



Impact of disordered eating on physical, physiological and psychological health of men and women: A literature review

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ABSTRACT

Disordered eating (DE) is highly prevalent in today's population. DE has found to be particularly associated with considerable deterioration in physical, psychological and physiological health, psychosocial morbidity, and increased risk of mortality. However, so far no comprehensive review has been conducted yet which comments on actual impact of DE on physical, physiological and psychological variables. The objective was to review literature on effect of DE on physical, physiological and psychological health variables. The search of major databases including Pubmed, Google Scholar and Research gate was conducted using specific keywords such as "Disordered eating", "Bulimia nervosa", "Anorexia nervosa", "Menstruation", "osteoporosis", "Injury", "Body image dissatisfaction", "Physical performance". Studies published from inception till December 2021 were included which evaluated the relationship of DE with physical, physiological and psychological variables. Findings of this comprehensive review suggest there is higher prevalence of DE especially in weight class category sports. Moreover, DE have negative impact on physical, physiological and psychological health variables.

Key words: *Disordered eating; Injury; Menstruation; Body image Dissatisfaction; Physical performance.*

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INTRODUCTION

Disordered Eating (DE) is abnormal and harmful eating behavior that is usually adapted by athletes to lose weight or maintain abnormal and unhealthy low body weight [1]. Achieving and maintaining desired body shape for particular sports to improve performance involves eating control practices, i.e., eating very less, no eating for whole day, frequently skipping meals, and purging etc. are all used to lose weight. All these habits, together with overeating and binge eating are collectively termed as DE. These behaviors are generally adopted to adjust body weight in accordance with demands of competitive sports, generally seen in weight category sports [2].

Sports in which DE is highly prevalent are: a) those in which weight category are involved, such as wrestling; taekwondo b) those in which mentality is set that leanness will improve performance, such as long-distance running; gymnastic c) those in which subjective judgment for looks and beauty exist, such as figure skating [2,3]. Researchers and practitioners have likened the range of DE behavior as a continuum [3,4](Figure 1). On extreme of this behavior continuum are clinical eating disorders i.e. anorexia nervosa (AN) and bulimia nervosa (BN) while in between lie a variety of DE eating behaviors that are ranging in severity including significantly restricting energy intake to occasionally or sometimes bingeing and purging (Figure 1).

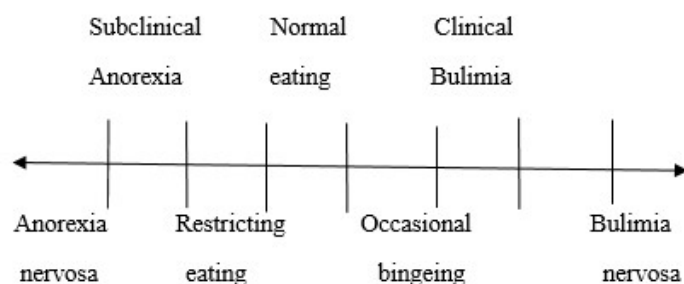


Figure 1. Disordered eating behavior continuum

According to DSM-IV (APA1994), clinical eating disorders- AN and BN are severe abnormality in eating behavior and disturbed body image [5]. Individual with AN are always hungry, they are starving, yet choose to deny their hunger. AN is further categorized into two types namely restricting type and binge eating/ purging type. One with restricting type of AN loses their weight by skipping their meals, fasting and by doing excessive workout. Individual with bingeing/purging type of AN also severely restricts energy intake and exercises excessively but sometimes they also have period of excessive eating then purging such as defensive vomiting and use of certain medications i.e., laxatives and diuretics for weight management. On other hand, BN is the ED in which individual usually have cycles in which individual get out of control while eating food & then they try to get rid of that food by defensive vomiting, excessive workout & use of medications for weight management.

Athletes who do not match somatotype of their sport usually experience internal and external pressures to realize that specific body figure, which may result in psychological disturbances i.e., body image dissatisfaction (BID). [6,7,2].

DE is related to various physical, physiological and psychological variables. Psychological variable consists of BID which is a dissatisfaction with their physical appearance, especially weight and shape [8]. BID develops when a person is concerned about gaining weight or getting obese, and both AN and BN have an inappropriate influence of body image on self-evaluation. The present study intended to address the research question "Is there any impact of DE on various physiological, physical and psychological health variables in human participants"

PATHOPHYSIOLOGY OF DISORDERED EATING

Broadly following theories have been proposed that explain the pathophysiology of DE:

Formal genetic studies

According to Strober et al. (2001), first-degree relatives of people with AN have a 10 times more chances of getting ED than relatives of those who aren't affected [9]. Bulik et al. (2006) found that ED had a high heritability in a large twin study (50-60 percent) [10].

Molecular genetic studies

In the development of ED, genetics plays a significant influence. In EDs, indications for AN and BN were found on chromosomes 1, 2, 3, 4, and 13 for AN and chromosome 10 for BN [11]. Nakazato et al. revealed that level of brain-derived neurotrophic factor (BDNF) were decreased in both AN and BN individuals but levels were markedly decreased in AN individual [12]. A study performed in Israel found that Catechol-O-methyltransferase (COMT) gene is associated with AN as it is involved in the catabolism of dopamine [13]

METHODOLOGY

The present review is reported in accordance with SANRA (A scale for the assessment of non-systematic review articles) guidelines.

The search of major databases including Pubmed, Google scholar, Research gate was conducted using specific keywords such as "Disordered eating", "Bulimia nervosa", "Anorexia nervosa", "Menstruation", "osteoporosis", "Injury", "Body image dissatisfaction", "Physical performance".

Inclusion and Exclusion Criteria

Studies published from inception to December 2021 that evaluated the effect of DE on physical, physiological and psychological variables such as menstrual dysfunction, injury, physical fitness and BID were taken into consideration. I review included only: (I) manuscripts in English; (ii) original articles; (iii) prospective or retrospective observational (analytical or descriptive), experimental or quasi-experimental studies. Thesis, dissertations, editorials, newsletters and letters to the editor were excluded from the present review.

RESULTS AND DISCUSSION

Prevalence of disordered eating

Overall studies reported a wide range of DE prevalence starting 1% to 62% but prevalence appears to be higher in top athletes than in athletes, lower competitive level persons, and controls [14,15,16,17]. Moreover, DE and EDs conditions are more prevalent among female athletes who are competing in aesthetic, weight-class and endurance sports than athletes who competes in sports where leanness is considered less significant [18]. When comparing thin build (TB) and normal build (NB) athlete groups, it was discovered that female athletes participating in sports that promote a slim physique have more weight issues and body dissatisfaction [19] (Table I).

A study in London Sports Institute, UK reported that 44%, 16% and 53% athletes were at the risk of DE; ED and low energy availability (LEA) [20]. Another study in US suggested that DE is also seen in sport lead rock climbers and risk is more prevalent among female climbers who are elite/high elite climbing ability level [21]. Moreover, if comparing lean versus non lean sport groups, there is a strong linear correlation of lean group with prevalence of DE [22] (Table I).

Interestingly, a study on elite male and female soccer players reported that DE prevalence was same in both group of soccer players; but prevalence was more in non-athlete female controls [23]. Greece population study between elite female athletes and non-athletes revealed that athletes were five times more likely to have eating disturbances than non-athletes [24]. Furthermore, a study on 306 female marathon runners in South Africa reported that 44.1% females were at the risk for female athlete triad. Among them, one-third of participants had DE behaviors and half of population had restrictive eating behaviors (Table I) [25].

Moreover, a study in Purdue University, USA describes the strategies used by athletes to lose their weight i.e. 58.8% athletes engaged in excessive workout, 23.5% reported consuming 600 calories or less. Fasting and Fad diet was used by 11.9% and 10.6% of athletes respectively. Athletes also reported self-induced vomiting, laxatives, diuretics and enemas (Table I) [26]. Furthermore, a study with 1445 participants reported that prevalence for uncontrolled episode of overeating is found to be more in female athletes (81% compared to 45%) than male athletes. Female athletes had vomited more to lose weight at some time in their life compare to male athletes (Table I) [27]. These observations clearly indicate towards higher prevalence and severity of DE in female participants as compared to males.

Impact of Disordered eating on physiological variables

Relationship between Disordered Eating and Menstrual Dysfunction

A study in Sri Lankan university reported that 24.0% of 308 participants had irregular cycles. 15.3%, 3.2%, 8% & 6.6% reported having oligomenorrhea, polymenorrhagia, hypomenorrhea and menorrhagia. A strong correlation was also observed between DE and menstrual dysfunction (MD) [28]. Other studies of North American population showed that an average of 43.3% population had MD but only 8.1% had DE [29]. Surprisingly, another study reported that 35.4%, 18.8% had DE and MD [30]. These findings suggest that there is no strong correlation between DE and MD. Accordingly, a study on athletes with LEA were more likely to be classified as having increased risk of MD. LEA measured using self-report questionnaires suggest a strong association with MD (Table II) [31].

A European study on 846 participants found that 25%, 18% participants had restrictive eating, current or past ED, but 32% of athletes reported MD respectively. Athletes from lean sport had higher prevalence of MD compared to non-lean sport athletes (Table II) [32].

Another study comparing athlete versus non athletes reported that athletes had LEA which might be due to restrictive eating than non-athletes. Athletes reported more clinical MD (32.7%) in comparison to non-athletes (18.3%). Moreover, menstrual cycle changes reported more during competition season i.e., 45% of athletes, menstrual changes that most likely to occur were missing of cycles and low bleeding (Table II) [33]. However, female athletes in southern California reported that only 11.2% of athletes had DE while 21.3% athletes had MD which indicates that MD might not be solely related to DE (Table II) [34].

Beals and Manore (2002) recruited 425 female collegiate athletes from three category based sports i.e. aesthetic, endurance and anaerobic sports. It was reported that athletes who scored higher on EAT-26 and EDI- BD, respectively had delayed menarche (7.4%). Among them, aesthetic athletes reported significantly delayed menarche (Table II) [18].

Effect of disordered eating on physical variables

Relationship between disordered eating and injury

North American studies on gymnast states correlation between DE and incidence of injury in athletes. 34%, 42% gymnast had DE and concussion during gymnastics, 69% had time-loss gymnastics injury in college; 58% had gymnastics injury during middle/high school or college resulting in surgery; and 21% had injury during collegiate gymnastics that resulted in retirement [35]. Another study on injured females reported higher score on EAT-26 suggesting a relationship between sport injury and DE [36]. Moreover,

37.4% injured athletes reported higher mean scores for all eating disorder inventory questionnaire (EDE-Q) (Table III) [34]. Findings of these studies suggest that individuals with DE are more likely to get injured due to energy deficiency which might cause lack of attentiveness and fatigue which in turn leads to injury. A study on track and field sports participants had prevalence of 13% for DE, however, prevalence of injury found to be 43.5% suggesting that DE do not directly results in injury [37]. One study also showed more than half (58.6%) of patients with ED engaged in at least one type of non-suicidal self-injury (NSSI) and body parts that usually injured were arms, hands, fingers, belly, and thighs (Table III) [38]. Moreover, US athletes who scored above the EAT-26 cut-off reported existence of bone injury (21.5%) during their collegiate career (Table III) [18].

Effect of disordered eating on physical performance

A North American study states that BED group individuals were less active i.e., 63.8%, followed by overweight individuals (41.7%), and healthy weight (29.2%) [39]. Moreover, A European study revealed that women with BED had lower maximal oxygen uptake (VO_2 max) and more body mass index and blood pressure [40]. Similarly, other studies have also revealed that VO_2 and anaerobic threshold both at rest and during exercise is lower in AN patient than in controls [41]. Resting and maximal heart rate and VO_2 were less in girls with AN than in controls [42]. Interestingly, VO_2 at rest was reported to be 20% lower than predicted normal values in AN participant (Table IV) [43].

Performance on the sit and reach flexibility test, standing broad jump test, handgrip test, sit-up test, and six-minute walk test all increased significantly in AN patient after in-patient treatment based on cognitive behavior therapy [44]. Interestingly, BN patients had more postural instability than healthy controls. Furthermore, one study on Norway population revealed that muscular strength was lower among long standing ED patients than in control group but there was no significant difference in aerobic fitness between patients and controls (Table IV) [45]. A lower VO_2 observed in DE subjects might be due to lack of proper blood supply and low blood volume as a result of DE or LEA. Decreased muscular strength in long standing ED patients might be the result of low muscle mass and LEA.

Effect of Disordered eating on psychological variables

Relationship between Disordered eating and body image dissatisfaction

A South America study on 1,156 adolescents reported a higher correlation between DE and BID. Perception of oneself as overweight was linked to 1.795-fold odds of DE [46]. Another Asian study of native Indians found that 31% of girls and 22% of males had moderate to severe BID. (Table V) [47]

Interestingly, European studies reported that 17.9% of the athletes presented with moderate or severe BID and positive correlation between DE and BID [48]. In male bodybuilders, ED psychopathology was also linked to BID and body dysmorphic disorders (See Table V) [49]

Table I. Prevalence Disordered eating in human participants

Study	Location	Participants	Outcome variables	Findings
Joubert et al., [21]	US	604 rock climbers	DE	6.3%, 16.5% male and female climbers had DE prevalence
Abbott et al., [23]	UK	137, 70 elite male & female soccer player	DE	prevalence was greatest in non-athlete female controls.
Kampouri et al., [24]	Greece	129 elite level and 46 females were non-athletes	EDE-Q 4.0 and Physical activity Q	6.2% had ED; athletes were five times more likely to reveal than non-athletes
Rousselet et al., [22]	Western Europe	340 high level French athletes.	DE	Lean sports athletes had higher prevalence of DE
Folscher et al., (2015)	South Africa	306 female marathon participated	Triad and DE	44.1 % at risk for female athlete triad. One-third of participants demonstrated DE behavior.
Beals and Manore [18]	US	425 female collegiate athletes	EAT-26 and EDI-BD	3.3 and 2.4 % of athletes diagnosed of CL and BN.
Davis and Cowles [9]	Britain	126 female athletes, 64 (TB) and 62 (NB) sports.	EDI	89%,58% athletes in TB, NB sports reported desire to lose weight; 38%,27% of athletes in TB and NB sports reported constantly dieting.
Johnson, Powers, and Dick [27]	South Florida	1445 collegiate athletes (883 men and 562 women)	EDI-2 and Q developed by authors using DSM-IV criteria	1.1% women met criteria for BN; 9.2%,0.01% women had subclinical bulimia; 2.8% women had subclinical anorexia
LEA =Low energy availability, ED=Eating disorder, DE=Disordered eating, CL=Clinical Anorexia, BN= Bulimia Nervosa, EAT-26=Eating attitude test 26, EDI-BD=Eating disorder inventory BD, TB=Thin build, NB= Normal build, EDE-Q=Eating Disorder Examination Questionnaire				

According to another study, only 13.4 percent of 65.2 percent male sample who were having BID had higher EAT-26 scores [50]. BID had both direct and indirect consequences on self-esteem, as well as a detrimental impact on DE (Table V) [51]. According to Costarelli and Patsai (2012), stress is also a psychological factor which increases the symptomatology of DE. These studies suggest that BID and DE might be interdependent as BID leads to low self-esteem about their body and negative thoughts which in turn lead to DE for achieving their desired body weight [52].

Table II. Relationship of Disordered Eating with Menstrual Dysfunction

Study	Location	Participants	Outcome variable	Findings
Ariyaratne et al., [28]	Sri Lanka	308 female athletes	EAT-26 used to assess DE and menstrual history Q	24.0%, 15.3%, 3.2% had irregular cycles, oligomenorrhea and polymenorrhagia. 19.8% reported ED.
Ravi et al., [32]	Europe	846 participants	DE and MD	25%; 32% athletes reported restrictive eating and MD
Beals et al. [18]	North America	1000 female athletes	LEA, ED/DE assessed by online Q and BEDA-Q and SR	LEA is strongly associated with MD
Prather et al. [29]	North America	220 female soccer athletes	DE and MD	43.3% had MD but only 8.1% had DE
Muia et al. [33]	Kenya	61 athletes and 49 non-athletes	DE and MD	32.7% athletes had MD compare to 18.3% non-athletes
Rauh et al. [34]	Southern California	89 female athletes	ED, menstrual history	11.2% had DE and 21.3% had MD.
Thein-nissenbaum et al. [30]	North America	311 female	EDE-Q, HWHSFAS to assess menstrual status	35.4% reported DE, 18.8% had MD.
Beals and Manore [18]	US	425 female collegiate athletes	EAT26, EDI-BD, health/medical history Q, menstrual history Q	DE was highly correlated with MD
EAT-26= Eating attitude test 26, MD=Menstrual dysfunction, DE=Disordered Eating, BMD=Bone mineral density, EDE-Q=Eating Disorder Examination Questionnaire, HWHSFAS= Healthy Wisconsin High School Female Athletes Survey, MST= musculoskeletal, BEDA-Q =Brief Eating Disorder in Athletes Questionnaire, ESP=Eating Disorder Screen for Primary Care, SR=Self-reported current or past history of ED or DE				

Table III. Relationship of disordered eating with physical injuries

Study	Location	Participants	Outcome variables	Findings
Sweeney et al. [38]	North America	473 gymnasts participated	concussion history & DE	32%, 6% gymnasts had DE and ED with 42% had concussion history.
Gufsa et al., [36]	North America	308 adolescent athletes	DE and Injury	There was relationship between DE and injury
Wilkinson et al. [37]	Europe	138 athletes	Musculoskeletal injury and DE	13%, 43.5% had DE and injury
Laurence Claes et al. [23]	Europe	99 females with ED	Relationship between ED and NSSI	58.6% ED patients engaged in NSSI
Rauh et al., [34]	North America	163 Athletes	Injury and DE	37.4% injured athletes reported higher mean scores EDE-Q
Beals and Manore [18]	US	425 female collegiate athletes	Bone injury and DE	Athletes with higher EAT-26 cutoff reported 21.5% bone injury
DE= Disordered eating, ED= Eating disorder, NSSI= Non suicidal self-injury, EAT-26= Eating attitude test-26, EDE-Q= Eating Disorder Examination Questionnaire				

Table IV. Effect of disordered eating on physical performance

Study	Location	Participants	Outcome variables	Findings
Carr et al., [39]	North America	2,384 participants	Activity level	BED group had highest self-reported insufficiently active individuals (63.8%)
Mathisen et al., [40]	Europe	156 female	VO ₂ max, BMI, BP	BED scored lower on VO ₂ max and higher on BMI and BP
Alberti et al., [44]	Europe	37 AN & 57 healthy females	Flexibility, power, strength	significantly improved performance after inpatient treatment
Bratland-Sanda et al., [45]	Norway	59 females with DE	Strength and aerobic fitness	Muscular strength was lower in long standing ED patients.
Rowland et al., [42]	North America	8 adolescent female AN inpatients and 8 controls	HR, VO ₂ max	Low HR and lower VO ₂ max in AN patients than in controls
Biadi et al., [41]	Italy	Nineteen AN female patients and 20 constitutionally thin women	VO ₂ max and anaerobic threshold	Lower VO ₂ max & anaerobic threshold among AN group than in control
Fohlin et al., [43]	Sweden	17 female & 11 male with AN	O ₂ uptake	20% lower O ₂ uptake than normal ranges.

AN= Anorexia Nervosa, BED= Binge-eating disorder, O₂= Oxygen, VO₂ max = maximum oxygen uptake, HR= Heart rate, BP= Blood pressure, BMI= Body mass index

Table V. Relationship of Disordered eating with body image dissatisfaction

Study	Location	Participants	Outcome variables	Findings
Leal et al. [45]	South America	1,156 adolescents	DE assessed by self-report Q, BID assessed by Stunkard's silhouettes	17.3%,80.1% participants had DE & BID
Singh et al., [46]	Asia	262 participants	BSQ-8C, EAT-26	10% had DE & BID among 31% of females and 22% of males.
Kristjánadóttir et al. [48]	Europe	755 Athletes	BSQ, BULIT-R, EDE-Q	17.9% had BID, 18.2% were above the clinical cutoff for body image concern, 2.4% had bulimia, and 9.5% had ED symptoms
Turel et al., [50]	North America	518 participants	DE, BID	47.7% had smaller body shape than ideal, 17.5% larger body shape and 13.4% had DE
Devrim et al., [49]	Europe	120 male bodybuilders	ED, BID	ED is positively associated with BID
Cruz-Saez et al. [51]	North America	806 adolescent participants	DE, BID	BID had negative effect on DE
Costarelli & Patsai [52]	Greece	60 participants	Stress and DE	Stress increases DE symptomatology

BID= Body image dissatisfaction, BSQ= Body shape Questionnaire, EAT-26= Eating attitude test-26, EDE-Q= Eating Disorder Examination Questionnaire, DE= Disordered eating, BULIT-R= Bulimia Test-Revised

CONCLUSIONS

Findings of the review suggests that (1) DE is a highly prevalent condition among athletes (2) DE is closely related to MD which may impose infertility issues in females (3) Incidence of injuries is high in participants with DE which might be occur by low energy availability (4) DE is closely associated to abnormal psychology states such as BID in athletes. Considering the profound hazardous impact of DE on various health outcomes in humans and specifically in female athletes, early detection strategies should be adopted by coaches and health care providers. Maintaining BMI to optimal levels could be considered an important measure in order to avoid the outcome of DE.

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