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THE DIETARY AND FLUID INTAKE PRACTICES OF MALE PARTICIPANTS IN A MULTI-DAY CANOEING EVENT

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ABSTRACT

Dietary record-keeping was used to determine intake of food, fluid, alcohol and nutritional supplements in 35 male canoeists during the 24 hours prior to, the three days of and day following the 1998 Dusi Canoe Marathon. Control data were obtained from 13 male, age-matched sedentary control subjects during the three days of the event. These data were coded and analysed using a computerised dietary analysis programme. Changes in body mass were used to assess hydration status. In the canoeists, mean total daily energy consumption from a combination of diet, liquid and supplement consumption over the 5-day period, ranged from 14.0±0.70 MJ to 14.6±1.45 MJ and was significantly higher (p<0.05) than the mean daily energy intake of the sedentary control subjects (range: 11. 7±0.87-12.7±1.64). Carbohydrate (CHO) supplementation was reported in 34.3 % of canoeists, while 37.1 % reported using vitamin supplementation. In the canoeists, relative mean protein intake exceeded 1.75 g/kg/d, CHO intake was less than 5.8 g/kg/d and mean fat intake comprised 32.6 % of total kilojoule intake over the 5-day period. A loss of body mass was apparent in 22.8% of the canoeists following the 3-day event and the mean percentage of dehydration was 1.9 ±1.1. There was no apparent incidence of overhydration. Alcohol usage occurred in 74. 3% of the canoeists and 30.8% of the controls during the 5-day race period. The findings of this study indicate that participants in this multi-day event do not adhere to current recommendations regarding the percentage contribution of CHO & fat to total energy intake during endurance events.

Key words: Dusi Canoe Marathon; dietary intakes; body mass loss.

INTRODUCTION

The Dusi Canoe Marathon is a 3-day event which is held on the Umsindusi and Umgeni Rivers of KwaZulu-Natal and covers a distance of approximately 120 km between Pietermaritzburg and Durban. It is held annually, in mid-January each year, in sub-tropical summer conditions in which temperatures reach up to 30° C and relative humidity up to 85%. The 3-day race provides physical challenges which include not only coping with a river which may be in flood and the necessity to negotiate rapids, but also long portages. While the race winners complete the course in approximately eight hours, the majority of the field require 15-20 hours, depending on the water level of the river and environmental conditions (Farman & Mars, 2002).

Due to limited endogenous muscle and liver glycogen concentrations and the physiological hazards associated with substantial changes in plasma volume during prolonged exercise, the optimisation of performance in ultra-endurance events is dependent on body fuel and hydration balance (Noakes, 2001). This is, in turn, dependent on adequate pre- and in-race nutrition and fluid intake. Although considerable research data are available on the nutritional and fluid intake practices of participants in single day ultra-endurance events (Sawka, 1992; Speedy *et al.,* 2001; Peters, 2003), the documented literature on multi-day endurance events is limited to that of marathon runners completing a 20-day road race covering distances of 28 km /day (Dressendorfer *et al.,* 1982) and four professional cyclists completing 4 000 km in a 22-day *Tour de France* cycling race (Saris *et al.*, 1989). In both of these studies, the mean daily energy intake was in excess of 20 MJ. Despite many anecdotal reports of canoeists not being able to access sufficient water to maintain their fluid balance during the race due to event regulations and limited seconding (Mars & Foreman, 2000), no previous scientific papers have been published on the energy and fluid intakes of participants in multi-day canoeing events. The primary aim of the study was therefore to establish the current dietary habits of participants before, during and after a Dusi Canoe marathon and to compare these with general recommendations which apply to ultra-endurance events (Peters, 2003). A secondary aim was to investigate the fluid intake practices and determine the hydration status of the participants in the Dusi Canoe Marathon.

METHOD AND PROCEDURES

Study design and ethical clearance

This study was confined to a cross-sectional survey involving dietary record-keeping in canoeists who provided their own food during the event and matched controls who were in their normal environment and not at the site of the race. Twenty-four dietary records obtained from a randomly chosen sample of 35 male canoeists who agreed to participate in the study over a period of five days before, during and after the 1998 Dusi Canoe Marathon and 13 age- and gender-matched, sedentary controls, during the three days of the event. These were analysed for the nutritional and fluid content. Ethical clearance to conduct this study was granted by the Human Ethics Committee of the University of Natal Medical School (Number: H002/98).

Data collection

Subjects in this study were randomly chosen male canoeists who were in the process of registering for the 1998 Dusi Canoe Marathon and subsequently agreed to sign informed consent forms and comply with all requirements of the study. These canoeists and their age- and gender-matched controls completed questionnaires which elicited details regarding their basic physical characteristics including age, height and training schedule in preparation for the Dusi Marathon during the six months prior to the event. They were further required to complete dietary record sheets on which they were asked to record as accurately as possible, the food and liquids consumed during breakfast, lunch and supper of each day as well as “in-between” meal snacks for five days (i.e. the day prior to, the three days of the event and the day following the event). Subjects and controls were asked to express food portions in household measurements (e.g. teaspoons, ladles, glasses, cups and slices). Body masses of both canoeists were recorded on the morning of the event and immediately following completion of the event on the third and final day.

Computation of data

Information provided on the dietary record sheets was utilised to analyse the dietary intake. In the event of insufficient detail being provided on the record sheets, subjects were interviewed by telephone to elicit the additional information. The analyses of the diets were completed by a trained data collector, who worked in close liason with a fully qualified dietician.

Each 24 hr dietary record was coded and analysed using a computerised dietary analysis programme (Dietary Manager, Program Management, Randburg, South Africa) containing a data base of 6 400 foods and food quantities table that evaluates and converts household measurements into standard grams/liters. This programme analyses each food according to macro- and micronutrient content. Macro- and micro-nutrient supplement data (as specified by the manufacturers) were compiled by a separate database that was linked to the food database.

The final analysis yielded individual daily intakes derived from (a) food alone (b) supplements alone (c) combined food and supplements and (d) fluid intakes. Intakes of total kilojoules (kJ), carbohydrate (CHO), proteins, fats (both saturated and unsaturated), refined sugar, fibre, cholesterol, 12 vitamins and nine minerals/trace elements were determined. The relative contribution of the macronutrients to total kilojoule intake was calculated as percentage using the Atwater Factors (Mathews, 1995) which provide an index of average kilojoule provision from one gram of fat (37.8 kJ), CHO (16.7 kJ) and protein (16.7 kJ).

Body mass loss in the canoeists was determined from the difference in pre- and post-race body mass (kg) and this was expressed as a percentage of pre-race body mass in order to determine fluid losses/gains during the event. Both canoeists and controls were also required to record their total intake of liquid during the three days of the race on the dietary record sheets and canoeists were required to report any treatment for dehydration following participation in the Dusi Canoe Marathon.

Statistical Analysis

Raw data were analysed using tailor-made statistical programs that were linked to the dietary analysis programmes. Separate group statistical data were calculated for the 35 subjects and the 13 controls who participated in this study. Results are expressed as means ± SD. A two (groups)-by-three (time-points) analysis of variance (ANOVA) for repeated measures was used to assess group-time interaction on the race days. Pillais trace statistic was used as the test statistic and a Tukey *post-hoc* correction applied to determine the time point of the significant differences. The significance of the difference between the mean descriptive data of the two groups was determined using two-tailed unpaired student t-tests, while two-tailed paired student t-tests were used to determine the significance of between-day differences among the canoeists. Statistical analysis was executed using SAS statistical software (SAS Institute, Cary, NC) and the level of confidence was set at 0.05.

RESULTS

Subject Characteristics

The mean (± SD) subject characteristics are provided in Table 1. Controls were matched individuals of the same gender who did not participate in any regular form of physical activity and did not differ significantly from the canoeists in terms of age or mass (p>0.05).

TABLE 1. **MEAN(± SD) SUBJECT CHARACTERISTICS**

	Canoeists (n=35)	**Controls (n=13)**
Age (yrs)	31.2 (± 9.20)	34.5 (± 12.2)
Mass (kg)	76.6 (± 10.5)	69.0 (± 6.45)
Training for Event:		
Weeks:	14.7 (± 7.30)	-
Frequency/week	4.30 (± 1.80)	-
Duration (min)	51.3 (± 13.4)	-
Racing experience		
Number of Dusi Marathons completed	5.90 (± 6.20)	-
Cigarettes/day	0 (± 0)	2.10 (± 3.50)

Daily energy intake of canoeists and controls

The average daily total kJ consumption of the canoeists and controls on the pre-race day, day 1, day 2, day 3 and post-race days, respectively, is provided in Table 2. This includes a breakdown of the kJ obtained from food alone and additional nutritional supplements.

The total mean daily kJ intake (derived from both food and supplements) of the canoeists ranged from 13 957(± 698) on post-race day to 14 602 (± 1450) kJ on the second race day in the canoeists, while controls consumed a significantly lower (p<0.001) average of 12 085 (±1141) kJ on the three race days. As only 12 subjects (34.3%) made use of energy-boosting supplements (containing CHO, fats or proteins), the contribution of supplements to the increment in total mean daily kJ consumption was relatively small, contributing between 384 (± 368) and 248 (± 249) kJ on the five days.

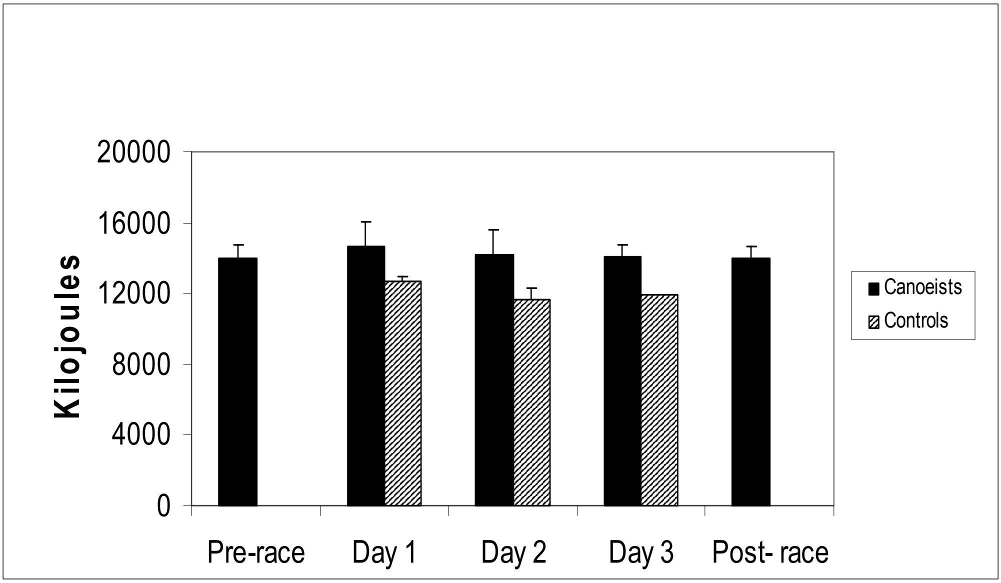

FIGURE 1. **MEAN DAILY KILOJOULE INTAKES OF CANOEISTS (N=35) AND CONTROLS (N=13),** *p<0.001 vs. controls; repeated measures ANOVA (Tukey adjustment)

Nutritional Supplementation by Canoeists

The canoeists supplemented their dietary intakes by means of dietary adaptations as well as commercially nutritional supplements. While only 20% of the canoeists acknowledged using purposeful dietary adaptations to increase the CHO content of their pre-race diets (e.g. high intake of pasta, bread, potatoes and rice), 83% of the canoeists made use of different forms of commercially available nutritional supplementation. These included vitamins in 37.1% (n=13), CHO in 34.3% (n=12), protein in 9% (n=3) and herbs in 2.9 % (n=1) of the canoeists.

Macro-nutrient intake in canoeists and controls

While the absolute (gm/d) and relative (gm/kg/d) carbohydrate, fat and protein intake of the canoeists and controls on each of the five days is summarized in Table 3, the percentage contribution of CHO: fats: proteins to the total kJ content in the diets of both canoeists and controls is presented in Table 4.

Total mean relative carbohydrate intake on the pre-race day was 5.39 (± 1.1) g/kg and varied between 5.33 (± 1.1) and 5.77 (± 1.1) g/kg on the race days. Although the absolute mean daily CHO intake was higher in canoeists ($p<0.01$) when compared with the matched, sedentary controls over the 3-day race period, when the data are expressed relative to body mass, the difference was only significant ($p<0.05$) on the third race-day (Table 3). Mean contribution of carbohydrate to total kJ content was also below 51% in both canoeists and controls, dropping to 43.2 % in the diet of canoeists on post race-day and 37.9% in the controls on the third race-day.

TABLE 3. **MACRONUTRIENT INTAKE (GMS/D AND GM/KG/D) IN CANOEISTS (N=35) AND CONTROLS (N=13)**

	Pre-Race	Day 1	Day 2	Day 3	Post-race
CHO:					
Canoeists: gm/d	413 (± 84)	442 (± 85)*	433(±105)*	409(± 86)*	365(±95)
gm/kg/d	5.39 (±1.1)	5.77(± 1.1)	5.65(±1.2)	5.33(±1.1)*	4.76(±1.2)
Controls: gm/d	-	322 (± 69)	313 (± 51)	270 (± 57)	-
gm/kg/d	-	4.67(±1.0)	4.54(± 0.7)	3.91(± 0.8)	-
FATS:					
Canoeists: gm/d	118 (±30)	116 (± 29)	119(± 34)	118 (± 28)	140(±32.4)
gm/kg/d	1.54(±0.4)	1.51 (±0.4)	1.52(±0.4)	1.54(±0.4)	1.83(±0.4)
Controls: gm/d	-	125(±29)	118(±15)	123(± 28)	-
gm/kg/d	-	1.81(±0.4)	1.71(±0.2)	1.78(±0.4)	-
PROTEINS:					
Canoeists: gm/d	152 (±47)	147(±50)*	135(±50)*	142 (±55)*	139(± 42.3)
gm/kg/d	1.98 (±0.6)	1.91(±0.7)*	1.76(±0.7)*	1.85(±0.7)*	1.81(±0.5)
Controls: gm/d	-	120(±32)	114(±36)	121(±33)	-
gm/kg/d	-	1.73(±0.5)	1.65(±0.5)	1.75(±0.5)	-

$p<0.001$ vs. controls; repeated measures ANOVA (Tukey adjustment)

Relative mean contribution of fat to total kJ content was above 30% in each of the diets of both canoeists and controls reaching a significantly higher proportion in the three 24 hr diets reported by the controls (Table 4). Although the post–race diet of the canoeists displayed a consistently higher total fat content when compared with that on race days, the difference did not reach statistical significance ($p>0.05$).

Relative mean contribution of protein to total kJ content fell within the recommended 15-20% (American Dietetic Association, 1993) in the recorded diets of both canoeists and controls. The highest mean percentage contribution to energy intake (18.1%) was recorded in the pre-race diets of the canoeists, while the relative mean protein intake varied from 1.76 to 1.98 gm/kg/d in canoeists as opposed to a range of 1.65 to 1.75 gm/kg/d in the control subjects.

TABLE 4. **THE RELATIVE PERCENTAGE OF TOTAL KILOJOULE INTAKE# DERIVED FROM MACRONUTRIENTS## BY CANOEISTS (n=35) AND THE CONTROLS (n=13)**

	Pre-race	Day 1	Day 2	Day 3	Post-race
CHO:					
Canoeists	49.2(±10.0)	50.5 (±9.7)	50.8 (±9.4)	48.6(±9.8)	43.7(±10.5)
Controls	-	42.4(±9.3)*	44.7(±7.3)*	37.9(±8.2)*	-
FATS:					
Canoeists	31.8(±8.1)	30.0(±7.5)	31.6(±9.0)	31.7(±7.5)	37.9(±6.2)
Controls	-	37.3(±8.6)*	38.2(±4.8)*	39.1(±8.8)*	-
PROTEINS:					
Canoeists	18.1(±5.6)	16.8(±5.7)	15.8(±5.9)	16.9(±6.5)	16.6(±5.1)
Controls	-	15.8(±4.2)	16.3(±5.1)	17.0(±3.9)	-

combined kJ intake from diet and supplements
kJ obtained from alcohol not included
* p<0.05 vs. controls; repeated measures ANOVA (Tukey adjustment)

The micronutrient content of the canoeists diet

The micronutrient content of the canoeists diet during the pre-race, day 1, day 2, day 3 and the post-race diet is tabulated in Table 5. Mean intake of each of the minerals and trace elements listed was above Recommended Daily Allowances (RDA; Monsen, 1989), and although mean intake of only vitamin A (on race days) and vitamin E (days 2, 3 and post-race) were below RDA (Monsen, 1989), the difference was not significant (p>0.05). Mean vitamin C intake averaged almost 3-fold RDA on pre-race and race days, but dropped to 81.5 mg on post-race day.

Fluid loss and fluid replacement trends in multi-day canoeists (n=35)

The canoeists (n=35) reported consuming an average of 5.47 liters/3 days which is equivalent to 1.83 liters per day. Mean mass lost over the 3-day canoeing event was 1.4 (± 0.9) kg, which translated to a 1.9 (± 1.1) % dehydration with a range of 0-4.5%. According to pre-post mass differences, 22.8% of the canoeists presented with an estimated percentage dehydration which exceeded 3%. Six of the 35 canoeists (17%) reported receiving treatment for dehydration in the medical tent post-race. No incidence of an increase in body mass was reported.

Alcohol usage of canoeists and controls

Seventy-four percent of the canoeists (n=26) and 30.8 % (n=3) of the controls reported that they utilized alcohol on a regular basis. The beverage consumed amongst canoeists was exclusively beer, while the controls reported consuming spirits, beer and cider. The daily consumption reported by the canoeists was 0.72 (±0.45) liters and 1.4 (±0.6) liters for the controls.

TABLE 5. **MICRONUTRIENT INTAKE IN CANOEISTS (N=35)**

	Pre-Race	Day 1	Day 2	Day 3	Post-Race	RDA*
Calcium (mg)	1168(±508)	1207(± 624)	998(± 502)	990(±461)	887(±437)	800
Iron (mg)	26.2(±12.0)	25.4(±12.5)	21.5(±11.1)	21.9(±9.82)	19.3(± 8.21)	10
Magnesium (mg)	384(±116)	393(± 95.9)	372(± 83)	407(±324)	338(±84.0)	350
Phosphorus (mg)	2079(± 600)	2065(±573)	1922 (±535)	1873(±407)	1866(±342)	800
Potassium (mg)	3161(±1068)	3417(±1019)	3331(±1208)	3198(±1006)	2995 (± 728)	2000
Sodium (mg)	4079(±585)	3339(±1496)	3937(±2560)	3372(±1226)	4524(±2663)	500
Zinc (mg)	18.4 (±9.80)	19.6(±11.4)	13.24(±4.00)	15.0(±5.80)	16.6(±6.20)	15
Copper (mg)	2.18 (±1.3)	4.72(±14.5)	1.97(±0.92)	2.00(±0.80)	1.93(± 0.62)	1.5-3.0
Manganese (mg)	4.00 (± 5.70)	3.98 (±5.80)	2.61(±1.21)	2.69(±1.62)	2.62(±1.01)	2.0
Vitamin A (RE)	1482(±1056)	992 (±662)	959(±749)	953(±652)	1110 (±756)	1000
Thiamine (mg)	5.51(±10.2)	3.29(±5.70)	2.71(±3.42)	10.6(±50.0)	2.62(±3.12)	7.0
Riboflavin (mg)	6.34 (±10.0)	5.03 (±6.4)	4.26(±5.23)	11.4(±50.0)	3.40(±4.00)	1.7
Nicotinic acid	59.5 (±58.9)	46.1 (±29.8)	39.8(±33.3)	70.0(±165)	38.0(± 27.1)	19
Vitamin B_6 (mg)	4.55 (±6.5)	4.44 (±5.7)	3.23(±1.60)	8.69(±33.2)	2.51(±1.31)	2.0
Folic acid (µg)	428 (±272)	421(±248)	412(±286)	355 (±159)	342 (±179)	200
Vitamin B_{12} (µg)	8.64 (± 8.3)	6.86(±6.10)	4.79(±3.40)	11.3(±33.2)	5.94(± 3.4)	2.0
Vitamin B_5 (µg)	14.2(±28.6)	13.7(±27.7)	7.70(±3.62)	20.9(±76.0)	7.08(±2.10)	4-7
Biotin (µg)	32.3 (± 52.1)	43.2(±116)	25.3(±18.3)	107(±498)	31.0 (±17.3)	30-100
Vitamin C (mg)	157 (±332)	176(±235)	155(± 284)	184(± 318)	81.5(±89.2)	60
Vitamin D(µg)	6.33 (±6.5)	8.35 (±13.5)	6.40 (±5.80)	5.32(±5.3)	7.28 (±4.90)	5.0
Vitamin E (µg)	10.3(±12.7)	12.4(±14.6)	8.85(±8.6)	6.11 (±5.1)	8.00 (±5.93)	10

* RDA values for adult men, 30-50 years alone; Monsen, 1989.

TABLE 6. **ALCOHOL CONSUMPTION OF CANOEISTS AND CONTROLS**

	Canoeists (n=35)	Controls (n=13)
% using alcohol beverages	74.3	30.8
Volume/5 days (liters)	3.6 (± 2.3)	4.3 (± 3.1)
Volume/day (liters)	0.72 (± 0.45)	1.4 (± 0.6)
Type of beverage: Beer (n)	26	3
Spirits (n)	0	3

DISCUSSION

Despite the limited scope of this work and the inequality of the size of control and canoe groups (which occurred due to the failure of numerous male canoeists to nominate sedentary control subjects of the same age and gender), a number of interesting trends have been highlighted by the findings of this study.

The mean age and relatively small standard deviation (31.2 ± 9.2 years) of the random sample of canoeists who agreed to participate in this study, confirms the popularity of this sport among young adult endurance athletes. The training schedules of the canoeists 14.7 (±7.3) weeks at a frequency of 4.3 (±1.8) times a week and with a duration of 51.3 (±13.4) minutes per week, indicates a pattern of training in this sample group which is not as intensive, prolonged and frequent as the training for other endurance activities such as marathon running (Noakes, 2001).

Canoeists completed an average of 5.9 (±6.2) Dusi Marathons. The high standard deviation is indicative of a wide range of experience in the sample of canoeists who volunteered to participate in this study. The mean value, however, indicates substantial former experience in a large percentage of this sample of canoeists.

Canoeists consumed a mean total kilojoule intake of 14 293 over the five-day period while the controls consumed a mean 12 420 kJ on the three race days. The mean daily energy intake of the controls on the three race days fell within the range of RDA for persons of their age-group and gender (Monsen, 1989), but the kilojoule intake of the canoeists, which was highest on the actual race days, reached a peak of 2467 kJ/d greater than RDA for sedentary adults of this age and gender (Monsen, 1989). This difference in kJ intake between the canoeists and the controls, which exceeds that previously reported by Peters and Goetzsche (1993) in ultramarathon runners, but is considerably lower than the 20.2 MJ/d reported by Dressendorfer *et al.* (1982) in a multi-day road running event and 24.7 MJ/d reported by Saris *et al*. (1989) in cyclists participating in the *Tour de France.* When expressed in relative terms (kJ/kg body mass) the mean energy intake is also considerably less than the 210 kJ/kg/day recommended for athletes engaged in endurance sport by William (1989). Of further interest is the fact that mean total kJ intake of the canoeists was 1 822 kJ above RDA (Monsen, 1989) on the post-race day. This enhanced post-race kJ intake in the canoeists appeared to be due to elevated post-race intakes of fat (Tables 3 & 4).

It is well accepted that adequate CHO intake is essential in determining endurance capacity in ultradistance events and optimising rates of post-exercise repletion of muscle glycogen (Burke, 1999). This is particularly relevant to multi-day endurance events in which less than 24 hours separate the exercise bouts and endurance capacity on subsequent days is affected by the size of the muscle glycogen stores (Wright *et al*., 2004a). The mean percentage contribution of CHO to kilojoule expenditure in subjects in this study, however, ranged from 48.4 pre-race to 50.0 on the race days and dropped to 43.2 on the post-race day. This is well below the 60% of total kilojoule intake recommended by Coyle and Coyle (1993) in order to optimise post-race glycogen repletion and the 61% reported by both Saris *et al.* (1989) in *Tour de France* cyclists and Dressendorfer *et al.* (1982) in road runners. Expressed as intake relative to body mass, the CHO content of the diets also falls well below 7-10 g/kg/d recommended during both the carboloading phase (Burke *et al.,* 2001) and during the 24-hour post-event period (Wright *et al.,* 2004a).

This research therefore showed that athletes made minimal use of the "supercompensation" concept of "CHO-loading" (Burke & Hawley, 1999). Although "CHO-loading" occurred in the form of increased consumption of CHO-rich foods, including pasta, rice, ice-cream and fruits high in CHO content in 22 % of the canoeists during the 24 hour pre-race period, this was not sufficient to reach current recommendations for CHO intake before, during or after this multi-day endurance event (Peters, 2003; Wright *et al.,* 2004a). It is interesting that only 34.3% of the canoeists reported making use of commercial CHO-loading supplements in addition to those who reported making purposeful adaptations to their diets including the recommended increase in the intake of high glycaemic index carbohydrates on pre-race day and low glycaemic index carbohydrates during the course of the 3-day event (Peters, 2003; Wright *et al.,* 2004a).

In contrast, the contribution of fat to total kilojoule intake in the canoeists was consistently above 30% throughout the 5-day period and exceeded the 23% reported by Saris *et al*. (1989) and 27% reported by Dressendorfer *et al.* (1982). It is of interest that a substantial increment in fat intake was evident on post-race day (Tables 3 & 4). This is contrary to the current recommendations (Burke *et al*., 2004; Carey *et al.,* 2001) and appears to have offset the lower CHO content in the post-race diet of the canoeists, resulting in total kilojoule intakes remaining elevated during the 24-hour post-event period. While the drop in the CHO content of their post-race diet indicates that the enhanced post-race kJ intake is unlikely to be due to attempts to enhance glycogen repletion rates (Burke *et al*., 2004; Wright, 2004a), it may be the result of an enhanced post-event appetite for fatty foods. This requires further investigation.

Protein intake, which varied from 1.76 to 1.98 g/kg/d, and remained relatively high throughout the trial period, comprised 18.1% (pre), 16.9% (day 1), 15.6% (day 2), 16.4% (day 3) and 16.0% (post) of total kJ intake in the canoeists. This is in keeping with current recommendations (Wright *et al*., 2004b; American Dietetics Association, 1993) and compares favourably to the 15% contribution of proteins to the total energy intake in *Tour de France* cyclists (Saris *et al*., 1989), but is considerably higher than the 12% reported by Dressendorfer *et al. (*1982) in road runners.

Of interest is the fact that canoeists' diets sampled in this work, did not reflect adherence to the eating regimen known as the "zone" diet, which has recently been popularised among endurance athletes as an alternative to the traditional high CHO diet. This a high fat: high protein: low CHO diet (ratio of percentage contribution to total energy intake: 30:30:40) which is thought to promote a favourable insulin: glucagon ratio (Cheuvront, 2003). Although fat intakes of the canoeists fell within this range recommended in this diet, the prescribed 0.75 protein: CHO ratio, was not adhered to. Protein intakes of the canoeists did not reach 30% of total energy intake, while carbohydrate did not drop quite as low as the prescribed 40%.

In the sedentary controls, the average percentage contribution of CHO: fats: proteins to total kilojoule intake on the three race days was 41.6: 39.4: 15.5, 42.9: 39.4: 15.7 and 37.1: 41.1: 16.5 respectively. The percentage of fat consumed by the controls was therefore too high and the percentage of CHO consumed, too low. Of additional interest was the absolute protein intake in the sedentary controls which ranged from 135 to 147gm/d and was more than double of the current RDA (Monsen, 1989).

Eighty-three percent of the canoeists and 47% of controls made use of commercial nutritional supplementation including vitamin, CHO, protein and herbal supplements. This widespread use of supplements in both groups could be attributed to the intensive commercial marketing programmes aimed at athletes. Vitamin supplementation was most prevalent in the canoeists. There is, however, no known evidence that vitamin supplementation enhances performance (Maughan, 1999). Although Peters (2000) warns against indiscriminate use of micronutrient supplementation by endurance athletes, in view of the additional stress imposed by endurance activities, particularly those lasting a few days, it is essential that endurance athletes meet the RDA in each of the micronutrients (Belko, 1987). Although this was generally confirmed by the findings of this study, the low intake of the anti-oxidants, Vitamin A, E and zinc, in some of the subjects (Table 5), may be a matter of concern and hence warrants further investigation.

From the pre-post race body mass differences, it would appear that the incidence of dehydration due to inadequate fluid intake, did not reach dangerous levels in this sample of canoeists (Convertino *et al*., 1996; Sawka, 1992). Although Mars and Foreman (2000) suggested that the incidence of dehydration in the Dusi Marathon is increased by the hot, humid weather experienced in KwaZulu-Natal, there appeared to be adequate awareness of the need to drink sufficiently in this group of male canoeists who reported a mean fluid intake of 5.47 (±1.38) litres over the three days.

Although these data provide an interesting view of the general hydration status of these canoeists, actual determination of blood status (including hematocrit, haemoglobin and electrolyte concentrations) would have been required in order to accurately assess plasma volume changes and hydration status before, during and after the event. More detailed case studies, which include monitoring of plasma volume changes and actual haemoconcentration/dilution, are necessary future research areas.

Seventy-four percent of the canoeists reported consumption of alcohol on a regular basis during the five days of the event as opposed to a 23% alcohol intake in the control group. Noakes (2001) notes that athletes are frequently under the misconception that alcohol intake is a rapid source of energy and warns against high alcohol consumption in athletes, which is detrimental to performance. However, when considering the data reported more closely, it is of interest that although the consumption of alcoholic beverages was more common amongst canoeists than the sample of sedentary controls, the volume consumed per subject was lower than in the sedentary controls. Furthermore, the type of alcoholic beverage was almost entirely restricted to beer (containing only ± 5% alcohol). It would thus appear that canoeists are adhering to the recommendation of Noakes (1992) that moderate consumption of alcohol has no detrimental effect on endurance athletes.

CONCLUSION

The primary finding of this work indicates that in addition to a relatively low kilojoule intake when compared to other participants in multi-day endurance events, the proportion of macronutrient intake was not appropriate for these endurance athletes. Far greater awareness of the importance of an adequate CHO intake before, during and after multi-day endurance events appears to be required. It is, however, necessary that this work is supplemented by further in-depth dietary investigations to confirm these preliminary findings on a larger sample of male canoeists. It would also be of interest to establish whether the high fat, low CHO-intake trends identified in this survey, are evident in female canoeists.

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