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Disordered Eating and Exercise Dependence in Endurance Athletes

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Abstract

Background: The goal of this study was to assess the prevalence of disordered eating and exercise dependence among elite and amateur endurance athletes, both male and female, and to find out whether there was an association between disordered eating and exercise addiction in these athletes. Methods: 1031 participants of major German endurance events (745 male, 286 female, 528 elite athletes and 503 hobby athletes) with a mean age of 41.6 ± 10.7 years old completed a set of questionnaires, including the SCOFF questionnaire and the Exercise Addiction Inventory (EAI). Results: A rate of 18.9% of the athletes surveyed were at risk for developing an eating disorder, slightly higher than that in the normal population, and 2.7% had the potential to develop an exercise addiction. There was a significant correlation between exercise addiction and eating disorders. No gender difference related to the probability of developing an eating disorder or an exercise addiction, nor a difference between elite or amateur athletes was found. Exercise addiction and eating disorders showed a significant correlation.

Keywords

Athlete's Triad, Running Addiction, Anorexia Athletica, Commitment to Running, Running, Cycling, Triathlon

1. Introduction

Endurance sports, including long distance running, cycling and triathlon, are associated with many positive phy-

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siological effects, such as improvement in aerobic capacity (Saltin et al., 1968; Kasch et al., 1973), cardio-protection (Ascensao et al., 2007; Bo et al., 2014), treatment of Type I and Type II diabetes (Palermo et al., 2014; Karstoft & Pedersen, 2015; Roberts & Taplin, 2015; Ryninks et al., 2015; Yoon et al., 2015), athletic body composition (Pollock et al., 1975), and bone density (Kemmler et al., 2006; Winzenberg et al., 2006; Kemmler et al., 2015). In addition, a large body of evidence demonstrates specific benefits of endurance sports on psychological health, including protection from depressive disorders, enhanced self-esteem, an improved feeling of wellness and an increased sense of personal control (Leonardson, 1977; Greist et al., 1978; Lion, 1978; Greist et al., 1979; Jorgenson & Jorgenson, 1979). In this context, NICE (National Institute for Health and Care Excellence, London, UK) guidelines suggest that regular athletic activities (e.g., 3 times a week for 45 - 60 minutes) for 10 - 14 weeks can improve mild to moderate depression (Nice-Guidelines, 2009; Kim et al., 2015). A number of authors even assume that the effect of endurance exercise is comparable to pharmacological and behavioral therapy (Dirmaier et al., 2010).

Despite these positive effects, sports activities have been determined a risk factor for the development of eating disorders. In this context, eating disorders may include all kinds of pathological eating behaviours that impact patient's health in a negative way such as anorexia nervosa, bulimia nervosa and binge-eating disorders. Performance sports with an emphasis on aesthetic body appearance enhancement, sports organized according to weight categories and those in which a lower body weight may raise performance, especially endurance sports, seem to be associated with risk factors (Sundgot-Borgen & Torstveit, 2004; Nice-Guidelines, 2009; Le Page, 2010; MayoClinicStaff, 2010; Busanich, 2014; Maraz et al., 2015). Although eating disorders in sports have been studied as early as 1986 (Wheeler et al., 1986), the results from the existing studies are conflicting. While various groups have found a two-fold increase in the prevalence of developing eating disorders among sports participants (Thopson, 2007; Chapman & Woodman, 2015; Wheeler et al., 1986; Sundgot-Borgen & Torstveit, 2004; Torstveit & Sundgot-Borgen, 2005; Glazer, 2008; Hoch et al., 2009), others have not observed any differences among people exposed to regular exercise versus controls (Fulkerson et al., 1999; Smolak et al., 2000). Of note, two reports even identified a higher incidence of eating disorders among the non-sport control group (Rosendahl et al., 2009; Martinsen et al., 2010). Major variations in study cohorts, design and goals most likely account for these striking differences. This includes evaluating only young women, examining athletes engaging in all kinds of sports, using unique measurement instruments, often not even validated questionnaires, assessing a very small number of participants or looking at just elite athletes (Sundgot-Borgen & Larsen, 1993; Johnson et al., 1999; Hoch et al., 2007; Lejoyeux et al., 2008; Hoch et al., 2009; Rosendahl et al., 2009; Busanich, 2014; Chapman & Woodman, 2015). There is a lack of data specifically on male subjects.

Many sports, especially endurance sports, are associated with exercise addiction, which means a pathological behaviour regarding to body workout. Most authors classify sports addiction as a behavioural and mental disorder comparable to shopping or internet addiction (Griffiths et al., 2005; Edmunds et al., 2006). General criteria for addiction like repeatedly performing of a given behaviour despite any negative consequences are used for diagnosis. Many authors have even suggested that people participating in endurance sports—especially running—are at very high risk for developing such an addiction (Salmon, 1991), whereas others have predicted only a very low number of exercise-dependent athletes (de Coverley Veale, 1987; Edmunds et al., 2006). There are very heterogeneous data relating to gender differences with regards to exercise dependence which may be because of different questionnaires measuring dissimilar aspects of exercise addiction (Weik & Hale, 2009).

Taking the lack of available data, especially from endurance sports, and the assumption that endurance sports might be a risk factor for eating disorders into account, the prevalence of disordered eating and exercise dependence for endurance athletes, both male and female, was assessed. Moreover, the objective was to investigate a potential association between disordered eating and exercise addiction in these athletes.

2. Methods

2.1. Recruitment

Participants were recruited at six supra-regional endurance competitions in Germany between 2007 and 2008, composed of two running, two triathlon and two cycling events. One of each was an event for elite athletes and one an event for amateur competitors. In detail, the individual events were a 10 km hobby run without timing, the German marathon championships, an amateur-oriented Olympic distance triathlon (1.5 km swim, 40 km bike, 10 km run), the German long distance triathlon championships (3.8 km swim, 180 km bike, 42 km run), an

amateur bike ride with various tracks without timing and a bike marathon (multiple tracks up to 250 km). After the event, athletes were randomly asked to participate in the study and to fill out the questionnaires after the events in the finisher areas. For participating in our study it was obligatory to speak and understand German language. All questionnaires were anonymized. The study was subject to conditions of the Declaration of sinki (Revision, 2008) and all participants gave their informed consent (Williams, 2008).

2.2. Instruments

The questionnaire included data pertaining to general socio-demographic status, such as age, height, weight, gender, marital status, working status (working, in vocational training/student, not working), educational level (less than 10 years of school, at least 10 years of school), years practicing endurance exercise (ey), training hours per week (thw), number of training units per week (tuw), type of training (alone or in a group) and the type of sporting activity practiced.

The two national championships (long distance triathlon and marathon) and the bike marathon were defined as elite events and the other three events which focus on amateur athletes as hobby events.

Two screening questionnaires were used to assess exercise dependence (Exercise Addiction Inventory; EAI (Griffiths et al., 2005)) and disordered eating (SCOFF (Morgan et al., 1999)); German version (Holling et al., 2007). The EAI consists of 6 screening questions representing a single component assessing salience, conflict, mood modification, tolerance, withdrawal, and relapse associated with exercising, based on Brown's general components of addiction (Brown, 1993). All items were scored on a five-point Likert scale (1 = strongly disagree to 5 = strongly agree) and coded so that high scores reflect attributes of addictive exercise behaviour. The EAI showed robust and concurrent validity with the Obligatory Exercise Questionnaire (OEQ) (Pasman & Thomson, 1988) (r = 0.80) and the Exercise Dependence Scale (EDS) (Hausenblas & Symons Downs, 2001) (r = 0.81). A cut-off score of 24 or more identifies individuals considered at risk for exercise addiction. The EAI was translated by a professional translator for medical texts and then verified by all authors. Factor analysis showed one dimensionality also in the German version. The Exercise Addiction Inventory can be found in **Table 1**.

The SCOFF is a widely-used and well-validated (Hill et al., 2009) screening tool for eating disorders. It contains five questions addressing core features of anorexia nervosa and bulimia nervosa. A cut-off score of 2 is applied to identify probable cases of eating disorders. The single items are:

S Do you make yourself SICK (vomit) because you feel uncomfortably full?
C Do you worry that you have lost CONTROL over how much you eat?
O Have you recently lost more than ONE stone (15 pounds) in a 3 month period?
F Do you believe yourself to be FAT when others say you are thin?
F Would you say that FOOD dominates your life?

In primary care, the SCOFF showed a sensitivity of 84.6% and a specificity of 89.6%, detecting all cases of anorexia nervosa and bulimia nervosa and seven of nine eating disorders not otherwise specified (Hill et al., 2009).

Table 1. The exercise addiction inventory.

	Strongly disagree		Neither agree nor disagree		Strongly agree
Exercise is the most important thing in my life.	1	2	3	4	5
Conflicts have arisen between me and my family and/or my partner about the amount of exercise I do.	1	2	3	4	5
I use exercise as a way of changing my mood (e.g. to get a buzz, to escape etc.).	1	2	3	4	5
Over time I have increased the amount of exercise I do in a day.	1	2	3	4	5
If I have to miss an exercise session I feel moody and irritable.	1	2	3	4	5
If I cut down the amount of exercise I do, and then start again, I always end up exercising as often as I did before.	1	2	3	4	5

Based on the participants' self-reported height and weight, the BMI (kg/m^2) was calculated. For the purpose of the present study, BMI was recorded into four categories according to WHO recommendations: underweight (BMI < 18.49 kg/m^2), normal weight (BMI 18.5 - 24.99 kg/m^2), overweight (BMI > 25 - 29.99 kg/m^2) and obesity (BMI > 30 kg/m^2) (WHO, 2012).

2.3. Statistical Analysis

PASW 18 (SPSS Inc, Chicago, Il, USA) was used for statistical analyses. Results are expressed as mean values (SD) for continuous values and absolute numbers (N) and percentages (%) for categorical data. For the main analyses the samples were divided into SCOFF positive (>2 positive answers) and SCOFF negative (<2 positive answers) participants. The independent sample t-test was employed to compare continuous variables and the χ^2 test was used to evaluate categorical variables. An alpha level of 0.05 was adopted for all analyses.

3. Results

3.1. Description of the Sample

1187 participants were asked to take part in the study. 1093 (92.1%) answered the questionnaire (men 788, woman 305, NN 26, with a mean age of 41.2 ± 11.2 years). All people were Caucasian Whites speaking German as their mother language. The mean BMI was 23.3 ± 2.8 kg/m^2 (23.1 ± 2.9 kg/m^2 elite athletes, 23.6 ± 2.6 kg/m^2 hobby athletes). Study participants had exercised on average for 13.0 ± 10.2 years (ey), reported 8.3 ± 4.6 hours of training a week (thw) and 4.5 ± 2.3 training units per week (tuw). 871 participants (83.3%) had spent at least 10 years at school and 177 (16.7%) less than 10 years, NN 45. A majority of 931 (87.6%) had a regular job, while 66 (6.1%) participants were students or in vocational training and another 66 (6.1%) were neither employed with a job nor training, NN 30. Elite athletes' thw was 8.7 ± 4.3 hours and tuw was 4.5 ± 2.1, and the corresponding numbers for hobby athletes were 7.7 ± 4.9 thw and 4.4 ± 2.4 tuw. While there was a significant difference in training hours per week between elite and hobby athletes ($t = 3.7$, $df = 1021$ $p = 0.000$), the numbers of training units between the two groups were similar ($t = 0.3$, $df = 1013$, $p = 0.791$), suggesting that elite athletes spend more time in one training unit. Male athletes exercised 8.5 ± 4.89 thw and 4.4 ± 2.3 tuw, whereas females attained 7.5 ± 4.2 thw and 4.5 ± 2.3 tuw. There was a significant difference in thw between men and women ($t = 3.7$, $df = 1020$, $p = 0.000$), but not in tuw ($t = -0.3$, $df = 1012$, $p = 0.790$).

Twenty participants were excluded because they were younger than 18 years old and one because they were older than 80 years old. 42 participants did not complete the SCOFF questionnaire and were excluded from further analyses. The final sample was comprised of 1031 participants (745 male, 286 female, 528 elite athletes and 503 hobby athletes) with a mean age of 41.6 ± 10.7 years.

3.2. Prevalence of Disordered Eating Behaviour

195/1031 (18.9%) athletes obtained scores above the threshold value of the SCOFF for disordered eating behaviour (>2 positive answers). The most commonly endorsed item was the question regarding whether food dominates the subject's life. The frequencies of positive answered items are shown in **Table 2**.

SCOFF-positive athletes were significantly younger (38.9 ± 9.9 vs. 42.3 ± 10.8 years, $p < 0.001$) and have a significantly higher BMI (24.4 ± 3.1 vs. 23.1 ± 2.6 kg/m^2, $p < 0.001$). With respect to employment status, there were a significantly higher number of SCOFF-positive athletes in the group "in vocational training, student" than expected ($p < 0.001$) (**Table 3**).

Table 2. Positive answered items at the SCOFF questionnaire.

	Frequency	Percent agreement
Would you say that food dominates your life?	417	40.4%
Do you worry that you have lost control over how much you eat?	157	15.2%
Do you believe yourself to be fat when others say that you are thin?	132	12.8%
Have you recently lost more than 15 pounds in a 3-month period?	76	7.4%
Do you make yourself sick because you feel uncomfortably full?	31	3.0%

Table 3. Differences between SCOFF positive and negative sample.

Characteristic	Sample/no answer	SCOFF positive	SCOFF negative	Analysis
all	1031	195 (18.9%)	836 (81.1%)	
Age (years)	1031	38.9 (SD = 9.9)	42.3 (SD = 10.8)	t = 4.0, df = 1029, p < 0.001
BMI (km/m^2)	1026/5	24.4 (SD = 3.1)	23.1 (SD = 2.6)	t = 5.8, df = 1024, p < 0.001
BMI-Categories	1026/5			χ^2= 49.5, df = 3, p < 0.001
Underweight	17	2 (11.8%)	15 (88.2%)	
Normal-weight	790	117 (14.8%)	673 (85.2%)	
Overweight	196	57 (29.1%)	139 (70.1%)	
Obesity	23	14 (60.9%)	9 (39.1%)	
EAI Score	999/27	18.0 (SD = 4.1)	16.8 (SD = 3.9)	T = 3.9, df = 997, p < 0.01
EAI ≥ 24	999/27			χ^2 = 9.3, df = 1, p < 0.01, Cramer V = 0.56
Negative	972	172 (17.7%)	800 (82.3%)	
Positive	27	11 (1.1%)	16 (1.6%)	
Employment	1016/15			χ^2 = 17.2, df = 2, p < 0.001
Working	893	173 (19.4%)	720 (80.6%)	
Vocational training, students	59	19 (32.2%)	40 (67.8%)	
Not working	64	2 (3.1%)	62 (96.9%)	

In addition, there was a significant difference in scoring the EAI-SCOFF-positive participants scored significantly higher (18.0 ± 4.1) than that were SCOFF negative (16.8 ± 3.9, p < 0.01). This difference can also be seen comparing the EAI-and SCOFF-positive/negative groups (χ^2 = 9.3, df = 1, p < 0.01) (**Table 3**).

There was no difference found in gender and in the sport mainly practiced by the participants that were developing an eating disorder. The rate of SCOFF-positive participants was not higher in elite level athletes versus hobby athletes.

Neither training hours per week nor training sessions per week or exercise years had a significant influence on developing eating disorders. The level of education also exhibited no influence.

The in-test reliability was, as expected, low at Cronbach Alpha = 0.417.

3.3. Prevalence of Exercise Addiction

In this study's sample, 27/999 participants who completed the EAI were observed to be at risk for developing exercise dependence resulting in a frequency of 2.7%. The age distribution can be seen in **Table 4**.

EAI positive participants were significantly younger (36.1 ± 10.3 vs. 41.7 ± 10.7 years, p < 0.01) and were characterized by a higher number of training hours per week (9.6 ± 4.3 vs. 8.2 ± 4.6 thw, p < 0.01) and training units per week (5.7 ± 2.4 vs. 4.5 ± 2.3 tuw, p < 0.01).

EAI positive participants also scored significant higher on the SCOFF test (1.3 ± 0.9) versus EAI negatives (0.8 ± 0.9, p < 0.01); the risk for scoring SCOFF "positive" was significantly greater in the EAI positive group (χ^2 = 9.3, df = 1, p < 0.01) (**Table 5**). There is also a weak but highly significant correlation between EAI-Sum and SCOFF-Sum (r = 0.155, p > 0.01).

In relation to employment status, there were significantly more participants out of the "vocational training, student" group that scored EAI positive (χ^2 = 9.9, df = 2, p < 0.01).

EAI positive and EAI negative participants did not demonstrate any differences in the following variables: gender, BMI, exercise years, level of engaging in sports, sport mainly practiced and education. Moreover, there was no variation between runners and participants that engaged mainly in another sport.

In our study the EAI questionnaire showed a reliability of Cronbach Alpha = 0.588.

4. Discussion

In the work presented here, the prevalence of disordered eating among endurance athletes was 18.9%. Disordered

Table 4. Age distribution among EAI positive subjects.

			EAI negative	EAI positive
Age group	16 - 20	N	16	2
		% within age group	88.9%	11.1%
	21 - 25	N	45	2
		% within age group	95.7%	4.3%
	26 - 30	N	95	8
		% within age group	92.2%	7.8%
	31 - 35	N	120	6
		% within age group	95.2%	4.8%
	36 - 40	N	148	8
		% within age group	94.9%	5.1%
	41 - 45	N	189	5
		% within age group	97.4%	2.6%
	46 - 50	N	182	3
		% within age group	98.4%	1.6%
	51 - 55	N	73	6
		% within age group	92.4%	7.6%
	56 - 60	N	43	1
		% within age group	97.7%	2.3%
	61 - 65	N	24	1
		% within age group	96.0%	4.0%
	66 - 70	N	15	0
		% within age group	100.0%	0.0%
	71 - 75	N	7	0
		% within age group	100.0%	0.0%
Overall		N	957	42
		%	95.8%	4.2%

Table 5. Differences between EAI positive and negative sample.

Characteristic	Sample/no answer	EAI positive	EAI negative	Analysis
Age (years)	999/32	36.1 (SD = 10,3)	41.7 (SD = 10.7)	$t = 2.7$, $df = 997$, $p < 0.01$
Training hours per week	992/39	9.6 (SD = 4.3)	8.21 (SD = 4.6)	$t = -1.5$, $df = 990$, $p < 0.01$
Training lessons per week	985/46	5.7 (SD = 2.4)	4.5 (SD = 2.3)	$t = -2.845$, $df = 983$, $p < 0.01$
SCOFF Score	999/32	1.3 (SD = 0.9)	0.8 (SD = 0.9)	$t = -3.0$, $df = 997$, $p < 0.01$
SCOFF ≥ 2	999/42			$\chi^2 = 9.3$, $df = 1$, $p < 0.01$
Positive		11 (1.1%)	172 (17.2%)	
Negative		16 (1.6%)	800 (80.1%)	
Employment	985/46			$\chi^2 = 9.9$, $df = 2$, $p < 0.01$
Working		21 (2.1%)	846 (85.9%)	
Vocational training, students		5 (0.5%)	53 (5.4%)	
Not working		0.0%	60 (6.1%)	

eating is a major burden for public health with predominance in young female adults. Approximately two-thirds of young female adults are chronically on a diet or using alternative methods for weight reduction and every fifth woman reports attacks of hunger more than once monthly (Jacobi & de Zwaan, 2006).

The existing literature on eating disorders in sports is mainly hampered by the following limitations: (1) Previous studies are biased with a focus on young females (Hausenblas & Carron, 1999; Blaydon & Lindner, 2002; Torstveit & Sundgot-Borgen, 2005; Hoch et al., 2007; Rosendahl et al., 2009; Martinsen et al., 2010) who seem to carry, per se, an increased risk for developing an eating disorder (Hausenblas & Carron, 1999; Blaydon & Lindner, 2002; Torstveit & Sundgot-Borgen, 2005; Wilson & Shafran, 2005; Hoch et al., 2007; Rosendahl et al., 2009; Martinsen et al., 2010; Wunderer et al., 2011); and (2) Many studies recruited and analyzed individuals from very different sports, including both endurance and non-endurance activities (e.g., archery and rifle shooting) (Chapman & Woodman, 2015; Sundgot-Borgen & Larsen, 1993; Fransen, 1996; Fulkerson et al., 1999; Smolak et al., 2000; Augestad & Flanders, 2002; Sundgot-Borgen & Torstveit, 2004; Torstveit & Sundgot-Borgen, 2005; Torstveit et al., 2008; Hoch et al., 2009; Rosendahl et al., 2009; Martinsen et al., 2010). To overcome these limitations of the existing literature, a broad spectrum of athletes were investigated, further categorized by activity status, age and sex, and focused on endurance sports. Moreover, the well-validated SCOFF test was employed that shows high sensitivity (84.6%) and specificity (89.6%) in general practice (Morgan et al., 1999; Luck et al., 2002; Hill et al., 2009).

In this study, 195/1031 participants (18.9%) were SCOFF positive, indicating that they are at risk for developing an eating disorder. This result corresponds to the KiGGS study ("Kinder-und Jugendgesundheitssurvey") (Holling et al., 2007) that showed a prevalence of 21.9% among German teenagers between ages eleven to sixteen years, although the present sample contained participants with an average age of 42 years. Research using other study methods often shows a lower prevalence for eating disorders. The cause for this phenomenon is the design of the SCOFF questionnaire, created as a screening tool with the highest possible sensitivity (Luck et al., 2002). The high negative predictive value of 99.3% and the low positive predictive value of 24.4% suggest that the SCOFF test tends to overrate individuals at risk (Morgan et al., 1999; Luck et al., 2002; Hill et al., 2009). Additionally the SCOFF is validated as a test for general health. Examining athletes especially the questions "Have you recently lost more than one stone (15 pounds) in a 3 month period?" and "Would you say that food dominates your life?" tend to overrate, too. Nonetheless, two positive answers indicate disordered eating behaviour and attitudes (Morgan et al., 1999; Luck et al., 2002; Hill et al., 2009). Therefore, the SCOFF questionnaire was the ideal instrument for examining a group of more than 1000 participants providing their information voluntarily, also leading to the high response rate of 92.1%. In addition, and as mentioned earlier, the SCOFF is a highly validated instrument (Luck et al., 2002).

The significantly higher rate among participants between 21 and 25 years is consistent with other reports in the literature (Hoek & van Hoeken, 2003; Van Son et al., 2010; Smink et al., 2012; Van Son et al., 2012; Smink et al., 2013). The fact that the group from 18 to 20 years did not have a significantly higher rate is likely based on the small number of participants (18/1031 corresponding to 1.7% of the whole sample).

Unlike the results published in many studies (Wittchen et al., 1998; Hudson et al., 2007; Nice-Guidelines, 2009), a significant difference between male and female athletes in developing eating disorders was not found. Although this observation clearly deserves further experimental investigation, it suggests that endurance sports might be a risk factor for developing an eating disorder in male but not female athletes.

We discriminated elite and hobby athletes by the event in which they participated. We considered athletes taking part at national championships, including the Challenge Roth Triathlon and German Championships Marathon Running, as elite athletes, while others taking part at a 10 km hobby run without timing were most likely hobby athletes. Although this approach was very pragmatic, we believe it allowed us to not only categorize athletes by training hours but by the motivation with which the athletes participated. Based on this categorization, we didn't observe any significant differences neither between elite and hobby athletes nor between runners and other endurance sports for developing an eating disorder, by contrast to the results published by Sundgot-Borgen (Sundgot-Borgen & Torstveit, 2004). This is of particular interest because leanness is a key success factor for runners (Marriott & Grumstrup-Scott, 1992; Boileau & Horswill, 2000). This may give rise to speculations that the willingness to succeed is not a risk factor for developing an eating disorder, even in sports where weight is an important factor of ranking. Of note, this observation is in agreement with other reports that found an even higher prevalence for eating disorders among teenage non-athletes compared to athletes (Rosendahl et al., 2009; Martinsen et al., 2010). Of note, we did not observe a link between training quantity (hours per week and train-

ing lessons per week) with eating disorders, but an association with endurance addiction as reported in literature (Chapman & De Castro, 1990; MacLaren & Best, 2007).

In this work, overweight or even obese athletes were at higher risk for developing an eating disorder according to the SCOFF test. The small number of obese participants (22/1073 corresponding to 2.2%), however, does not allow final conclusions. Assuming that the higher risk for developing eating disorders among obese athletes can be confirmed by future studies, the following interpretations appear to be plausible: First, obese individuals might be prone to score positive for the following assessment: "Would you say that food dominates your life?"; Secondly, a weight loss of more than one stone in a three month period might be even considered beneficial among obese participants who begin exercising.

The significantly higher percentage of participants at risk for developing eating disorders who are in vocational training can be attributed to the age distribution and the fact that most people in vocational training are younger than 30 years of age.

The very low Cronbach Alpha was expected. The SCOFF questionnaire consists of 5 diametric questions and was constructed to indicate all kinds of eating disorders, which show big differences (e.g., between binge eating and anorexia nervosa).

In the current study, 27/999 (2.7%) scored at least 24 points in the Exercise Addiction Inventory, indicating exercise dependency. The rate of exercise dependency among endurance sportsmen in the available literature ranges from 3 all the way up to 52% (Blaydon & Lindner, 2002; Griffiths et al., 2005; Edmunds et al., 2006). Several explanations might account for these striking differences (de Coverley Veale, 1987; Szabo, 2000; Szabo, 1997): Difficulties in separating exercise dependence from exercise commitment might have led to the high percentages of exercise dependency in a number of studies. Moreover, further (non-endurance) sports studied by other investigators might be subject to different aetiologies and levels of exercise addiction.

Other than Pierce (Pierce et al., 1993), no difference was seen between the type of endurance sports nor between hobby and elite athletes. There was also no difference between runners and persons engaging in other types of sports with respect to the number of subjects at risk of developing exercise dependence. Additionally, in this study's sample, other than the examination of 408 university students by Hausenblas (Hausenblas & Downs, 2002) who found more male subjects being exercise dependant, or Pierce (Pierce et al., 1997) who found women scoring significantly higher scores on an exercise dependence survey among 32 marathon road racers, no gender difference in the risk for developing an exercise addiction.

The relatively low Cronbach Alpha should be due to the brief screening tool with only 6 questions and the goal to indicate as many symptoms of addiction as possible. Thus, the questionnaire shows a high bandwidth but only the relatively low reliability (bandwidth fidelity dilemma).

12 of 27 (44.4%) participants scoring EAI positive were also at risk for developing an eating disorder, indicating a strong correlation between exercise dependence and eating disorders ($\chi^2 = 9.3$, df = 1, $p < 0.01$). Here, it can be postulated that exercise dependence is secondary to the eating disorder. On the other hand, 54.6% of participants that were seen to score EAI positive were, in fact, SCOFF negative, suggesting that primary exercise dependence is an existing phenomenon and makes up about half of all exercise-dependent patients, also observed by other authors (Bamber et al., 2000; Blaydon & Lindner, 2002; Bratland-Sanda et al., 2010). The high co-morbidity of exercise dependence and eating disorders seems to be in parallel with the fact that endurance sports can contribute to decreasing body weight and are associated with the same risk factors for developing exercise dependence or eating disorders such as an obsessive-compulsive personality (Edmunds et al., 2006; Sansone & Sansone, 2010). The relatively weak Cramer-V should be due to the high number of subjects scoring positive for eating disorders compared with the relatively small number of subjects scoring positive for exercise addiction.

This present study had certain restrictions: In order to interview as many participants as possible at each event and obtain a cross-section, rapid screening assessments (i.e., less than 10 min) were used for exercise addiction and disordered eating in endurance sports. Extensive interviews were not performed to study personality types amongst other characteristics of the individuals, which might have given more precise estimates of exercise dependence and eating disorders. As it was impossible within the given setting to recruit a sufficient number of professional athletes whose incomes depend on competition earnings, the quality of the event was utilized to divide high performers (elites) and hobby athletes. For logistical reasons, events in Southern Germany were focused on and German speakers were included specifically by using questionnaires in German language. With the goal of involving as many participants as possible, after each event, every single participant was approached.

However, there was no ability to document how many denied participating in our study. Participants were randomly asked in the finisher areas. Especially when many athletes reached the finish line the same time it was not possible to ask all finishers. For measuring body composition we used the well-known BMI which is not exact. So different populations with the same degree of body fat result in different BMI scores, e.g. at the same BMI Blacks have lower body fat than Whites and athletes have lower body fat than non-athletes due to the different body composition with a higher proportion of muscles compared with body fat. Unfortunately there is no validation for BMI cut-offs for athletes.

5. Summary

With a rate of 18.9% being at risk for developing an eating disorder, eating disorders seem to be a major problem in general practice.

Eating disorders do not appear to be more common in endurance sports athletes than in the general population, thus these types of sports cannot be considered as risk factors for developing one.

As reported by others, equal numbers of male and female participants at risk for developing an eating disorder were seen.

In general, one might come to the reasonable conclusion that an eating disorder should be kept in mind if the patient either has an abnormal BMI or endurance sports are practiced excessively, especially in male patients.

A prevalence of exercise dependence among endurance athletes of 2.7% is consistent with most of the data reported in the literature.

There is a strong correlation between disordered eating and exercise dependence.

Primary exercise dependence is a real diagnosis and constitutes about half of all exercise-dependent patients.

Therefore, primary care takers as well as sport coaches should be vigilant about eating disorders and exercise addiction in both elite and amateur athletes.

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