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Dietary intakes of male endurance cyclists during training and racing

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Competitive endurance cycling entails repeated, prolonged, and vigorous exercise. Repeated bouts of prolonged and vigorous exercise have been shown to produce a marked depletion in muscle glycogen stores in endurance athletes (1). The consumption of 525 to 648 g carbohydrate during the 24 hours after a bout of strenuous exercise has been reported to restore muscle glycogen levels (2). According to the Nationwide Food Consumption Survey (3), men 19 to 22 years old consume approximately 250 g of carbohydrate daily. If endurance cyclists consumed this amount, their recovery from repeated workouts could be hampered. Consequently, we conducted this study to determine the dietary intakes of male endurance cyclists during training and racing competition.

METHODS

Fourteen male cyclists competing on the University of California-Berkeley Club Cycling Team participated in the study. Mean age was 23.1 ± 2.4 years; mean body fat was 7.2 ± 1.1% as determined by chest, triceps, and subscapular skinfold measurements (4,5). Cyclists trained for 15 to 20 hours/week, covering distances of 200 to 300 miles. Training included endurance rides averaging 3 to 5 hours and multiple short bursts of high-intensity cycling to simulate the changing pace of a cycling race. Racing events were sanctioned by the US Cycling Federation or were intercollegiate competitions. The cyclists raced in US Cycling Federation category 2 and 3 races or collegiate category A races.

Cyclists were free-living, prepared or obtained their own meals, and did not have access to a dormitory cafeteria. Dietary data were obtained by weighing food intake (Diet Scale Kit Model 3100, Continental Scale Corp, Bridgeview, Ill). Data were collected over 5 consecutive days of training and 3 consecutive days that included a racing weekend; these two collection periods were within 30 days of each other. Only food sources of nutrients were included in the dietary analyses (Nutritionist III, version 5.0, 1990, N-Squared Computing, Salem, Ore). Mean nutrient intakes were calculated for the training and racing periods for each cyclist; the within-cyclist differences between periods were also calculated. The average of the differences was tested against the null hypothesis of no change using a paired t test at $P<.05$, which was adjusted for the multiplicity of tests performed. *Exchange Lists for Meal Planning* (6) was used to quantify servings consumed within food groups by the cyclists.

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RESULTS

Athletes consumed up to nine meals or snacks daily with very little discretionary intake of meat, fish, or poultry as distinct entree items (eg, steak). Instead, athletes consumed carbohydrate-rich mixed dishes such as casseroles and noodle dishes; they also relied heavily on bread and cereal items, including muffins, bagels, rolls, and hot and cold cereals (Table 1). Despite the heavy consumption of breads, discretionary fat intake (eg, butter) was minimal. Cereals were commonly consumed at breakfast and as evening snacks. Milk intake was generally restricted to that which was consumed with cereal. Low-fat cheeses, fruit, and yogurt were common snack items. Fruit juices were the most

Table 1
Mean (± standard deviation) dietary intakes of male endurance cyclists

	Training	Racing	RDA[a]
	← mean ± SD	→	
Food group servings			
Milk	1.6 ± 1.4	0.7 ± 0.6	...
Vegetable	3.4 ± 1.92	2.6 ± 1.1	...
Fruit	4.5 ± 3.0	7.0 ± 4.2*	...
Bread	29.2 ± 7.4	32.7 ± 9.3	...
Meat	7.4 ± 5.5	7.1 ± 2.7	...
Fat	20.8 ± 8.2	20.4 ± 7.0	...
Macronutrient analysis			
Energy (kcal)	4,162 ± 703	4,460 ± 681	...
Carbohydrate (g)	609 ± 114	698 ± 166*	...
Fat (g)	125 ± 49	127 ± 30	...
Protein (g)	147 ± 38	149 ± 27	...
% of energy as carbohydrate	58 ± 8	61 ± 7	...
% of energy as fat	27 ± 8	26 ± 7	...
% of energy as protein	14 ± 2	13 ± 2	...
Cholesterol (mg)	274 ± 138	266 ± 142	...
Dietary fiber (g)	38 ± 11	42 ± 14	...
Vitamin A (IU)	16,683 ± 8,702	11,184 ± 6,216**	5,000
Vitamin C (mg)	230 ± 128	295 ± 120	60
Thiamin (mg)	4 ± 1	5 ± 2*	1.5
Riboflavin (mg)	5 ± 2	5 ± 2	1.7
Niacin (mg)	53 ± 19	62 ± 28	19
Vitamin B-6 (mg)	5 ± 2	6 ± 3*	2
Folate (μg)	683 ± 230	925 ± 386*	200
Vitamin B-12 (μg)	8 ± 6	11 ± 7*	2
Pantothenic acid (mg)	10 ± 3	17 ± 9**	4-7
Calcium (mg)	1,744 ± 413	1,618 ± 513	1,200
Phosphorus (mg)	2,516 ± 675	2,437 ± 620	1,200
Magnesium (mg)	599 ± 189	684 ± 253	350
Iron (mg)	39 ± 14	41 ± 15	10
Zinc (mg)	18 ± 7	21 ± 7	15

[a]Recommended Dietary Allowances (7).
Significant difference, training vs racing: *$P<.05$, **$P<.01$.

frequently consumed beverages with meals. Vegetable intake was generally restricted to the lunch and dinner meals.

Mean daily energy intakes were approximately 60 kcal/kg body weight (Table 1) and exceeded 4,000 kcal during both training and racing periods. Approximately 60% of energy consumed was obtained from carbohydrates (>600 g/day) and less than 30% was from fat. Mean daily protein intakes were approximately 2.1 g/kg body weight (13% to 14% of energy consumed). Mean dietary cholesterol intakes were under 300 mg/day, and dietary fiber intakes were approximately 40 g/day. Mean vitamin and mineral intakes exceeded Recommended Dietary Allowances (7) for men aged 19 to 24 years during both training and racing periods.

Mean carbohydrate intake did increase during the racing period (Table 1) as a result of a significant increase in the mean number of fruit servings from 4 to 7/day ($P<.05$) and bread servings from 29 to 33/day. Fruit and bread consumption was especially heavy around the time of the race itself. Athletes consumed restaurant meals more frequently during the racing period, usually after the race. They typically consumed large servings of rice or beans, or both, with their meals.

Table 2
Comparison of studies of energy and macronutrient intakes in male athletes

Author (s)/ Ref. no.	No.	Sport	Energy (kcal)	% of energy as			Recording days
				Protein	Carbohydrate	Fat	
Current study	14	Cycling	4,162	14	58	27	5
	14	Cycling	4,460	13	61	26	3
Saris et al (20)	5	Cycling	5,785	15	62	23	22
Johnson et al (21)	6	Cycling	3,894	14	54	33	3
Nowak et al (14)	16	Basketball	3,558	17	48	34	3
Ellsworth et al (15)	9	Cross-country skiing	3,492	14	44	40	3
Peters et al (17)	15	Running	4,410	10	49	26	4
Khoo et al (18)	19	Triathlon	3,623	14	56	30	3
Burke and Reed (19)	20	Triathlon	4,095	13	60	27	7
Short and Short (22)	33	Football	4,853	16	44	38	1
	13	Basketball	5,550	15	42	41	1
	8	Crew	3,905	26	44	36	1
	10	Track	4,212	14	49	36	1
	10	Lacrosse	3,696	17	43	31	1
	10	Gymnastics	2,080	15	44	39	1
	8	Soccer	2,965	16	43	41	1
	6	Bodybuilding	3,962	19	39	36	1
Kleiner et al (23)	19	Bodybuilding	2,015	34	48	18	7
Faber et al (24)	66	Bodybuilding	3,588	22	36	39	7

DISCUSSION

The number of days of food intake records required to estimate true mean intakes for groups of individuals ranges in men from 3 to 6 days for energy, protein, carbohydrate, and fat intake to as high as 39 days for vitamin A intake (8). The 5- and 3-day dietary recording periods in our study suggest that the data on energy and macronutrient intake are probably closer estimates of true average intake than are the data on intake of vitamins and minerals.

The carbohydrate diets of 609 g/day and 698 g/day (8.7 to 10.0 g/kg body weight/day) observed during training and racing periods are comparable to the range of 6.6 to 9.0 g/kg body weight per day that Costill et al (2) found normalized muscle glycogen stores within 24 hours after exercise.

The apparent excellence of the diets of these cyclists is in contrast to the low intakes of energy, carbohydrate, and select micronutrients observed in female cyclists (9), gymnasts (10-12), runners (13), basketball players (10,14), nordic skiers (15), and female college athletes across many sports (16).

The diets of these cyclists appear to be similar in energy intake and macronutrient distribution (Table 2) to those of male distance runners (17) and triathletes (18,19) and lower in energy intake but similar in macronutrient distribution to cyclists competing in the Tour de France (20). Cyclists' diets appear to be higher in percentage of energy intake derived from carbohydrates and lower in fat than those observed in male Olympic cyclists (21), nordic skiers (15), basketball players (14), and male college athletes across sports such as football, crew, gymnastics, and soccer (22). Male bodybuilders are reported to consume diets with a substantially higher percentage of energy as protein and lower percentage of energy as carbohydrate in comparison to cyclists (23,24).

APPLICATIONS

The diets of these male endurance cyclists (as a group) conform to current dietary recommendations for the general public and for endurance athletes. Their diets can serve as a model for attaining a low-fat, high-carbohydrate diet.

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