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Rehydration in long distance athletes. An open randomized controlled cross-over Nuclear Magnetic Resonance (NMR) study

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27/02/2007	No longer recruiting	[ ] Protocol
Registration date	**Overall study status**	[ ] Statistical analysis plan
02/04/2007	Completed	[ ] Results
Last Edited	**Condition category**	[ ] Individual participant data
22/09/2021	Other	[ ] Record updated in last year

Plain English summary of protocol
Not provided at time of registration

Contact information

Type(s)
Scientific

Contact name
Dr Pere Pujol i Amat

Contact details
Dietary and Nutrition Department
Centre dAlt Rendiment
Avgda. Alcalde Barnils s/n
Sant Cugat del Vallès
Spain
08190
-
ppujol@car.edu

Additional identifiers

EudraCT/CTIS number

IRAS number

ClinicalTrials.gov number

Secondary identifying numbers

Study information

Scientific Title
Rehydration in long distance athletes. An open randomized controlled cross-over Nuclear Magnetic Resonance (NMR) study

Study objectives
Shirreffs et al (1996) investigated the influence of drink volume on rehydration effectiveness after exercise-induced dehydration equivalent to approximately 2% of body mass. Drink volumes equivalent to 50, 100, 150, and 200 % of the sweat loss were consumed after exercise. To investigate the possible interaction between beverage volume and its sodium content, a drink with relatively low sodium content (23 mmol.L-1) and one with moderately high sodium content (61 mmol.L-1) were compared. With both beverages, the urine volume produced was related to the beverage volume consumed (the smallest volumes were produced when 50 % of the loss was consumed and the greatest when 200 % of the loss was consumed). When a drink volume equal to 150 % of the sweat loss was consumed, subjects were slightly hypohydrated 6 h after drinking if the test drink had a low sodium concentration, and they were in a similar condition when they drank the same beverage in a volume of twice their sweat loss. With the high-sodium drink, enough fluid was retained to keep the subjects in a state of hyperhydration 6h after drink ingestion when they consumed either 150 or 200 % of their sweat loss.

With regard to energy production for muscle machinery, fatigue can be viewed as the result of a simple imbalance between the ATP requirements of a muscle and its ATP-generating capacity (Sahlin, 1992). When exercise begins and the need for ATP accelerates, a series of ATP-generating reactions occur to replenish the ATP. As the cross-bridges use ATP and generate ADP, phosphocreatine (PCr) provides for the immediate re-synthesis of the ATP (PC + ADP = ATP + C). As the phosphocreatine becomes depleted, ADP begins to accumulate and the myokinase reaction occurs to generate ATP (ADP + ADP = ATP + AMP). The accumulation of all these products stimulates glycolysis to generate additional ATP, which may result in a H+ accumulation. However, as ATP demand continues to exceed supply, a variety of reactions occur in the cell that limit work and protect the cell from damage (ATP is needed to pump ions and maintain cell structure, and in this sense, fatigue serves a protective function). When ATP-generating mechanism cannot keep up with ATP use, inorganic phosphate (Pi) begins to accumulate in the cell (Pi and ADP are not being converted to ATP). An increase in Pi in the muscle has been shown to inhibit maximal force, and the higher the Pi concentration, the lower the force measured during recovery from fatigue. The Pi seems to act directly on the cross-bridges to reduce its binding to actin (Fitts, 1994; McLester, 1997). Although fatigue during high-intensity exercise has been associated with accumulation of metabolic products, fatigue during prolonged exercise is often linked with depletion of energy substrates, specifically carbohydrates. During prolonged exercise in which the intensity is greater than 50-60 % of VO2max, muscle glycogen is the principal substrate utilized. Depletion of muscle glycogen is often considered as a primary cause of fatigue, although this may take 2 h or more while exercising above 70 % of Maximal oxygen uptake (VO2max). Exercise can continue after glycogen depletion although at a reduced intensity provided the blood glucose is adequate.

The first study hypothesis is whether the intake of a relatively high-sodium drink will retain enough fluid to keep the subjects in a state of hyperhydration 6 h after drink ingestion when they consumed 150 % of their sweat loss. The second study hypothesis is to demonstrate that this state of hyperhydration with this beverage influences the energetic metabolism of the muscle.

Fitts RH. Cellular mechanisms of muscle fatigue. Physiol Rev 1994; 74: 49-94.
McLester JR Jr. Muscle contraction and fatigue. Sports Med 1997; 23: 287-305.
Sahlin K. Metabolic factors in fatigue. Sports Med 1992; 13: 99-107.
Shirreffs SM, Taylor AJ, Leiper JB, and Maughan RJ. Role of osmolality and plasma volume during rehydration in humans. J Appl Physiol 1996; 28: 325-331.

Ethics approval required
Old ethics approval format

Ethics approval(s)
Approved on 25/09/2003 by the Ethics Committee of Centre dAlt Rendiment (CAR). All volunteers gave their informed consent in writing.

Study design
Open randomized controlled cross-over study

Primary study design
Interventional

Secondary study design
Randomised controlled trial

Study setting(s)
Not specified

Study type(s)
Not Specified

Participant information sheet

Health condition(s) or problem(s) studied
Rehydration in athletes

Interventions
A comparison was made of the rehydration effectiveness after exercise-induced dehydration of a solution with a moderately high content of sodium (A) - Recuperation lemonEnergético lemon flavor (0.15 g/100 mL) versus a low sodium solution content (B) -Isostar Fast Hydration theflavor (0,07g/100 mL). All subjects intake 150 % of the weight-loss post exercise. The test was performed in two days, both in the morning between 9.00 h and 13.00 h, with a washout period of 35 days (K1 20/12/03 and K2 24/01/04).

Meteorological conditions for both test days were the following (Institut Fabra, Barcelona): temperature K1 10.35 ± 0,96 °C and K2 8.66 ± 0.35 °C ($p<0.001$), barometer K1 980.272 ± 0.63 hPa and K2 969.912 hPa ($p<0.001$), humidity K1 80.72 ± 1.17 % and K2 99.00 ± 0.0 % ($p<0.001$). The athletes ran a distance of 30 km cross-country in each one of the periods (K1 and K2). The variable of efficacy was evaluated by the plasma osmolality (mOsm*L-1) before each period and 0, 30 60, 90, 120, 150 and 180 post-exercise. Total volume of liquid intake (mL) and the percentage of variation in weight (% body weight loss [BWL]) were recorded. The following muscle energetic parameters were determined in a sub sample of subjects (n=5): pH, Pi/total, PCr /Total, Pi/beta-ATP, PCr/beta-ATP and Pi/PCr by means of Phosphorus-31 Nuclear Magnetic Resonance Spectroscopy (31P-NMR) before each period and at 0 h, 2 h and 6 h post-exercise. A descriptive analysis was carried out through descriptive statistics (measures of central tendency and measures of spread or variability). Prior to the inference analysis, Kolmogorov-Smirnov test was carried out to corroborate the normal distribution of the sample, and the Levene statistic was calculated to verify that the variances were constant. In the inference analysis, the treatment effect, the period effect, and the carry-over and/or treatment by period interaction effect were checked by means of t tests for two independent samples to corroborate the null hypothesis of equality of means; afterwards, an analysis of variance (ANOVA-one way) was performed and posthoc multiple comparisons by the Tukey test. The significant level was fixed at 5% [IC 95%].

Intervention Type
Other

Phase
Not Specified

Primary outcome measure
The influence of drink volume (150 % of the sweat loss) and its sodium content on rehydration effectiveness after exercise-induced dehydration with two beverages: one with a moderately high sodium content and one with relatively low sodium content.

Secondary outcome measures
The influence of rehydration post-exercise in the energetic metabolism of the muscle.

Overall study start date
20/12/2003

Completion date
24/01/2004

Eligibility

Key inclusion criteria
1. Healthy male trained athletes, between 25 and 35 years old
2. [(dot)O2maxR] 40-50 %
3. Maximum heart rate reserve (HRRmax) 55-65 %
4. Regular physical activity three times a week with duration of 30-40 minutes each session
5. Body mass index (BMI) < 25 kg/m2,
6. Euhydrated (plasma osmolality 280-300 mOsm.L-1)
7. Normal physical examination, laboratory analysis (including electrolytes) and electrocardiogram recording
8. Informed consent in writing

Participant type(s)
Patient

Age group
Not Specified

Sex
Not Specified

Target number of participants
12

Key exclusion criteria
1. Positive answer(s) to one or more questions listed in the Physical Activity Readiness Questionnaire (PAR-Q)
2. Drugs, tobacco, and alcohol abuse
3. Dietary supplements and nutritional ergogenic aids used for enhancing physical and athletic performance
4. History of cardiovascular, liver, respiratory, renal, neuropsychiatric, and endocrine/metabolic diseases
5. Any disease or treatment in the previous seven days before randomization
6. Removal or blood lost 400 mL in previous three months
7. Any extenuating physical practice in previous week before entering in the study
8. Concomitant participation in any clinical trial or previous participation in any clinical trial in the last 30 days before enter in the study
9. Lack of cooperation due to psychological troubles or psychiatric illness
10. Lack of cooperation (i.e. loss of interest, lack of motivation)

Date of first enrolment
20/12/2003

Date of final enrolment
24/01/2004

Locations

Countries of recruitment
Spain

Study participating centre
Dietary and Nutrition Department
Sant Cugat del Vallès
Spain
08190

Sponsor information

Organisation

Recuperat-ion Electrolitos, S.L. (Spain)

Sponsor details
Aribau, 198
Barcelona
Spain
08036
+34 902 190 246
info@recuperat-ion.com

Sponsor type
Industry

Website
http://recuperat-ion.com

ROR
https://ror.org/05pe6et34

Funder(s)

Funder type
Industry

Funder Name
Recuperat-ion Electrolitos, S.L. (Spain)

Results and Publications

Publication and dissemination plan
Not provided at time of registration

Intention to publish date

Individual participant data (IPD) sharing plan

IPD sharing plan summary
Not provided at time of registration