Title: Energy and macronutrient intakes of elite figure skaters
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ABSTRACT

Objectives Dietary guidelines for athletes emphasize complex carbohydrates. This study examined dietary intakes of elite figure skaters relative to current recommendations in sports nutrition.

Participants Subjects were male (n=80) and female (n=81) figure skaters taking part in a series of training camps held in Colorado between 1988 and 1995. Mean age was 18 years for men and 16 years for women.

Design Measures of height, weight, and skinfold thickness were used to calculate body mass index and percent body fat. Blood samples were drawn for analysis of nutritional status. Energy and nutrient intakes were based on 3-day food records.

Statistical analyses Multivariate regression model and correlation analyses used the SPSS for Windows program. Results Values of body mass index and percent body fat were similar to those obtained for elite athletes in other studies. Plasma chemistries were in the normal range. Energy intakes (2,329 kcal/day for men and 1,545 kcal/day for women) were below recommended values for sex and age. The skaters derived approximately 50% of their daily energy from sugars and fat. Sugars alone accounted for 25% of daily energy intakes--the skaters consumed between 100 g (women) and 142 g of sugars per day. Sugar and fat intakes, when expressed as percent of daily energy, were inversely linked, providing evidence of a fat-sugar seesaw. Higher-energy diets were higher in fat but lower in carbohydrate and protein.

Applications High consumption of sugars and fat by elite athletes was not associated with overweight or excess body fat. Although recommended diets are usually built around complex carbohydrates, dietetics professionals can address the increased energy needs of elite athletes by recommending energy-dense foods. Sugars and fats are efficient sources of energy per unit volume. J Am Diet Assoc. 2001;1O0:319-325.

Competitive figure skating demands both physical strength and endurance. In addition, athletic performance must be accompanied by physical grace and beauty [1-3]. As in gymnastics, much attention is given to issues of body shape and body weight [1-4]. The male skater's ideal is to be muscular but trim; the female is athletic and feminine.

The nutritional status of elite athletes is a key factor in sports performance [5]. Studies of female skaters, runners, dancers, and gymnasts have revealed a tendency toward energy-restricted diets [6], and high rates of clinical and subclinical eating disorders [3,7-9]. This energy restriction can hinder growth, delay menarche, and increase risk for anemia in adolescent females (8-10). The "female athlete triad" of amenorrhea, disordered eating, and osteoporosis (manifested as stress fractures) has been documented previously [11,12]. However, not all studies agree that female skaters show the clinical symptoms of the eating disorder anorexia nervosa. In at least 1 study of competitive skaters [1], body weights, energy intake, and macronutrient intakes were in the low-normal range. Another study found that elite skaters who dieted had largely positive body images [2]. Although energy restriction was prevalent among figure skaters, dieting seemed to be mandated not by primary psychopathology, but by the strin gent demands of this particular sport.

Nutrition recommendations for elite athletes tend to emphasize carbohydrate-rich diets, favoring complex carbohydrates over simple sugars [13-15]. The recommended diets deliver 70% of energy from carbohydrates, 15% of energy from protein, and up to 25% to 30% of energy from fat [16]. Athletes are encouraged to limit sugar consumption to 9% to 14% of daily energy intake [16]. These sports nutrition recommendations were principally designed for young adults [16,17]. However, many figure skaters and gymnasts who now compete at the Olympic

level are still in their lower- to mid-teenage years [9]. The chief goal of sports nutrition, optimal performance, may conflict with the demands of adolescent nutrition, especially if energy restriction is imposed to control body weight [18,19]. Meeting the nutrition needs of adolescent athletes is especially difficult, given that adolescents are still in a critical period of maturation and growth [1,3,4].

Optimizing energy intakes for sports performance while controlling body weight can pose an additional challenge for skaters of any age. The key objective of our study was to compare energy and nutrient intakes of elite figure skaters to the current recommendations in sports nutrition. Given past suggestions that Olympic athletes ought to consume bulky, low-energy diets [20], estimated consumption of sugar and fat was a topic of particular interest.

METHODS

Subjects

Participants were 161 skaters (80 men and 81 women), mean age 17 years, who took part in training camps for elite figure skaters between 1988 and 1995. The 1-week Sports Medicine and Science Training Camps were sponsored by the US Figure Skating Association and the US Olympic Committee. The camps were conducted 2 months after the US Figure Skating Championships, which are held in February, and participants were selected based on their top placements at the national meet. Participants included competitive skaters in individual, pairs, and dance categories in the 12 to 28 year age range. Mean ages were 16 years for women and 18 years for men. The number of study respondents per year ranged from 10 in 1989 to a high of 38 in 1994. Among the participants were future Olympic athletes and olympic medal winners.

Anthropometric Measures

Skaters were weighed and measured and body mass index values (BMI; kg/[m.sup.2]) were calculated. Weight was measured using a balance beam scale with nondetachable weights for maximum accuracy. Skinfold thickness measures were taken at triceps and subscapular sites using skinfold calipers. Percent body fat and amount of fat-free weight were calculated using the formula of McArdle et al [21]. Data for height, weight, BMI, and percent body fat were compared to values for men and women aged 16 to 19 years in the Second National Health and Examination Survey (NHANES II) data set [22].

Dietary Intake Assessment

Three-day food records were collected to determine dietary intakes. These included 2 nonconsecutive weekdays and 1 weekend day. Participants were given detailed instructions on how to complete food records during a group training session, with measuring utensils, food models, and handouts as instructional tools. Three days of diet records were obtained from 153 skaters, 2 days of records from 7 skaters, and 1 day from 1 skater. Diet records were verified, coded, entered, and analyzed using Nutritionist IV (version 4.1, First Data Bank, Inc, San Bruno, Calif, 1997). Estimated energy and macronutrient intakes as well as intakes of simple sugars, fiber, calcium, iron, folate, vitamin C, and vitamin A were compared to appropriate Recommended Dietary Allowances values and to normative Third National Health and Nutrition Examination Survey (NHANES III) data by sex and age [23,24].

Blood Chemistries

Fasting blood samples were obtained for analysis. Serum levels of albumin, glucose, cholesterol, and triglycerides were determined for most participants. Iron status was measured using serum ferritin.

Data Analyses

All data were analyzed using SPSS for Windows statistical program (version 7.0, SPSS, Inc, Cary, NC, 1997). Multivariate regression model and correlation analyses were used to assess the chief sources of energy in the skaters' diets.

RESULTS

Body Weights and Body Fat

Mean body weights and BMI values were low to normal by sex and age. Women were more likely to be underweight than men. As shown in Table 1, men weighed a mean of 65.2 kg and were 172-cm tall. Women weighed a mean of 47.8 kg and were 157cm tall. The range of BMI values for women was 14.9 to 24.3 and for men 15.6 to 26.7. While mean BMI for males [22.3] was close to the mean [22.7] in the NHANES II data [22], mean BMI for females [19.4] was much lower than the NHANES II mean [21.8]. In other words, female but not male skaters were significantly underweight relative to the same-age national probability sample [22].

Men had 6.6% body fat on the average (range=2% to 12%), while females had 14.1% body fat (range=9% to 25%). All but 11 females had less than 18% body fat. Although no information on menstrual status was obtained in this study, body fat percentages of [less than]18% have been linked in at least 1 past study with absence of menstrual cycles and primary or secondary amenorrhea [25]. In that study [25], 12 female gymnasts and figure skaters (aged 16 to 23 years) had a mean of 17.5% body fat, as compared to 26.4% for non-exercising controls. Five of the 12 female athletes had reported either primary amenorrhea or oligomenorrhea. In other studies also, energy restriction and fat avoidance were also associated with hormonal abnormalities in young females [26]. Body fat values in the range of 5% to 12% for male skaters and 8% to 16% for female skaters have been reported in other studies [4,27].

Serum Chemistries

Blood chemistries for males and females, as well as normative values [28], are summarized in Table 2. As expected, the skaters were normoglycemic and had low total cholesterol and triglyceride levels. Ferritin levels is this group were in the normal range, and there was no evidence of iron deficiency anemia [29].

Energy and Nutrient Intakes

Mean estimated energy intakes over the 3-day period were 2,329 kcal/day for men and 1,545 kcal/day for women. These values were significantly lower than mean energy intakes for 16 to 19 year old men (3,097 kcal) and women (1,958 kcal), as reported in the NHANES III data [23]. Estimated mean energy intakes ranged from a low of 748 kcal/day to a high of 4,438 kcal/day for men and from a low of 465 kcal/day to a high of 3,303 kcal/day for women. However, only 4 women and 1 man reported mean daily energy intakes below 1,000 kcal over the 3-day period.

Mean intakes of carbohydrate, protein, and fat (in grams) were all lower than mean values in the NHANES III data for 16 to 19 year olds. Mean intakes of fiber, calcium (for females), iron, and folate were no different from mean intakes for the same-age NHANES III group [24]. Mean intakes of vitamin C were 172 mg for men and 133 for women, both above the Recommended Dietary Allowances.

Dietary Recommendations for Aerobic Athletes

Current energy intake recommendations for aerobic athletes training more than 90 minutes per day are [greater than] 50 kcal/kg/day for men and 45 to 50 kcal/kg/day for women. Athletes in training are advised to consume 65% to 70% of total energy as carbohydrates, or a minimum of 500 g/day to maximize body carbohydrate stores [15]. Only 9% to 14% of energy is supposed to come from simple sugars [16], whereas between 25% and 30% of energy is to be derived from fat [15,16]. These recommendations are summarized in Table 3.

Figure skaters consumed fewer kilocalories per kilogram than recommended. For male skaters, nutrient composition of the diet was 15% protein, 30% fat, and 56% carbohydrate. For female skaters, nutrient composition of the diet was 15% protein, 25% fat, and 60% carbohydrate. Such diets were comparable to those of other elite aerobic athletes [16] and were similar to diets of adolescents in the 1995 Continuing Study of Food Intakes of Individuals data set [30].

Sugar and Fat Intakes

Mean sugar consumption was 142 g/day for men and 100 g/day for women. Simple sugars provided approximately 25% of daily energy intake for both men and women and accounted for most of carbohydrate consumption (60%).

Generally, sugars provide between 10% and 15% of adolescents' daily energy intakes. This level of sugar intake was much higher than had been observed for same-age groups in other studies [31,32].

Mean fat intakes were 80 g/day for men and 44 g/day for women, accounting for 25% to 30% of daily energy. Fat intakes ranged from 14% to 48% of daily energy for men and from 7% to 59% of daily energy intakes for women. Although some fat intakes were low, there was no evidence that figure skaters, as a group, followed low-fat diets. Eleven male and 2 female skaters consumed more than 100 g fat per day. Relatively high fat intakes seem to be characteristic of other athletes also. Economos et al [16] noted that only 17% of elite male athletes and 40% of elite female athletes followed the recommendation to maintain fat intakes at 25% during training.

The figure skaters in our study derived more than 50% of total daily energy from sugar and fat. As shown in Figure 1, higher-energy intakes were associated with a higher percentage of energy from fat after controlling for age (partial [gamma]=0.35; P[less than].05). Higher energy diets were also associated with a lower percentage of energy from carbohydrate (partial [gamma]=20.20; P[less than].05). Stepwise multiple regression analysis with energy intakes (kcal/day) as the dependent variable showed that energy intakes were primarily linked with percent energy from fat (beta coefficient:0.33) and negatively with percent of energy from protein (beta coefficient: 20.20). Past studies of diets of strength-training athletes, as opposed to endurance athletes [33], also showed a positive correlation between energy intakes and the proportion of fat in the diet.

Some dietary survey studies, conducted with European adults [34,35], showed that fat and sugar intakes, when expressed as percent energy, were inversely linked. This phenomenon, called the fat-sugar seesaw [34], has not been observed in all studies [36]. As shown in Figure 2, fat and sugar intakes of elite skaters were inversely linked after controlling for age (partial [gamma]=20.46; P[less than].01). The relationship was stronger for male ([gamma]=-0.54; P[less than].01) than for female skaters ([gamma]=-0.41; P[less than].01). A substantial percentage of daily energy in this subject sample was derived from sugar and fat.

DISCUSSION

Dietary guidelines for athletes, especially endurance athletes, continue to emphasize diets that are high in complex carbohydrates and are low in fat. Figure skaters fall into a gray area, being part-endurance and part-strength athletes [4]. Figure skaters need an aerobic base to meet the metabolic demands of prolonged physical activity, as well as anaerobic capacity for intermittent bursts of intense effort. Male and female skaters in our sample were lean, had very low body fat, and consumed less energy than recommended for sex and age. Blood chemistries were normal and there was no evidence of iron deficiency anemia. Although no data on menstrual cycles were obtained, the distribution of body fat percentages suggested that at least some of the female skaters may have been amenorrheic.

The skaters in this study derived 56% to 60% of energy from carbohydrate, 15% of energy from protein, and 25% to 30% of energy from fat. Carbohydrate intakes were lower than the recommended 60% to 70% of energy. In contrast, the consumption of simple sugars was almost double the recommended 9% to 14%.

Other studies of male and female Olympic athletes also showed that their diets contained only 50% as opposed to 60% to 70% carbohydrate [37,38]. A study of 419 elite athletes [33] reported carbohydrate intakes in the 40% to 63% energy range. Studies of elite aerobic athletes [16], based on multiple days of food records, showed that carbohydrate intakes were lower than recommended values. Aerobic sports in those studies were distance running, cycling, swimming, rowing, and triathlon, whereas anaerobic sports were weight lifting, body-building, and throwing [16]. Yet the continuing emphasis on the consumption of complex carbohydrates in sports nutrition is such that one author [4] characterized diets containing 33.9% fat and only 52% carbohydrate as "nutritionally poor."

The emphasis on carbohydrate consumption varies somewhat from sport to sport. While anaerobic sports, such as weight lifting and wrestling, have focused on protein intakes and on protein or amino acid supplementation [39-41], high carbohydrate diets are regarded as optimal for aerobic or endurance sports [15]. According to current guidelines [13,16], dietary carbohydrate should increase to 65% to 75% of total energy during the precompetition phase, or to 70% to 80% of total energy when "loading" for exhausting events. At the same time, athletes are generally advised to avoid simple sugars.

This advice does not correspond to reality. It is difficult to achieve high levels of carbohydrate intake ([greater than] 60% of energy) while consuming a high-energy diet [43]. Diets based on vegetables, potatoes, rice, and grains are high in bulk, and many athletes complain of an inability to eat enough to maintain energy balance [5]. Although carbohydrate intakes of up to 41 g/kg/day have been observed among male aerobic athletes [16], some experts caution that such high levels of carbohydrate intake are not for everyone. High-fiber foods consumed before competition can cause flatulence and gastric distress. Common sense would dictate that the most efficient way to achieve a high-energy diet is through increased consumption of high-energy foods. As documented in past studies, such foods are typically high in sugar and fat [44]. Athletes aiming to minimize gastrointestinal symptoms have sought out energy-dense supplements for pre-event nutrition. In practice, this means chocolate, power bars, sucrose/glucos e mixtures, and glucose polymers [5], in other words simple sugars and fat.

The conventional belief that athletes should consume a low-fat diet, based around fresh vegetables and fruits, is at odds with our results. A study once described foods being offered to athletes in the Atlanta Olympic Village as a "[very] broad range of fresh vegetables and dips, fruits, cheeses, breads, salad bar, specialty pastas, rice, fruit salads, soups, meat and seafood entrees, hot vegetables, desserts and beverages" [20]. Many such foods provide very few kilocalories per unit weight or volume. Raw vegetables, fruits, and salad greens provide 0.1-0.3 kcal/g on the average, and soups tend to provide 0.5 to 1.0 kcal/g (44). While healthful, a diet based on fresh vegetables and fruit, salad greens, and fruit salads does not provide sufficient energy for competition and optimal sports performance. Not surprisingly, many athletes opt for sugar and fat. The diets of our subjects derived not 9% to 14% but fully 25% of energy from sugars on the average, with some skaters consuming 50% of energy from sugar. An other 30% of daily energy was provided by dietary fat.

APPLICATIONS

Adolescent athletes aiming to control body weight are susceptible to popular diet trends and should receive nutrition counseling. Sports nutrition recommendations should include energy-dense foods, at least during heavy training periods. A diet that includes as much as 50% of energy from fat has been shown to have no effect on body weight or adiposity when athletes are able to maintain energy balance during periods of endurance training [45] and may be the only way to satisfy an athlete's high energy needs. Efforts to restrict fat and sugar consumption, particularly when adequate energy balance is critical to endurance, may prove detrimental not only to sports performance but to development and growth.

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References

(1.) Ziegler P, Hensley S, Roepke JB, Whitaker SH, Craig BW, Drewnowski A. Eating attitudes and energy intakes of female skaters. Med Sci Sport Exer. 1998;30:583-586.

(2.) Ziegler PJ, Khoo CS, Sherr B, Nelson JA, Larson WM, Drewnowski A. Body image and dieting behaviors among elite figure skaters. Int J Eat Disord. 1998;24:421-427.

(3.) Rucinski A. Relationship of body image and dietary intake of competitive ice skaters. J Am Diet Assoc. 1989;89:98-100.

(4.) Delistraty DA, Reisman EJ, Snipes M. A physiological and nutritional profile of young female figure skaters. J Sport Med Phys Fitness. 1992;32:149- 155.

(5.) Applegate EA, Grivetti LE. Search for the competitive edge: a history of dietary fads and supplements. J Nutr. 1997;127(suppl):869S-873S.

(6.) Ziegler PJ, Nelson JA, Jonnalogadda SS. Nutritional and physiological status of US national figure skaters. Lnt J Sport Nutr. 1999;9:345-360.'

(7.) Calabrese LH, Kirkendall DT. Nutritional and medical considerations in dancers. Clin Sport Med. 1983:2:539-548.

(8.) Theintz GE, Howald H, Weiss U, Sizonenko PC. Evidence for a reduction of growth potential in adolescent female gymnasts. J Pediatr. 1993; 122:306-313.

(9.) Tofler IR, Stryer BK, Micheli LJ, Herman LR. Physical and emotional problems of elite female gymnasts. N Engl J Med. 1996;335:281-283.

(10.) Frisch R, Wyshak G, Vincent L. Delayed menarche and amenorrhea in ballet dancers. N Engl J Med. 1980;303:17-19.

(11.) Nattiv A, Agostini R, Drinkwater B, Yeager KK. The female athlete triad: the inter-relatedness of disordered eating, amenorrhea, and osteoporosis. Clin Sport Med. 1994;13:405-418.

(12.) Manore MM. Nutritional needs of the female athlete. Clin Sport Med. 1999;18:549-563.

(13.) Burke LM, Hawley JA. Carbohydrate and exercise. Curr Opin Clin Nutr Metab Care. 1999;2:515-520.

(14.) Miller SL, Wolfe RR. Physical exercise as a modulator of adaptation to low and high carbohydrate and low and high fat intakes. Eur J Clin Nutr. 1999;53(suppl1);S112-119.

(15.) Position of The American Dietetic Association and the Canadian Dietetic Association: nutrition for physical fitness and athletic performance for adults. 1993;93:691-697.

(16.) Economos CD, Bortz SS, Nelson ME. Nutritional practices of elite athletes: practical recommendations. Sport Med. 1993; 16:381-399.

(17.) Grandjean AC. Dietary strategies for modifying body weight or body composition. Strength Cond. 1995;17:7-10.

(18.) Cook PC, Leit ME. Issues in the pediatric athlete. Ortho C/in N Am. 1995:26:453-464.

(19.) Nevin-Folino NL. Sports nutrition for children and adolescents. In: Queen PM, Lang CE, ads. Handbook of Pediatric Nutrition. Gaithersburg, Md: Aspen: 1993:187-205.

(20.) Grivetti LE, Applegate EA. From Olympia to Atlanta: a cultural-historical perspective on diet and athletic training. J Nutr. 1997:1 27(suppl):860S-868S.

(21.) McArdleWD, Ketch Fl, Ketch VL. Exercise physiology: energy, nutrition, and human performance. Baltimore, Md: Williams & Wilkins: 1996.

(22.) Najjar MF, Rowland M. Anthropometric Reference Data and Prevalence for Overweight: United States, 1976-80. Hyattsville, Md: National Center for Health Statistics: 1987. Series 11, No. 238.

(23.) McDowell MA, Briefel RR, Alaimo K, Biachof RD, at al. Energy and Macronutrient Intake of Persons Ages 2 Months and Over in the United States: Third National Health and Nutrition Examination Survey, Phase 1, 1988-91. Hyattaville, Md: National Center for Health Statistics, 1994. Advance Data from Vital and Health Statistics, No 255.

(24.) Alaimo K, McDowell MA, Briefel RR, Bischof RD, et al. Dietary Intake of Vitamins, Minerals, and Fiber of

Persons Ages 2 Months and Over in the United States: Third National Health and Nutrition Examination Survey, Phase 1, m 1988-91. Hyattsville, Md: National Center for Health Statistics: 1994. Advance Data from Vital and Health Statistics, No. 258.

(25.) Fogelholm GM, Kukkonen-Harjula TK, Taipale SA, Sievanen HT, Oja P, Vuori IM. Resting metabolic rate and energy intake in female gymnasts, figure skaters, and soccer players. Int J Sport Med. 1995:16:551-556.

(26.) Rock C, Gorenflo C, Drewnowski A, Demitrack MA. Nutritional characteristics, eating pathology, and hormonal status in young women. Am J Clin Nutr. 1996:64:566-571.

(27.) Wilmore JH, Costill DL. Physiology of sport and exercise, 2nd ed. Champaign, II: Human Kinetics: 1999:506.

(28.) The Mini Book: Pathology Laboratories Handbook, 1994-95. Ann Arbor: University of Michigan Medical Center: 1994.

(29.) Raunikar RA. Anemia in the adolescent athlete. Am J Dis Child. 1993:146:1201-1205.

(30.) CSFII/DHKS 1994-96 [CD-ROM]. Beltsville, Md: United States Department of Agriculture, Beltsville Human Nutrition Research Center, Agriculture Research Service; 1997.

(31.) Glinsmann WH, Irasquin H, and Youngmee K. Evaluation of health aspects of sugars contained in carbohydrate sweeteners: report from FDA's Sugars Task Force, 1986. J Nutr. 1986;116(suppl 11):S1-S216.

(32.) Drewnowski A. Sensory preferences for fat and sugar in adolescence and adult life. Ann NY Acad Sci. 1989;561:243-250.

(33.) Van Erp-Baart AMJ, Saris WHM, Binkhorst RA, Vos JA, Elvers JWH. Nationwide survey on nutritional habits in elite athletes. 1. Energy, carbohydrate, protein, and fat intake. Int J Sports Med. 1989;10(suppl)S3-S10.

(34) MacDiarmid JI, Cade JE, Blundell JE. Extrinsic sugar as vehicle for dietary fat [letter]. Lancet. 1995;346:696.

(35.)Gibney M, Sigman-Grant M, Stanton JL, Keast DR. Consumption of sugars. Am J Clin Nutr. 1995;62 (suppl):178S-194S.

(36.) Drewnowski A, Henderson SA, Shore AB, Fischler C, Preziosi P, Hercberg S. The fat-sucrose seesaw in relation to age and dietary variety in French adults. Obes Res, 1997;5:511-518.

(37.) Grandjean AC. Macronutrient intake of US athletes compared with the general population and recommendations made for athletes. Am J Clin Nutr. 1989;49:1070-1076.

(38.) Grandjean AC, Ruud JS. Olympic athletes. In: Wolinsky I, Hickson JF, eds. Nutrition in Exercise and Sport. 2nd ed. Boca Raton, Fla: CRC Press; 1994:447-454.

(39.) Anderson RE, Barlett SJ, Morgan GD, Brownell KD. Weight loss, psychological, and nutritional patterns in competitive male body builders. Int J Eat Disord. 1995;18:49-57.

(40.) Shills ME, Olson JA, ed. Modern Nutrition in Health and Disease. 8th ed. Malvern, Pa: Lea & Febiger; 1993.

(41.) Lemon PW. Protein and amino acid needs of the strength athlete. Int J Sport Nutr 1991l;1:127-145.

(42.) Lemon PW. Is increased dietary protein necessary or beneficial for individuals with a physically active lifestyle? Nutr Rev. 1996;54(suppl)S169-75.

(43.) Burke L, Read R. Diet patterns of elite Australian male triathletes. Phys Sport Med. 1987;15:140-155.

(44.) Drewnowski A. Energy density, palatability, and satiety: implications for weight control. Nutr Rev. 1998:56:347-353.

(45.) Brown RC, Cox CM, Goulding A. High-carbohydrate versus high-fat diets: effect on body composition in trained cyclists. Med Sci Sports Exer. 2000;32:690-694.

Subject characteristics by sex

	Men (n=80) mean[+ or -]standard deviation
Age (y)	18.4[+ or -]3.6
Height (cm)	171.7[+ or -]8.0
Weight (kg)	65.2[+ or -]8.9
Body mass index (kg/[m.sup.2])	22.0[+ or -]16.1
Body fat (%)	6.6[+ or -]20.6
	Women (n=81)
Age (y)	15.9[+ or -]3.6
Height (cm)	157.1[+ or -]7.2
Weight (kg)	47.8[+ or -]6.3
Body mass index (kg/[m.sup.2])	19.3[+ or -]13.5
Body fat (%)	14.1[+ or -]28.8

Serum chemistry values

	Men (n=80) Mean[+ or -]SD	Range of normal values [a]
Albumin (g/L)	47[+ or -]3.0	35-49
Ferritin ([micro]g/L)	66[+ or -]36	23-70 [b]
Glucose (mmol/L)	4.8[+ or -]0.5	4.0-6.3
Triglycerides (mmol/L)	0.9[+ or -]0.3	0.33-1.0
Cholesterol (mmol/L)	4.4[+ or -]0.7	[less than]6.2
	Women (n=81) Mean[+ or -]SD	Range of normal values
Albumin (g/L)	46[+ or -]3	35-49
Ferritin ([micro]g/L)	48[+ or -]27	6-40 [b]
Glucose (mmol/L)	4.8[+ or -]1.0	4.0-6.3
Triglycerides (mmol/L)	0.9[+ or -]0.3	0.33-1.0
Cholesterol (mmol/L)	4.6[+ or -]0.7	[less than]6.2

(a.)Source reference 29.

(b.)Range for men or women aged 10 to 19 years.

Energy and nutrient intakes and percent body fat of elite figure skaters by sex, as compared to other elite athletes during training [16] and to current recommendations in sports nutrition [15,16]

	Elite figure skaters mean[+ or -]standard deviation
Men (n=80)	
Energy (kcal/kg)	36[+ or -]12.1
Protein (g/kg)	1.3[+ or -]0.5
Carbohydrate (g/kg)	5.1[+ or -]1.7
Protein (% energy)	15[+ or -]3
Fat (% energy)	30[+ or -]7
Carbohydrate (% energy)	57[+ or -]7
Sugar (% energy)	25[+ or -]9
Body fat (%)	6.6

Women (n=81)		
Energy (kcal/kg)	33[+ or -]11	
Protein (g/kg)	1.3[+ or -]0.4	
Carbohydrate (g/kg)	5.0[+ or -]1.8	
Protein (% energy)	16[+ or -]4	
Fat (% energy)	25[+ or -]9	
Carbohydrate (% energy)	60[+ or -]10	
Sugar (% energy)	26[+ or -]8	
Body fat (%)	14.1	
	Other elite aerobic athletes range	Recommendations
Men (n=80)		
Energy (kcal/kg)	45-87	[greater than]50
Protein (g/kg)	1.4-3.0	1
Carbohydrate (g/kg)	5.3-11.5	6-10
Protein (% energy)	12-17	12-15
Fat (% energy)	20-40	25-40
Carbohydrate (% energy)	44-65	55-60
Sugar (% energy)	N/A	9-14
Body fat (%)	7.6-12.7	4-12
Women (n=81)		
Energy (kcal/kg)	30-46	40-50
Protein (g/kg)	1.1-1.5	1
Carbohydrate (g/kg)	4.4-6.4	6-10
Protein (% energy)	13-16	12-15
Fat (% energy)	26-38	25-30
Carbohydrate f% energy)	46-60	55-60
Sugar (% energy)	N/A	9-14
Body fat (%)	13-27	10-20

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