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【Review】

Characteristics and prevalence of eating disorders in aesthetic athletes

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Abstract

The prevalence of eating disorders in dancers was shown to be 12.0% in controls (16.4% for ballet dancers), 2.0% for those with anorexia (4% for ballet dancers), 4.4% for those with bulimia (2% for ballet dancers), and 9.5% for those with an eating disorder not-otherwise-specified (EDNOS) (14.9% for ballet dancers). New criteria for eating disorders were published in the 'Feeding and Eating Disorders' chapter of the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5) with modifications in 2013 by the American Psychiatric Association. Validation analyses demonstrated that the DSM-5 ED subgroups were well diagnosed to have variances in psychopathology as compared to the DSM-IV subgroups. In a study of aesthetic athletes, individual differences in the desire to be leaner to improve sports performance were associated with disordered eating. However, ballet dancers had a 3 times higher risk of suffering from eating disorders, particularly anorexia nervosa, and EDNOS, and appeared to be more similar to eating-disordered individuals than controls in measures of eating pathology. Ballet dancers are particularly prone to control their physiques, especially via restricted dietary practices, because of the aesthetic requirements of their genre, as well as the related issue of the pressure to manage every detail of their existence as a means to maintain their place in a dance company. Among 35 elite Brazilian professional female ballet dancers, 3 dancers (15.8%) had a lifetime diagnosis of anorexia nervosa and 2 others (10.5%) had a current diagnosis of body dysmorphic disorder (BDD). And moreover for elite gymnasts, as with other aesthetic athletes, weight and shape are areas of concern, thus the risk of eating disorders may be unusually high. Adolescent gymnasts, who are developing their own sense of self at a time of life when body image concerns are common, often compete at the very top of the sport with a need to maintain optimal body shape and weight for elite performance.

Preventive reports of methods available to reduce eating disorders in athletes have been increasing in recent years. Athletic trainers, coaches, and athletes are encouraged to increase their knowledge of eating disorders seen in athletes, and learn about risk factors, highest risk, and early identification strategies. Finally, when an athlete with anorexia nervosa, bulimia nervosa, or another type of eating disorder does not respond to sound advice, introduction to a psychiatrist specialized in treating eating disorders is important. Early detection and treatment of disordered eating should be a high priority for athletics programs.

Ⅰ. Introduction

All athletes hope to show their best performance when participating in their chosen sport. Unfortunately, some develop eating disorders, among which anorexia nervosa and bulimia nervosa are serious problems, especially in dancers and gymnasts. In the general population, Eating disorders (EDs) have a prevalence in about 0.6% individuals with anorexia nervosa, 1% in those with bulimia nervosa, and 3% in those with binge eating disorder,[1-3] while the present lifetime prevalence of all

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EDs is about 5%.[2] In a recent study of women that utilized the lifetime prevalence criteria of the Diagnostic and Statistical Manual of Mental Disorders 5th Edition (DSM-5), anorexia nervosa was noted in 1.7%, bulimia nervosa in 0.8%, and binge eating disorder in 2.3%.[4] Eating disorder not-otherwise-specified (EDNOS) before publishing of the DSM-5 ranged from 40% to 70% of patients with an eating disorder seeking treatment.[5, 6] EDs are particularly common in adolescents and young adults, and also seem to be more prevalent among athletes as compared to non-athletes. Indeed, in a large and well designed study of top athletes, EDs were found in 13.5%, far higher than reported for the general population.[7]

In a review of the prevalence of EDs in dancers, those were seen in 12.0% of controls (16.4% for ballet dancers), 2.0% of those with anorexia (4% for ballet dancers), 4.4% of those with bulimia (2% for ballet dancers), and 9.5% of those with EDNOS (14.9% for ballet dancers).[8] Furthermore, the ballet dancer group had a higher mean score for the Eating Attitudes Test-26 (EAT-26)[9] and Eating Disorder Inventory subscales.8 In general, dancers in that study had a higher risk of suffering from eating disorders, anorexia nervosa, and EDNOS, but not bulimia nervosa. The authors concluded that since ballet dancers had a 3 times higher risk of suffering from eating disorders, particularly anorexia nervosa and EDNOS, specifically designed services for that population should be considered.[8] However, a more recent paper showed that the definition shift between DSM IV and DSM-5 changes the risk of developing anorexia nervosa to double in dancers.[10] In another study, 83% of dancers met the lifetime criteria for anorexia nervosa (6.9%), bulimia nervosa (10.3%), anorexia nervosa + bulimia nervosa (10.3%, coincidentally the same as for bulimia nervosa), or EDNOS (55.0%). Moreover, dancers appeared to be more similar to eating-disordered than control individuals in measures of eating pathology.[11] In this paper, we introduce recent papers in characteristics, prevalence and noticeable points of aesthetic athletes mainly in ballet dancers.

Ⅱ. Psychiatric diagnosis of feeding and eating disorders (DSM-IV, DSM-IV-TR, DSM-5)

There are major changes DSM-5 as compared to DSM-IV, which have led to an increased prevalence of anorexia and bulimia nervosa, and decreased prevalence of EDNOS. According to DSM-5, binge-eating disorder (BED) has a distinct category of its own.[12] Another study that compared DSM-IV and DSM-5 showed that the prevalence of full-threshold eating disorders increased from 1.8% (DSM-IV) to 3.7% (DSM-5), with a higher prevalence of bulimia nervosa (1.6%) along with the addition of the diagnosis of purging disorder (1.4%), while the prevalence of binge eating disorder was unchanged (0.5%) and non-specified cases decreased from 5.1% (DSM-IV) to 3.4% (DSM-5). Validation analyses demonstrated that the DSM-5 ED subgroups had a more well-diagnosed variance in psychopathology than the DSM-IV subgroups.[13]

New criteria for eating disorders are presented in the "Feeding and Eating Disorders" chapter of DSM-5 with modifications in 2013 by the American Psychiatric Association (APA).[14] Those modifications include addition of 3 disorders (avoidant/restrictive food intake disorder, rumination disorder, pica) previously described in the DSM-IV-TR section title "Feeding and Eating Disorders of Infancy or Early Childhood," along with clarifications and modifications to anorexia nervosa and bulimia nervosa, and inclusion of binge eating disorder as a formal diagnosis.[15] Anorexia nervosa is defined by persistent restriction of energy intake leading to significantly low body weight, intense fear of gaining weight, or persistent behavior that interferes with weight gain and disturbance in the way one's body weight or shape is experienced. The requirement for amenorrhea has been eliminated in DSM-5.[15] Pica is defined as the repeated ingestion of nonnutritive substances (pebbles, hair, small metal objects, etc.). This disorder is common in children

and more rarely in adults with developmental disorders (e.g., autism) or mental retardation.[16] Though pica and rumination disorder have been studied in select populations (e.g., pregnant women, intellectually disabled individuals), their typical features and overall prevalence remain generally unknown.

Application of the DSM-5 criteria effectively reduces the frequency of the residual diagnosis EDNOS, by lowering the threshold for anorexia nervosa and bulimia nervosa, and adding binge eating disorder as a specified eating disorder.[17, 18] In another study, the most common DSM-5 eating disorder diagnoses in adolescents in the community were anorexia nervosa and binge eating disorder. Severity ratings for EDs seem valid in terms of both distribution in the community, and the correlation with detection and treatment by health care services. In contrast, the "Feeding and Eating Disorders" chapter of DSM-5 may be not well constructed, thus some critical papers have been presented. For example, it is argued that there are a number of problems in the checklist approach to diagnosis, including no points of rarity between common disorders, and that many disorders are rough groupings containing highly heterogeneous syndromes. The tendency to rectify these disorders and view them as independent entities, and to stretch the concept of co-morbidity to cover individuals who satisfy more than one of the diagnostic checklists is seen as being misleading, as it gives a false air of precision.[19] DSM-IV was published in 1994 by APA, while DSM-IV-TR (Table 1-B) was published in 2000 and DSM-5 in 2013. Thus, there are some differences such as prevalence or percentage of patients, depending on use of criteria from one of those.[13, 15, 17-19] Diagnostic criteria for anorexia nervosa, bulimia nervosa, EDNOS, and binge eating are presented in Table. 1-A (DSM-IV) and Table. 1-B (DSM-IV-TR), while surprising changes from DSM-IV to DSM-5 are shown in Table 2. Furthermore, a schematic presentation of EDNOS is shown in Figure 1.[6] Subtyping of bulimia nervosa has been removed, while there are very few changes in the criteria for pica and rumination disorder. In addition, 2 new official feeding and eating disorders have been introduced in DSM-5, avoidant/restrictive food intake disorder and binge eating disorder (Table. 2).[20]

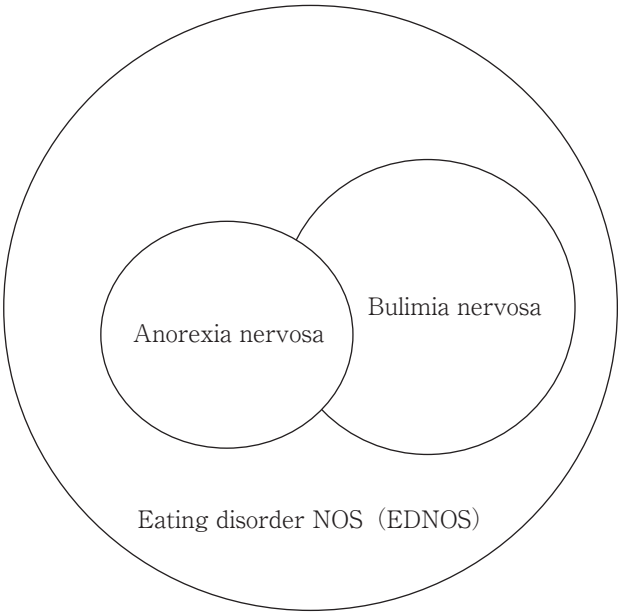

Figure 1. Eating disorder "case"

Table. 1-A. DSM-IV Diagnostic Criteria for Eating Disorders

Anorexia Nervosa A. Refusal to maintain body weight at or above a minimally normal weight for age and height (e.g., weight loss leading to maintenance of body weight less than 85% of that expected; or failure to make expected weight gain during period of growth, leading to body weight less than 85% of that expected).
B. Intense fear of gaining weight or becoming fat, even though underweight.
C. Disturbance in the way in which one's body weight or shape is experienced, undue influence of body weight or shape on self-evaluation, or denial of the seriousness of the current low body weight.
D. In postmenarcheal females, amenorrhea, i.e., the absence of at least three consecutive menstrual cycles. (A woman is considered to have amenorrhea if her periods occur only following hormone, e.g., estrogen, administration.)
Specify type: **Restricting Type:** during the current episode of Anorexia Nervosa, the person has not regularly engaged in binge eating or purging behavior (i.e., self-induced vomiting or the misuse of laxatives, diuretics, or enemas)
Binge-Eating/Purging Type: during the current episode of Anorexia Nervosa, the person has regularly engaged in binge eating or purging behavior (i.e., self-induced vomiting or the misuse of laxatives, diuretics, or enemas)
Bulimia Nervosa A. Recurrent episodes of binge eating. An episode of binge eating is characterized by both of the following:
(1) eating, in a discrete period of time (e.g., within any 2-hour period), an amount of food that is definitely larger than most people would eat during a similar period of time and under similar circumstances (2) a sense of lack of control over eating during the episode (e.g., a feeling that one cannot stop eating or control what or how much one is eating)
B. Recurrent inappropriate compensatory behavior in order to prevent weight gain, such as self-induced vomiting; misuse of laxatives, diuretics, enemas, or other medications; fasting; or excessive exercise.
C. The binge eating and inappropriate compensatory behaviors both occur, on average, at least twice a week for 3 months.
D. Self-evaluation is unduly influenced by body shape and weight.
E. The disturbance does not occur exclusively during episodes of Anorexia Nervosa.
Specify type: **Purging Type:** during the current episode of Bulimia Nervosa, the person has regularly engaged in self-induced vomiting or the misuse of laxatives, diuretics, or enemas
Nonpurging Type: during the current episode of Bulimia Nervosa, the person has used other inappropriate compensatory behaviors, such as fasting or excessive exercise, but has not regularly engaged in self-induced vomiting or the misuse of laxatives, diuretics, or enemas
Eating Disorder Not Otherwise Specified The Eating Disorder Not Otherwise Specified category is for disorders of eating that do not meet the criteria for any specific Eating Disorder. Examples include
1. For females, all of the criteria for Anorexia Nervosa are met except that the individual has regular menses.
2. All of the criteria for Anorexia Nervosa are met except that, despite significant weight loss, the individual's current weight is in the normal range.
3. All of the criteria for Bulimia Nervosa are met except that the binge eating and inappropriate compensatory mechanisms occur at a frequency of less than twice a week or for a duration of less than 3 months.
4. The regular use of inappropriate compensatory behavior by an individual of normal body weight after eating small amounts of food (e.g., self-induced vomiting after the consumption of two cookies).
5. Repeatedly chewing and spitting out, but not swallowing, large amounts of food.
6. Binge-eating disorder: recurrent episodes of binge eating in the absence of the regular use of inappropriate compensatory behaviors characteristic of Bulimia Nervosa (see Appendix B in DSM-IV-TR for suggested research criteria).
In the DSM-IV-TR, **Binge Eating Disorder** was listed in the Appendix B as "Criteria Sets and Axes for Further Study." In relation to this then "proposed disorder", the following was observed: ("The essential features are recurrent episodes of binge eating associated with subjective and behavioral indicators of impaired control over, and significant distress about, the binge eating and the absence of the regular use of inappropriate compensatory behaviors (such as self-induced vomiting, misuse of laxatives and other medications, fasting, and excessive exercise) that are characteristic of Bulimia Nervosa…") (Reference: American Psychiatric Association. (1994). Diagnostic and Statistical Manual of Mental Disorders (4th Ed.) United States of America: American Psychiatric Association.)

Table. 1-B Eating Disorder Diagnostic Criteria from DSM IV-TR

Anorexia Nervosa: Refusal to maintain body weight at or above a minimally normal weight for age and height, for example, weight loss leading to maintenance of body weight less than 85% of that expected or failure to make expected weight gain during period of growth, leading to body weight less than 85% of that expected.
Intense fear of gaining weight or becoming fat, even though underweight. Disturbance in the way one's body weight or shape is experienced, undue influence of body weight or shape on self evaluation, or denial of the seriousness of the current low body weight. In postmenarcheal females, amenorrhea, i.e., the absence of at least 3 consecutive menstrual cycles. A woman having periods only while on hormone medication (e.g. estrogen) still qualifies as having amenorrhea.
Type: Restricting Type: During the current episode of Anorexia Nervosa, the person has not regularly engaged in binge-eating or purging behavior (self-induced vomiting or misuse of laxatives, diuretics, or enemas).
Binge Eating/Purging Type: During the current episode of Anorexia Nervosa, the person has regularly engaged in binge-eating or purging behavior.
Bulimia Nervosa
Recurrent episodes of binge eating characterized by both
1. Eating, in a discrete period of time (e.g., within any 2-hour period), an amount of food that is definitely larger than most people would eat during a similar period of time and under similar circumstances.
2. A sense of lack of control over eating during the episode, (such as a feeling that one cannot stop eating or control what or how much one is eating).
Recurrent inappropriate compensatory behavior to prevent weight gain, such as selfinduced vomiting, misuse of laxatives, diuretics, enemas, or other medications, fasting, or excessive exercise.
The binge eating and inappropriate compensatory behavior both occur, on average, at least twice a week for 3 months.
Self evaluation is unduly influenced by body shape and weight.
The disturbance does not occur exclusively during episodes of Anorexia Nervosa.
Type: Purging Type: During the current episode of Bulimia Nervosa, the person has regularly engaged in self-induced vomiting or the misuse of laxatives, diuretics, or enemas.
Nonpurging Type: During the current episode of Bulimia Nervosa, the person has used other inappropriate compensatory behavior but has not regularly engaged in selfinduced vomiting or misused laxatives, diuretics, or enemas.
Eating Disorder Not Otherwise Specified
This diagnosis includes disorders of eating that do not meet the criteria for the above two eating disorder diagnoses. Examples include
1. For female patients, all of the criteria for Anorexia Nervosa are met except that the patient has regular menses.
2. All of the criteria for Anorexia Nervosa are met except that, despite significant weight loss, the patient's current weight is in the normal range.
3. All of the criteria for Bulimia Nervosa are met except that the binge eating and inappropriate compensatory mechanisms occur less than twice a week or for less than 3 months.
4. The patient has normal body weight and regularly uses inappropriate compensatory behavior after eating small amounts of food (e.g., self-induced vomiting after consuming two cookies).
5. The patient engages in repeatedly chewing and spitting out, but not swallowing, large amounts of food.
6. Binge-eating disorder: recurrent episodes of binge eating in the absence if regular inappropriate compensatory behavior characteristic of Bulimia Nervosa.
(Adapted from American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders, 4th ed, text rev. Washington, DC, American Psychiatric Association, 2000.)
Listed in the DSM IV-TR appendix as a diagnosis for further study, Binge Eating Disorder is defined as uncontrolled binge eating without emesis or laxative abuse. It is often, but not always, associated with obesity symptoms. Night eating syndrome includes morning anorexia, increased appetite in the evening, and insomnia. These patients can have complete or partial amnesia for eating during the night. (Reference: American Psychiatric Association. (1994). Diagnostic and Statistical Manual of Mental Disorders (4th Ed.) United States of America: American Psychiatric Association.)

Table. 2 DSM-5

Anorexia Nervosa: According to the DSM-5 criteria, to be diagnosed as having Anorexia Nervosa a person must display: Persistent restriction of energy intake leading to significantly low body weight (in context of what is minimally expected for age, sex, developmental trajectory, and physical health). Either an intense fear of gaining weight or of becoming fat, or persistent behaviour that interferes with weight gain (even though significantly low weight). Disturbance in the way one's body weight or shape is experienced, undue influence of body shape and weight on self-evaluation, or persistent lack of recognition of the seriousness of the current low body weight.
Subtypes: Restricting type Binge-eating/purging type
Bulimia Nervosa: According to the DSM-5 criteria, to be diagnosed as having Bulimia Nervosa a person must display: Recurrent episodes of binge eating. An episode of binge eating is characterised by both of the following: Eating, in a discrete period of time (e.g. within any 2-hour period) , an amount of food that is definitely larger than most people would eat during a similar period of time and under similar circumstances. A sense of lack of control over eating during the episode (e.g. a feeling that one cannot stop eating or control what or how much one is eating). Recurrent inappropriate compensatory behaviour in order to prevent weight gain, such as self-induced vomiting, misuse of laxatives, diuretics, or other medications, fasting, or excessive exercise. The binge eating and inappropriate compensatory behaviours both occur, on average, at least once a week for three months. Self-evaluation is unduly influenced by body shape and weight. The disturbance does not occur exclusively during episodes of Anorexia Nervosa.
Binge Eating Disorder: According to the DSM-5 criteria, to be diagnosed as having Binge Eating Disorder a person must display:
Recurrent episodes of binge eating. An episode of binge eating is characterised by both of the following: Eating, in a discrete period of time (e.g. within any 2-hour period) , an amount of food that is definitely larger than most people would eat during a similar period of time and under similar circumstances. A sense of lack of control over eating during the episode (e.g. a feeling that one cannot stop eating or control what or how much one is eating).
The binge eating episodes are associated with three or more of the following: eating much more rapidly than normal, eating until feeling uncomfortably full, eating large amounts of food when not feeling physically hungry, eating alone because of feeling embarrassed by how much one is eating, feeling disgusted with oneself, depressed or very guilty afterward
Marked distress regarding binge eating is present
Binge eating occurs, on average, at least once a week for three months
Binge eating not associated with the recurrent use of inappropriate compensatory behaviours as in Bulimia Nervosa and does not occur exclusively during the course of Bulimia Nervosa, or Anorexia Nervosa methods to compensate for overeating, such as self-induced vomiting.
Note: Binge Eating Disorder is less common but much more severe than overeating. Binge Eating Disorder is associated with more subjective distress regarding the eating behaviour, and commonly other co-occurring psychological problems.
Pica: According to the DSM-5 criteria, to be diagnosed with Pica a person must display: Persistent eating of non-nutritive substances for a period of at least one month…
Rumination Disorder:…
Avoidant/Restrictive Food Intake Disorder (ARFID) : …
Other Specified Feeding or Eating Disorder (OSFED) …
Atypical Anorexia Nervosa::…
Binge Eating Disorder (of low frequency and/or limited duration) : ….
Bulimia Nervosa (of low frequency and/or limited duration) :….
Purging Disorder: …
Night Eating Syndrome: Recurrent episodes of night eating….The behavior causes significant distress/impairment. The behavior is not better explained by another mental health disorder (e.g. BED).
Unspecified Feeding or Eating Disorder (UFED) …..
(American Psychiatric Association. (2013). Diagnostic and Statistical Manual of Mental Disorders, 5th Edn. Washington, DC: APA.)

Ⅲ. Prevalence and characteristics of Eating disorders in aesthetic sports

A 1-year longitudinal investigation was developed with 2 assessment points to identify risk factors for disordered eating in aesthetic sports, including gymnastics, figure skating, diving, and ballet.[21] Sixty-five adolescent elite athletes (mean age 14.0±2.2 years: 38 girls, 27 boys) participated. To identify disordered eating, a self-report questionnaire was applied. The study focused on sports-related variables as potential risk factors. It is important to note that the authors claimed to be unaware of any other studies that had prospectively examined sports-related social pressure. This study found that individual changes in desire to be leaner to improve sports performance were associated with disordered eating. A cross-lagged partial correlation analysis also showed that the desire to be leaner to improve sports performance was predictive of disordered eating and not vice versa. For aesthetic sports, the prevalence of disordered eating was estimated to be approximately 40%, while that was approximately 30% in weight-class sports for elite female athletes.[22] In contrast, the rate of prevalence for team sports was 15% in elite female athletes,[23] while that in the general population ranges from 0% to 21%.[1-4, 24]

Optimization of body weight and composition may be a key priority for elite athletes striving for a competitive advantage. A study of 223 Swedish athletes participating in the Olympic Games of 2002 and 2004 compared those participating in disciplines that emphasize leanness with those participating in non-leanness sports. The results showed that the lean athletes had a lower mean body mass index, greater variation in weight during the year prior to the competition, more frequent attempts to lose weight, longer total training time, and higher training load, yet weighed more than they desired during the competition. Beyond that, 9.4% reported previously suffering from an ED as compared to 2.7% of the non-lean athletes. Therefore, weight control practices employed by Olympic athletes participating in disciplines that emphasize leanness appear to be suboptimal. Counseling concerning weight control could be used as a tool to prevent illness and enhance performance.[25]

Female athletes are often very body conscious with respect to their weight and appearance, and evidence has been presented showing that a positive body image is often associated with physical activity.[26] However, results of a study of 1445 elite Division I athletes suggest that gender, ethnicity, sport, and self-esteem are associated with several behaviors and attitudes indicative of disordered eating in elite athletes[27] The EAT-26 test[9] was used to study female adolescent Brazilian tennis players (n=24) and sedentary female adolescents as controls (n=21), which showed that the controls had more body image distortion or dissatisfaction as compared to the athletes. The authors speculated that athletes can adopt disordered eating practices while maintaining a realistic sense of themselves as being leaner than, or more fit than, their non-athlete counterparts. They also noted that tennis players appeared to have more severe disorders than the controls, and recommended that they be monitored to avoid damage to their performance and health.[28] It is speculated that some female tennis players feel that tennis is a partially aesthetic sport, based on media representations.

It was previously reported that ballet dancers had a 3 times greater risk of suffering from EDs, particularly anorexia nervosa and EDNOS,[8] and seemed to be more similar to eating-disordered subjects than to control subjects in measures of eating pathology.[11] Disordered eating and EDs are well known to have a relationship to injuries in dancers.[29-32] In addition, physiques generally associated with female ballet dancers, i.e., high ectomorphy, low mesomorphy, and low percent body fat, have been linked to increased injury risk.[33] Ballet dancers are particularly prone to control their physiques, especially by restricted dietary practices, because of the aesthetic requirements of their genre, as well as the related issue of pressure to

manage every detail of their existence as a means to maintain their position in a dance company.[34]

Among 35 elite Brazilian professional female ballet dancers, 3 (15.8%) had a lifetime diagnosis of anorexia nervosa and 2 others (10.5%) had a current diagnosis of body dysmorphic disorder (BDD).[32] Anorexia nervosa and BDD are severe body image disorders that impair individuals in regard to daily functioning. Although discrete, they are overlapping nosological entities.[35] In this confusing understanding between anorexia nervosa and BDD, it is argued that EDs and psychotic disorders are different expressions of the same illness, with distorted thoughts about eating being a form of delusion.[36] Interestingly, auditory hallucinations, the hallmark of psychotic conditions, also occur in anorexia nervosa.[37-41] In addition, depersonalization and derealization are common symptoms of both disorders,[42] as are overvalued ideas.[35, 43] Anorexia nervosa and BDD are characterized by distorted body image and frequently show co-morbidity, though their relationship remains largely unknown. Those were investigated using 2 complementary modalities, event-related potentials (ERPs) and functional magnetic resonance imaging (f MRI), to test for abnormal activity associated with early visual signaling. fMRI and ERP data were acquired in separate sessions from 15 non-medicated individuals in each of 3 groups (weight-restored anorexia nervosa, BDD, healthy controls) while each subject viewed images of faces and houses at different spatial frequencies. Joint independent component analyses were used to compare activity in visual systems. The anorexia nervosa and BDD groups demonstrated a similar level of hypoactivity in the early secondary visual processing regions and dorsal visual stream when viewing low spatial frequency faces, which are linked to the N170 component (the vertex positive potential, VPP, see Jeffreys, 1989), as well as in early secondary visual processing regions when viewing low spatial frequency houses, linked to the P100 (the major positive) component. Additionally, the BDD group exhibited hyperactivity in the fusiform cortex when viewing high spatial frequency houses, linked to the N170 component. Greater activity in this component was associated with lower attractiveness ratings of faces. It was concluded that those findings provided preliminary evidence of similar abnormal spatiotemporal activation in anorexia nervosa and BDD for configural/holistic information for appearance- and non-appearance-related stimuli. In addition, a common phenotype of abnormal early visual system functioning was suggested, which may contribute to perceptual distortions.[44]

For elite gymnasts, as with other aesthetic athletes, weight and shape are areas of concern, thus the risk of EDs may be unusually high. Adolescent gymnasts, who are developing their own sense of self at a time of life when body image concerns are common, often compete at the very top of the sport with a need to maintain optimal body shape and weight for elite performance.[45] Thus, the athletes and their coaches make efforts to not develop EDs. Parents, teachers, and coaches generally have a strong influence on young athletes, thus their coordinated efforts play important roles in the development or prevention of disordered eating.[46] Aesthetic sports, especially when performed on a competitive level, are often considered as risk factors for development of EDs. In a previous study, 50 elite rhythmic gymnasts (mean age 14.8 years) including the German national team, 58 female patients with anorexia nervosa (mean age 15.5 years), and 56 high school girls (mean age 14.9 years) completed the Eating Disorder Inventory-2 and the Test for Detecting Body Image Distortion in Children and Adolescents (test of body image interference for children and adolescents), while body weight and height, body mass index, presence of amenorrhea, and frequency of exercise were surveyed. Even though some physical similarities were found between the elite rhythmic gymnasts and anorexia nervosa patients, contrary to previous studies, there were no noticeable prob-

lems related to attitudinal aspects of EDs detected in the elite rhythmic gymnasts. A mildly distorted body image of the abdomen was identified in those elite rhythmic gymnasts, while the anorexia nervosa patients expressed broad body image distortion and the students expressed no body image distortion. However, those data were not sufficient to draw conclusions regarding prevalence rates, long-term effects, or male athletes.[47] Another study of 138 equestrian athletes (mean age 19.9 ± 1.3 years; English riding 91, Western riding 47) used the EAT-26 and concluded that disordered eating risk prevalence among them was similar to that reported in other aesthetic sports and lower than in non-aesthetic sports. Athletic trainers working with such athletes should be sensitive to these risks and refer each athlete as needed to clinicians knowledgeable about disordered eating. Professionals working with this population should also avoid making negative comments about physical size and appearance.[48] Reports of prevention and decreased EDs in athletes have been increasing in recent years.

Ⅳ. Prevention of EDs in athletes

It is recommended that prevention of EDs be a mandatory part of educational curricula for coaches and athletes across all sports. An excellent strategy to initiate eating disorder prevention in female athletes is simply to increase knowledge among them and related health professionals about correlates, risk factors, highest risk, and early identification strategies.[22] Notably, athletic trainers and those who participate in athletic health care should be familiar with the current National Athletic Trainers' Association (NATA) position statement that outlines prevention, detection, and management of disordered eating in athletes.[49] However, it remains to be addressed what should be done athletes at the greatest risk are identified.

Inadequate food intake appears to be the first symptom of an ED, followed by use of inappropriate methods for weight loss, and excessive increases in exercise time and load. As compared with disordered eating-negative athletes, positive athletes had a higher percentage of body fat and fat mass, lower protein consumption in the 11- to 14-year-old group, and lower calcium intake adequacy in the 15- to 19-year-old group. It was concluded that greater attention should be given to the nutritional state of these athletes, especially after considering the number of adolescents with anemia and inadequate dietary intake.[50] Early detection is important and can lead to early prevention. The Eating Attitudes Test EAT-26[9] and Eating Disorders Inventory[51] are questionnaires most often used in studies included in a well-known review article.[24] Both questionnaires represent the most commonly used measures to screen for psychological and behavioral symptoms of anorexia nervosa and bulimia nervosa. Additionally, the Eating Disorder Examination Questionnaire is a valid and reliable questionnaire, as it is a self-reported version of the Eating Disorder Examination Interview (EDE),[52] the gold standard for diagnosis of EDs. By using these 2 questionnaires and clinical interviews, certified athletic trainers and physical coaches can become more skilled observers of the behavior of athletes, which may provide the quickest means of detecting disordered eating. In a recent study, eating pathology and BMI were positively associated with anti-dieting advice received from teammates.[53] Therefore, education is an important step, not only for health professionals but also athletes, to enhance prevention of EDs.[22, 49]

It is considered that early detection and treatment of disordered eating should become a high priority for athletics programs. Disordered eating occurs along a continuum of severity. Mild symptoms that increase in frequency and severity may progress to 3 clinically diagnosable conditions identified in the DSM-5 (original expression: DSM-IV as anorexia nervosa, bulimia nervosa, and EDNOS).[49] If the athlete is classified as anorexia nervosa, bulimia nervosa, or EDNOS, the detecting individual should introduce them to a psychiatrist

specialized in EDs.

V. Psychological effects of exercise and problems in athletes

Results of 14 selected studies regarding the effectiveness of exercise as intervention in management of depression in the general population, the effect of exercise for reducing symptoms of depression could not be determined because of a lack of good quality research on clinical populations with adequate follow-up examinations.[54] However, a meta-analysis of randomized trials showed that exercise in individuals with anxiety and sedentary patients with comorbid chronic illnesses was associated with improvements in anxiety symptoms.[55] Another study of patients with anxiety disorders, including panic attacks, social phobia, and generalized anxiety, found that exercise improved anxious symptoms, but not to the same extent as improvements seen with pharmacological treatment.[56] In a study of 20 patients with schizophrenia, 13 patients with depression, and 20 healthy controls, high aerobic intensity training used as acute intervention improved positive attitude and sense of well-being, and also reduced distress and state anxiety in patients with depression and schizophrenia.[57] Also, effective training to improve peak VO_2 provided acute psychological benefits. Reductions in distress and state anxiety were sustained for more than 3 hours after high aerobic intensity training, and patients with depression also sustained an improved positive affect and sense of well-being. The duration of the improved positive affect was longer for those with depressive and schizophrenia disorders than for healthy individuals. Another study revealed that aerobic exercise was associated with modest improvements in attention/processing speed, executive function, and memory. In addition, trials that used individuals with mild cognitive impairment demonstrated greater improvement in memory performance relative to healthier samples, suggesting that the beneficial effects of exercise on various cognitive functions may be most evident in participants with pre-existing cognitive impairment.[58]

Although epidemiological studies on the psychological health of high level athletes are few, results of an investigation that focused on the psychological health of high level athletes in female and men were published in 2011. In that study, the occurrence of lifetime generalized anxiety disorder (GAD) according to type of sport is presented (Figure 2), with significantly higher rates of GAD found for aesthetic sports (38.9% vs. 10.3% for women in all other sports, 16.7% vs. 6.8% for men in all other sports). The gender difference in the prevalence of GAD remained significant when only aesthetic sports were examined, while high risk sports had the lowest prevalence of GAD for both women and men (3.5% and 3.0%, respectively). The prevalence of depression problems according to type of sport followed the trend observed with GAD (Figure 3). The lifetime occurrence of at least 1 period of depression was highest in aesthetic sports (24.2%), followed by aiming and fine motor skills sports (18.2%). Furthermore, the rate of depression was significantly lower in team ball sports (8.1%) and high risk sports showed the lowest prevalence of depression at 7.4%, though significance was not reported due to the low number of athletes studied.[59] In a French adult population (n=36,105), the overall prevalence of anxiety disorders was estimated to be 21.6%, with generalized anxiety disorder the most prevalent (12.8%). Women, young individuals, and individuals earning a low income were identified as more at risk. A major depressive episode, alcohol abuse, and drug addiction frequently co-occur with anxiety disorders (28.3%, 4.4%, and 2.8% respectively).60 Sleep problems were also more prevalent in aesthetic sports (33.3%), while athletes in high risk sports had significantly less sleep issues than the others.[59]

The lifetime occurrence of any ED showed different sport-specific trends in men and women, with the highest rates of EDs found in women involved in racing sports and fine motor skills sports, while those playing team ball sports had the low-

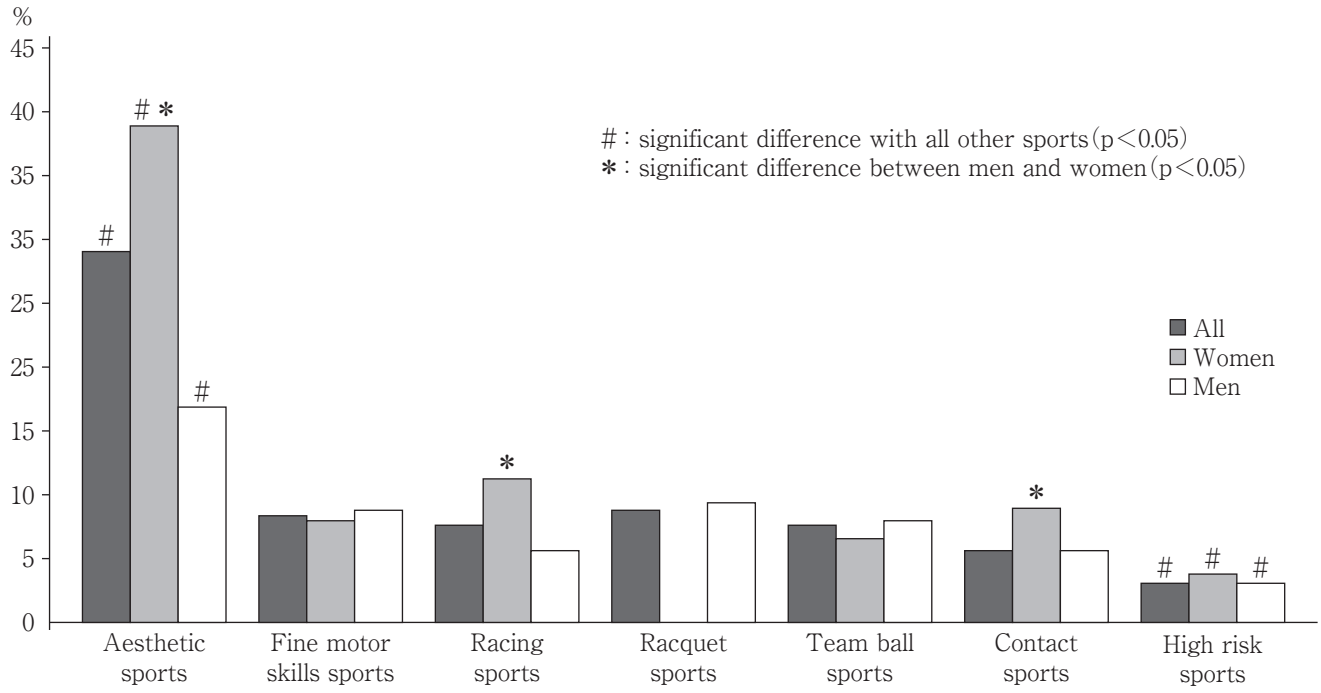

Figure 2. Lifetime prevalence of generalized anxiety by type of sport played.

Schaal K, Tafflet M, Nassif H, Thibault V, Pichard C, et al. (2011) Psychological Balance in High Level Athletes: Gender-Based Differences and Sport-Specific Patterns. PLoS ONE 2011 May 4;6(5):e19007. doi: 10.1371/journal.pone.0019007.

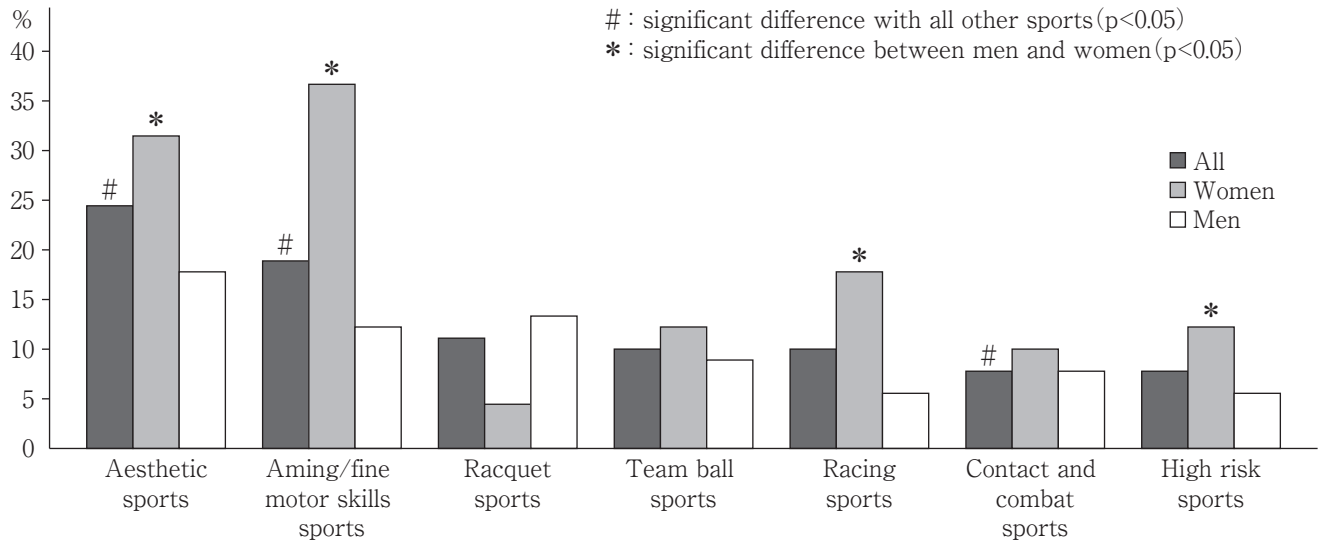

Figure 3. Lifetime prevalence of minor or major depression according to the type of sport practiced.

Schaal K, Tafflet M, Nassif H, Thibault V, Pichard C, et al. (2011) Psychological Balance in High Level Athletes: Gender-Based Differences and Sport-Specific Patterns. PLoS ONE 2011 May 4;6(5):e19007. doi: 10.1371/journal.pone.0019007.

est occurrence of such problems (14%, 14%, and 5.8% respectively).[59] For male athletes, participation in combat and contact sports showed the highest prevalence of EDs (7.3%). In the general population over 18 years old, the lifetime estimated prevalence rates of anorexia nervosa, bulimia nervosa, binge eating disorder, sub-threshold binge eating disorder, and any binge eating were 0.48%, 0.51%, 1.12%, 0.72%, and 2.15%, respectively, and those were 3-8 times higher in women for all EDs.[61]

Longitudinal human studies can now identify el-

evated trait anxiety, and genetic, behavioral, or physiological parameters, such as anxiety sensitivity[62] or baseline pro-inflammatory state[63] as early markers of inherent vulnerability.[64] Unfortunately, no comprehensive studies have been conducted on the interaction of biological sex and gender identity regarding anxiety disorders in transgender men and women.[65, 66] Anxiety-relevant research on sex differences within central autonomic control of the sympathetic and parasympathetic pathways are also chronically under-researched and deserve more attention.[67, 68]

The prevalence of EDs is higher in athletes than the general population.[7] The practice of a sport at a high level does not appear to be a psycho-pathogenic behavior, since the prevalence of psychopathology identified in athletes is no higher than that in the general population. Rather, it is the presence of very particular stressors, such as problems in the athletes' social, personal, and sporting environments that is associated with psychopathology. Psychological issues and the stressors from which they stem should be addressed early, in order to help avoid the development of a full-blown disorder and its potential consequences on the health and career of the affected athlete. The presence of sex bias in regard to anxiety and affective disorders provides reason enough to acknowledge, instead of ignore, the complexity introduced by the female menstrual cycle and intensify research on sexually dimorphic developmental programming of the brain as well as sex-dependent stress coping mechanisms in adulthood.[64] It was reported that participation in a high-performance sport was not an additional source of distress for adolescents who reported high stress levels, despite prior research that has pointed toward such a relationship.[69] Additional studies are needed to for athletes to provide their best performance with a healthy mind and body. When a coach, trainer, or individual working with athletes is highly suspicious of anorexia nervosa, bulimia nervosa, or any other ED that cannot be coped with, it is important to consult with a psychiatrist specialized in treating such conditions.

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