

Eating Disorder Pathology in Elite Adolescent Athletes

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ABSTRACT

Objective: We aimed to investigate eating disorder pathology in German elite adolescent athletes. Evidence suggests that eating disorder pathology is more common in adult elite sports, especially in female athletes and in sports emphasizing leanness. There is a scarcity of studies in elite adolescent athletes who are in a vulnerable developmental stage and are affected by general as well as sport-specific risk factors.

Method: Our data was derived from the German Young Olympic Athletes' Lifestyle and Health Management Study (GOAL) which conducted a survey in 1138 elite adolescent athletes. In this sample, we assessed body weight, weight control behavior, body acceptance and screened overall for core symptoms of eating disorders, depression and anxiety. We performed a tree analysis to identify high risk groups for eating disorder pathology.

Results: High risk groups comprised (a) athletes competing in weight dependent sports, and among athletes competing in

disciplines other than weight dependent sports (b) athletes who are high on negative affectivity, (c) female athletes and (d) male athletes competing in endurance, technical or power sports. Athletes competing in weight dependent disciplines reported wide spread use of compensatory behaviors to influence body weight. Athletes reporting eating disorder pathology showed higher levels of depression and anxiety than athletes without eating disorder pathology.

Discussion: Increased psychosocial burden in athletes with eating disorder pathology suggests that eating disorder symptoms should not be accepted as an unproblematic and functional part of elite sports. The prevention and management of eating disorder pathology is especially important in weight dependent sports. © 2016 Wiley Periodicals, Inc.

Keywords: athletes; adolescent; eating disorders; sports; weight control behaviors; body acceptance

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INTRODUCTION

An athlete's body is the vehicle to perform and to achieve in sports. Besides training and practicing, nutrition and eating are relevant for the influence and improvement of bodily functions in sports as body weight and composition are pivotal determinants of performance in many sport disciplines.

This body-focus, including related attitudes, emotions and behaviors, requires athletes to deal with multiple potentially discordant demands and expectations: For instance, body ideals in society versus body ideals in their field of sports^{1,2}; individual eating preferences versus nutritional recommendations and diet plans provided by the trainer or sport association²; (dis)satisfaction with individual body weight versus weight-related attitudes and practices anchored within the culture of their field of sports.^{2,3} Additionally, in some sport disciplines, leanness and weight classes play a crucial role for achievement which might put a particular pressure on athletes with respect to their eating behavior and body weight.³

This context might put athletes at risk for the development of pathological attitudes or behaviors, as seen in clinical eating disorders, such as body dissatisfaction, disturbed eating patterns or disordered weight-control behaviors, or even the development of a full-syndrome eating disorder.^{1,2} Evidence from a large well-controlled study in elite athletes across the age spectrum from adolescence to adulthood

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supports this assumption: As compared to age-matched non-athletes, Sundgot-Borgen and Torstveit⁴ found a higher prevalence of eating disorders in Norwegian elite athletes. Prevalence of eating disorders was higher in sports focusing on leanness and weight.⁴ While findings of different studies in the field are difficult to interpret due to heterogeneity of definitions, instruments and samples, two recent reviews support the overall picture that eating disorder pathology is more common in adult elite sports, especially in female athletes and in sports emphasizing leanness or in high-intensity sports.^{1,2}

Young elite athletes might be even more prone to the development of eating disorder pathology as, compared to adult athletes, they find themselves in a specifically vulnerable developmental period in which they are faced with a range of general as well as sport-specific risk factors: Adolescence and early adulthood is characterized by growth, physical changes and personality development and has been identified as the period of first onset of eating disorders in the general population.⁵ For adolescents performing in competitive sports, there are additional demands and strains, including potential discontinuities due to growth and injuries, decisions and arrangements about their further career and pressure to perform.^{2,6,7}

In this context, eating disorder pathology in young elite athletes might not only emerge from a desire to influence body weight or shape and eventually improve performance,¹ but might also represent a dysfunctional strategy to cope with psychosocial challenges in elite sports.⁷ However, the adequate appraisal of aberrant eating or weight-control in athletes is generally challenging — an issue that was nicely put by Martinsen et al.⁸ in their paper title by asking “Dieting to win or to be thin?” Athletes have partly different motives for specific behaviors generally labelled as “disordered” and it has been argued that, to a certain extent, these behaviors might rather be understood as functional by athletes who adopt them as part of the subculture within their sport discipline and might e.g., experience them as an important part of preparing for a competition or a sign of special commitment.^{9,10}

As a further alternative hypothesis, engaging in competitive sport in youth might be a protective factor for the development of eating disorder pathology: Intensive physical activity might foster the development of a positive body image and the aim of achievement in sports might generally promote a healthy lifestyle,⁸ which for instance also includes to a large extent abstinence from substance use.^{11,12}

However, up to now, it remains largely unclear if high-performance sports is a risk or rather a protective factor for the development of eating disorder pathology in adolescents and if aberrant eating and weight-control patterns should indeed be seen as pathologic or rather functional. Studies have mainly focused on eating disorder pathology in adult athlete samples or in samples covering the age spectrum of adolescence and adulthood. Previous studies in adolescents have predominantly investigated comparably small samples from single sport disciplines, e.g., figure skaters¹³ and swimmers.¹⁴ There are two recent large well-controlled studies in the field focusing specifically on adolescent elite athletes.^{8,9} Based on self-report data, Martinsen et al.⁸ found young elite athletes to be less likely than an age-matched comparison group to show eating disorder pathology. Prevalence of full-syndrome eating disorders, however, seems to be higher in adolescent elite athletes than in a comparison Group (7 versus 2%) when using clinical interviews for assessment.⁹ In both studies, female athletes were more likely than male athletes to show eating disorder pathology, while there were no increased prevalences found for disciplines emphasizing leanness. In a recent review,¹⁵ we specifically investigated the use of disordered weight-control behaviors, such as use of laxatives or vomiting, in adolescent elite athletes who are competing at least in a national selection squad. Only a minority of the 15 studies included had included a comparison sample. Given this restriction, we found no evidence for an overall higher prevalence of disordered weight-control behaviors, however, adolescents competing in leanness sports seem to more often use such behaviors than non-athletes. Conclusions with respect to sex differences are not reliable as only two studies investigated this question.

Taken together, the limited evidence on eating disorder pathology in elite adolescent athletes is difficult to interpret and shows mixed results. The overall picture suggests that adolescent athletes might not generally be prone to show eating disorder pathology, but there might be vulnerable subgroups which are at a higher risk, including female athletes and athletes competing in specific sport disciplines.

The major aim of the present study was the investigation of potential vulnerabilities for eating disorder pathology in a large nationally representative sample of German adolescent elite athletes. As a secondary aim, we investigated psychopathological burden in athletes reporting eating disorder symptoms as an indicator of functionality versus pathology of these symptoms in the context of

TABLE 1. Sport disciplines classified into six kind of sports according to Sundgot-Borgen and Larsen (1993)

Kind of Sport					
Technical Sports	Endurance Sports	Aesthetic Sports	Weight Dependent Sports	Ball Games	Power Sports
Archery	Canoe/Kayak (Sprint)	Synchronized Swimming	Boxing	Badminton	Javelin Throw
Fencing	Cycling	Gymnastics (Artistic)	Weightlifting	Basketball	Discus Throw
Canoe/Kayak (Slalom)	Rowing	Gymnastics (Rhythmic)	Judo	Soccer	Hammer Throw
Modern pentathlon	Swimming	Gymnastics (Trampoline)	Taekwondo	Handball	Shot-Put
Equitation (Dressage)	Triathlon	Figure Skating	Wrestling (Freestyle)	Field Hockey	Sprint
Equitation (Eventing)	Biathlon			Water polo	Hurdles
Equitation (Jumping)	Speed Skating			Tennis	Multiple Event Contests
Shooting	Nordic Combined			Table Tennis	
Diving	Cross-country Skiing			Volleyball (Beach)	
Skeleton	Middle- and Long-Distance Running			Volleyball (Indoor)	
Curling	Steeplechase			Ice Hockey	
Luge	Race Walking				
Alpine Skiing					
Freestyle Skiing					
Ski Jumping					
Snowboard					
High Jump					
Long Jump					
Pole Vault					
Triple Jump					

sports. We conducted a full cross-sectional survey resulting in a total sample of 1138 participants competing in 51 Olympic sport disciplines. Among other health-related variables, we assessed body weight, weight control behavior, body acceptance and screened overall for core symptoms of eating disorders. We assessed general psychopathological burden by screening for depression and anxiety. Based on a range of general and sport-specific risk factors, we identified contrast groups within the athlete cohort which are at a higher risk for showing eating disorder pathology.

We hypothesized that eating disorder pathology would be (a) more prevalent in female athletes as compared to male athletes; (b) more prevalent in athletes competing in aesthetic and weight dependent sports as compared to athletes competing in other sports disciplines. Moreover we expected (c) athletes showing increased eating disorder pathology to also show a generally higher psychopathological burden.

Methods

Study Design

The data reported on eating disorder pathology were derived from the German Young Olympic Athletes' Lifestyle and Health Management study (GOAL-study). The GOAL study used a mixed-method design,¹⁶ combining quantitative and qualitative approaches, including a cross-sectional survey assessing current health status as well as a range of health-related attitudes and behaviors, including body weight, body image, eating behavior and

weight-control behavior. A detailed description of the study design, research questions and methods used has previously been published.¹⁶

Participants

The aim of the cross-sectional quantitative study part was to conduct a complete survey of all adolescent German elite athletes competing in one of the Winter Olympics 2010 or Summer Olympics 2011 sports. Participants had to be born between 1992 and 1995 and had to compete at least at the lowest national squad or a corresponding team level. In the sport disciplines sailing and bobsledding, no athlete met these inclusion criteria, while Greco-Roman wrestling refused to participate in the study. Hence, 1843 athletes from 51 sport disciplines were eligible for study participation. Response rate was 61.8%. For sport-specific response rates, see Ref. 16.

According to Sundgot-Borgen and Larsen (1993),¹⁷ we classified the 51 sport disciplines into the following six categories: technical sports, endurance sports, aesthetic sports, weight dependent sports, ball games, and power sports (Table 1).

Ethical Consideration

The ethics committee of the Medical Faculty and the University Hospital Tübingen approved this study. All study participants provided written informed consent.

Measures and Psychometric Instruments

All psychometric instruments used were suitable for assessment in adolescents.

Body Mass Index (BMI). Study participants were asked to indicate their height in cm and their weight in kg.

From this information, the body mass index (BMI) was calculated and transferred into BMI percentiles. A BMI percentile >90 indicates overweight, while a BMI percentile <10 indicates underweight.

Frankfurt Body Concept Scales (FKKS). We used the FKKS subscale *body acceptance* which assesses global attitudes towards one's own biological body functions as well as aesthetic appraisal of one's own body.¹⁸ Items are answered on a 6-point Likert scale and scores are summed-up to a total score. High scores reflect high body acceptance. Total scores ≤ 18 are interpreted as negative body concept, while total scores ≥ 24 reflect a positive body concept. The subscale showed high split-half reliability (.82) and high re-test reliability (.81) and construct validity of the FKKS has been confirmed using different self-report instruments assessing adjacent constructs.¹⁸ In the present sample, internal consistency of the subscale *body acceptance* was excellent ($\alpha = 0.90$).

Patient Health Questionnaire-4 (PHQ-4). The PHQ-4 is a 4-item self-report instrument which assesses core criteria of depressive disorder and generalized anxiety disorder.¹⁹ Response options reflect the frequency of the respective symptom and item scores are summed-up to a total score. High scores reflect higher symptom burden. In the present sample, internal consistency of the PHQ-4 was satisfactory ($\alpha = 0.62$).¹⁹

Structured Inventory for Anorexic and Bulimic Disorders (SIAB-S). We used five items from the SIAB-S examining the most common compensatory behaviors, including fasting, self-induced vomiting, use of laxatives, diuretics and appetite suppressants.^{20,21} Response options reflect the frequency of the respective symptom. The SIAB-S showed a sensitivity of 70.0% and a specificity of 80.0%.²⁰ Construct validity was confirmed via strong correlations with the Eating Disorder Inventory.²⁰

We created a sixth item assessing weight control via dehydration as this method is known to be especially used by athletes.¹⁵ This item asked: *Are you using methods causing dehydration (e.g., through sauna taking, jogging in tight-fitting suits. . .) prior to competitions in order to reduce body weight?*

For the data analysis, we categorized athletes who indicated that they used at least one of the provided methods at least occasionally as using compensatory behaviors.

Additionally, we created an item asking for the frequency of diets in the last year. This item asked: *How often have you been dieting in the last year?* Response options ranged from 1 (never) to 5 (I am constantly trying to lose weight). For the data analysis, we coded the item into a binary variable (constantly trying to lose weight – yes/no).

SCOFF. The SCOFF is a self-report screening instrument which assesses five core symptoms of eating disorders.²² SCOFF questions are answered with yes or no. The threshold for a positive screening result is two questions answered with “yes”. In the validation study, the SCOFF showed a sensitivity of 84.6% and a specificity of 89.6%.²² Construct validity was confirmed via strong correlations with the Eating Disorder Inventory.²²

Case Definition of Eating Disorder Pathology

Athletes were classified as showing eating disorder pathology when fulfilling one or more of the following criteria: (a) two or more SCOFF questions are answered affirmatively; (b) FKKS subscale *body acceptance* score <19 (negative body concept); (c) one or more of the weight control behaviors are reported

Statistical Analyses

Data were analyzed using SPSS 20.

Prior to analyses, we inspected continuous data (FKKS subscale score and PHQ total score) for normal distribution and found that both scores were not normally distributed in the present sample. We therefore used non-parametric tests when analyzing these variables.

Analysis of Sex and Sport-Specific Group Differences. We analyzed potential group differences between the female and male subgroup as well as between kind of sports using Mann-Whitney *U* test for continuous data or using χ^2 test for categorical data.

Group Classification According to Eating Disorder Pathology. We compared the subgroup of athletes classified as showing eating disorder pathology with the remaining subgroup with respect to their PHQ-4 scale score using Mann-Whitney *U* test. Moreover, we used this classification for the identification of vulnerable subgroups.

Classification and Regression Tree Analysis (CART). In order to identify subgroups of athletes at risk for eating disorder pathology, we performed a CART. The goal of this non-parametric procedure is to create homogeneous and exhaustive subgroups with respect to a specific outcome within a population, using a set of categorical and/or continuous independent variables.²³ As independent variables, we used several general and sport-specific risk factors for eating disorders²: sex, sport discipline, negative affect as assessed by the PHQ-4,¹⁹ perfectionism, days withdrawn from competition due to injury in the last season, and risk acceptance.

A regression tree starts with a parent node, and the analysis tries to find the best variable to split this node into two child nodes by maximizing the average “purity” of the two child nodes (here: groups with similar prevalence of eating disorder pathology).²³ As statistical splitting criterion, we used the Gini improvement measure

and set this measure to a minimum value of .001 which represents a modest difference between two nodes.²³ We did not use a stopping rule for tree growth and set the minimal number of cases in a terminal node at 1% of the sample size.

Results

Study Sample

Table 2 displays basic demographic and sport-specific characteristics of the study sample. The largest group of athletes formed those competing in ball games, followed by endurance sports. A quarter of the elite adolescent athletes attended a sport-oriented boarding school.

Body Weight

Tables 3 and **4** display findings with respect to body weight.

Eating Disorder Pathology Based on SCOFF Results

One fifth of athletes were found to have a positive SCOFF screening result (**Table 3**). The question most often answered with “yes” was “Would you say that food dominates your life?” (86.7% in the subgroup of athletes with a positive screening result). The positive screening rate was roughly twice as high in female than in male athletes ($X^2 [N = 1115] = 43.608$; $df = 1$; $P < 0.001$). Athletes competing in ball games were less likely to have a positive screening result than athletes from all other kind of sports ($X^2 [N = 1112] = 18.155$; $df = 5$; $P < 0.01$; std. residual = -2.7).

Body Acceptance

Tables 3 and **4** display findings with respect to body acceptance. With a mean scale score above 24, athletes showed on average a positive body concept (**Table 3**). Female athletes reported a significantly lower body acceptance as compared to male athletes ($U[1104] = 88873.5$, $P < 0.001$) and scored significantly more often in the range of a negative body concept than male athletes ($X^2 [N = 1104] = 32.653$; $df = 1$; $P < 0.001$). We found no sport-specific differences in body acceptance.

Weight Control Behaviors

Nearly 8% of athletes reported that they were constantly trying to lose weight, and 12% of athletes reported to use one or more compensatory behaviors (**Table 3**). Activities inducing passive or active dehydration (e.g., sauna, exercise in sweat

TABLE 2. Demographic and sport-specific characteristics of the study sample

	Total Sample	Females	Males
<i>n</i>	1138	500	638
Age (yrs; $M \pm SD$)	16.3 ± 1.1	16.3 ± 1.1	16.4 ± 1.1
Weekly training quantity (hrs; $M \pm SD$; $n = 1109$)	13.7 ± 5.4	13.2 ± 5.6	14.2 ± 5.1
Competitions during last season (days; $M \pm SD$; $n = 957$)	40.8 ± 30.8	40.3 ± 32.9	41.2 ± 29.1
Squad (%)			
A	4.0	2.8	4.9
B	3.2	3.0	3.3
C	43.2	48.8	38.9
D/C	43.1	38.6	46.6
Other	6.6	6.8	6.4
Kind of Sport (%) ($n = 1134$)			
Technical	16.2	16.3	16.2
Endurance	28.9	26.1	31.1
Aesthetic	4.1	5.6	2.8
Weight dependent	8.6	9.2	8.2
Ball games	35.9	35.1	36.5
Power	6.3	7.6	5.2

Squads A, B and C generally represent a performance on a national level, C-squad and D/C-squad generally represent a performance on a state level.

suits) were methods most commonly used. Female athletes were significantly more likely to report constantly trying to lose weight ($X^2 [N = 1126] = 29.161$; $df = 1$; $P < 0.001$) and to report compensatory behaviors ($X^2 [N = 1130] = 6.618$; $df = 1$; $P < 0.05$) than male athletes. Athletes competing in weight dependent sports were significantly more likely to report use of compensatory behaviors ($X^2 [N = 1126] = 435.832$; $df = 5$; std. residual = 18.6 ; $P < 0.001$). Athletes competing in ball sports were significantly less likely to be on a constant diet ($X^2 [N = 1121] = 15.491$; $df = 5$; std. residual = -2.3 ; $P < 0.01$) and to use compensatory behaviors ($X^2 [N = 1126] = 435.832$; $df = 5$; std. residual = -4.6 ; $P < 0.001$). Use of compensatory behaviors was also significantly less often reported by athletes competing in endurance sports (std. residual = -3.3).

Psychopathological Burden in Athletes Showing Eating Disorder Pathology

32.5% of the total athlete sample fulfilled the criteria for eating disorder pathology according to pre-defined criteria. This subgroup scored significantly higher on a screening measure of depression and anxiety than athletes without eating disorder pathology [2.6 ± 2.1 vs. 1.6 ± 1.4 ; $U(1082) = 91273.5$, $P < 0.001$].

Subsamples at Risk for Eating Disorder Pathology

Figure 1 displays the regression tree produced by the classification and regression tree analysis. The

TABLE 3. Body weight, core eating disorder symptoms, body acceptance and weight control behaviors in the study sample

	Total Sample	Females	Males	Kind of Sport				
				Technical Sports	Endurance Sports	Aesthetic Sports	Weight Dependent Sports	Ball Games
<i>Body weight</i>								
<i>n</i>	1126	496	630	181	324	46	97	403
BMI percentiles (M ± SD)	56.4 ± 23.6	49.2 ± 23.4	62.0 ± 22.2	53.2 ± 24.9	53.4 ± 21.9	37.1 ± 23.4	55.3 ± 27.4	60.7 ± 21.0
Underweight (%)	3.1	4.9	1.8	4.4	2.2	15.2	7.2	1.0
Normal weight (%)	90.5	91.3	89.8	87.3	95.0	84.8	83.5	94.8
Overweight (%)	6.4	3.8	8.4	8.3	2.8	0	9.3	4.2
Screening for core ED symptoms								
<i>n</i>	1115	488	627	178	322	46	97	398
Positive screening result (%)	21.5	30.7	14.4	20.2	25.8	26.1	28.9	15.3
<i>Body acceptance</i>								
<i>n</i>	1104	483	621	179	317	44	94	395
M ± SD	25.1 ± 4.0	23.6 ± 4.0	26.3 ± 3.6	24.4 ± 4.2	24.8 ± 4.0	24.8 ± 4.8	25.9 ± 4.1	25.3 ± 3.8
Negative body concept (%)	7.3	12.4	3.4	11.7	7.6	13.6	6.4	5.3
<i>Weight control behaviors</i>								
<i>n</i>	1125	491	632	182	320	46	97	406
Constant dieting (%)	7.5	12.4	3.8	9.9	9.1	13.0	12.4	4.4
<i>n</i>	1130	499	631	183	327	45	97	403
Use of compensatory behaviors (%)	12.2	6.6	5.6	10.4	5.8	4.4	78.4	4.2

Sample size of subgroups does not necessarily sum up to number of total sample for each variable as data on kind of sport was available for $n = 1134$ participants (see Table 1).

TABLE 4. Weight status, core eating disorder symptoms, body acceptance and weight control behaviors broken down by sex for each kind of sport

	Kind of Sport											
	Technical Sports		Endurance Sports		Aesthetic Sports		Weight Dependent Sports		Ball Games		Power Sports	
	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
<i>Body weight</i>												
<i>n</i>	101	80	196	128	18	28	51	46	229	174	33	38
BMI percentiles (M ± SD)	57.4 ± 23.8	47.9 ± 25.4	57.8 ± 20.9	46.7 ± 21.8	49.3 ± 20.3	29.3 ± 22.1	60.4 ± 27.7	49.6 ± 26.3	66.6 ± 19.7	53.0 ± 20.2	79.9 ± 17.1	58.1 ± 27.2
Underweight (%)	4.0	5.0	1.5	3.1	0	25.0	3.9	10.9	0.9	1.1	0	5.3
Normal weight (%)	87.1	87.5	94.9	95.3	100	75.0	82.4	84.8	92.6	97.7	54.5	76.3
Overweight (%)	8.9	7.5	3.6	1.6	0	0	13.7	4.3	6.6	1.1	45.4	18.4
Screening for core ED symptoms												
<i>n</i>	101	77	195	127	18	28	51	46	228	170	33	38
Positive screening result (%)	15.8	26.0	19.5	35.4	16.7	32.1	25.5	32.6	6.6	27.1	15.2	39.5
<i>Body acceptance</i>												
<i>n</i>	102	77	191	126	16	28	51	43	226	169	33	38
M ± SD	25.5 ± 3.9	22.9 ± 4.3	25.9 ± 3.6	23.2 ± 4.0	27.1 ± 3.8	23.4 ± 4.8	27.5 ± 4.0	24.0 ± 3.4	26.5 ± 3.4	23.8 ± 4.0	27.2 ± 2.9	24.3 ± 3.9
Negative body concept (%)	5.9	19.5	4.2	12.7	6.2	17.9	3.9	9.3	1.8	10.1	0	7.9
<i>Weight control behaviors</i>												
<i>n</i>	103	79	194	126	18	28	51	46	232	174	31	38
Constant dieting (%)	4.9	16.5	5.2	15.1	0	21.4	11.8	13.0	1.3	8.6	0	5.3
<i>n</i>	102	81	197	130	18	27	51	46	228	175	33	38
Use of compensatory behaviors (%)	4.9	14.8	5.1	6.9	0	7.4	76.5	80.4	2.2	6.9	6.1	7.9

parent node includes a total sample of 1091 athletes. Sport discipline proved to be the first splitter (Gini = 0.045) with athletes competing in weight dependent sports representing a high risk group. In these athletes, the tree had no further nodes, that is, no further variables created homogeneous groups. Among the remaining five sport disciplines, negative affect was the next splitter (Gini = 0.032): Those athletes scoring higher on the screening instrument PHQ-4 (threshold of 5) were identified as a further high risk group for eating disorder pathology. In this subgroup, the tree had no further nodes. In athletes with low negative affect, sex proved to have an additional grouping effect (Gini = 0.013): Female athletes were identified as a further high risk group for eating disorder pathology. In male athletes, sport discipline was a further splitter identifying those competing in endurance, technical or power sports as another high risk group (Gini = 0.004).

Discussion

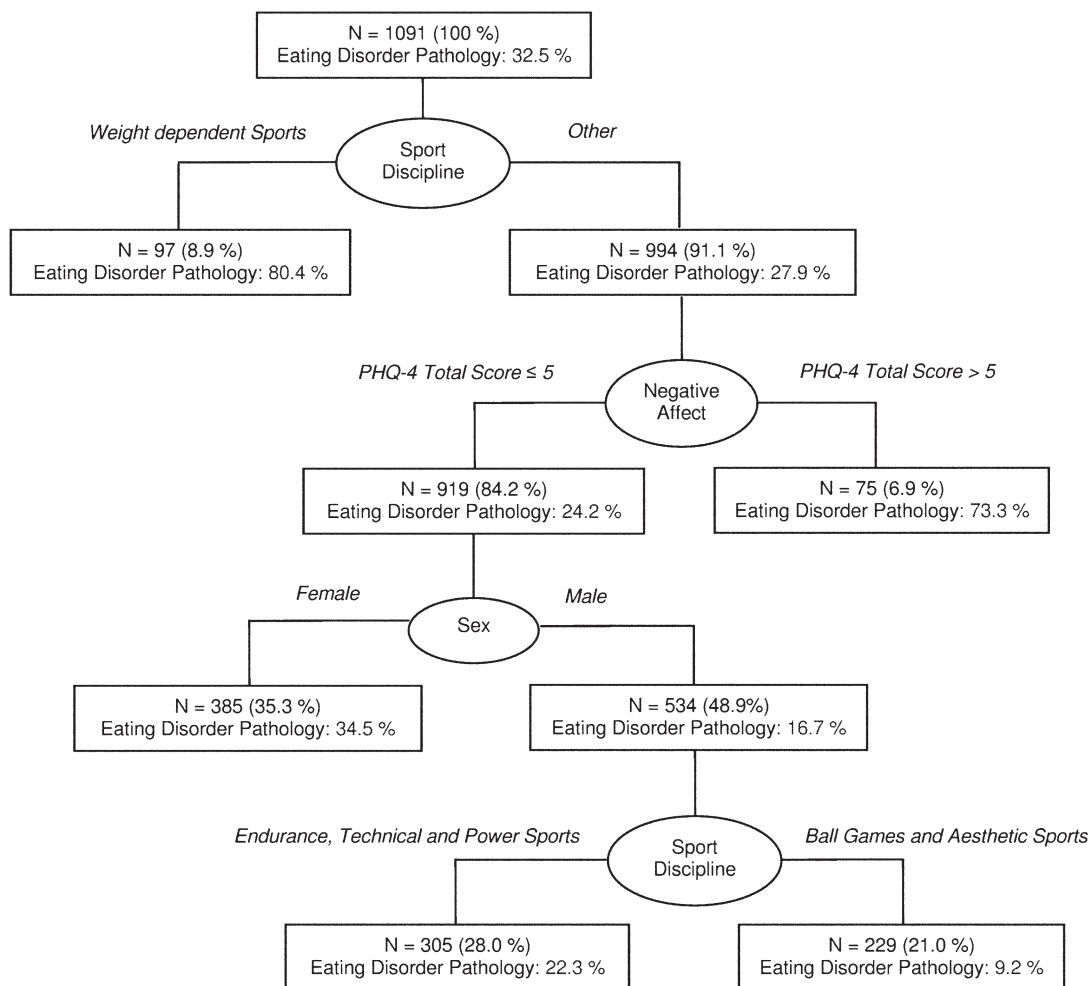
In the present study, we report data from a complete survey of German adolescent elite athletes from 51 Olympic sport disciplines. Main results comprise higher rates of eating disorder pathology (a) in female athletes than in male athletes and (b) in athletes competing in weight dependent sports which was mainly due to wide use of weight control behaviors, and (c) higher levels of depression and anxiety in athletes showing eating disorder pathology than in athletes without eating disorder pathology. Hence, our hypotheses were mainly confirmed, except for the expectation that also athletes competing in aesthetic sport would be more affected by eating disorder pathology.

Eating Disorder Pathology Based on SCOFF Results

Using the screening instrument SCOFF, eating disorder symptoms were more common among females than among males (Tables 3 and 4). Sport disciplines focusing on leanness and weight were not found to show higher SCOFF screening rates.

However, when interpreting our results, it has to be taken into account that the screening question agreed to most often by athletes was asking for a high significance of food in one's personal life. While for a non-athlete adolescent, answering this with "yes" might reflect undue preoccupation with food, it seems less surprising that athletes ascribe food and nutrition a high importance which might indeed be rather functional than pathological. This

FIGURE 1. Regression tree for the presence of eating disorder pathology. % eating disorder pathology is related to the total subsample of the respective node. PHQ-4 = Patient Health Questionnaire-4 (Löwe et al., 2010).



could mean that the true prevalence of eating disorder pathology in athletes might rather be overestimated using the SCOFF.

Weight Control Behaviors

Both, consistently dieting and compensatory behaviors were reported by a significant subgroup of adolescent elite athletes, and again, predominantly by females and by athletes competing in weight dependent sports. In the latter group, nearly four-fifth of athletes reported to practice short-term weight loss methods. This finding is in line with earlier evidence supporting a higher prevalence of weight control behaviors in leanness sports¹⁵ and with data from the large-scale study by Martinsen et al.⁸ showing that female athletes use such practices more often than male athletes. However, with 24% in females and 8% in males, the prevalence of compensatory behaviors was much higher in the sample of adolescent elite athletes studied by Martinsen et al.⁹ Data from a recent

large-scale survey in the US show that in adolescents from the general population, the point prevalence of dieting was with 13% higher than in our athlete sample, while the point prevalence of compensatory behaviors was with 1% much lower.²⁴ Notably, the compensatory behavior most often reported by athletes was related to dehydration methods, while eating disorder patients predominantly use self-induced vomiting, laxative and diuretic use.²⁵ This suggests that short-term weight control used by athletes might indeed be embedded in a sport-specific subculture. However, this does not mean that these practices are less alarming. Rapid weight-loss has extensive negative consequences for performance in sports, physical health and cognitive functions, especially in vulnerable periods of bodily growth.^{1,3,26,27}

Body Acceptance

Overall, we found a positive body self-concept in the athlete sample. This is in line with findings on

body dissatisfaction in elite adolescent athletes by Martinsen et al.⁸ and a recent review²⁸ on body image in college athletes generally showing less body dissatisfaction. Remarkably, the positive body image in our sample was primarily held by male athletes. In line with this, we found in an own recent review an increased prevalence of weight concerns, especially with female adolescent athletes.¹⁵ We speculate that this sex difference might reflect discrepancies between body ideals in society versus body ideals in sports: While males who practice competitive sports generally rather comply with the societal male body ideal, bodies of female elite athletes might partly be stronger and more muscular than the societal female body ideal allows.

Subsamples at Risk for Eating Disorder Pathology

In a tree analysis, we identified four subgroups of athletes who are at a high risk to show eating disorder pathology: (1) athletes competing in weight dependent sports, (2) athletes competing in sport disciplines other than weight dependent sports who are high on negative affect, (3) female athletes competing in sport disciplines other than weight dependent sports and (4) male athletes competing in endurance, technical or power sports. The tree analysis revealed that athletes competing in weight dependent sports represent a high risk group for eating disorder pathology, and those athletes in the remaining sport disciplines who show increased levels of depression and anxiety represented a further high risk group. This symptom cluster of depression, anxiety and disturbed eating might reflect high psychosocial burden of adolescent athletes and underpins that eating disorder pathology should not be understood as a mere functional phenomenon in elite sports.⁷

As mentioned above, the SCOFF could have led to an overestimation of the true prevalence of eating disorder pathology in athletes as many athletes agreed to the screening question asking for a high significance of food in one's personal life. We performed a post-hoc tree analysis to address this issue. In this post-hoc analysis, we excluded the respective SCOFF item and included only those screening results as "positive" where two or more of the other screening questions have been endorsed. Using this modification for the definition of eating disorder pathology resulted in a widely identical tree and identified the identical first three subgroups at risk for eating disorder pathology as the original analysis (see below).

Psychopathological Burden in Athletes Showing Eating Disorder Pathology

Athletes with eating disorder pathology were characterized by increased levels of depression and anxiety. This increased psychosocial burden suggests that eating disorder pathology should not be accepted as an unproblematic and functional part of elite sports. Given our cross-sectional design, our study cannot answer the question of whether eating disorder pathology contributes to the development of depression or anxiety, or whether dysfunctions in mood or anxiety and eating behavior are all a result of maladaptive coping with psychosocial challenges in elite sports.⁷

Strengths and Limitations

With a total sample size of 1138 participants, this is to the best of our knowledge so far the largest health survey in adolescent elite athletes. We have included a broad range of Olympic sport disciplines, allowing us to categorize participants in several sport categories. However, our data are exclusively based on self-report, causing problems concerning underreporting and social desirability.² Self-report instruments and screening tools designed for the general population might partly not be suitable for athletes.⁹ Height and weight was not measured, but self-reported by athletes. Dieting behavior was assessed by a single self-developed item that limits validity and reliability. We have not assessed an age-matched non-athlete comparison group which would have been helpful to e.g., compare prevalence data. Moreover, the assessment of co-morbidities is limited and we have not assessed the potentially adaptive function of eating disorder pathology.

Conclusion

Our results suggest that, individuals who work with athletes need to be aware that especially athletes competing in weight dependent sports may be at elevated risk to show eating disorder pathology and steps towards prevention and management are needed. In spite of novel therapy approaches,^{29,30} treatment of eating disorders, especially anorexia nervosa, remains a challenge. There are several recent guidelines by experts, national sport associations and the International Olympic Committee targeting eating disorder pathology in athletes.^{3,31,32} First evidence supports the efficacy of a school-based prevention programme in adolescent female elite athletes³³ and emphasizes the importance of involvement of coaches in the recognition

and management of eating disorders in athletes.³⁴ Major steps should comprise approaches covering education and prevention,³⁵ early identification of problematic behavior, implementation of healthy weight practices and, in some sports, modifications of regulation.^{3,31}

An important research perspective covers longitudinal designs, especially studies conducting samples of adolescent elite athletes into adult sports. While there are few recent examples for this approach, e.g., a longitudinal study on disordered eating in aesthetic sports³⁶ and a retrospective study on outcomes of weight-cycling in former athletes,³⁷ large-scale prospective studies allow for a closer examination of risk factors for and long-term consequences of eating disorder pathology in sports.

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