many kinds of items related to physical activity including collective sports, tennis, aerobics, bodybuilding and gymnastics. All consecutive clients aged 18 years old and over were invited to participate in the study when they arrived at the cash desk to pay for their purchases.

#### *Interviews*

All interviews were personally conducted by the same investigator (C. G.) trained to use the study instruments. Interviews were carried out between 9 a.m. and 6 p.m. in the shop itself. The study lasted four months between January and April, 2010. To ensure confidentiality, we did not record any identifying data. Questionnaires were strictly anonymous. The study was approved by the Human Subjects Review Committee of the department (Ethical Committee of Research conducted in the department). All subjects participated voluntarily in the study. Informed written consent was obtained from all participants after an explanation of the study. Before the beginning of the study, the acceptability of all questionnaires was tested on 20 subjects.

#### *Assessment*

*Socio-demographic characteristics and type of items bought.* For each customer, we noted their age, sex, marital and work status and we invited them to choose among ten categories of sport items the category of the item they had just bought (tennis, swimming, soccer, running, bodybuilding, horse-riding, dancing, martial arts, ski, rugby). When they had bought more than one category of sport items, they were invited to choose the item corresponding to their preferred sport or to the sport they personally practiced.

*Assessment of exercise addiction.* We designed a specific questionnaire for the study which allowed to check all the Hausenblas and Giacobbi (2004) diagnostic criteria for exercise dependence. The questionnaire had seven questions, each of them corresponding to the Hausenblas and Giacobbi criteria. Questions consisted to check the presence or absence of each diagnostic criteria in a standardized manner (Example question: Do you present anxiety and tiredness when the amount of exercise decreases?). We noted for each subject the number of diagnostic criteria they presented. Subjects with more than three diagnostic criteria were considered exercise dependent. Customers of the sport shop also completed a standardized scale of exercise dependence: the French version of the Exercise Addiction Inventory (Terry, Szabo & Griffiths, 2004).

*Eating disorders.* We checked the DSM-IV-R criteria for bulimia in all subjects and we assessed the number of binge eating episodes defined by the presence of the two following patterns 1: eating, in a discrete period of time (e.g. within any two-hour period), any amount of food that is definitely larger than most people would eat during a similar period of time and under similar circumstances and 2: a sense of lack of control over eating during the episode (e.g. a feeling that one cannot stop eating or control what or how much one is eating). We also quantified the number of inappropriate compensatory behavior to prevent weight gain, such as self-induced vomiting, misuse of laxatives, diuretics, or other medications, fasting or excessive exercise.

*Alcohol and nicotine use and abuse disorders.* Subjects answered the CAGE (Cut Down, Annoyed, Guilty, Eye opener) questionnaire (Ewing, 1984). Responses of the CAGE are scored 0 or 1. A total score of 2 or more is considered clinically significant and evokes alcohol use disorder. The quantity of drinks taken within a 24-hour period during the previous week was assessed with a specific questionnaire previously published (Achour, Brun, Mc Loughlin, Adès & Lejoyeux, 2004); a drink being defined as the amount of alcohol in 300 ml of beer, 100 ml of wine, or 25 ml of whisky. We also noted the number of days per week when drinking had occurred in the last month before the interview and the number of acute alcohol intoxications (more than four drinks of alcohol on an occasion) occurring during the previous month.

We studied cigarette smoking with the Fagerström questionnaire (Fagerström & Schneider, 1989). This test is designed to provide a measure of nicotine dependence. It contains four yes-no and two multiple-choice questions. The average score in randomly selected smokers is approximately 4.5. In samples of cigarette smokers seeking treatment, mean scores range from 5.2 to 6.3. We completed the investigation of nicotine consumption by a count of the number of cigarettes smoked each day and the number of days of the week when patients smoked nicotine. Lastly, we checked the DSM-IV-TR diagnostic criteria for alcohol and nicotine abuse and dependence with a specific section of the Mini International Neuropsychiatric Interview (MINI) (Sheehan et al., 1997). This questionnaire appeared to be effective in the detection of alcohol and nicotine use disorders (Richoux et al., 2011).

*Assessment of other behavioral addictions: Hypochondria, bulimia and compulsive buying.* We assessed hypochondria with the Whiteley Index (Pilowsky, 1967). This index contains 14 items discriminating between patients with and without hypochondria. We also checked the DSM-IV-R

criteria for hypochondria. To assess eating disorders, we studied the number of bulimic access fulfilling the DSM-IV-R criteria for bulimia. With a specific questionnaire previously validated (Lejoyeux et al., 2008), we noted the number of binge eating episodes and of compensation behavior to lose weight. We used another specific questionnaire (Lejoyeux & Weinstein, 2010) to assess compulsive buying. The 19 items (questions with yes or no answers) represent major basic features of compulsive buying. Dimensions of the questionnaire are: impulsivity, urges to shop and buy, emotions typically felt before, during and after purchase, post purchase guilt and regrets, degree of commitment to short-term gratification, tangible consequences of buying, avoidance strategies. Subjects with a score superior to 9 are considered compulsive buyers. The relation to items bought was studied by measuring tendency to be deceived by items bought, lesser than expected use of items recently bought, regular purchase of luxury brands, purchases made to impress others or to restore self-esteem.

#### Data analysis

Data analysis was performed in two ways: First, customers with (ED+) and without exercise dependence (ED-) were compared.  $\chi^2$  test was used for univariate comparisons of qualitative data and Student *t* test for quantitative data. Secondly, possible predictive factors of the presence of ED were identified with multinomial regression analysis. The group without exercise dependence (ED-) was chosen as reference category for regression analysis. The variables bulimia, alcohol intoxication, unemployment, compulsive buying and family status (living alone) were selected for regression analysis because of their known influence on ED. All statistical tests were two-tailed and a *p* value of 0.05 or less was considered to be significant.

## RESULTS

During the 4-month period of the study, the first 650 consecutive customers who arrived to pay for their purchases between 9 a.m. and 7 p.m. were interviewed. The population of the study was not pre-selected and strictly reflected customers present in the shop during the study period. One hundred and fifty of the customers refused the assessment, 100 said they had no time to fill the questionnaires and 50 refused to be interviewed in the shop. Among the 500 subjects who accepted to participate in the study, 148 were identified as exercise dependent (29.6%). All customers considered as exercise addicts presented more than three of the following criteria: withdrawal effects, loss of control, time spent in exercising, social and physical consequences, persistence despite physical problems. One hundred and four customers presented four criteria, 25 five criteria and 21 six criteria.

#### Socio-demographic characteristics and types of sport items bought

Table 1 shows that ED+ subjects were significantly younger (27.1 vs 29.8 years, *t* test = -2.6, *df* = 498, *p* = 0.008). ED was more frequent among women (54% vs 38.5%,  $\chi^2$  = 10.8, *df* = 1, *p* = 0.001). Levels of education and work status were equivalent in the ED + and ED- groups. ED+ subjects more

Table 1. Subjects presenting or not exercise dependence (ED+ and –).  
Socio-demographic characteristics

	ED+ (N = 148)		ED– (N = 352)		All subjects (N = 500)		Statistics
Age mean (SD)	27.1	(8.6)	29.8	(10.8)	29	(10.3)	<b>t = –2.6, df = 498, p = 0.008</b>
Women N (%)	80	(54%)	135	(38.5%)	215	(43%)	<b>χ<sup>2</sup> = 10.8, df = 1, p = 0.001</b>
Education N (%)							χ <sup>2</sup> = 0.311, df = 2, p = 0.85
College undergraduates	4	(2.7%)	9	(2.5%)	13	(2.6%)	
College graduates	43	(29%)	94	(26%)	137	(27.4%)	
High school graduates	101	(68%)	249	(70%)	350	(70%)	
Work status N (%)							χ <sup>2</sup> = 7.1, df = 3, p = 0.06
Unemployed	5	(3%)	8	(2%)	13	(2.6%)	
Working	77	(52%)	223	(63%)	300	(60%)	
Student	65	(43%)	115	(32%)	180	(36%)	
Retired	1	(1%)	6	(2%)	7	(1.4%)	
Family N (%)							χ <sup>2</sup> = 2.7, df = 1, p = 0.09
Lives with family	94	(63%)	250	(71%)	344	(68%)	
Lives alone	54	(36%)	102	(29%)	156	(32%)	
Type of item bought N (%)							χ <sup>2</sup> = 17.7, df = 9, p = 0.03
Tennis	19	(12.8%)	30	(8.5%)	49	(9.8%)	
Swimming	18	(12.1%)	60	(17%)	78	(15.6%)	
Soccer	21	(14%)	29	(8.2%)	50	(10%)	
Running	19	(12.8%)	36	(10.2%)	55	(11%)	
Bodybuilding	26	(17.5%)	51	(14.4%)	77	(15.4%)	
Horse-riding	9	(6%)	17	(4.8%)	26	(5.2%)	
Dancing	13	(8.7%)	35	(10%)	48	(9.6%)	
Martial arts	10	(6.7%)	24	(6.8%)	34	(6.8%)	
Ski	7	(4.7%)	50	(14.2%)	57	(11.4%)	
Rugby	6	(4%)	20	(5.6%)	26	(5.2%)	

often bought sport items related to tennis (12.8% in the ED+ group vs 8.5% in the ED– group), soccer (14% vs 8.2%), running (12.8% vs 10.2%), bodybuilding (17.5% vs 14.4%) and less often to swimming, dancing, skiing and rugby. Due to the limited number of subjects concerned, these differences according to the types of sports were not statistically significant.

*Alcohol and nicotine use disorders, hypochondria, bulimia*

Mean alcohol consumption was equivalent in the two groups (Table 2), however ED+ subjects were more often dependent on alcohol. They had more acute alcohol intoxications each month and higher scores at the CAGE questionnaire. Alcohol abuse and dependence disorders were more fre-

Table 2. Subjects presenting or not exercise dependence (ED+ and –).  
Alcohol and nicotine use and dependence, bulimia, hypochondria

	ED+ (N = 148)		ED– (N = 352)		Statistics
Score at the Exercise Addiction Inventory					
Mean (SD)	4.8	(1.1)	1.2	(1.1)	<b>t = 32.1, df = 498, p &lt; 0.0001</b>
Alcohol consumption Mean (SD)					
Drinks/day	1.1	(1.9)	1	(2.1)	t = 0.26, df = 498, p = 0.79
Drinking days/week	1.7	(1.6)	1.5	(1.5)	t = 1.46, df = 498, p = 0.143
Intoxication/month	1.3	(2.3)	0.8	(1.8)	<b>t = 2.7, df = 498, p = 0.007</b>
CAGE score	0.4	(0.7)	0.28	(0.6)	<b>t = 2.2, df = 498, p = 0.02</b>
Nicotine consumption Mean (SD)					
Cigarettes/day	2.9	(4.9)	3.1	(5.7)	t = –0.36, df = 498, p = 0.7
Smoking/week	2.2	(3)	2	(3.1)	t = 0.45, df = 498, p = 0.648
Fagerström score	0.56	(1.3)	0.77	(1.6)	t = –1.3, df = 498, p = 0.165
Substance use disorders (abuse or dependence) N and %					
Alcohol use disorders	19	(12%)	25	(7%)	χ <sup>2</sup> = 4.2, df = 1, p = 0.03
Nicotine dependence	47	(32%)	100	(29%)	χ <sup>2</sup> = 0.56, df = 1, p = 0.45
Hypochondria					
Score of Whiteley Index Mean (SD)	3	(2.4)	2.3	(2.2)	<b>t = 2.9, df = 498, p = 0.003</b>
Diagnosis of hypochondria N (%)	35	(23%)	56	(15%)	<b>χ<sup>2</sup> = 4.1, df = 1, p = 0.04</b>
Bulimia					
Binge eating/week Mean (SD)	1.9	(3)	0.98	(2.2)	<b>t = 4, df = 498, p &lt; 0.0001</b>
Compensatory behaviour Mean (SD)	0.5	(1.4)	0.06	(0.35)	<b>t = 5.2, df = 498, p &lt; 0.0001</b>
Diagnosis of bulimia N (%)	91	(61%)	171	(48%)	<b>χ<sup>2</sup> = 6.9, df = 1, p = 0.008</b>

Table 3. Subjects presenting or not exercise dependence (ED+ and -), Compulsive buying and scores of exercise obsession

	ED+ (N = 148)		ED- (N = 352)		Statistics
Score at the compulsive buying scale (Mean, SD)	3.8	(3.1)	3.7	(3.2)	$t = 0.3, df = 498, p = 0.7$
Diagnostic of compulsive buying N (%)	42	(28%)	77	(21%)	$\chi^2 = 2.4, df = 1, p = 0.12$
Percentage of useful purchases	47%	(28)	48%	(31)	$p = -0.3, df = 498, p = 0.74$
Percentage of purchases as a gift to oneself or others (mean)	41%	(27)	35%	(28)	<b><math>t = 2, df = 498, p = 0.04</math></b>
Percentage of purchases made alone	70%	(26)	66%	(31)	$t = 1.4, df = 498, p = 0.15$
Percentage of purchases considered as a one off	18%	(17)	15%	(17)	$t = 1.69, df = 498, p = 0.09$
Percentage of purchases followed by deception	8.4%	(11)	8%	(9)	$t = 0.4, df = 498, p = 0.64$
Percentage of purchases made to impress others	7.3%	(15)	3%	(9)	<b><math>t = 3, df = 498, p = 0.003</math></b>
Percentage of items considered as a way to improve self-esteem	21.9%	(28)	19.2%	(26)	$t = 1, df = 498, p = 0.3$
Percentage of items bought in relation to the brand	48	(31)	34	(30)	<b><math>t = 4.5, df = 498, p &lt; 0.0001</math></b>

quent in the ED+ group. Subjects from the ED+ group had higher scores at the Whiteley Index of illness anxiety and fulfilled criteria of hypochondria more often (23% vs 15%  $\chi^2 = 4.1, df = 1, p = 0.04$ ). They more often presented bulimia, higher access to binge eating each month and more episodes of weight compensation.

#### Compulsive buying

Diagnosis of compulsive buying was equally frequent in the ED+ and ED- groups (Table 3). Assessment with standardized scales of relation to items bought and to money revealed differences. Subjects from the ED+ group more often made gifts to themselves and to others, purchases to impress others and purchases related to the item brand name.

#### Risk factors for exercise dependence

Multinomial logistic regression presented in Table 4 identified factors associated with ED: bulimia, alcohol acute intoxication, unemployment, alcohol use disorders and compulsive buying. The most important factor was alcohol acute intoxication and the less important was compulsive buying; 69% of the observations are classified by the model.

Table 4. Multinomial logistic regression among subjects presenting with or without exercise dependence

Variable	Odd ratio	95% confidence interval	Probability interval
Bulimia	1.6	1.1–2.5	$p = 0.01$
Alcohol acute intoxication	1.66	1–2.5	$p = 0.02$
Unemployed	1.65	0.4–5.7	$p = 0.4$
Hypochondria	1.6	0.9–2.6	$p = 0.06$
Alcohol use disorders	1.5	0.76–2.9	$p = 0.2$
Compulsive buying	1.5	0.9–2.5	$p = 0.07$
Living alone	0.7	0.4–1	$p = 0.1$
Gender: male	0.3	0.3–0.7	$p = 0.3$

Reference category: female with exercise dependence, likelihood ratio  $\chi^2 = 37, df = 8, p < 0.0001$ , 69% of the observations are classified by the model, sensitivity = 16.4%, specificity = 91.4%.

## DISCUSSION

#### Prevalence of exercise dependence

Our study reveals an addictive relation to physical exercise among 29.6% of customers of a sport shop. This prevalence rate is congruent with results from previous studies conducted in populations of subjects involved in sport. Blaydon and Lindner (2004) found that 28% of non-professional athletes present exercise dependence. Other studies demonstrated higher rates of exercise dependence in the general population: in a sample of 19,288 adolescents from the general population, De Moor et al. [19] found 51.4% of regular exercisers (with a minimum of 60 min weekly). Lejoyeux et al. (2008) identified 42% of exercise dependence among 300 customers of a fitness center aged 18 years old and over. No other studies, to our knowledge, concerned customers of a sport shop. Our observed prevalence rate thus cannot be compared to results of equivalent studies. Prevalence rate of exercise dependence could have even been higher if our study had been concentrated on customers who repetitively buy sport items for themselves.

#### Exercise dependence and other addictions

Since excessive involvement in physical activity can be described as a form of dependence, we studied association between ED and other forms of dependence. Exercise addicts had more alcohol intoxications each month, higher scores at the CAGE questionnaire and more often presented the diagnostic criteria for alcohol abuse or dependence disorders. This observation shows an association between a form of behavioral dependence and a form of chemical dependence (alcohol dependence). Equivalent associations between chemical and non-chemical dependences have been shown in pathological gamblers (Grant, Kushner & Kim, 2002) and compulsive buyers (Lejoyeux & Weinstein, 2010).

Relation between exercise dependence and nicotine dependence appears more complex. Exercise addicts are concerned by their physical health and tend to be more vigilant

than non addicts about the effects of nicotine. We did not confirm a previous result found among customers of a fitness center suggesting that exercise addicts smoke significantly less than controls. Nicotine consumption and rate of nicotine dependence was equivalent in the ED+ and ED- groups. Customers of a sport shop with ED did not smoke less than those without ED. It can be suggested that exercise addicts customers regularly attending a fitness center are more preoccupied by their physical health and their sportive performances than customers of a sport shop who "only" buy a sport item. Compulsive buying, another form of behavioral dependence, was not more frequent among exercise addicts than among controls. Their relation to buying has however common points with compulsive buyers (Lejoyeux & Weinstein, 2010). Both more often made gifts to themselves or to others than controls, bought items to impress others and were more influenced in their buying by the brand name.

We confirmed an association between ED and bulimia. Diagnosis of bulimia was significantly more frequent and exercise addicts more often presented binge eating and behavior of weight compensation. We also confirmed that exercise addicts are more often hypochondriacs and present a higher level of illness anxiety. Our work is the first to identify in the same sample an association between exercise addiction, hypochondria, bulimia and alcohol dependence. Multinomial regression also showed that alcohol acute intoxication and alcohol use disorders, bulimia and hypochondria increase the risk of ED.

#### Limitation of the study

The choice to assess a non-clinical population limited the exhaustiveness of our clinical evaluation. Subjects could not spend more than 15 minutes answering questionnaires and we could not check all psychiatric diagnosis with a standardized questionnaire. We deliberately limited our research to psychological and psychiatric dimensions known to be associated to ED. In spite of its limitation our study is the first to simultaneously assess eating disorders, hypochondria, compulsive buying, alcohol and nicotine use disorders. Another limitation of our study is the limited size of the sample. Due to the small number of subjects, some differences between the ED+ and ED- groups did not appear as statistically significant. A third limitation is the number of subjects who refused to be interviewed. It incites to interpret prevalence rates of ED with prudence since customers of the sport shop who refused to participate in the study may have been more dependent to exercise than others. A last limitation is our lack of distinction between customers who personally practiced sport from those who did not practice sport and bought sport items for someone else. A complementary study performed during the same period showed that 80% of a population of 200 customers of the same shop personally practiced physical exercise.

#### Implication of the results for prevention and public health

A major finding of our research is the high prevalence of exercise addiction in a non-clinical population of customers of a sport shop. This observation is an incitation to more systematically assess exercise addictions among people involved in physical and sport activity. Exercise addiction is

not limited to marathon runners, body runners and professional athletes. All people involved in sport should directly be asked about their relation to physical activity. This diagnosis could especially be frequent in subjects presenting eating disorders, hypochondria or health anxiety and dependence to alcohol. Our data provide support to the idea that primary exercise dependence can be considered as a clinical syndrome characterized by certain clinical characteristics and addictive comorbidity. This form of behavioral dependence is too often unrecognized and untreated. Further research remains needed to precise the phenomenology of exercise addiction and help to propose specific psychological treatments of the addiction itself and of its addictive comorbidities.

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