The Comparison of Dietary Intakes Between Adolescent Swimmers and Sedentary Peers

Adölesan Yüzücüler ile Spor Yapmayan Yaşıtlarının Besin Tüketim Durumlarının Karşılaştırılması

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ABSTRACT Objective: The aim of this study was to compare dietary intakes between adolescent swimmers and sedentary peers (control group). **Material and Methods:** This cross-sectional study examined 46 adolescent swimmers (10.9±1.99 years, %41.3 male) and 102 age- and sex-matched controls (10.6±1.98 years, %41.2 male). All of the adolescents completed 3-day food records. Height, body weight, and triceps skinfold measurement was recorded for each adolescent. Adolescents' recorded their 24 hours exercise program and physical activity details were and total energy expenditure was calculated by multiplying physical activity level by basal metabolic rate. The values obtained for energy and nutrient intakes were compared with dietary reference intakes (DRIs) and American Heart Association (AHA) recommendations. **Results:** Swimmers had higher body weights, heights, body mass indexes, and smaller triceps skinfolds compared with the control group (p<0.05). The mean difference between the energy intake and total energy expenditure was significantly higher in swimmers than it was in controls (p<0.05). In addition swimmers consumed significantly more energy, carbohydrate, protein, fat, cholesterol, saturated fat, and fluid than controls (p<0.05). However, carbohydrate and protein intakes were not significantly different between the groups when expressed as per kilogram of body weight per day (p>0.05). Total fat, saturated fat, and sodium consumption of adolescents exceeded the AHA recommendations. In both groups, the fluid, fiber, and calcium consumptions were below than the AHA recommendations, the sodium consumption was above them. Mean intakes of thiamin, riboflavin, vitamin E, and vitamin B12 were significantly higher in swimmers. With the exception of niacin (90% DRIs) and folate (94% DRIs), all vitamin intakes were above the DRIs for swimmers. In controls, however, thiamin, niacin, vitamin E, and vitamin B12 were under the DRIs. **Conclusion:** The results of this study indicated nutrient inadequacies and unbalances among adolescent swimmers and sedentary peers. Swimmers should be encouraged to consume low-fat foods, dense meals with high carbohydrate nutrients and increase their intakes of fluids and dairy products.

Key Words: Athletes, adolescent, nutrition, swimming

ÖZET Amaç: Bu çalışmanın amacı, adolesan yüzücüler ile hiç spor yapmayan yaşıtlarının (kontrol grubu) diyet tüketimlerini karşılaştırmaktır. **Gereç ve Yöntemler:** Bu kesitsel çalışma, 46 yüzücü adolesan (10.9±1.99 yaş, %41.3'ü erkek) ile yaş ve cinsiyet açısından eşleştirilmiş 102 adolesan (10.6±1.98 yaş, %41.2'si erkek) üzerinde yapılmıştır. Adolesanlar 3 günlük besin tüketim kaydı doldurmuşlardır. Adolesanların boy uzunluğu, vücut ağırlığı ve triseps deri kıvrım kalınlıkları ölçülmüştür. Günlük antrenman ve fiziksel aktivitelerini kaydetmişler ve toplam enerji harcamaları, fiziksel aktivite düzeyi ile bazal metabolik hızın çarpımından hesaplanmıştır. Enerji ve besin öğelerinin tüketim durumları Diyet Alım Düzeyleri (DRI) ve Amerikan Kalp Birliğinin (AHA) önerileri ile karşılaştırılmıştır. **Bulgular:** Yüzücülerin vücut ağırlığı, boy uzunluğu, beden kitle indeksi değerleri kontrol grubundan daha yüksek iken, triceps deri kıvrım kalınları daha düşüktür (p<0.05). Enerji alımı ve harcaması arasındaki fark yüzücülerde kontrol grubundan daha yüksektir (p<0.05). Ayrıca yüzücüler kontrol grubundan daha fazla enerji, karbonhidrat, protein, yağ, kolesterol, doymuş yağ ve sıvı tüketmektedir (p<0.05). Fakat yüzücülerin karbonhidrat ve protein tüketim miktarları, vücut ağırlığının kilogramı başına gram olarak verildiğinde iki grup arasında fark yoktur (p>0.05). Adolesanların toplam yağ, doymuş yağ ve sodyum tüketimleri AHA önerilerinin üzerindedir. Her iki gruptaki adolesanların sıvı, posa ve kalsiyum alımları AHA önerilerinin altındayken, sodyum tüketimleri AHA tarafından önerilen miktardan daha fazladır. Yüzücülerin diyet tiamin, riboflavin, E ve B12 vitaminleri tüketim ortalamaları, kontrol grubundan daha yüksektir. Yüzücülerin niasin (%91 DRIs) ve folat (94%DRIs) hariç diğer vitaminleri tüketim miktarları DRIs üzerindedir. Kontrol grubunda ise tiamin, niasin, E ve B12 vitamin tüketimleri DRIs altındadır. **Sonuç:** Bu çalışmanın sonuçları, yüzücü adolesanlar ve hiç spor yapmayan yaşıtları arasında besin öğeleri yetersizlikleri ve dengesizlikleri olduğunu göstermektedir. Yüzücülere düşük yağlı besinler ile yüksek karbonhidrat içeren enerjisi yoğun besinlerin tükettirilmesi ve sıvı alımları ile süt ve ürünlerinin tüketimlerini artırmaları konusunda yardımcı olunmalıdır.

Anahtar Kelimeler: Sporcu, adolesan, beslenme, yüzme

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Swimmers, like all athletes, require a well-balanced diet for normal daily activities and demands of training and competition.[1-3] The prolonged nature of swimming requires attention to good eating habits and drinking enough fluids.[2] If only normal daily eating is maintained, the swimmer's nutritional intake could be severely inadequate.[1,3]

Researchers typically have studied the nutritional statuses of swimmers during heavy or peak training.[1,3] Unfortunately, because most research has focused on adolescent and young adult swimmers,[4-6] there remains a paucity of information regarding the dietary needs of middle and high school athletes and nonathletes. Young athletes differ from adults and their nonathletic peers in important physiological, metabolic, and biochemical regards,[6,7] and these differences affect the nutritional needs of these young athletes. Most children and adolescents who are strongly committed to swimming are not concerned about proper nutrition as it relates to energy balance.[1,3] To stay in energy balance, it is necessary that a sufficient amount of calories is eaten to balance energy expenditure.[5] Studies show that energy intake for swimmers is an average of 11% to 43% lower than total energy expenditure.[1,3,5] While not all adolescents fail to consume enough micronutrients, a significant percentage do not meet the minimum recommendations for calcium, iron, folic acid, and several other vitamins and minerals.[1] Adolescent athletes might consume more nutrients if they increased their food intake to meet energy expenditures.[8]

Children and adolescents should be encouraged to eat well so that they receive the adequate nutrients for growth and sports participation.[6,9] It is therefore necessary to evaluate the dietary intake of adolescent swimmers to establish specific dietary guidelines to enhance their peak athletic performance and overall health. Therefore, the purposes of this study were to compare the dietary intakes of adolescent swimmers and sedentary peers and compare their dietary intakes with the recommendations.

MATERIAL AND METHODS

SUBJECTS

A convenient sample of competitive school-age club swimmers was recruited from swim teams in Ankara, Turkey. Of the 102 enrolled swim-team members, 46 voluntary swimmers (41.2% males; mean age, 10.9 ± 1.99 years) participated in this study. These swimmers were compared with 102 age- and sex-matched sedentary peers (41.3% males; mean age, 10.6 ± 1.98) years) (controls) from the surrounding community. Inclusion criteria were good health, with no known disease including diabetes, cancer, or heart disease; and currently not being on a weight loss diet; for controls, no vigorous exercising (ie, <3 moderate to vigorous aerobic sessions longer than 30 minutes a week) was allowed. Swimmers had trained for a mean of 3.6 ± 1.74 years. The mean total time spent swimming daily was 1.5 ± 0.49 hours. Written, informed consent was obtained from each swimmer and their parents.

DIETARY ANALYSIS

A food record was used to collect data regarding the dietary intake for 3 consecutive days including 1 weekend day. Although no one dietary assessment method can precisely measure dietary intake, three-day food records have been shown to be appropriate for determining mean nutrient intake of the group.[10] Adolescents and their parents were given the food record and were instructed about how to record all food and fluids consumed. Subjects gave detailed descriptions of consumed food and drink. They recorded brand names of commercial and ready-to-eat foods; they estimated portion sizes; and they recorded the method of preparation, place of consumption, and whether they used any added fats or oils. Adolescents and their families met with the dietician at the end of each day; at that time, the completed food record was reviewed with the adolescent (or their parents) by dieticians for accuracy and completeness. The completed diet records were analyzed using a commercial computer program (Nutrient Data Base Program- BEBIS5, version 616000, 2006, Germany). The adolescents' nutrient intakes were compared with Dietary Reference Intakes (DRIs) matched for age and sex. Levels of total fat, saturated fatty acid (SFA), monounsaturated fatty acid (MUFA), polyunsaturated fatty acid (PUFA), and cholesterol were compared with American Heart Association (AHA) recommendations for these levels.[11]

ENERGY EXPENDITURE AND ENERGY BALANCE

Data for energy expenditure were collected with activity records. Activity records were collected for the same days for which the dietary records were kept. Adolescents and their parents were given forms with which to record information, and they were given written and verbal instructions on how to record activities. Physical activity for swimmers during practice was prescribed each day by the swimming coach. Tabulated energy costs for the different activities were used to estimate physical activity level. Basal metabolic rate was calculated using the equation recommended by the World Health Organization, the Food and Agriculture Organization, and the United Nations University in 2001. Total energy expenditure was calculated as basal metabolic rate ´ physical activity level.

ANTHROPOMETRIC DATA

Anthropometric measures included weight, height, and triceps skinfold thickness. Height was measured with a nonstretchable tape measure attached to the wall. Body weight was measured using an electronic scale (Seca model, 770, Hamburg, Germany). Body mass index was calculated as kg/m^2. Skinfold measurement (triceps) was obtained using a Harpenden Skinfold Caliper (H.E. Morse Co. British Indicators, Ltd, Burgess Hill, West Sussex, UK) according to procedures described by Lohman et al.[12] Three measurements were taken at the triceps (±0.1 mm) and averaged.

STATISTICAL ANALYSES

All data were analyzed with SPSS software (Statistical Product and Services Solutions, version 11.0, SPSS Inc, Chicago, IL, USA). The results are expressed as means ± standard deviation or as percentages. A Kolmogorov-Smirnov test was performed to determine the normality of the distribution of the data. For normal data, differences between swimmers and controls were compared using an unpaired *t* test. For nonnormally distributed data, a Mann-Whitney *U* test was used to compare the 2 groups. Values for p were 2-tailed and were considered statistically significant at a level of less than 0.05.

RESULTS

The physical characteristics of swimmers and controls are shown in Table 1. Body mass index (BMI), height, and weight were significantly different between two groups. Swimmers had significantly greater BMIs than controls ($p < 0.05$). The triceps skinfold thickness of controls was significantly higher than those of swimmers ($p < 0.05$).

Table 2 shows the results for reported total energy expenditure and energy balance for swimmers and controls. When the total energy expen-

TABLE 1: Physical characteristics of swimmers and controls.

	Swimmers (n= 46)	Controls (n= 102)	p value
Height (cm)	146.7 ± 12.34	140.7 ± 13.83	0.001
Weight (kg)	39.6 ± 12.34	33.6 ± 9.16	0.001
BMI (kg/m^2)	18.1 ± 2.12	16.6 ± 1.79	0.001
Triceps (mm)	12.8 ± 5.41	16.2 ± 2.26	0.033

Values are means ± SD.

TABLE 2: Total daily energy expenditure and energy balance of swimmers and controls ‡.

	Swimmers (n= 61)	Controls (n= 102)
Total energy expenditure (TEE), kcal	2496 ± 705.7	1751 ± 299.1
Basal metabolic rate, kcal	1196 ± 320.4	1175 ± 156.2
Physical activity level	2.08 ± 0.18	1.49 ± 0.15
†Energy balance, kcal	-604 ± 650.8	-153 ± 358.6
†Energy balance, %	-17.7 ± 30.6	-7.7 ± 19.3

Values are means ± SD,
‡p < 0.05,
†Energy balance = Energy intake-Total energy expenditure.

diture of both groups was calculated, swimmers were shown to have higher total energy expenditures than controls. The mean difference between the energy intake and total energy expenditure was -604 ± 650.8 $kcal.d^{-1}$ for swimmers and -153 ± 358.6 $kcal.d^{-1}$ for controls, resulting in energy balances of -17.7% and -7.7%, respectively.

The reported means ± SD daily dietary intakes of energy, macronutrients, and percentage of total energy of macronutrients for the two groups are presented in Table 3. The 3-day food record showed that swimmers had significantly higher energy intakes compared with controls, but swimmers consumed 50.2 ± 13.75 $kcal.kg^{-1}.d^{-1}$, while controls consumed 50.0 ± 13.62 $kcal.kg^{-1}.d^{-1}$ (p = 0.940). Swimmers consumed significantly more carbohydrate, protein, fat, SFA, MUFA, PUFA, cholesterol, and fluid than did controls. When macronutrient intake is expressed as $g.kg^{-1}.d^{-1}$, carbohydrate and protein intakes did not differ significantly between the groups. In the energy contributions of the percentage of carbohydrate, protein, and fat, there were no statistically significant differences between swimmers and controls. The reported energy intake from SFA was significantly higher in swimmers than in controls (p= 0.006). In groups, total fat and SFA consumption exceeded recommended maximums of less than 30% kcal and less than 10% kcal, respectively (Table 3). Mean fluid intake was significantly higher in swimmers than controls, but the amount of the fluid intake was less than that was recommended by the DRIs.

Mean vitamin intakes are shown Table 4. Mean intakes of thiamin, riboflavin, vitamin E, and vitamin B12 were significantly higher in swimmers than in controls. With the exception of niacin (90% DRIs) and folate (94% DRIs), all vitamin intakes were above the DRIs for swimmers. In controls, however, thiamin, niacin, vitamin E, and vitamin B12 were below the DRIs.

TABLE 3: Daily dietary intakes of energy and macronutrients of swimmers and controls.

	Swimmers (n= 46)	Controls (n= 102)	p value
Energy, kcal	1891 ± 378.7	1598 ± 358.8	0.000
Energy, $kcal.kg^{-1}$	50.2 ± 13.75	50.0 ± 13.62	0.940
Carbohydrate, g	233.9 ± 64.16	203.4 ± 52.6	0.003
Carbohydrate, $g.kg^{-1}$	6.2 ± 1.78	6.4 ± 1.95	0.531
Protein, g	63.9 ± 13.32	52.0 ± 16.31	0.000
Protein, $g.kg^{-1}$	1.7 ± 0.57	1.6 ± 0.53	0.345
Fat, g	74.5 ± 15.37	60.2 ± 18.54	0.000
SFA, g	28.5 ± 6.97	21.6 ± 8.78	0.000
MUFA, g	25.3 ± 6.70	22.2 ± 8.62	0.037
PUFA, g	15.9 ± 5.34	11.9 ± 5.49	0.000
Cholesterol, mg	258 ± 109.3	206 ± 93.3	0.003
Fiber, g	17.7 ± 6.78	17.6 ± 5.77	0.872
Fluid, mL	1883 ± 479	1363 ± 497	0.000
Percentage of total energy			
Carbohydrate, %	50.5 ± 6.06	52.6 ± 6.76	0.077
Protein, %	13.9 ± 2.19	13.5 ± 2.77	0.086
Fat, %	35.6 ± 4.85	33.9 ± 6.84	0.159
SFA, %	13.7 ± 2.95	12.1 ± 3.48	0.006
MUFA, %	12.1 ± 2.28	12.5 ± 3.59	0.415
PUFA, %	7.7 ± 2.28	6.8 ± 3.06	0.105

Values are means(SD); SFA: saturated fatty acid; MUFA: monounsaturated fatty acid; PUFA: polyunsaturated fatty acid.

TABLE 4: Vitamin intakes of swimmers and controls, compared with recommendation.

	Swimmers (n= 46)		Controls (n= 102)	
	Mean (SD)	% DRI†	Mean (SD)	% DRI†
Vitamin A, mcg RE	983.7 ± 37.5	172 ± 97.4	920.5 ± 679.2	158 ± 106.7
Vitamin E, mg	15.0 ± 6.05^{a}	142^{f} ± 53.3	9.9 ± 5.06^{a}	95^{f} ± 49.7
Vitamin C, mg	143.0 ± 9.5^{b}	344^{g} ± 212.4	93.8 ± 42.55^{b}	226^{g} ± 109.4
Thiamin, mg	0.91 ± 0.24^{c}	106^{h} ± 35.1	0.74 ± 0.19^{c}	88^{h} ± 25.4
Riboflavin, mg	1.49 ± 0.33^{d}	173^{i} ± 68.2	1.0 ± 0.28^{d}	119^{i} ± 33.7
Niacin, mg	10.4 ± 3.48	90 ± 31.5	9.4 ± 4.28	82 ± 36.0
Vitamin B6, mg	1.31 ± 0.27	140 ± 42.7	1.2 ± 0.32	131 ± 41.8
Vitamin B12, mcg	3.0 ± 1.52e	176^{j} ± 96.6	1.6 ± 1.34^{e}	97^{j} ± 81.6
Folate, mcg	271.0 ± 8.28	94 ± 31.6	289.6 ± 95.02	102 ± 37.3

$^{a-j}$ Means in the same row bearing the same superscript differ significantly ($p < 0.05$).

† Dietary Reference Intakes (DRIs) for 8- to 14-year-old girls and boys (IOM, 2001).

TABLE 5: Mineral intakes of swimmers and controls, compared with recommendations.‡

	Swimmers (n= 46)		Controls (n= 102)	
	Mean (SD)	% DRI†	Mean (SD)	% DRI†
Sodium, mg	2193 ± 645.5	151 ± 64.0	1851 ± 751.8	128 ± 49.7
Potassium, mg	2618 ± 614.9	60 ± 21.3	2074 ± 580.5	47 ± 12.9
Calcium, mg	873 ± 220.1	73 ± 43.4	462 ± 165.8	39 ± 15.1
Phosphorus, mg	1142 ± 228.3	108 ± 60.2	806 ± 219.2	81 ± 38.8
Iron, mg	10.7 ± 2.46	126 ± 38.9	8.7 ± 2.49	99 ± 33.4
Zinc, mg	9.6 ± 1.67	131 ± 40.1	7.2 ± 2.13	96 ± 30.7
Magnesium, mg	271 ± 68.9	121 ± 46.7	187.8 ± 52.2	86 ± 34.7

‡$p < 0.05$ for all comparisons.

†Dietary Reference Intakes (DRIs) for 8- to 14-year-old girls and boys (IOM, 2001).

The reported mean daily mineral intakes by swimmers and controls are presented in Table 5. Swimmers exceeded the established DRIs for all major minerals measured except potassium and calcium. Controls met none of the established DRIs except for sodium. Unfortunately, dietary sodium intake was not in recommended intake level for the two groups. Approximately 91.3% of swimmers and 100% of controls had inadequate calcium intakes. While 73.9% of swimmers had iron intakes at or above that recommended, only 46.1% of controls met recommendations (data not shown).

DISCUSSION

Swimming is a very popular sport in Turkey, however little data is available on the nutritional adequacy of both competitive and recreational adolescent swimmers. Adequate dietary intake is important to maintain health, growth, and maturation for children and adolescents. Optimum diet and exercise in childhood and adolescence will promote an enjoyable and health-promoting life.[8]

Our results show that height, weight, BMI, and triceps skinfold measurement in a large sample of adolescent swimmers was significantly different from controls. Training 1 or 2 hours per day was shown to exert a positive effect of growth and development in adolescent in the present study. The triceps skinfold measure of our swimmers was lower than those of controls which indicated that swimmers might have larger muscle mass than controls. Unfortunately, body fat mass for both groups was not measured. Athletic children with a low ratio of body fat to lean body mass, however, may exceed their recommended weight range without being overweight.[13]

Despite different training loads and body masses, the swimmers in this study consumed 1881 ± 609 kcal.d^{-1} and controls consumed 1598 ± 359 kcal.d^{-1}. This difference, however, disappeared when energy intake was expressed as kcal/kg/body weight. While swimmers in this study consumed nearly 50 kcal.kg^{-1}.d^{-1}, Hawley and Williams[1] reported that male swimmers consume 55 kcal.kg^{-1}.d^{-1} while female swimmers consumed 40 kcal.kg^{-1}.d^{-1}. Especially, the swimmers in this study were more in negative energy balance than controls and both groups did not maintain energy balance. Similar to the energy balance values reported for the swimmers in our study (-17.7%), other studies using the doubly labeled water method with endurance athletes[14] have reported mean energy balances of -32 to -35. In some studies,[14,15] as in our study, subjects maintained their body weight, despite the difference between energy intake and total energy expenditure. The maintenance of body weight may be explained by the underreporting of food intake by the adolescents, under consuming by the adolescents, or by an increased metabolic efficiency of the adolescents. The US Food and Nutrition Board[16] reported that children and adolescents need adequate energy intake to ensure proper growth, development, and maturation. The athletic or very active child or adolescent generally needs more energy because of their increased physical activity.

A diet that gets 45% to 65% of its energy from carbohydrates is typically adequate for children and adolescents.[16] With regard to energy source, carbohydrates provide, on average, nearly 46% of the energy consumed by athletes.[17] Short and Short[18] reported that in swimmers, 43% of their total energy intake was derived from carbohydrates. A somewhat higher value (49%) was found by Smith et al[19] for competitive female college swimmers. In the present study, the relative contribution of carbohydrates to total energy intake was 50.5% (6.2 g.kg^{-1}.d^{-1}) and 52.6% (6.4 g.kg^{-1}.d^{-1}) for swimmers and controls, respectively. Because of a lack of research, it is unclear whether young athletes require carbohydrate intakes (per kilogram of body weight per day) comparable to those of adults.[20] Costill and Miller[21] recommended a diet that provides approximately 7 g.kg^{-1}.d^{-1}. Our swimmers consumed 6.1 g.kg^{-1}, a value higher than that found by Smith et al,[19] who reported a daily intake of 4.7 g.kg^{-1} for female college swimmers. Although swimmers in our study were more active than controls, their daily intakes of carbohydrate per kilogram were similar.

It is generally recommended that adults obtain at least 12% to 15% of their dietary energy from protein.[16] This recommendation also appears reasonable for the child and adolescent athletes. The protein content of athletes' diets usually accounts for approximately 14% to 16% of their daily energy intake, with athletes involved in endurance sports typically having lower protein intakes than athletes engaged in strength or power events.[22] In the current study, the contribution of protein to the total energy intake did not differ significantly between swimmers (13.9%) and controls (13.5%). The DRIs recommends a range of 0.85 g to 0.95 g protein per kilogram of body weight for sedentary boys and girls aged 8 to 18 years.[16] Limited data is available on the protein requirements of young athletes.[8] In most circumstances, protein intake will be adequate if the energy intake meets the daily requirements. Even in studies of young athletes who typically restrict energy intake, protein intakes usually are adequate.[6] Many sports nutritionists and exercise physiologists recommended 1.5 g.kg^{-1}.d^{-1} of protein for the adolescent in the midst of a growth spurt. Smith et al[19] report an intake of 1.4 g.kg^{-1}.d^{-1} for female swimmers, which is almost identical to the value for female swimmers in our study.

The AHA recommends that 25% to 30% of a person's total daily calories come from fats. SFA should provide no more than 10% of the total daily calories.[11] In the swimmers and controls in our study, consumption of total fat and SFA exceeded the recommendations. In the 2 groups, intake of dietary cholesterol was within the recommended dietary guidelines. However, dietary fiber intake was slightly below recommended levels. Intake of total fats and SFA exceeded the recommendations. These maximum limits are important for health and athletic performance. Adolescents and their parents are advised that further increases in fat intake would be detrimental. Daily intakes of carbohydrate should be increased to a level that promotes optimal muscle glycogen resynthesis and protein resynthesis; fat intake should be decreased so as to be beneficial for health and performance.[23]

We also looked at the intakes of vitamin and minerals consumed by the swimmers and controls. According to research, most young athletes consume more than their daily requirement of vitamins, and most swimmers consume more vitamins than their sedentary peers.[24,25] In general, as long as athletes are meeting their energy needs from a variety of recommended foods groups, the DRIs for micronutrients for athletes should be met.[26] Regarding diets for children and adolescents, iron and calcium are 2 minerals frequently identified as being deficient.[27] In the current study, swimmers met or exceeded the requirements for most vitamins and minerals, but controls did not. In our study, the mean calcium intake was significantly lower in controls compared with swimmers, but mean intake for both groups was less than the recommended daily intake of 1300 mg. Very low calcium intake (< 400 $mg.d^{-1}$) is deleterious for bone development and health.[8] However, having a calcium-fortified beverage such as orange juice could help adolescents achieve their dietary goals for proper intake of calcium and other vitamins and minerals. Puberty increases the requirement for iron due to increases in hemoglobin mass, tissue deposition, growth support, and onset of menstruation in females.[2] Eleven-years-old boys participating in 6 months intense endurance swim training combined with cross-training experienced a progressive and significant decline in serum ferritin when compared with age-matched-non athletic controls. Such a decline occurred despite dietary iron intakes that met the recommendation of 12 mg/d.[28] Although, iron intake was above the DRIs for swimmers in this study, iron status depends on a balance of intake and absorption versus loss.

The observed fluid intake of swimmers and controls is below the baseline recommendation. [16] Both groups drink enough fluid, but swimmers must replace fluid losses during training and matches. Carroll[29] reported that 120 to 240 mL of fluid must be consumed every 20 minutes to replace loss from sweat during exercise. In the current study, swimmers who trained a minimum of 90.9 ± 29.4 minutes daily would need a minimum of 540 mL of fluids although exact fluid needs are individual and depend upon intensity and duration of exercise; body size; body surface area; individuals' sweat rates; and poor environmental conditions such as warm pool water, warm air temperatures, or high humidity.[29] Current data indicate a shortfall in daily fluid intake of approximately 329 ± 548.3 mL for swimmers and 808 ± 523.8 mL for controls. All adolescents should drink enough and understand recommended requirements for proper hydration. Because of increased loss of water and electrolytes, mainly through sweat, fluids are essential for health.[30] Sodium is an essential micronutrient and plays an important role in maintaining muscle contraction; however, excessive intake of sodium can negatively affect the cardiovascular system over the long term.[11] Unfortunately, the results of our study showed that 89.1% of swimmers and 71.6% of controls exceeded the AHA dietary recommendations for sodium.

STRENGTHS AND LIMITATIONS

This study investigated nutrient adequacy among adolescent swimmers and sedentary peers, an area in the literature in which there are few data. This study was done with adolescents in only 1 major metropolitan area, which limits extrapolations to other populations. Although food records are an excellent way to assess the nutrient intake of different populations, no one dietary assessment technique can precisely assess everyone's intake. Although the adolescents and their parents in the present study were highly motivated and dedicated individuals, eager to understand how to improve their performance through proper nutrition, errors may have occurred during the reporting of their dietary intake.

CONCLUSION

Because dietary inadequacies were detected for all the participants in this study, it is clear that all adolescents need help to meet the dietary recommendations for optimal health and performance. Although all of the adolescents in our study had sufficient protein intakes, a negative energy balance will cause protein to be used as a substrate for energy rather than for synthesizing lean tissues. In addition, all of the adolescents' diets were higher in fat and SFA than what is recommended, and diets high in fat and SFA are associated with increased risk of coronary and vascular disease.[11] Those who participated in this study would benefit from learning more about nutrition; this knowledge would enhance their growth, health, and athletic performance.

REFERENCES

1. Hawley JA, Williams MM. Dietary intakes of age-group swimmers. Br J Sports Med 1991; 25(3):154-8.
2. Petrie HJ, Stover EA, Horswill CA. Nutritional concerns for the child and adolescent competitor. Nutrition 2004;20(7-8):620-31.
3. VanHandel PJ, Cells KA, Bradley PW, Troup JP. Nutritional status of elite swimmers. J Swim Res 1984;1(1): 27-31.
4. Ousley-Pahnke L, Black DR, Gretebeck RJ. Dietary intake and energy expenditure of female collegiate swimmers during decreased training prior to competition. J Am Diet Assoc 2001;101(3):351-4.
5. Trappe TA, Gastaldelli A, Jozsi AC, Troup JP, Wolfe RR. Energy expenditure of swimmers during high volume training. Med Sci Sports Exerc 1997;29(7): 950-4.
6. Bass S, Inge K. Nutrition for special populations: Children and young athletes. In: Burke LM, Deakin V, eds. Clinical Sports Nutrition. 3rd ed. Sydney: McGraw-Hill Australia Pty Ltd, North Ryde; 2006. p.589-632.
7. Başarır Özkan T, Erdemir T. [Nutrition in toodler and school ages]. Turkiye Klinikleri J Pediatr Sci 2007;3(7):120-3.
8. Meyer F, O'Connor H, Shirreffs SM. Nutrition for the young athlete. J Sports Sci 2007; 25(Suppl 1):S73-S82.
9. Tarım Ö. [Nutrition in adolescence]. Turkiye Klinikleri J Pediatr Sci 2006;2(7):14-7.
10. Mertz W. Food intake measurements: is there a "gold standard"? J Am Diet Assoc 1992; 92(12):1463-5.
11. Krauss RM, Eckel RH, Howard B, Appel LJ, Daniels SR, Deckelbaum RJ, et al. AHA Dietary Guidelines: revision 2000: A statement for healthcare professionals from the Nutrition Committee of the American Heart Association. Circulation 2000;102(18):22 84-99.
12. Lohman TG. Assessment of body composition in children. Pediatr Exer Sci 1989;1(1):19-30.
13. Richardson J, Beerman K, Heiss C, Shultz J. Comparison of body weight and body fat classifications of competitive school-age club swimmers. J Am Diet Assoc 2000; 100(2):237-40.
14. Edwards JE, Lindeman AK, Mikesky AE, Stager JM. Energy balance in highly trained female endurance runners. Med Sci Sports Exerc 1993;25(12):1398-404.
15. Hawley JA, Williams MM. Relationship between upper body anaerobic power and freestyle swimming performance. Int J Sports Med 1991;12(1):1-5.
16. Anon. Estmated average requirements. Institute of Medicine of the National Academies. Food and Nutrition Board. Dietary References Intakes. Washington, DC: The National Academy Press; 2001. p.282-5.
17. Costill DL, Sherman WM, Fink, WJ, Maresh C, Witten M, Miller JM. The role of dietary carbohydrates in muscle glycogen resynthesis after strenuous running. Am J Clin Nutr 1981; 34(9):1831-36.
18. Short SH, Short WR. Four-year study of university athletes' dietary intake. J Am Diet Assoc 1983;82(6): 632-45.
19. Smith MP, Mendez J, Druckenmiller M, Kris-Etherton PM. Exercise intensity, dietary intake, and high-density lipoprotein cholesterol in young female competitive swimmers. Am J Clin Nutr 1982;36(2):251-5.
20. Burke LM, Millet G, Tarnopolsky MA. Nutrition for distance events. J Sports Sci 2007; 25(Suppl 1):S29-S38.
21. Costill DL, Miller JM. Nutrition for endurance sport: carbohydrate and fluid balance. Int J Sports Med 1980;1(1): 2-14.
22. Brotherhood JR. Nutrition and sports performance. Sports Med 1984;1(5):350-89.
23. Martin L, Lambeth A, Scott D. Nutritional practices of national female soccer players: Analysis and recommendations. J Sports Sci Med 2006;5(1):130-7.
24. Rankinen T, Fogelholm M, Kujala U, Rauramaa R, Uusitupa, M. Dietary intake and nutritional status of athletic and nonathletic children in early puberty. Int J Sport Nutr 1995; 5(2):136-50.

25. Cupisti A, D'Alessandro C, Castrogiovanni S, Barale A, Morelli E. Nutrition knowledge and dietary composition in Italian adolescent female athletes and non-athletes. Int J Sport Nutr Exerc Metab 2002;12(2):207-19.

26. Volpe SL. Micronutrient requirements for athletes. Clin Sports Med 2007;26(1):119-30.

27. Clarkson PM, Haymes EM. Exercise and mineral status of athletes: calcium, magnesium, phosphorus, and iron. Med Sci Sports Exerc 1995;27(6):831-43.

28. Spodaryk K. Iron metabolism in boys involved in intensive physical training. Physiol Behav 2002;75(1-2):201-6.

29. Carroll C. Swimming. In: Rosenbloom CA, ed. Sports Nutrition. 3rd ed. The Chicago, Ilinois: American Dietetic Association; 1999. p.653-66.

30. Convertino VA, Armstrong LE, Coyle EF, Mack GW, Sawka MN, Senay LC Jr, et al. American College of Sports Medicine position stand. Exercise and fluid replacement. Med Sci Sports Exerc 1996;28(1): i-vii.