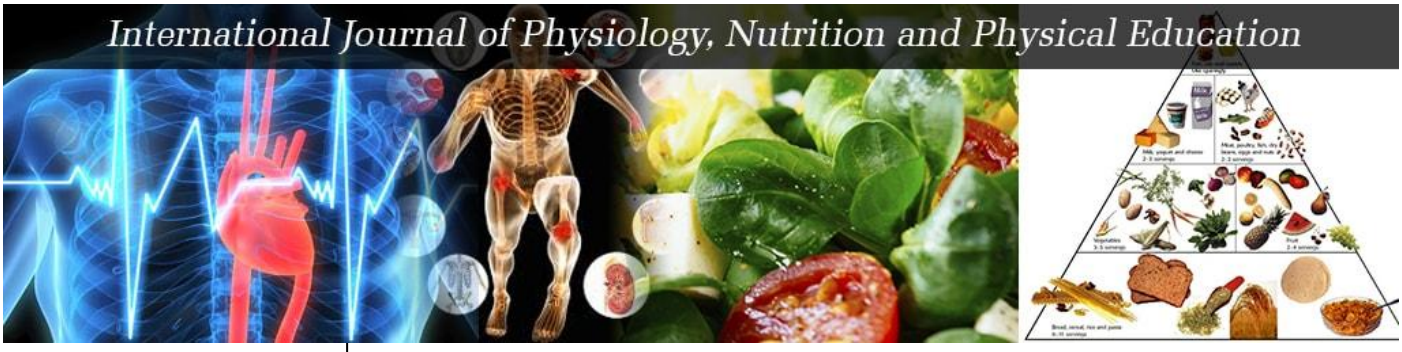

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Hima Bindu Malla
PhD Scholar, Department of Food & Nutrition, University of Delhi, Lady Irwin College New Delhi, India

Dr. Meenu Dhingra
Senior Scientific Officer, Sports Authority of India, New Delhi, India

Dr. Priti Rishi Lal
Assistant Professor, Department of Food & Nutrition, University of Delhi, Lady Irwin College, New Delhi, India

Correspondence
Hima Bindu Malla
PhD Scholar, Department of Food & Nutrition, University of Delhi, Lady Irwin College New Delhi, India

Nutritional status of athletes: A review

Hima Bindu Malla, Dr. Meenu Dhingra and Dr. Priti Rishi Lal

Abstract
Sports Nutrition in India gained momentum after the conduct of 2010 Common Wealth Games. However, studies on Nutritional intake of elite Indian athletes are limited and there is a critical need for enhanced research in this area. This review paper, therefore, summarizes the dietary profile of athletes of all age groups with a specific focus on Indian athletes. The paper highlights the reported calorie consumption pattern, dietary practices, supplement consumption, deficiencies, diseases like metabolic abnormalities, eating disorders, hypertension, FAT/RED-S and discusses relevant status amongst Indian athletes. The paper attempts to form a basis for further research in various areas of Sports Nutrition in India.

Keywords: Nutritional status, athletes, health, eating behaviour, dietary practices

Introduction
The quest for excellence in sport predisposes an athlete to undertake excessive training loads for higher levels of achievement. This load consistently improves performance, but also generates sport related stress, immune suppression, predisposing an athlete to various threats, one such important area being the nutritional status of athletes for which continuous nutrition support is continuously planned and implemented for athletic excellence and the athletes' long term good health [1].

Nutrition plays an important role in sports performance because it helps an athlete to maintain ideal body weight, body composition specific to sports and faster recovery [2]. Training and nutrition should go hand in hand to attain high level of achievements in sports [2]. Adequate nutrition enhances aerobic capacity or Vo_2max [3], reduces fatigue [4], fastens recovery [5] and provides injury prevention and preservation of immunity [6].

Adequate food and fluid intake is vital to ensure athletic performance at its peak [7]. Macro nutrients & micronutrients play an important role in energy production, lean mass & haemoglobin synthesis, maintenance of bone health, adequate immune functioning, and protection against oxidative damage [8]. Specific nutrients have been identified as important in sports performance like thiamin which plays a critical role in carbohydrate metabolism and its low intake for 11 weeks decreases peak power, maximal work capacity and mean power output [9]. Nutrients like vitamin – A, E, C, β carotene, zinc & selenium known as antioxidants when deficient, lead to oxidative stress and lowers performance [10].

Eating behavior of Athletes - Global scenario
Nutritional practices of elite athletes are reportedly subnormal all over the world [11]. Waly *et al*. (2013) [12] studied the nutritional practices of Omani national hand ball players and reported that they exhibited poor eating habits & their meals are rich in carbohydrate, red meat, saturated fat with fewer intakes of fresh fruits & vegetables. Similar results were reported by Ubeda *et al*. (2010) [13] in Spanish elite athletes from combat sports.

Calorie deficit was observed in National female soccer players of England, elite Kenyan distance runners, female national level rhythmic gymnasts, female professional volleyball players, weightlifters of Brazilian Olympic Committee and elite female soccer players compared to recommendations [11, 14-18]. Carbohydrate intake was suboptimal i.e. below the recommendations which were reported among over trained boxers [19] and higher fat intake

especially saturated fat and dietary cholesterol, were above the recommendations as observed in female professional volleyball players, male Kuwaiti national level fencers, football players of Spain, elite Greek aquatic athletes and elite Irish athletes [16, 20-23]. The percentage of calories from carbohydrate, protein and fat are mentioned below in (Table: 1).

Table 1: Carbohydrate, protein and fat intake of elite athletes of different countries.

S. No	Countries	Sex, Level of participation & Sport	Carbohydrate (En %)	Protein (En %)	Fat (En %)	Reference
1	Brazil	Female professional soccer players	54	19.7	26.3	D Santos *et al*., 2016 [18]
2	Poland	Female, professional volleyball players	45.9	21.3	32.8	Zapolska *et al*., 2014 [16]
3	Poland	Professional weightlifers	60.9	20.2	18.8	Pilis *et al*., 2014 [24]
4	Poland	Professional race walkers	59.5	22.1	18.5	Pilis *et al*., 2014 [24]
5	Oman	Male, National handball players	64.8	16	19.1	Waly *et al*., 2013 [12]
6	Iran	Male Isfahani Wrestlers	59.7	15.35	29.4	Daneshvar *et al*., 2013 [25]
7	Hong Kong	Elite athletes	51	16	32	Chung *et al*., 2012 [26]
8	Kuwait	Male, National fencers	45.5	16.7	38	Ghloum and Hajji, 2011 [20]
9	England	Female, National soccer players	53.8	16.8	28.8	Martin *et al*., 2006 [11]
10	Brazil	Male Weightlifters	54	14.5	28.5	Cabral *et al*., 2006 [17]
11	Brazil	Female Weightlifters	56	13.7	28.6	Cabral *et al*., 2006 [17]
12	Greece	Male, aquatic athletes	41.8	17.4	40	Farajian *et al*., 2004 [22]
13	Greece	Female, aquatic athletes	48.4	17.6	33.9	Farajian *et al*., 2004 [22]
14	Australia	Elite athlete	54	17	28	Burke *et al*., 2003 [27]
15	France	Male, elite soccer player	52.5	14.6	32.4	Leblanc *et al*., 2002 [28]
16	France	Male, elite judo player	48	16.3	35.5	Filaire *et al*., 2001 [29]
17	Finland	Male, elite athletes	55	15	30.5	Fogelholm *et al*., 1992 [30]
18	China	Male, elite athletes	38	20	43	Chen *et al*., 1989 [31]
19	China	Female, elite athletes	38.5	21	45.5	Chen *et al*., 1989 [31]
20	Ireland	Male, elite athletes	43.8	15.5	40.7	Barry *et al*., 1981 [23]
21	Ireland	Female, elite athletes	45	14.9	40.1	Barry *et al*., 1981 [23]

*En%: % total energy intake

The above studies showed similarity in problems among athletes, such as low energy intake, a combination of percentage calories from carbohydrate less than 60%, protein greater than 20% and fat greater than 30% of total energy.

Micronutrient intake was below the recommendations especially iron and calcium. Suboptimal iron intake was observed in female professional volley ball players, national female soccer players of England, female elite Greek aquatic athlete and female national level rhythmic gymnasts [16, 11, 22, 15]. Lower intake of calcium below the recommendations was reported in adolescent competitive soccer players, adolescent elite cyclists, professional weight lifters, female professional volley ball players and male Kuwaiti national level fencers [32, 24, 16, 20]. Low Vitamin-A intake was observed in elite Greek aquatic athletes and National female soccer players of England [22, 11], zinc in female national level rhythmic gymnasts [15], vitamin-C & E in elite Greek aquatic athletes [22], folic acid in elite adolescent team sports athletes, adolescent competitive soccer players, adolescent elite cyclists, female elite Irish athletes and professional weight lifters [33, 32, 23, 24], Vitamin-D in elite adolescent team sports athletes, professional weight lifters and race walkers [33, 24] and pyridoxine in adolescent competitive soccer players, adolescent elite cyclists, female elite Irish athletes [32, 23]. D Santos *et al*. (2016) [18] reported in his study that the intake of sodium in elite female soccer players was high compared to recommendations. Another study reported that the potassium intake in adolescent competitive soccer players was less compared to the recommendations [32].

Dietary fibre intakes were below the recommended amounts in female professional volleyball players (19.8g), male Kuwaiti national level fencers (14.8g.), football players of Spain (16.2g) and elite female soccer players of Brazil (16.5g) [16, 20, 21, 18]. Skipping of meals is commonly noticed in athletes especially breakfast as reported by Ruiz *et al*. (2005) [21] in adult football players of Spain who have the habits of skipping meals especially breakfast. Another study conducted on male athletes from south western Nigeria also reported that 72% athletes skipped meals [34].

Supplement use was wide spread among athletes and over use of it is detrimental to health. High consumption of anabolic androgenic steroids was observed in weightlifters, track & field athletes and basketball players of Puerto Rico [35]. Another study by Piacentino *et al* (2016) [36] reported consumption of anabolic androgenic steroids, amphetamine-like substances, cathinones, ephedrine, and caffeine derivatives like guarana in 21.4% of professional and amateur athletes of Italy. Table: 2 summarize the prevalence of supplement consumption in elite athletes worldwide.

Table 2: Prevalence of supplement consumption in elite athletes worldwide

S. No	Sport	Nationality	Level of participation & gender	Total Sample size	Dietary supplements	Prevalence (%)	Reference
1	Triathlon, cycling, swimming, volleyball, soccer, football, combat sports, track & field, shooting and others	Brazil	Competitive athletes, both male & female	182	Whey protein BCAA Malto-dextrin Glutamine Multivitamin/minerals Creatine Thermogenics	53.5% 32.6% 29.1% 18.6% 13.9% 13.9% 10.46%	Nabuco *et al*., 2017 [37]
2	Ball games, endurance, weight class, anti-gravity	Egypt	Competitive & recreational athletes	358	Sports drinks Creatine	66.9% 54.3%	Tawfik *et al*., 2016 [38]
3	Cycling, athletics, triathlon, gymnastics, rugby, basket ball, volley ball, judo, swimming, baseball, hand ball, boxing, fencing	Portugal	High performance athletes, both the sex	241	Multivitamin/minerals Sports drinks Magnesium Protein Glutamine Vitamin-C Iron Sports gel	71% 59% 58% 47% 28% 28% 24% 21%	Sousa *et al*., 2016 [39]
4	Volleyball	Poland	Professional, female	17	Protein supplements Carbohydrates Vitamins & minerals BCAA Amino acids Creatine Glutamine Caffeine Caffeine tablets Energy bars Guarana L-carnitine Chromium, CLA, green tea HCA	71% 24% 71% 12% 76% 12% 6% 65% 41% 24% 8% 35% 18% 6%	Zapolska *et al*., 2014 [16]
5	Baseball, basket ball, foot ball, golf, soccer, tennis, volleyball, softball, track & field	Georgia	Student athletes, both male & female	255	Multivitamin/minerals Iron Chromium Protein shakes, drinks & powder Amino acids HMB Andro/norandro Calcium Herbal supplements Glucosamine/chondroitin Weight loss supplements Weight gain supplements Others Energy drinks	37.6% 6.66% 22.7% 56.5% 11.7% 1.17% 1.17% 14.1% 4.31% 4.7% 3.5% 12.9% 1.56% 17.6%	Wertheimer, 2013 [40]

6	Foot ball	Saudi Arabia	Professional athletes, Male	105	Sports drinks Vitamin-C Multivitamin Omega-6 Creatine Ginkgo biloba	88.7% 82.6% 52% 18.6% 16.3% 10.2%	Aljaloud & Ibrahim, 2013 [41]
7	13 national sports	Portugal	National athletes, both male & female	292	Multivitamin/minerals Sports drinks Magnesium	67% 62% 53%	Sousa *et al*., 2013 [42]
8	Judo	Korea	National athletes, both male & female	101	Oriental supplements Vitamins Protein powders	34% 23% 12%	Kim *et al*., 2013 [43]
9	Judo	Japan	National athletes, both male & female	71	Vitamins Protein powders Minerals	45% 33% 15%	Kim *et al*., 2013 [43]
10	Speed & power, endurance, motor skill, team sports events	Finland	Olympic athletes, both male & female	372	Multivitamin Vitamin-B Vitamin-C Vitamin-D Vitamin-E Antioxidant β-carotene Omega-3fatty Acids Homeopathic supplement Protein Iron Calcium Magnesium Zinc Other minerals Amino acids Carbohydrate Creatine Herbal supplements Others	44.6% 4.6% 21.2% 2% 1.9% 1.3% 0.8% 19.1% 1.6% 38.4% 11.8% 5.9% 17.2% 3.2% 6.5% 7.3% 15.6% 8.1% 5.6% 4%	Heikkinen *et al*., 2011 [44]
11	Wrestlers	Iran	Club level Wrestlers	436	Multivitamin Vitamin-C Vitamin-E Vitamin-B Creatine Protein	8% 7% 6% 4% 7% 3%	Kordi *et al*., 2011 [45]
12	Kayaking, field hockey, rowing, water polo, swimming, athletics, net ball	Australia	Elite athletes, both male & female	72	Minerals Vitamins Iron Caffeine Protein Protein & carb mix	45.8% 43.1% 30.6% 22.2% 16.7% 13.9%	Dascombe *et al*., 2010 [46]

					Creatine Glucosamine Others	12.5% 4.2% 31.9%	
13	Football, Badminton, Athletics, Cricket, Rugby, Swimming, Cycling, Tennis, Ice-hockey, Basket ball etc	UK	High performing athletes, both male & female	847	Multivitamin Vitamin-C Creatine Whey protein Echinacea Iron Caffeine Magnesium & Ginseng	72.6% 70.7% 36.1% 31.7% 30.9% 29.9% 23.7% <11%	Petroczi & Naughton, 2008 [47]
14	Track & field, football, basket ball, volleyball, golf, cross country, softball, baseball, soccer	California	Junior College athletes, both male & female	130	Amino acids HMB Creatine Thermogenics DHEA Chromium Androstenedione Protein products Ephedra, Caffeine & Mu Huang	10.36% 1% 12.95% 3.62% 0.51% 1% 2.59% 21.24% 11.91%	Eliseo & Mun, 2008 [48]
15	Swimming, combat, skill, hockey, rugby, sailing, racket sports, volley ball, net ball, sepak takraw & others	Singapore	Elite athletes, both male & female	160	Sports drinks Caffeine Vitamin-C Multivitamin/minerals Essence of chicken Creatine Ginseng Sports bar Birds nest Protein/ weight gain powder	39% 37% 33% 21% 19% 16% 15% 15% 14% 13%	Slater *et al*., 2003 [49]

The above table summarizes that most commonly consumed supplements by larger percentage of athletes were multivitamins, creatine, caffeine, sports drinks, and protein powders etc.

Indian Scenario

Nutritional and dietary practices of Indian athletes are reportedly subnormal [50]. Skipping of breakfast was observed in State/National level sportswomen, University/State level male and female athletes, Indian competitive wrestlers, South Indian district level sportspersons; lunch was being skipped by sportspersons of Coimbatore district & Indian competitive wrestlers and dinner was skipped by sportspersons of Coimbatore district [51-54, 50]. The frequency of skipping ranged between 3 to 7 day/week. Cereals consumption was shown to be low in collegiate volleyball players, weightlifters and runners [55]. Fruit intake is low in North and South Indian collegiate Hockey players and sport persons of Coimbatore district [56, 50].Vegetable consumption was reported to be subnormal in North and South Indian collegiate Hockey players, volleyball players, weightlifters, runners, male professional basket ball players and sportspersons of Coimbatore district [56, 55, 57, 50]. Consumption of fat was high compared to suggested dietary allowances in male professional basket ball players [57]. Fat consumption especially ghee (100g) is shown to be high in Indian competitive wrestlers [53]. High consumption of nuts especially almonds (75to 100g) in Indian competitive wrestlers [53], dates (40g), and cashew (50g) in male professional basket ball players of Dharwad city [57] per day were reported. Complex carbohydrates are replaced by refined carbohydrates due to choices such as bread and processed snacks by South Indian district level sports persons [54]. High consumption of junk foods (Chowmein, cold drinks, and aloo chips) and oily foods (samosa, bread pakora, bathura etc) were common amongst State/National level sportswomen [51].

Suboptimal protein intake has been observed in Indian competitive runners, boxers and weightlifters, North Indian collegiate female hockey players, sportspersons of Coimbatore district and volleyball players and runners as compared to recommended dietary allowances during training as well as competitions [53, 56, 50, 55]. Negative energy balance was pointed out in the diets of male National level throwers, State/ National level sportswomen, North and South Indian male and female collegiate hockey players and sportspersons of Coimbatore district [58, 51, 56, 50]. Lower carbohydrate intake below the recommendations and higher fat intake especially saturated fat above the recommendations is reported on male National level throwers, male professional basket ball players of Dharwad city, Indian competitive wrestlers, female collegiate kabaddi players and North Indian college male hockey players [58, 57, 53, 59, 56]. High protein intake is observed in South Indian collegiate hockey players and male National level throwers [56, 58]. Carbohydrate intake was shown to be high in North Indian collegiate female hockey players [56]. The percentage of calories from carbohydrate, protein and fat in Indian athletes' diet are summarized in (Table: 3).

Table 3: Carbohydrate, protein and fat intake of athletes of India.

S. No	State	Level of participation	Sex & Sport	Carbohydrate (En %)	Protein (En %)	Fat (En %)	Reference
1	Punjab, Haryana, Chandigarh, Himachal Pradesh, Delhi	All India inter university level	Male, Weight lifting	45.77	19.4	31	Singh, 2016 [60]
2	Punjab, Haryana, Chandigarh, Himachal Pradesh, Delhi	All India inter university level	Male, Wrestling	43.5	16.6	36.7	Singh, 2016 [60]
3	Punjab, Haryana, Chandigarh, Himachal Pradesh, Delhi	All India inter university level	Male, Swimming	46.9	18.6	30.4	Singh, 2016 [60]
4	Punjab, Haryana, Chandigarh, Himachal Pradesh, Delhi	All India inter university level	Male, 100m running	43.3	19.5	33.3	Singh, 2016 [60]
5	Punjab, Haryana, Chandigarh, Himachal Pradesh, Delhi	All India inter university level	Male, Basket ball	44.89	15.5	35.8	Singh, 2016 [60]
6	Punjab, Haryana, Chandigarh, Himachal Pradesh, Delhi	All India inter university level	Male, Cycling	46.5	18.1	31.5	Singh, 2016 [60]
7	Punjab, Haryana, Chandigarh, Himachal Pradesh, Delhi	All India inter university level	Male, Football	48.3	17.66	30.04	Singh, 2016 [60]
8	Punjab, Haryana, Chandigarh, Himachal Pradesh, Delhi	All India inter university level	Male, Handball	46.8	16.4	32.8	Singh, 2016 [60]
9	All India	National	Male, throwers	46.7	21.9	30.1	Chahal *et al*., 2012 [58]
10	Karnataka	Professional	Male, basketball players	51	10.7	35.7	Asha *et al*., 2009 [57]
11	Delhi-NCT	State/National	Female, Volleyball, hockey, football & kabaddi	<60	15	>25	Jain *et al*., 2008 [51]
12	All India	State, National & International	Male, Wrestlers, runners, boxers & weightlifters	34	15	49	Kelkar *et al*., 2006 [53]
13	Karnataka	College	Female, kabaddi players	54.1	14.4	31.2	Sharma, 2014 [59]
14	North India	College	Male, hockey players	60.6	16.6	22.7	Suman and Sharma, 2013 [56]
15	North India	College	Female, hockey players	63.7	16.9	20.2	Suman and Sharma, 2013 [56]
16	South India	College	Male, hockey players	58	25.2	16.8	Suman and Sharma, 2013 [56]
17	South India	College	Female, hockey players	59.6	22.2	15.2	Suman and Sharma, 2013 [56]
18	Tamil Nadu	College	Volleyball players	48.8	12.3	24.7	Nazni and Vimala, 2010 [55]
19	Tamil Nadu	College	Weightlifters	61	17.4	23	Nazni and Vimala, 2010 [55]
20	Tamil Nadu	College	Runners	44.4	10.5	22.4	Nazni and Vimala, 2010 [55]

*En%: % total energy intake

These studies showed commonality in problems among athletes playing different sports, such as low energy intake, a combination of percentage calories from carbohydrate less than 60%, protein greater than 20% and fat greater than 30% of total energy.

Micronutrient intake is reported to be below the recommendations especially iron and calcium. Inadequate intake of iron is commonly observed in Indian athletes, as reported by Ashwini *et al* (2012) [61] on Indian female fencers (14mg/dl) than the recommended dietary allowances of iron (30mg/dl). Their serum ferritin values were also below (14.85ng/ml) the desirable range (20-212.3ng/ml).Similar studies conducted on male professional basket ball players of Dharwad city (26.1mg), University/State level male and

female athletes, competitive runners (29.9mg), boxers (32.2mg), weightlifters (36.3mg), wrestlers (19.1mg), sportspersons of Coimbatore district and collegiate volleyball players, weightlifers and runners reported inadequate iron intake compared to recommendation (50mg/d) [57, 52, 53, 50, 55]. Hemoglobin levels were low when compared to the standards in male professional basket ball players of Dharwad city, University/State level male and female athletes and sportspersons of Coimbatore district [57, 52, 50]. Calcium intake was reported to be low which is below the recommendations in competitive boxers, University/State level male and female athletes, sportspersons of Coimbatore district, collegiate volleyball players, weightlifers and runners [53, 52, 50, 55]. Suboptimal niacin intake was reported by male professional basket ball players of Dharwad city, State/National level sportswomen and sportspersons of Coimbatore district [57, 51, 50]. Low thiamine, riboflavin intake has been observed in State/National level sportswomen and University/State level male and female athletes [51, 52]. Nande *et al*. (2009) [52] reported lower intake of folate in University/State level male and female athletes.

Adequate amount of dietary fibre needs to be consumed for good health. Low intake of fibre causes colon cancers [62]. Fibre protects against hypertension, hyperlipidemia and CVD [63, 64]. Dietary fibre intake has been observed to be low which is below the recommended amounts in male National level throwers (16.5g.), sportspersons of Coimbatore district and Indian collegiate female athletes (18g) [58, 50, 65].

Very few Indian studies on supplement use amongst athletes have been reported. However, in one of the reported studies, supplement use was reported to be wide spread among athletes with 83.3% of the subjects who were Indian competitive weightlifters using various supplements [53].

Fluid intake has also been reported to be sub-optimal amongst elite athletes, globally [66] as well as in India [67]. Dehydration has been reported to deteriorate performance and long term health [67, 1, 68].

Eating behavior and health

It is well established that diet and nutrition play important roles in maintaining health and preventing diseases [69]. Eating behavior governs several aspects of health [70] and in turn is affected by life style parameters [70]. Eating behavior of athletes is affected by various stimuli present in their environment like coaches, parents, peers, game stress etc.

Attitudes play an important role in the adoption and maintenance of a variety of health and nutritional habits. Socio-economic factors also affect food selection and food intake in human societies [71].

Elite athletes are prone to deficiencies and diseases because of following unhealthy dietary practices. Metabolic abnormalities like low HDL level, hypercholesterolemia were observed in South Indian professional weightlifters [72]. De Matos *et al*. (2011) [73] reported high prevalence of hypertension in both male and female athletes; low ferritin levels and anemia were observed in amateur and professional female athletes. High prevalence of metabolic syndrome was observed in collegiate football lineman [74].

Studies have shown that athletes are more prone to developing eating disorders than non-athletes [75]. Among athletes, prevalence of eating disorders was 23-25% and disordered eating was 15-62% [76, 77]. There is strong and consistent evidence that eating disorders are prevalent in weight sensitive sports such as endurance, weight category and aesthetic sports as well as jumping events [78] and higher in females than males [78, 79]. Smolak *et al*. (2000) [80] reported elite athletes in sports emphasizing thinness, are at increased risk for eating disorders compared to non-athletes. Similar study by Torstveit *et al*. (2008) [81] reported that the prevalence of eating disorder in Norwegian female elite athletes was high in leanness sports (46.7%) than in nonleanness sports (19.8%). Eating disorders and disordered eating have multifactorial risk factors (Psychological, biological & social) [82, 83]. Body image dissatisfaction [84], negative perfectionism and social physique anxiety influences disordered eating and eating disorders in elite athletes [85]. Trigger factors associated with onset of ED were prolonged periods of dieting, frequent weight fluctuations, sudden increase in training volume and traumatic events such as injury [86].

Menstrual irregularities are commonly seen in athletes all over the world [87-89]. There is a high prevalence of menstrual irregularities (amenorrhea and oligomenorrhea) in female Iranian athletes (9%) and Norwegian elite female athletes (16.5%) [88, 89]. Similar study conducted on Indian female gymnasts reported that 78.13% of athletes were identified with menstrual irregularities and most of them suffered from increased fatigue, joint pain, pulse rate, mood swings, premenstrual tension, dysmenorrhoea and menorrhea [87]. Athletes competing in leanness sports have high percentage of menstrual dysfunction (24.8%) than athletes competing in non-leanness sports (13.1%) [91].

Prevalence of Female athlete triad (FAT) (now renamed as RED-S) which is a combination of disordered eating, menstrual dysfunction, and low bone mineral density is low in US collegiate athletes (2.6%) and young Turkey female athletes (1.36%) [92, 93]. Similar study is conducted by Torstveit and Sundgot-Borgen (2005) [89] on 186 Norwegian female elite athletes reported prevalence rate as 5.4-26.9%. Another study conducted on elite athletes reported 60.4% are at risk for FAT and athletes competing in leanness sports (70.1%) are at higher risk of the triad compared with athletes competing in nonleanness sports (55.3%) [91].

Female athlete triad is now renamed as relative energy deficiency (RED-S) in 2007 because the aetiological factor underpinning the triad is an energy deficiency relative to the balance between dietary energy intake (EI) and the energy expenditure required to support homoeostasis, health and the activities of daily living, growth and sporting activities. This syndrome affects many aspects of physiological function including metabolic rate, menstrual function, bone health, immunity, protein synthesis, cardio-vascular and psychological health. In addition, it is evident that relative energy deficiency also affects male athletes [94].

Unhealthy weight cutting methods are used reportedly by weight category athletes. Studies conducted on male wrestlers of Tehran and Judo competitors of Brazil to identify patterns of weight loss reported that these athletes used fasting, restricting meals like missing 1 or 2 meals in a day, & fluid reduction methods like restricting fluids, using saunas, steam room, rubber or plastic suits, and drugs like laxatives, diuretics and others. Fatigue, dizziness, muscle cramps were the most prevalent side effects of the weight loss noticed in these athletes [45, 95].

These illnesses are not only common but lead to significant physical and psychological morbidity and impaired performances.

Conclusions

Nutrition education is needed to improve nutrition knowledge and bring changes in dietary practices [55]. Nutrition-education programs are often based on the premise that superior nutrition knowledge may translate into better dietary intake. The notion of translation of knowledge into practice was supported by results from a large community sample in the United Kingdom showing an association between nutrition knowledge and increased fruit and vegetable intake and reduced fat consumption [96].

Most studies on nutrient intake of elite Indian athletes report an inadequate intake, with lowered biochemical profile such as hemoglobin, anthropometry, eating disorders, associated of poor dietary intake with anthropometry, physiological and performance parameters remains unexplored. Nutrition education is frequently reported to be neglected in sports programs around the nation. There is a paucity of nutrition education interventions among different sports in India. More studies are needed to be done in this area & provide right information & encourage athletes to bring healthy changes in their diet.

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