

**Eating disorders and their putative risk factors among  
female German professional athletes**

Pia Thiemann<sup>1</sup>, Tanja Legenbauer, Silja Vocks, Petra Platen,  
Bonnie Auyeung and Stephan Herpertz

<sup>1</sup> Now at the Department of Public Health and Primary Care, University of Cambridge, UK.

The work was carried out at:

The Department of Psychosomatic Medicine and Psychotherapy,  
LWL-University Hospital of the Ruhr-University Bochum,  
Alexandrinenstraße 1-3  
44791 Bochum  
Germany

Correspondence

Pia Thiemann  
Institute of Public Health,  
Forvie Site,  
Robinson Way,  
Cambridge CB2 0SR  
Tel: +44 1223 330337 or +44 790 1046506  
Fax: +44 1223 762515  
Email: pt350@medschl.cam.ac.uk

Sponsors:

Swiss Anorexia Nervosa Foundation and Scheme to Support Specific Activities of Doctoral  
Students of the Ruhr-University Bochum

**Abstract**

This study examines putative non-sport-specific and sport-specific risk factors for eating disorders (ED) among groups of professional female athletes vs. non-athletes. In detail, societal pressure to be thin, its internalisation, body dissatisfaction, sports pressure, and early specialisation were investigated. The cross-sectional study included 46 aesthetic and 62 ball game sports athletes and 108 age-matched non-athletes. Study methods comprised a clinical interview to detect ED and questionnaires. More athletes from aesthetic (17%) than from ball game sports (3%) and non-athletes (2%) suffered from ED. Aesthetic sports athletes did not differ from non-athletes in non-sport-specific factors, but obtained higher levels than ball game sports athletes in sport-specific variables ( $p < .01$ ). All factors together accounted for 57.3% of variation in disordered eating, with sports pressure and body dissatisfaction as significant predictors. The results confirm ED risk for German aesthetic athletes, and indicate the importance of sports pressure and body dissatisfaction in explaining athletes' vulnerability.

**Keywords:**

sports pressure, body dissatisfaction, aesthetic and ball game sports, women and sport, elite performance

## 1 **Eating disorders and their putative risk factors among female German** 2 **professional athletes**

3  
4 Disordered eating in athletes has been frequently studied. The risk of developing eating  
5 disorders (ED) among athletes varies, depending on gender, sports discipline and  
6 competitive level (Petrie & Greenleaf, 2007). Adolescent females who participate at a  
7 professional level in aesthetic sports (e.g. rhythmic gymnastics) have a particular high risk of  
8 ED (Thompson & Sherman, 2010). In these sports, an outstandingly lean body build and low  
9 weight are promoted, because a leaner body or a thinner appearance can enhance  
10 performance and/or lead to a better score in judge-assessed sports (Sherman & Thompson,  
11 2006). In sports in which shape or weight are considered less important, such as ball game  
12 sports (e.g. basketball, field hockey), female athletes have a lower risk, but are still more  
13 prone to develop ED than non-athletes (Sundgot-Borgen, 1993). Large-scale studies from  
14 Norway revealed ED prevalence rates of over 30% for aesthetic sports athletes, 11% for ball  
15 game sports athletes and 5–9% for non-athletes (Sundgot-Borgen, 1993; Sundgot-Borgen &  
16 Torstveit, 2004). Similar results were found in a large study in Australia (Byrne & McLean,  
17 2002). Given these figures and the consequences of disordered eating for physical and mental  
18 health as well as for athletes' performance and social relationships (Scoffier, Woodman, &  
19 d'Arripe-Longueville, 2011; Sundgot-Borgen & Torstveit, 2010), effective prevention is  
20 necessary in professional sports. Only by understanding the causes of ED can targeted  
21 prevention strategies be developed. For athletes non-sport-specific risk factors (for a detailed  
22 list see Jacobi, Hayward, de Zwaan, Kraemer, and Agras (2004)) and sport-specific factors  
23 need to be considered (Sundgot-Borgen et al., 2013). Experts assume that the increased risk  
24 for ED in athletes is triggered by sport-specific factors (International Olympic Committee  
25 Medical Commission Working Group on "Women in Sport", 2005). According to Sundgot-  
26 Borgen (1994) one sport-related factor is early specialisation, i.e. selecting a sport when

27 prepubertal, before the body matures sufficiently. This may yield a discrepancy between the  
28 adult body type and the sport-specific body ideal and can result in disordered eating. Another  
29 sport-specific factor is sports pressure that encourages possession of an ideal body for  
30 physical performance (Petrie & Greenleaf, 2007). The degree of sports pressure and how  
31 much it promotes a thin physique varies between sports due to their different body  
32 requirements (Byrne & McLean, 2002). This means that athletes can be exposed to two  
33 sources of pressure: the sports pressure and the Western societal pressure to be thin. The  
34 aetiological model of Petrie and Greenleaf (2007) for ED in athletes embodies this idea:  
35 Being exposed to both sources of pressure leads to an increased likelihood of internalisation  
36 of societal body ideals and body dissatisfaction, depending on the discrepancy between the  
37 real and the ideal body. This results in higher risk of restrained eating and ED. More  
38 specifically, *societal pressure* to be thin is present for athletes and non-athletes, e.g. through  
39 the media (Stice, 2002). In contrast, *sports pressure* regarding physique, for example that  
40 exerted by team-mates or coaches (de Bruin, Oudejans, & Bakker, 2007; Thompson &  
41 Sherman, 2010), affects only athletes. The impact of this pressure is significantly influenced  
42 by the degree of *internalisation* of socially defined body ideals into the personal belief system  
43 (Stice & Shaw, 2002). Unattainable internalised ideals lead to *body dissatisfaction*, a main  
44 risk factor for ED in general populations (Jacobi et al., 2004; Stice, 2002). The relationship  
45 between body dissatisfaction and ED in athletes is less evident since athletes participating in  
46 high-risk sports do not seem to show increased body dissatisfaction (Hausenblas & Downs,  
47 2001; Smolak, Murnen, & Ruble, 2000).

48 To explain ED in professional sports it is necessary to investigate sport-specific and  
49 non-sport-specific factors. Given that sport studies rarely consider both at the same time or  
50 are limited to body dissatisfaction as a non-sport-specific factor, this study investigates  
51 societal pressure to be thin, the internalisation of a thin ideal, and body dissatisfaction,

52 together with sports pressure and early specialisation. Among athletes these factors have been  
53 insufficiently investigated and thus far, due to the lack of longitudinal studies, they can only  
54 be considered as putative risk factors. Before their risk factor status is tested longitudinally,  
55 their presence among athletes needs to be confirmed, for example through their increased  
56 incidence in groups with high disordered eating or ED (Jacobi et al., 2004; Kraemer et al.,  
57 1997). This study investigated the above-mentioned putative risk factors among female  
58 German aesthetic and ball game sports professional athletes; these are sport groups with  
59 elevated prevalence of ED according to international studies (see above).

60         Due to the diversity in terms of societal, cultural, and sport-specific training  
61 conditions in different countries (Digel & Burk, 2004), it is necessary to verify whether  
62 German athletes indeed have an increased risk of ED and are therefore appropriate subjects  
63 among whom to investigate putative ED risk factors. So far there is little empirical evidence  
64 for this: German ball game sports athletes have scarcely been investigated and results for  
65 aesthetic sports are inconsistent. With regard to eating-related pathology, Rosendahl,  
66 Bormann, Aschenbrenner, Aschenbrenner, and Strauß (2009), Salbach, Klinkowski, Pfeiffer,  
67 Lehmkuhl, and Korte (2007) and, with some limitations, Schneider, Bayios, Pfeiffer,  
68 Lehmkuhl, and Salbach-Andrae (2009) did not find differences between aesthetic sports  
69 athletes and non-athletes. In contrast, Krentz and Warschburger (2011a) (2011b) reported an  
70 increased level of disordered eating for aesthetic compared with ball game sports athletes and  
71 non-athletes. These few and partly contradictory results, based on self-report methods only,  
72 do not permit assessment of the eating pathology status of German professional athletes. A  
73 further investigation of the prevalence of ED among these athletes is necessary before  
74 potential risk factors for ED can be examined.

75         Considering the methodological problems of previous sport studies, such as the lack  
76 of adequate control groups (Jacobi et al., 2004; Smolak et al., 2000), age-cohort effects

77 (Thompson & Sherman, 2010; Torstveit, Rosenvinge, & Sundgot-Borgen, 2008) and data  
78 collection using only self-report methods, which may be unreliable (Sundgot-Borgen, 1993),  
79 this study investigated:

- 80 1. The prevalence rates of ED among German female aesthetic sports and ball game  
81 sports athlete controls and age-matched non-athletes, using clinical interviews.
- 82 2. The presence of putative risk factors for ED among aesthetic sports athletes in  
83 comparison with ball game sports and age-matched non-athletes.
- 84 3. The predictive power of sport-specific and non-sport-specific factors for disordered  
85 eating among athletes.

86

## 87 **Method**

### 88 **Participants**

89 In this study 108 German female professional athletes aged 12 to 34 years and 108 age-  
90 matched female non-athletes took part. Athletes were recruited with assistance of their  
91 coaches; non-athletes were recruited from high schools, universities, and at summer camps.  
92 Non-athletes were required not to have competed at a professional level in any sports before.  
93 They were allowed to participate in recreational sports for up to eight hours per week. For  
94 further information on the recruitment process and exclusion criteria see Figure 1. In this  
95 study a professional athlete is defined as somebody who competes on a national or  
96 international level (Smolak et al., 2000). According to the categories of Sundgot-Borgen  
97 (1994) , 46 aesthetic sports athletes (19 team vaulters, 11 rhythmic gymnasts, 10 figure-  
98 skaters, 3 artistic gymnasts, 3 synchronized swimmers), and 62 ballgame sports athletes (field  
99 hockey players) participated. Detailed group characteristics are summarized in Table 1. The  
100 study was conducted with the approval of the Ruhr-University Bochum Medical School  
101 Ethics Committee. All participants and parents for those younger than 18 years provided  
102 informed consent.

103

104 *Insert Figure 1 here*

105

106

### 107 **Measurements**

108 The Structured Clinical Interview for DSM-IV Axis I Disorders (SCID; Wittchen, Zaudig, &  
109 Fydrich, 1997) and a self-designed questionnaire containing items related to training history,  
110 health, weight and eating behaviour were used, in addition to the following instruments:

111

112 Patient Health Questionnaire (PHQ; Gräfe, Zipfel, Herzog, & Löwe, 2004)

113 The PHQ is a self-administered screening instrument for current mental disorders. The used  
114 modules mood, anxiety and alcohol ask for main symptoms and their frequency and consist  
115 of 40 items. The questionnaire has a diagnostic validity as good agreements between PHQ  
116 diagnoses and those of independent mental health professionals exist (inter-rater reliability:  $\kappa$   
117 = 0.65; overall accuracy: 85%; sensitivity: 75% and specificity: 90%) (Gräfe et al., 2004;  
118 Spitzer, Kroenke, Williams, & the Patient Health Questionnaire Primary Care Study Group,  
119 1999). The scoring system of the mood module allows to calculate internal consistency,  
120 which has shown to be good with Cronbach's  $\alpha=.88$  (Gräfe et al., 2004).

121

122 Eating Disorder Examination Questionnaire (EDE-Q; Hilbert, Tuschen-Caffier, Karwautz,  
123 Niederhofer, & Munsch, 2007)

124 The EDE-Q assesses the frequency of eating disorder attitudes, feelings and behaviour from  
125 the preceding 28 days. Four subscales (Restraint, Eating Concern, Weight Concern, Shape  
126 Concern) capture the attitudinal features while six single items refer to behavioural aspect of  
127 ED. The 22 items of the subscales are answered on a seven-point rating scale and form the  
128 EDE-Q global score. The latter is reported in this study, as it reflects the severity of ED  
129 psychopathology. Higher scores indicate greater psychopathology. The global score of the  
130 EDE-Q has shown excellent internal consistency with Cronbach's  $\alpha=.95$  (Hilbert et al.,  
131 2007).

132

133 Eating Disorder Inventory 2 (EDI-2; Paul & Thiel, 2005)

134 From the EDI-2, the scales *Drive for Thinness* and *Body Dissatisfaction* were used. The *Drive*  
135 *for Thinness* scale has six items and assesses the desire to lose weight, fear of weight gain and  
136 restricting tendencies. The subscale *Body Dissatisfaction* has nine items and assesses



137 displeasure about body shape by judging different body sites. All items are answered on a  
138 six-point rating scale. Higher scores indicate greater psychopathology. Both scales have  
139 shown good internal consistency in varied samples with Cronbach's  $\alpha > .80$  (Paul & Thiel,  
140 2005).

141

142 Sociocultural Attitudes Towards Appearance Scale (SATAQ-3; Thompson, van den Berg,  
143 Roehrig, Guarda, & Heinberg, 2004)

144 From the SATAQ-3, the scales *Pressures* and *Internalization* were used in the German  
145 version of Legenbauer (in preparation). The *Pressures* scale assesses with seven items  
146 societal pressure from the media to be thin. The subscale *Internalization* assesses with nine  
147 items the extent to which someone internalises the social standards of thinness and  
148 attractiveness portrayed by the media. All items are answered on a five-point rating scale.  
149 Higher scores indicate greater psychopathology. Both scales have shown excellent internal  
150 consistency with Cronbach's  $\alpha = .90$  (Thompson et al., 2004).

151

152 German ATHLETE (Thiemann, Legenbauer, Vocks, Platen, & Herpertz, 2014)

153 From the ATHLETE the scale *Sport and Body* was used. It assesses sports pressure to be thin.  
154 Pressure from the sports environment and pressure generated by an athlete's own beliefs that  
155 weight reduction increases performance are considered. Seven items are rated on a five-point  
156 rating scale. Higher values indicate higher pressure. This scale was identified when the factor  
157 structure of a German version of the ATHLETE (Hinton & Kubas, 2005) was examined for  
158 professional athletes. The scale has shown good internal consistency with Cronbach's  $\alpha = .89$   
159 (Thiemann et al., 2014).

160

161 **Procedure**

162 Athletes were surveyed on average four months prior to an important contest (the Olympics,  
163 or European, National, Regional-Championships at junior or senior level). They were  
164 measured and weighed in private (in light sports clothing), and were asked to complete the  
165 questionnaires. A SCID-I interview (Wittchen et al., 1997) was conducted by a clinical  
166 psychologist (first author) to detect ED and other mental illnesses. The most common mental  
167 disorders in competitive sport populations were considered including anxiety and mood  
168 disorders (Hoyer & Kleinert, 2010; Schaal et al., 2011). Furthermore psychotic symptoms  
169 and substance abuse/addiction were taken into account (for a detailed list see legend Figure  
170 2B). For non-athletes, height and weight were measured with 1kg adjustment for remaining  
171 clothes. Non-athletes completed an adapted set of questionnaires without sport measurements  
172 but additional screening instruments for mental health (PHQ (Gräfe et al., 2004), SCID-I  
173 screening questions (Wittchen et al., 1997)). Thirty-three (31%) non-athletes, who scored  
174 above the thresholds regarding mental health, eating behaviour, weight or menstrual cycles  
175 (see supplementary information 1) were interviewed via phone.

176 Eating disorder cases were discussed with a secondary ED expert (second author) and  
177 validated by a third blinded independent clinician. In addition, an overall diagnostic inter-  
178 rater reliability was calculated based on a sample of 30 randomly selected interview audio  
179 recordings and a blind assessment of the third expert. A Cohen's kappa coefficient of  $\kappa =$   
180 0.914 ( $p < .001$ ) indicated good inter-rater reliability.

181

## 182 **Data analysis**

183 The statistical analysis was conducted with SPSS 20<sup>®</sup>. To test categorical data across groups,  
184 Chi-square or Fisher's exact test were used. Continuous data were analysed using one-  
185 factorial Analysis of covariance. In all tests, group membership was the independent variable  
186 and comparisons were performed between 1) aesthetic sports vs. ball game sports athletes, 2)

187 aesthetic sports athletes vs. non-athlete controls (controls<sub>AS</sub>) and 3) ball game sports athletes  
188 vs. non-athlete controls (controls<sub>BS</sub>). Because of their impact on eating-related variables, BMI  
189 (de Bruin et al., 2007; Stice, 2002) and age (Byrne & McLean, 2001; Jacobi et al., 2004;  
190 Torstveit et al., 2008) were included as covariates except when age was controlled by the  
191 age-matching procedure. Tests which target ED, disordered eating or sport-specific variables  
192 in connection with aesthetic sports athletes or body dissatisfaction in connection with non-  
193 athletes were carried out as one-tailed hypotheses due to the empirical results presented in the  
194 introduction. A hierarchical multiple regression analysis was conducted to test the predictive  
195 power of putative sports-specific and non-sports-specific risk factors for disordered eating  
196 among athletes. An alpha level of  $p < .05$  was used. Bonferroni adjustments were applied for  
197 group comparisons (adjusted p-values  $p = .0167$ ). Cramér's  $\phi$ , Cohen's  $d$  and Partial  $\eta^2$  as  
198 effect size are reported.

## 199 **Results**

### 200 **Comparisons of group characteristics and mental health status**

201 First, we compared both athlete groups and second, we contrasted athletes to their respective  
202 control group regarding the baseline characteristics. As expected ball game sports athletes  
203 were older and heavier than aesthetic sports athletes. Additionally, the latter also trained  
204 significantly more hours per week. Group details are displayed in Table 1.

205 Analysis regarding research question 1 revealed that eight aesthetic sports athletes,  
206 two ball game sports athletes and one in each of the non-athlete groups suffered from an ED  
207 (Fig. 2A). One aesthetic sports athlete was diagnosed with Bulimia nervosa, the remaining  
208 eleven individuals were diagnosed with Eating Disorder Not Otherwise Specified (EDNOS).  
209 The point prevalence of ED among aesthetic sports athletes was significantly higher  
210 compared to controls<sub>SAS</sub> and ball game sports athletes. No significant differences were found  
211 between ball game sports athletes and their controls<sub>BS</sub>. Regarding the frequency of other  
212 mental disorders, no significant differences were found between groups (Fig. 2B).

213

214 *Insert Table 1 here*

215

216 *Insert Figure 2 here*

217

### 218 **Group comparisons of eating pathology and putative risk factor variables**

219 Results regarding research question 2 and the presence of disordered eating in each group are  
220 presented below. For further details regarding means and standard deviations see Table 2.

221

222 Aesthetic sports vs. ball game sports athletes

223 Aesthetic sports athletes obtained significantly higher scores on the EDE-Q global score  
 224 [F1,99 = 10.239,  $p = .001$ ,  $\eta^2_{\text{partial}} = .094$ ] and the EDI-2 Drive for Thinness scale [F1,99 =  
 225 13.880,  $p < .001$ ,  $\eta^2_{\text{partial}} = .123$ ]. They showed higher levels on the sport-specific factors  
 226 including the ATHLETE Sport and Body scale [F1,99 = 21.246,  $p < .001$ ,  $\eta^2_{\text{partial}} = .177$ ]  
 227 and significantly more aesthetic sports athletes 85% specialised before onset of puberty than  
 228 ball game athletes 53% did [ $\chi^2(2, N = 106) = 11.64$ ,  $p < .01$ ,  $\phi = .33$ ]. Aesthetic sports  
 229 athletes also scored significantly higher on the non-sport-specific factors SATAQ-3 Pressures  
 230 [F1,99 = 9.418,  $p = .003$ ,  $\eta^2_{\text{partial}} = .087$ ] and SATAQ-3 Internalisation [F1,99 = 9.241,  $p =$   
 231  $.003$ ,  $\eta^2_{\text{partial}} = .085$ ]. The two groups did not differ on the EDI-2 Body Dissatisfaction scale  
 232 [F1,99 = 1.189,  $p = .278$ ,  $\eta^2_{\text{partial}} = .012$ ].

233

234 Aesthetic sports athletes vs. non-athlete controls<sub>AS</sub>

235 Aesthetic sports athletes obtained significantly higher score on the EDI-2 Drive for Thinness  
 236 scale [F1,89 = 11.334,  $p < .001$ ,  $\eta^2_{\text{partial}} = .113$ ]. Taking the adjusted p-value into account ( $p$   
 237 =  $.0167$ ) a similar trend was shown for the EDE-Q global score [F1,89 = 4.449,  $p = .019$ ,  
 238  $\eta^2_{\text{partial}} = .048$ ]. Athletes did not differ from their controls<sub>AS</sub> in terms of non-sport-specific  
 239 factors. Groups did not differ on the SATAQ-3 Pressures scale [F1,89 = .984,  $p = .324$ ,  
 240  $\eta^2_{\text{partial}} = .011$ ], the SATAQ-3 Internalisation scale [F1,89 = .295,  $p = .589$ ,  $\eta^2_{\text{partial}} = .003$ ]  
 241 and the EDI-2 Body Dissatisfaction scale [F1,89 = .019,  $p = .446$ ,  $\eta^2_{\text{partial}} < .001$ ].

242

243 Ball game sports athletes vs. non-athlete controls<sub>BS</sub>

244 Ball game sports athletes obtained significantly lower scores on the EDE-Q global score  
 245 [F1,111 = 7.287,  $p = .006$ ,  $\eta^2_{\text{partial}} = .065$ ], but not on EDI-2 Drive for Thinness scale, when  
 246 applying the adjusted p-value of  $p = .0167$  [F1,111 = 4.404,  $p = .038$ ,  $\eta^2_{\text{partial}} = .038$ ]. Athletes  
 247 showed lower levels than their controls<sub>BS</sub> on non-sport-specific factors including the

248 SATAQ-3 Pressures scale [ $F_{1,111} = 22.166, p < .001, \eta_{\text{partial}}^2 = .166$ ], the SATAQ-3

249 Internalisation scale [ $F_{1,111} = 25.160, p < .001, \eta_{\text{partial}}^2 = .185$ ] and the EDI-2 Body

250 Dissatisfaction scale [ $F_{1,111} = 5.225, p = .012, \eta_{\text{partial}}^2 = .045$ ].

251

252 *Insert Table 2 here*

253

### 254 **Prediction of athletes' eating pathology**

255 To answer research question 3 a hierarchical regression was conducted. At step one, BMI and

256 age contributed significantly to the regression model [ $F(2,100) = 10.79, p < .001$ ] and

257 accounted for 17.7% of the variation of the EDE-Q global score among athletes. Inclusion of

258 all putative risk factors in step two explained an additional 57.3% of variation. The change in

259  $R^2$  was significant [ $F(7,95) = 40.65, p < .001$ ]. When all seven independent variables were

260 included in step two, only body dissatisfaction and sports pressure were significant predictors

261 (Table 3). Increase in these variables predicted higher pathology. SATAQ-3 predictors

262 missed the significance level with  $p = .079$  and  $p = .074$ .

263

264 *Insert Table 3 here*

## 265 **Discussion**

266 An increased risk for ED in several professional sports is widely recognised (Byrne &  
267 McLean, 2002; Sundgot-Borgen & **Torstveit**, 2004), though less certain is which factors  
268 contribute to the enhanced risk. This study examined the ED prevalence rates of German  
269 female professional athletes and non-athletes, as well as putative sport-specific and non-  
270 sport-specific risk factors for ED.

271

## 272 **Prevalence**

273 While the present study found no group differences in other mental disorders, groups differed  
274 significantly in prevalence of ED. Aesthetic sports athletes showed the highest rate of ED  
275 (17%), followed by ball game sports (3%) and non-athletes (2%). Similarly to other sport  
276 studies the most frequent ED diagnosis was EDNOS (Byrne & McLean, 2002; Ringham et  
277 al., 2006). Results from the EDE-Q and the EDI Drive for Thinness scale confirmed the  
278 aesthetic sports athletes' increased risk. Their high-risk status was in line with results of  
279 large-scale studies (Byrne & McLean, 2002; Sundgot-Borgen, 1993; Sundgot-Borgen &  
280 **Torstveit**, 2004). Compared with those studies, however, the prevalence in aesthetic sports  
281 athletes was less than half as high. This might be explained by different group composition,  
282 as the large-scale studies included the high risk group of dancers (Arcelus, Witcomb, &  
283 Mitchell, 2014), but did not consider team vaulters. Team vaulters may be exposed to less  
284 sports pressure, because their body requirements differ depending on their team position.  
285 With increasing age, body height and weight, vaulters often change their position within the  
286 team. In line with this interpretation Schneider et al. (2009) suggested that not all aesthetic  
287 sports have the same ED risk.

288 In contrast to the large-scale studies (Byrne & McLean, 2002; Sundgot-Borgen, 1993;  
289 Sundgot-Borgen & **Torstveit**, 2004), ball game sports athletes in this study had no enhanced

290 level of ED. Additionally, almost all self-report measures suggested that those athletes were  
291 healthier in terms of eating problems than non-athletes. Our ball game sample consisted of  
292 field hockey players only. Marshall and Harber (1996) exclusively investigated this group  
293 and also found no particular ED risk. It is possible that there may be factors specific to this  
294 group that influence eating and weight. Taking the risk factor results into account (see  
295 below), it might be possible that field hockey players benefit from a positive athletic  
296 participation effect, e.g. acting on self-esteem or body image (Schneider et al., 2009; Smolak  
297 et al., 2000; Zucker, Womble, Williamson, & Perrin, 1999), without paying the price of  
298 intense sports pressure.

299 Together with the reflections on team vaulters, this implies that it is worth judging  
300 sports individually for an exact ED risk assessment. The differences found in prevalence rates  
301 enabled us to perform the intended putative risk factor examination.

302

### 303 **Putative Risk factors**

304 In line with the assumption that putative risk factors are more prominent in groups with high  
305 disordered eating than in those with low (Kraemer et al., 1997), in this study putative risk  
306 factors were more prevalent in aesthetic than in ball game sports athletes.

307 Aesthetic sports athletes were more likely to have started sport-specific training  
308 before the onset of puberty than were ball game sports athletes. Since the discrepancy  
309 between the adult body and the ideal sports body is anyhow greater in aesthetic than in ball  
310 game sports (Thompson & Sherman, 2010), aesthetic sports athletes are at greater risk of  
311 developing a mismatch between the two body types (Sundgot-Borgen, 1994).

312 In support of the model of Petrie and Greenleaf (2007), aesthetic sports athletes also  
313 displayed the highest degree of sports pressure and differed from ball game sports athletes  
314 regarding two of the three investigated non-sport-specific factors. They reported more



315 societal pressure and a greater degree of its internalisation. Aesthetic sports athletes did not  
316 differ from non-athletes, however, in those non-sport-specific factors that might indicate the  
317 relevance of sports pressure, as suggested in other cross-sectional studies (Byrne & McLean,  
318 2002; Gomes, Martins, & Silva, 2011; Krentz & Warschburger, 2011a) and by the result of  
319 the regression analysis.

320         Body dissatisfaction, the third assessed non-sport-specific factor, is not particular high  
321 among aesthetic sports athletes. Even though in line with previous findings (Hausenblas &  
322 Downs, 2001; Smolak et al., 2000), this is counter-intuitive as their ED prevalence is  
323 elevated, and body dissatisfaction is a major risk factor for ED (Stice, 2002). Furthermore, in  
324 the regression analysis body dissatisfaction turns out to be a significant predictor for  
325 disordered eating. A similar pattern emerged in work by Krentz and Warschburger (2011b):  
326 body dissatisfaction predicts disordered eating, but does not differ among high- and low-risk  
327 groups. The absence of group differences may (mis)lead to the assumption that body  
328 dissatisfaction plays a minor role in ED among athletes (Smolak et al., 2000). An  
329 explanation, which could be tested by comparing athletes with and without ED, could be as  
330 follows: Athletes with ED pathology are dissatisfied with their bodies, but their high body  
331 dissatisfaction scores are averaged out by the majority of athletes, who are satisfied with their  
332 bodies. In this case no group difference appears but body dissatisfaction could still be a  
333 relevant ED predictor for athletes like in this study.

334         The regression analysis revealed that the putative risk factors together are able to  
335 explain almost 60% of the variation in disordered eating and it underlines the need to  
336 consider both sport-specific and non-sport-specific factors. The same conclusion could be  
337 drawn from the Gomes et al. (2011), which assessed a broader variety of sport-specific  
338 factors, e.g. sports performance anxiety.

339

### 340 **Strengths, Limitations and Perspective**

341 The strengths of this study are the joint consideration of sport-specific and non-sport specific  
342 factors, the use of clinical interviews to detect ED, an inter-rater reliability of  $\kappa = 0.914$  and  
343 avoidance of age-cohort effects; these features enhance the external validity. Nevertheless,  
344 when interpreting the data, the following limitations should be considered. The accuracy of  
345 prevalence rates in non-athletes might be affected by a possible selection effect and by the  
346 screening procedure, while the rates of aesthetic sports athletes might be underestimated by  
347 two coaches refusing their support and the heterogeneity of the group. It must be noted that,  
348 in general, cross-sectional findings are only the first step in terms of risk factor research and  
349 need to be followed by longitudinal studies. The interpretation is limited, furthermore, to the  
350 type of sports investigated and not all putative risk factors were considered e.g. those outlined  
351 in the new contextual approach to body dissatisfaction (de Bruin, Oudejans, Bakker, &  
352 Woertman, 2011). The sample size led to adequate power at moderate to large effect size  
353 levels, but to less than adequate statistical power at a small effect size level. In addition, due  
354 to the small number of ED cases, no logistic regression analysis to assess the predictive  
355 power of putative risk factors for ED could be performed (for details see [Peduzzi, Concato,](#)  
356 [Kemper, Holford, & Feinstein, 1996](#)). To overcome the limitations, one might need  
357 longitudinal risk factor studies and large-scale prevalence studies with single-sport groups,  
358 where athletes are approached directly and more putative risk factors are assessed.

359

### 360 **Conclusion**

361 Based on clinical interviews, this study confirms elevated prevalence of ED among female  
362 German aesthetic sports athletes and shows that risk assessment should be carried out  
363 individually for different sports. All investigated putative risk factors qualify to be further  
364 tested in a longitudinal design. In future research special attention should be focused on

365 sports pressure and body dissatisfaction. There are strong indications that both sport-specific  
366 and non-sport-specific factors need to be taken into account for prevention and treatment of  
367 ED in athletes.

368 **Acknowledgements**

369 The authors acknowledge the financial support provided by the Swiss Anorexia Nervosa  
370 Foundation and by the Ruhr-University Bochum. The authors would also like to acknowledge  
371 Dr. Gaby Bussmann and the Olympic Support Centre Westphalia for supporting the data  
372 collection. Particular thanks are due to the athletes, and non-athletes who took part, and the  
373 coaches who supported the study.

374 **References**

- 375 Arcelus, J., Witcomb, G. L., & Mitchell, A. (2014). Prevalence of eating disorders amongst  
 376 dancers: A systemic review and meta-analysis. *European Eating Disorders Review*,  
 377 22(2), 92–101. doi: 10.1002/erv.2271
- 378 Byrne, S., & McLean, N. (2001). Eating disorders in athletes: A review of the literature.  
 379 *Journal of Science and Medicine in Sport*, 4(2), 145–159. doi: 10.1016/S1440-  
 380 2440(01)80025-6
- 381 Byrne, S., & McLean, N. (2002). Elite Athletes: Effects of the pressure to be thin. *Journal of*  
 382 *Science and Medicine in Sport*, 5(2), 80–94. doi: 10.1016/S1440-2440(02)80029-9
- 383 de Bruin, A. P. K., Oudejans, R. R. D., & Bakker, F. C. (2007). Dieting and body image in  
 384 aesthetic sports: A comparison of Dutch female gymnasts and non-aesthetic sport  
 385 participants. *Psychology of Sport and Exercise*, 8(4), 507–520. doi:  
 386 10.1016/j.psychsport.2006.10.002
- 387 de Bruin, A. P. K., Oudejans, R. R. D., Bakker, F. C., & Woertman, L. (2011). Contextual  
 388 body image and athletes' disordered eating: The contribution of athletic body image to  
 389 disordered eating in high performance women athletes. *European Eating Disorders*  
 390 *Review*, 19(3), 201–215. doi: 10.1002/erv.1112
- 391 Digel, H., & Burk, V. (2004). Hochleistungssport im internationaler Vergleich [High  
 392 performance sport: An international comparison]. *Politik und Zeitgeschichte*, 26, 22–  
 393 30.
- 394 Gomes, A. R., Martins, C., & Silva, L. (2011). Eating disordered behaviours in Portuguese  
 395 athletes: The influence of personal, sport, and psychological variables. *European*  
 396 *Eating Disorders Review*, 19(3), 190–200. doi: 10.1002/erv.1113
- 397 Gräfe, K., Zipfel, S., Herzog, W., & Löwe, B. (2004). Screening psychischer Störungen mit  
 398 dem "Gesundheitsfragebogen für Patienten (PHQ-D)". Ergebnisse der deutschen

- 399 Validierungsstudie [Screening for psychiatric disorders with the Patient Health  
400 Questionnaire (PHQ). Results from the German validation study]. *Diagnostica*, 50(4),  
401 171-181. doi: 10.1026/0012-1924.50.4.171
- 402 Hausenblas, H. A., & Downs, D. S. (2001). Comparison of body image between athletes and  
403 nonathletes: A meta-analytic review. *Journal of Applied Sport Psychology*, 13(3),  
404 323–339. doi: 10.1080/104132001753144437
- 405 Hilbert, A., Tuschen-Caffier, B., Karwautz, A., Niederhofer, H., & Munsch, S. (2007). Eating  
406 Disorder Examination-Questionnaire: Evaluation der deutschsprachigen Übersetzung  
407 [Eating Disorder Examination-Questionnaire: Psychometric properties of the German  
408 version]. *Diagnostica*, 53(3), 144–154. doi: 10.1026/0012-1924.53.3.144
- 409 Hinton, P. S., & Kubas, K. L. (2005). Psychosocial correlates of disordered eating in female  
410 collegiate athletes: Validation of the ATHLETE questionnaire. *Journal of American  
411 College Health*, 54(3), 149–156. doi: 10.3200/JACH.54.3.149-156
- 412 Hoyer, J., & Kleinert, J. (2010). Leistungssport und psychische Störungen [Competitive  
413 sports and mental disorders]. *Psychotherapiejournal*, 3, 252–260.
- 414 International Olympic Committee Medical Commission Working Group on "Women in  
415 Sport". (2005). Position stand on the female athlete triad. Retrieved 20.12, 2006,  
416 from [http://multimedia.olympic.org/pdf/en\\_report\\_917.pdf](http://multimedia.olympic.org/pdf/en_report_917.pdf)
- 417 Jacobi, C., Hayward, C., de Zwaan, M., Kraemer, H. C., & Agras, W. S. (2004). Coming to  
418 terms with risk factors for eating disorders: Application of risk terminology and  
419 suggestions for a general taxonomy. *Psychological Bulletin*, 130(1), 19–65. doi:  
420 10.1037/0033-2909.130.1.19
- 421 Kraemer, H., Kazdin, A., Offord, D., Kessler, R., Jensen, P., & Kupfer D. (1997). Coming to  
422 terms with the terms of risk. *Archives of General Psychiatry*, 54, 337–343. doi:  
423 10.1001/archpsyc.1997.01830160065009.

- 424 Krentz, E. M., & Warschburger, P. (2011a). Sports-related correlates of disordered eating in  
425 aesthetic sports. *Psychology of Sport and Exercise*, *12*(4), 375–382. doi:  
426 10.1016/j.psychsport.2011.03.004
- 427 Krentz, E. M., & Warschburger, P. (2011b). Sports-related correlates of disordered eating: A  
428 comparison between aesthetic and ballgame sports. *International Journal of Sport  
429 Psychology*, *42*(6), 548–564.
- 430 Kromeyer-Hauschild, K., Wabitsch, M., Kunze, D., Geller, F., Geiß, H. C., Hesse, V., . . .  
431 Hebebrand, J. (2001). Perzentile für den Body-Mass-Index für das Kindes- und  
432 Jugendalter unter Heranziehung verschiedener deutscher Stichproben. *Monatsschrift  
433 Kinderheilkunde*, *149*, 807–818. doi: 10.1007/s001120170107
- 434 Marshall, J. D., & Harber, V. J. (1996). Body dissatisfaction and drive for thinness in high  
435 performance field hockey athletes. *International Journal of Sports Medicine*, *17*(7),  
436 541–544. doi: 10.1055/s-2007-972892
- 437 Palo Alto Medical Foundation pamf.org. Teenage Growth & Development: 11 to 14 Years.  
438 Retrieved 12.02., 2013, from [http://www.pamf.org/parenting-teens/health/growth-  
439 development/pre-growth.html](http://www.pamf.org/parenting-teens/health/growth-development/pre-growth.html)
- 440 Paul, T., & Thiel, A. (2005). *EDI-2: Eating Disorder Inventory-2. Manual*. Göttingen:  
441 Hogrefe.
- 442 Peduzzi, P., Concato, J., Kemper, E., Holford, T. R., & Feinstein, A. R. (1996). A simulation  
443 study of the number of events per variable in logistic regression analysis. *Journal of  
444 Clinical Epidemiology*, *49*(12), 1373-1379.
- 445 Petrie, T. A., & Greenleaf, C. A. (2007). Eating disorders in sport. From theory to research to  
446 intervention. In G. Tenenbaum & R. C. Eklund (Eds.), *Handbook of Sport Psychology*  
447 (pp. 352–378). Chichester: Wiley.

- 448 Ringham, R., Klump, K., Kaye, W., Stone, D., Libman, S., Stowe, S., & Marcus, M. (2006).  
449 Eating disorder symptomatology among ballet dancers. *International Journal of*  
450 *Eating Disorders*, 39(6), 503–508. doi: 10.1002/eat.20299
- 451 Rosendahl, J., Bormann, B., Aschenbrenner, K., Aschenbrenner, F., & Strauß, B. (2009).  
452 Dieting and disordered eating in German high school athletes and nonathletes.  
453 *Scandinavian Journal of Medicine and Science in Sports*, 19(5), 731–739. doi:  
454 10.1111/j.1600-0838.2008.00821.x
- 455 Salbach, H., Klinkowski, N., Pfeiffer, E., Lehmkuhl, U., & Korte, A. (2007). Body image and  
456 attitudinal aspects of eating disorders in rhythmic gymnasts. *Psychopathology*, 40(6),  
457 388–393. doi: 10.1159/000106469
- 458 Schaal, K., Tafflet, M., Nassif, H., Thibault, V., Pichard, C., Alcotte, M., . . . Toussaint, J.-F.  
459 (2011). Psychological balance in high level athletes: Gender-based differences and  
460 sport-specific patterns. *PLoS One*, 6(5), e19007. doi: 10.1371/journal.pone.0019007
- 461 Schneider, N., Bayios, V., Pfeiffer, E., Lehmkuhl, U., & Salbach-Andrae, H. (2009).  
462 Essstörungen und Leistungssport Essstörungsspezifische Merkmale bei Sportlerinnen  
463 ästhetischer Sportarten [Eating disorders and elite competitive sport: Eating-disorder-  
464 related characteristics in athletes from aesthetic sports]. *Zeitschrift für*  
465 *Sportpsychologie*, 16(4), 131–139. doi: 10.1026/1612-5010.16.4.131
- 466 Scoffier, S., Woodman, T., & d'Arripe-Longueville, F. (2011). Psychosocial consequences of  
467 disordered eating attitudes in elite female figure skaters. *European Eating Disorders*  
468 *Review*, 19(3), 280–287. doi: 10.1002/erv.1107
- 469 Sherman, R. T., & Thompson, R. A. (2006). Practical use of the International Olympic  
470 Committee Medical Commission position stand on the female athlete triad: A case  
471 example. *International Journal of Eating Disorders*, 39(3), 193–201. doi:  
472 10.1002/eat.20232



- 473 Smolak, L., Murnen, S. K., & Ruble, A. E. (2000). Female athletes and eating problems: A  
474 meta-analysis. *International Journal of Eating Disorders*, 27(4), 371–380. doi:  
475 10.1002/(SICI)1098-108X(200005)27:4<371::AID-EAT1>3.0.CO;2-Y
- 476 Spitzer, R., Kroenke, K., Williams, J. W., & the Patient Health Questionnaire Primary Care  
477 Study Group. (1999). Validation and utility of a self-report version of PRIMR-MD.  
478 The PHQ primary care study. *The Journal of American Medical Association*,  
479 282(18), 1737-1744.
- 480 Stice, E. (2002). Risk and maintenance factors for eating pathology: A meta-analytic review.  
481 *Psychological Bulletin*, 128(5), 825-848. doi: 10.1037//0033-2909.128.5.825
- 482 Stice, E., & Shaw, H. E. (2002). Role of body dissatisfaction in the onset and maintenance of  
483 eating pathology: A synthesis of research findings. *Journal of Psychosomatic*  
484 *Research*, 53, 985–993. doi: 10.1016/S0022-3999(02)00488-9
- 485 Sundgot-Borgen, J. (1993). Prevalence of eating disorders in elite female athletes.  
486 *International Journal of Sport Nutrition and Exercise Metabolism*, 3(1), 29–40.
- 487 Sundgot-Borgen, J. (1994). Risk and trigger factors for the development of eating disorders in  
488 female elite athletes. *Medicine and Science in Sports and Exercise*, 26(4), 414–419.  
489 doi: 10.1249/00005768-199404000-00003
- 490 Sundgot-Borgen, J., Meyer, N. L., Lohman, T. G., Ackland, T. R., Maughan, R. J., Stewart,  
491 A. D., & Muller, W. (2013). How to minimise the health risks to athletes who  
492 compete in weight-sensitive sports. Review and position statement on behalf of the  
493 Ad Hoc Research Working Group on Body Composition, Health and Performance,  
494 under the auspices of the IOC Medical Commission. *British Journal of Sports*  
495 *Medicine*, 47(16), 1012–1022. doi: 10.1136/bjsports-2013-092966

- 496 Sundgot-Borgen, J., & Torstveit, M. K. (2004). Prevalence of eating disorders in elite athletes  
497 is higher than in the general population. *Clinical Journal of Sport Medicine, 14*(1),  
498 25–32. doi: 10.1097/00042752-200401000-00005
- 499 Sundgot-Borgen, J., & Torstveit, M. K. (2010). Aspects of disordered eating continuum in  
500 elite high-intensity sports. *Scandinavian Journal of Medicine & Science in Sports,*  
501 20(s2), 112–121.
- 502 Thiemann, P., Legenbauer, T., Vocks, S., Platen, P., & Herpertz, S. (2014). Validierung einer  
503 deutschen Version des ATHLETE Fragebogens für Hochleistungssportlerinnen  
504 [Validating a German language version of the ATHLETE questionnaire for  
505 professional athletes]. *Zeitschrift für Sportpsychologie, 21*(1), 23–37. doi:  
506 10.1026/1612-5010/a000111
- 507 Thompson, J. K., van den Berg, J. K., Roehrig, M., Guarda, A. S., & Heinberg, L. J. (2004).  
508 The sociocultural attitudes towards appearance scale-3 (SATAQ-3): Development and  
509 validation. *International Journal of Eating Disorders, 35*(3), 293–304. doi:  
510 10.1002/eat.10257
- 511 Thompson, R. A., & Sherman, R. T. (2010). *Eating Disorders in Sport*. New York:  
512 Routledge.
- 513 Torstveit, M. K., Rosenvinge, J. H., & Sundgot-Borgen, J. (2008). Prevalence of eating  
514 disorders and the predictive power of risk models in female elite athletes: A  
515 controlled study. *Scandinavian Journal of Medicine and Science in Sports, 18*(1),  
516 108-118. doi: 10.1111/j.1600-0838.2007.00657.x
- 517 Wittchen, H.-U., Zaudig, M., & Fydrich, T. (1997). *Strukturiertes Klinisches Interview für*  
518 *DSM-IV*. Göttingen: Hogrefe.

- 519 World Health Organization. (1995). Physical status: Uses and interpretation of  
520 anthropometry. Report of a WHO Expert Committee on Nutrition. WHO Technical  
521 Report Series No. 854. Geneva: World Health Organization.
- 522 Zucker, N. L., Womble, L. G., Williamson, D. A., & Perrin, L. A. (1999). Protective factors  
523 for eating disorders in female college athletes. *Eating Disorders*, 7(3), 207–218. doi:  
524 10.1080/10640269908249286
- 525

526 **Table 1** Sample characteristics expressed as mean (standard deviation) or percentage  
 527 (number)

	Athletes		Non-athletes	
	Ballgame sports n=62	Aesthetic sports n=46	Controls <sub>AS</sub> n=46	Controls <sub>BS</sub> n=62
Age (years)	22.6 (3.6) <sup>1</sup>	16.6 (2.7) <sup>1</sup>	16.5 (2.6)	22.6 (3.6)
Body mass index (kg/m <sup>2</sup> )	22.4 (2.0) <sup>1,2</sup>	20.0 (2.0) <sup>1</sup>	20.4 (2.4)	21.1 (1.9) <sup>2</sup>
Underweight <sup>†</sup>	1.6% (1)	4.3% (2)	0% (0)	4.8% (3)
Overweight <sup>†</sup>	11% (7)	0% (0)	2.2% (1)	3.2% (2)
Training volume (h/week)	13.9 (3.3) <sup>1,2</sup>	18.7 (8.9) <sup>1,3</sup>	3.1 (2.4) <sup>3</sup>	2.9 (2.1) <sup>2</sup>
National sports performance	13% (8)	13% (6)		
International sports performance	87% (54)	87% (40)		

528 BMI, Body Mass Index; Controls<sub>AS</sub>, aesthetic sports controls; Controls<sub>BS</sub>, ball game sports  
 529 controls; h/week, hours per week.

530 <sup>†</sup>according to the WHO classification (World Health Organization, 1995) and standardized  
 531 percentile curves of BMI for German female adolescents (Kromeyer-Hauschild et al., 2001).

532 Means in the same row that share a superscript differ at p<.001.

533

534 **Table 2** Eating pathology and putative risk factors expressed as mean (standard deviation)

	<b>Athletes</b>		<b>Non-athletes</b>		
	$\alpha$	Ball game sports n=57 <sup>†</sup>	Aesthetic sports n=46	Controls <sub>SAS</sub> n=46	Controls <sub>SBS</sub> n=57
<b>Eating Pathology</b>					
EDEQ Global score	.95	0.7 (0.8)	1.1 (1.4)	0.7 (0.8)	0.9 (0.9)
EDI-2 Drive for Thinness	.90	13.4 (5.9)	17.4 (9.5)	12.8 (6.2)	14.4 (6.8)
<b>Putative Risk Factors</b>					
SATAQ-3 Pressures	.92	9.3 (4.0)	11.6 (5.8)	10.9 (5.6)	13.9 (6.5)
SATAQ-3 Internalization	.94	13.8 (7.0)	17.7 (8.6)	17.3 (8.1)	21.6 (8.9)
EDI-2 Body Dissatisfaction	.93	24.5 (9.4)	23.5 (11.2)	24.6 (9.3)	26.0 (10.7)
ATHLETE Sport & Body Athletes specialised before puberty <sup>1</sup>	.89	12.5 (5.9) 32 (53%)	16.2 (8.3) 39 (85%)		

535 BMI, Body Mass Index; Controls<sub>SAS</sub>, aesthetic sports controls; Controls<sub>SBS</sub>, ball game sports

536 controls; EDE-Q, Eating Disorder Examination Questionnaire; EDI-2, Eating Disorder

537 Inventory-2; SATAQ-3, Societal Attitudes Towards Appearance Scale-3.

538 <sup>†</sup> reduced sample sizes due to 5 missing questionnaires.539 <sup>1</sup> Puberty onset for girls = ages 10 (Palo Alto Medical Foundation pamf.org)

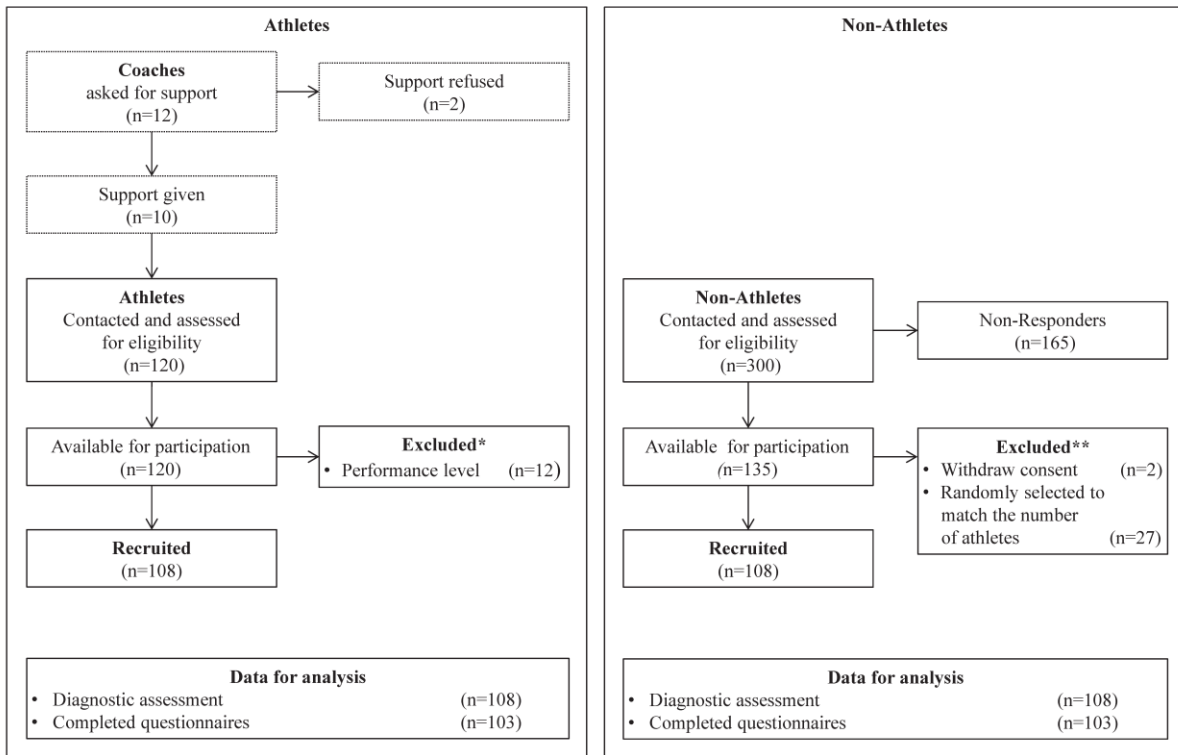
540 **Table 3** Summary of hierarchical regression analysis for variables predicting eating  
 541 disordered pathology (EDE-Q global score) among athletes (n=103)

	<i>B</i>	SEB	$\beta$	95% CI
Step 1				
Constant	-1.802	0.93		(-3.639 to 0.036)
BMI	0.201	0.05	.43**	(0.109 to 0.292)
Age	-0.080	0.03	-.30*	(-0.13 to 0.030)
Step 2				
Constant	-0.925	0.586		(-2.089 to 0.238)
BMI	-0.043	0.034	-.091	(-0.109 to 0.024)
Age	0.011	0.016	.044	(-0.021 to 0.044)
SATAQ-3 Pressures	0.041	0.023	.185	(-0.022 to 0.088)
SATAQ-3 General Internalization	0.028	0.015	.197	(-0.003 to 0.058)
EDI-2 Body Dissatisfaction	0.040	0.009	.365**	(0.022 to 0.058)
ATHLETE Sport & Body	0.046	.013	.303**	(0.021 to 0.071)
Age at sport-specific training start	0.004	.022	.009	(-0.040 to 0.048)

542 BMI, Body Mass Index; EDE-Q, Eating Disorder Examination Questionnaire; EDI-2, Eating  
 543 Disorder Inventory-2; SATAQ-3, Societal Attitudes Towards Appearance Scale-3.

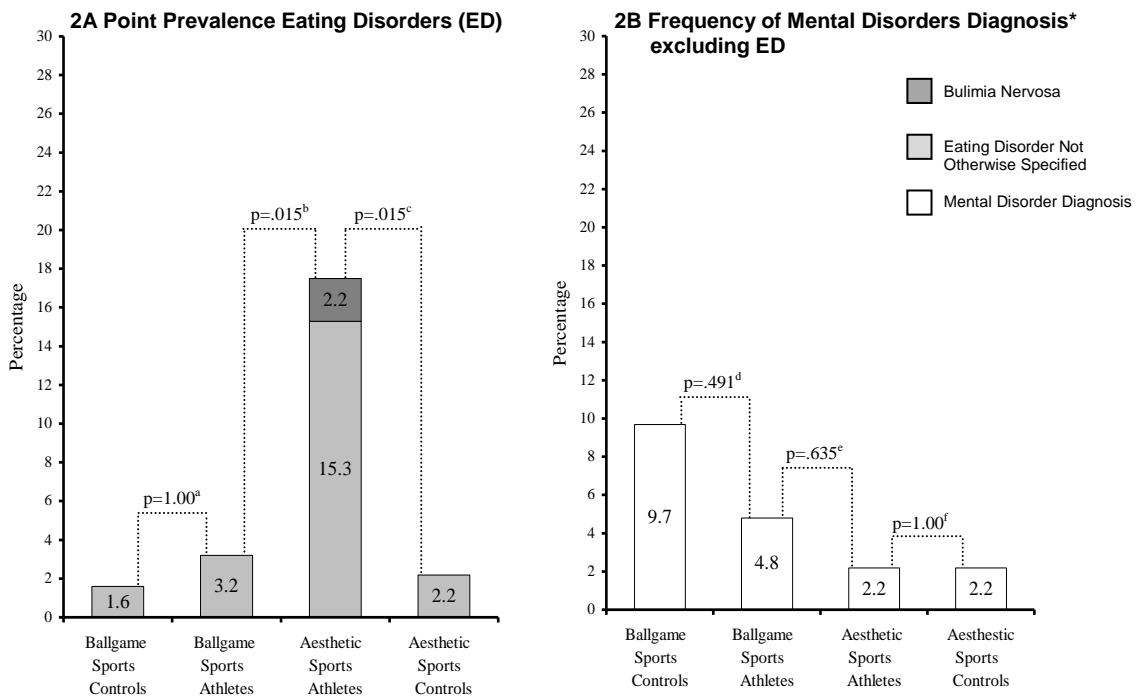
544  $R^2 = .18$  for Step 1;  $\Delta R^2 = .57$  for Step 2, \* $p < .01$ , \*\* $p < .001$ .

545 **Figure 1**



546  
547

548 **Figure 2**  
549





551

552 **Supporting information 1** Interview criteria for non-athlete controls

---

*Mental Health:*

- Report of current or past mental disorders
- Report of in- or outpatient treatment for mental health reasons
- Positive results on PHQ Diagnostic or SCID-I Screening questions

*Weight:*

- Current or past underweight: BMI < 18.5 kg/m<sup>2</sup> or a BMI < 10th percentile for all younger than 18 years

*Eating Behaviour:*

- Self-reported eating disorders
- Report of pathogenic weight control methods
- Scores of EDI-2 subscales at or above the 95<sup>th</sup> percentile of healthy controls (EDI-2 DT > 15; and EDI-2 BD > 25)

*Menstrual Cycle:*

- Menstrual dysfunction defined as primary or secondary amenorrhoea
- 

553 PHQ, Patient Health Questionnaire; SCID-I, Structured Clinical Interview for DSM-IV Axis

554 I Disorders; BMI, Body Mass Index; EDI-2, Eating Disorder Inventory 2.