Nutritional Intake During a Multi-day Paddle Race

Introduction

The purpose of this exploratory pilot study was to quantify the energy nutrient intake among multi-day race paddlers. Currently, nutrition recommendations for endurance athletes do not specifically address the needs of the multi-day race athlete. Given the increased participation and number of competitions around the world, the need for such nutrition recommendations is compelling. The multi-day race athlete must meet the high energy demands of exercise through continuous consumption of foods and fluids over very prolonged periods of activity. Also, these types of competitions present unique challenges that affect the safety of the athlete and the athlete's ability to sleep or consume adequate calories, including racing in the dark, navigation, water-related hazards, extreme heat, cold, or altitude, and difficult terrain. These factors confounded by the fatiguing effects of continuous exercise that can be strenuous at times make the nutritional component of the athlete's competition even more critical.

The project goal was to begin exploring this topic by first determining the nutritional strategies currently used by multi-day race athletes. While this study is observational in nature, the information gathered will initiate a long term goal that ultimately addresses several issues relating to nutrition, training and health of multi-day race athletes.

Methods

Three WaterTribe athletes agreed to provide personal information concerning training and racing history and nutrition during a multi-day race. These athletes competed in the MR340, the longest, non-stop river race in the United States. Prior to the MR340, each athlete was contacted and asked to describe his or her training schedule, racing/paddling history, medical history including musculoskeletal injuries, and nutrition strategy and goals for the race. Each athlete kept a diet record of foods and fluids that were consumed during the entire race. The amount of detailed information provided from all three allowed an accurate estimation of total calorie and macronutrient intakes. Two of the three athletes provided additional information that allowed the separation of calories consumed while paddling from those consumed during rest breaks, determination of total fluid intake and micronutrient intake, including sodium. For this report, the focus was specifically on calories and the energy nutrients consumed from start to finish. Calories and macronutrient intakes presented do not include foods consumed a few hours before the race, nor do they include intake immediately following the race. Calories were determined two ways; food labels obtained from Calorieking.com or specific food brand websites and the USDA nutrition database.

Results

The three athletes have over 30 years of long distance paddle race experience combined, and decades more paddling experience prior to racing. Paddling experience and expert skills allowed these athletes to avoid hazardous conditions and to complete the race in good health. Athlete 01 did not encounter any significant barrier or hindrance to paddling. Both athlete 02 and 03 encountered dense fog conditions that delayed paddling several hours. Table 1 below presents the race results for each athlete. Athlete 01 and 02 stopped twice for sleep breaks and completed the race on day 3. Athlete 03 stopped for sleep three times and completed the race on day 4. None of the athletes experienced significant change in body

weight during the race. Athlete 01 and 03 experienced some gastrointestinal discomfort, but only on the first day of the race.

Table 1. Personal attributes and race results

	Athlete 01 Male, 63 yr, 163 lb	Athlete 02 Female, 64 yr, 125 lb	Athlete 03 Male, 67 yr, 174 lb
Race experience (yr)	12	15	5
Boat/Paddle	West Side Boat Shop EFT kayak/Epic mid-wing	Kayakpro Nemo/Epic small mid-wing	Kruger Dreamcatcher/ Grey Owl Raven single blade
Official race time	47 hr, 17 min	57 hr, 51 min	79 hr, 36 min
Estimated paddle time (hr)*	40.5	45.5	51.0
Avg paddle speed (mph)*	8.4	7.4	6.6
Relative time not paddling (%)	14.5	21.4	36.0
Sleep time (hr)	5	9	15

** Values based on checkpoint in-and-out times provided on the MR340 website. Note: paddle velocities do not account for stop periods between checkpoints.*

Athlete 01 had recorded all the foods that were prepared for the race and then reported his intake based on what was leftover. This athlete did not consume foods other than what he packed for the race. Athlete 02 had also recorded all her foods packed for the race and had a checkpoint support person record what was leftover. The athlete did not consume any foods other than her own. Athlete 03 had a support crew at the checkpoints who kept record of his intake. He also consumed several food items acquired along the way. Table 2 below provides the energy nutrient intake for each athlete. While total calories were similar among these three athletes, paddle time and official race time was lowest for athlete 01. Thus, his average calorie intake per hour was considerably higher than the other athletes. Energy nutrients are also provided relative to individual body weights. Noteworthy is that the smallest athlete consumed the greatest amount of calories relative to her body weight and the greatest amount of carbohydrate.

Table 3 provides information concerning personal food and beverage choices of each athlete. Among the 3 athletes, a single beverage item contributed 31 to 46% of total calories and the greatest proportion of protein and fat calories. Athletes 01 and 02 were quite similar regarding the relatively low variety (8 and 11 items, respectively) among their food and beverage choice, and approximately half of the carbohydrate was obtained from the same foods listed in Table 3. In contrast, athlete 03 consumed a high variety of foods and beverages (19 items), many of which were acquired at the checkpoints. For this athlete, the highest single contributor to carbohydrate intake was from the cereal and milk, which contributed only 17% of the total carbohydrate.

Table 4 provides estimations of energy expended during the race from start to end. Using the *Compendium of Physical Activities Tracking Guide*, estimated paddling expenditure was calculated using a 4 to 8 MET range and then considering differences in average paddle speed between athletes. The estimated MET level for athlete 01, 02, and 03 was 6, 5.5, and 5, respectively. Calories expended per hour were computed from METS using the following equation: calories per hour = MET x body mass

(kg) x 1.05. From the data provided, each athlete experienced a large energy deficit during the race with the greatest deficit experienced by athlete 01.

Table 2. Calorie and energy nutrient intake for each athlete.

	Athlete 01	Athlete 02	Athlete 03†
Total Calories	6440	6207	6668
Calories/hr*	159.0	136.4	130.1
Calories/kg**	86.9	109.3	84.4
Total carbohydrate	975	1262	990
Carbohydrate/hr	24.1	27.7	19.3
Carbohydrate/kg	13.2	22.2	12.5
% Calories from carb	61	80	54
Total protein	212	132	363
Protein/hr	5.2	2.9	7.1
Protein/kg	2.9	2.3	4.6
% Calories from protein	13	8	24
Total fat	188	88	144
Fat/hr	4.6	1.9	2.8
Fat/kg	2.5	1.5	1.8
% Calories from fat	26	12	20

** Based on estimated paddle time; however, not all calories were consumed while paddling. ** kg = body mass. † The calories and macronutrients are the amounts consumed while on the water. The athlete consumed an additional 5730 calories at the checkpoints (approximately 46% of total calories). Carbohydrate, protein and fat values are grams.*

Table 3. Percent contribution of certain individual foods to total calories for each athlete. Combined, these foods comprised 76-78% of total calories.

Athlete 01		Athlete 02		Athlete 03	
Milk-based nutrition drinks	44.8	*Perpetuem* sport drink	46.1	Whey protein shake w/ milk	30.8
Clif bars	31.4	*Gatorade* sport drink	10.4	Dry cereal & milk	12.9
		Bananas	11.5	Gravy*	9.1
		Tuna sandwiches	9.6	*GU* gel	5.6
				Chocolate milk	5.5
				Peanut butter crackers	4.6
				Banana	3.8
				Carrot muffin	3.5

** The athlete consumed a bowl of gravy obtained from a breakfast food buffet the morning of day 4.*

Table 4. Estimated calorie expenditure while paddling

	Athlete 01	Athlete 02	Athlete 03
Total Days	2.0	2.4	3.3
Paddle hours	40.5	45.5	51.0
REE/day*	1500	1200	1550
Total REE	3000	2880	5115
Cal/hr exercise**	465	325	415
Total EEE	18830	14790	21165
TEE	21830	17670	26280
Avg daily TEE	10915	7360	7960
Avg daily energy deficit	7700	4770	4200

*REE = resting energy expenditure, EEE = exercise energy expenditure, TEE = total energy expenditure (total REE + total EEE). * based on body weight, age and gender. ** based on estimated expenditure during various intensities of canoeing. Low to moderate intensities were chosen and adjusted by average paddling speed.*

Discussion

General conclusions

All three athletes were capable of consuming significant quantities of foods and fluids during the race but were very likely in negative energy balance. Clearly, each athlete had come into the race with a well-planned nutrition strategy. Paddling experience and training time was used to experiment with foods and beverages and each athlete began the MR340 with very specific strategies and preferences concerning which foods and beverages to consume and when to consume them.

In terms of nutrition, athlete 01 and 02 can be distinguished from athlete 03 in several ways. First, athlete 03 obtained a significant portion (46%) of his total calorie intake (12400 calories) during his rest periods. Second, he consumed a larger variety of food items and a few of these were acquired by his checkpoint support crew during the race. Third, athlete 03 consumed less carbohydrate relative to his body weight and paddling time, and consumed a greater amount of protein. It is possible that the goals of each athlete may have dictated their individual nutrition. Coinciding with this is the significantly lower amount of rest time experienced by athlete 01 and 02 compared to athlete 03. Both athlete 01 and 02 wanted to finish in a time that would give them a high standing in their respective division. The primary goal for athlete 03 was to finish the race and not necessarily "race" it. He enjoyed spending time with his support crew (wife and daughter) and visiting with friends while at the checkpoints. Thus, much of differences in nutrition between athlete 03 and the other 2 athletes could simply be how they approached the race from the start.

Meeting recommendations

The American College of Sports Medicine in conjunction with the American Dietetic Association and Dietitians of Canada has set forth nutrition recommendations for athletes in their most recent position stand, "Nutrition and Athletic Performance". The position stand provides evidence-based analyses and recommendations that address important issues for endurance athletes. It should be noted that among the criteria for study inclusion was adults 18 to 40 yrs of age. Accordingly, these recommendations may not adequately address the needs of the older athlete. Further, most studies have been performed with male athletes; thus, some of these recommendations may not be appropriate for the female athlete.

The position stand summarizes the evidence for nutrition and athletic performance with several key points. Concerning the multi-day race athlete, some of those key points were used here as references from which to evaluate the athlete's nutrition during the race. At the end of each key point are specific recommendations, if any, for the individual athletes.

Key point: Athletes need to consume adequate energy during periods of high-intensity and/or long-duration training to maintain body weight and health and maximize training effects. The recommendations are based on energy requirements during training, which is typically viewed as being no more than 1 to 6 hrs per day, depending on the intensity of exercise. The paddling intensities most likely encountered by these athletes range from low to moderate with short periods of moderately-high to high intensities interspersed throughout the race. From table 4 above, it was estimated that each athlete experienced a significant energy deficit despite consuming a large quantity of calories. Keep in mind that these estimates come with error when not accounting for environmental and water conditions, length and number of rest stops while on the water, paddling technique and efficiency, and the athlete's boat. However, it is safe to assume that these athletes consumed fewer calories than they expended during the race. Most likely, the consequences of a negative balance are inconsequential if the race is followed by adequate recovery and perhaps by including significant amounts of protein consumption during the race. All athletes reported consuming large quantities of foods and beverages immediately following the race and none participated in paddling for at least three days following the race.

Specific recommendations to the athletes – none

Key point: During exercise, primary goals are to replace fluid losses and provide carbohydrates (approximately 30-60 g/hr) for maintenance of blood glucose levels. While there is no specific recommendation for calorie consumption *per se* during prolonged exercise, there is a specific recommendation for carbohydrate and that is to consume 120 to 240 (30 to 60 g) carbohydrate calories per hour. Using this as a reference point, it appears that each of these athletes fall short of the recommendation. However, this recommendation is based on studies that primarily tested athletes during running or cycling events lasting 1 to 4 hours. The intensity of exercise is significantly greater under those conditions (10 to 12 METs) compared to 15-20 hrs of continuous paddling (4-8 METS). Thus, it is quite likely that the current recommendation is an overestimation for multi-day race athletes and that these athletes could possibly get by with 50-60% of the recommended amount (20 to 35 g/hr, for instance). In addition, because these athletes loaded up on calories during the 24 hrs prior to the race and then consumed calories frequently throughout the race, it is also very likely that blood glucose was easily maintained as a result of those two strategies. Concerning fluid loss, it appears that each athlete consumed adequate fluids given that little, if any change in body weight occurred.

Specific recommendations–

Athlete 01 may benefit from high glycemic foods that will provide him quick energy for increased intensity, especially during the latter stages of the race.

Athlete 02 should continue experimenting with various carbohydrate sources and may be able to replace some carbohydrate calories with protein calories.

Athlete 03 might benefit from replacing some protein and fat calories with carbohydrate. Practically speaking, he could experiment with some high glycemic foods (gels and beverages) that would provide carbohydrate calories exclusively.

Key point: Protein recommendations for endurance-trained athletes range from 1.2 to 1.4 g/kg body weight/day. That's equivalent to 66-77 g for a 55-kg person and 90-105 g for a 75-kg person per day. While there are no specific recommendations for protein intake during prolonged exercise, this recommended amount is likely the minimum necessary for these athletes during a multi-day race. Since protein intake can affect recovery rate (including glycogen replenishment and ability to perform endurance exercise several hours later), it is possible that added protein intake is beneficial during a multi-day race. It is yet not known what role protein plays during prolonged exercise, but some evidence suggests it can replace some carbohydrate without compromising performance. Thus, a reasonable conclusion is that these athletes consumed adequate protein amounts.

Specific recommendations–
Athlete 01 no recommendations
Athlete 02 might benefit by increasing protein intake possibly in place of some carbohydrate or increasing protein intake during rest periods.
Athlete 03 might benefit from replacing some protein with carbohydrate since the protein intake during the race was comparatively high.

Key point: Fat intake should range from 20% to 35% of total energy intake. Consuming ≤ 20% of energy from fat does not benefit performance. Although no specific recommendations are provided concerning amounts of saturated or unsaturated fats, the importance of essential fatty acids and fat-soluble vitamins should not be overlooked. Concerning fat intake during prolonged exercise, there are no recommendations. However, fat intake is likely to benefit the multi-day race athlete because increased availability of fat does contribute fat energy to overall energy expenditure. At low to moderate intensities, it is possible that this could have a glycogen-sparing effect, which would benefit the athlete particularly if he or she attempts to increase paddle intensity as they approach the finish. The other benefit is meeting the needs for essential fatty acids and fat-soluble vitamins over a multi-day period.

Specific recommendations– none

Why was athlete 01 faster than the others?
Many variables go into a successful long distance paddle race, some of which are out of the paddler's control (e.g., water and weather conditions) and several that are beyond the scope of this discussion. Despite all the possible reasons that could explain an individual's race time, there is some compelling information here that might provide a few answers to the question.

Non-nutritional factors. Of the three athletes, athlete 01 had the most racing experience in multi-day events and had completed the MR 340 several times. His experience with multi-day racing prepared him better for longer distances and less sleep time. The amount of rest or sleep can have both a direct and indirect effect on the athlete's finish time. As an example, the second place athlete completed the race with the same paddle time as athlete 01, but finished approximately 4 hr before athlete 01. The difference in official race time was not paddling speed, rather athlete 01 stopped to rest longer than the other athlete. The athlete's boat is another important variable contributing to his successful race time. Athlete 01's kayak was 19.5 ft in length with only a 20" beam and weighing only 33 lb. In comparison, both athlete 02 and 03 paddled shorter and heavier boats with wider beams (athlete 03 paddled a canoe with a single blade paddle). Last, because athlete 01 stopped for less time during the

first half of the race, he did not encounter the dense fog as much as athlete 02 and 03. Both athletes 02 and 03 lost several hours due to dense fog conditions that kept them from paddling.

Nutritional factors.

When comparing athlete 01 and 02 who differed in total paddle time by only 5 hours, a few differences are evident in their nutritional intakes. These differences may or may not have contributed to the paddle times, but they are worth discussing. First, athlete 01 consumed on average more calories per hour while paddling. However, he did not consume as much carbohydrate as did athlete 02. Upon examining the protein intake of these two athletes, it appears that athlete 01, having consumed almost twice as much protein as athlete 02 made up for the lower carbohydrate intake. This is an interesting observation because replacing some carbohydrate with protein during exercise has been demonstrated to be as effective as carbohydrate alone in improving performance compared to no intake. Over the long multi-day race, the added protein may be beneficial especially toward the latter stages of the race and may contribute to better recovery following the race.

While inferences concerning fat intake and race performance among the athletes cannot be made, it is also interesting to note that athlete 01 consumed a much larger amount of fat on average per hour of paddling time compared to the other two athletes. Whether or not this contributed to his superior performance is unknown, but it is likely that the additional fat calories increased fat availability for energy and thus, may have spared muscle glycogen.

Other nutritional characteristics concerning athlete 01 are noteworthy. The estimated energy deficit during the race is much greater than athlete 02 and 03. While these are gross estimations, energy deficits of this amount are not unusual for elite athletes performing at high levels of competition. Athlete 01 also relied on fewer types of foods for his calories, receiving 75% of his total calories from one brand of nutrition drink and one brand of energy bars. Ability to consume foods while paddling takes skill and practice. Thus, it is likely that through experience and experimentation, athlete 01 found an optimal combination of foods and beverages for obtaining calories easily and frequently while minimizing GI discomfort and providing adequate energy. It might be that minimizing the variety of foods consumed and sticking with the few items that do work is a practical and effective approach to long distance paddling.

Summary and unanswered questions

- Negative energy balance is a consequence of multi-day racing. Unknown are the effects of the energy deficit and how much of it should be avoided. Also, chronic negative energy balance during training for multi-day races may have long term effects on the athlete's performance and health.
- Carbohydrate intake of the athletes did not meet the minimum recommended amount for prolonged exercise. The recommendations based on 1-4 hrs of higher intensity exercise may not apply to the multi-day race. The optimal amount of carbohydrate for multi-day races and whether or not it is a significant factor in performance are unknown at this time.
- Protein intake of the athletes was higher than the recommended daily intake for endurance athletes. It is largely unknown what role protein plays in endurance performance during exercise

and even more so, during multi-day races. Protein and recovery during training and following multi-day races is also an unexplored area at this time.

- Two effective strategies for food and beverage consumption appear to include a low variety of foods, and obtaining large quantities of calories from beverages. More observations will provide new insights into multi-day race athlete's nutrition strategies and how these relate to overall performance.

Several other issues must also be addressed:

- special considerations for the female athlete who is typically at greater risk for negative energy balance and disordered eating
- the importance of fat consumption during exercise and recovery
- the role of nutritional supplements and ergogenic aids such as caffeine
- risks and prevention of gastrointestinal disturbances during prolonged exercise
- risks and prevention of hyponatremia (low plasma sodium concentrations) and dehydration
- long term effects of distance paddling on physiology including bone density and muscle mass
- confounding effects of aging on paddle performance and nutritional requirements
- risks and prevention of musculoskeletal overuse injuries

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