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MUSCLE FATIGUE IN ELITE CROSS COUNTRY SKIERS: A LINK BETWEEN SARCOPLASMATIC RETICULUM FUNCTION AND GLYCOGEN AVAILABILITY?

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ORSTEBLAD, N.
UNIVERSITY OF SOUTHERN DENMARK

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The consistent observations that muscle glycogen (Gly) stores at the beginning of exercises are closely related to endurance capacity and that the point of exhaustion after prolonged exercise coincides with low muscle Gly levels clearly suggest a role for muscle Gly in fatigue (Hermansen et al. 1967). However, the link between Gly and impaired muscle function during fatigue is not well understood and a direct cause-and-effect relationship between Gly and muscle function remains to be established. Here presented is a system where events in the excitation-contraction (E-C) coupling are affected by Gly content and localisation.

We examined the effect of Gly content on the sarcoplasmatic reticulum (SR) function in the arm and leg muscles of elite cross country skiers (n=10). VO2max 51 ml·kg⁻¹·min⁻¹) before, immediately after, and 4h and 20h after a fatiguing 15-km race. During the first 4h of recovery the skiers received either water or carbohydrate (CHO), and thereafter the same CHO enriched food. Straight after the race arm Gly was reduced to 31±4% and the SR Ca²⁺ release rate had decreased to 85±2% of their initial levels. After 4h recovery with CHO, the SR Ca²⁺ release rate was fully normalized and Gly had noticeably recovered (59±5% initial). However, if CHO was absent during the first 4h recovery, the muscle Gly and the SR Ca²⁺ release rate remained low and reduced (29±2% and 77±8%, respectively), with both parameters being normalized after the remaining 16h recovery with CHO. Leg muscle Gly decreased to a lesser extent (7±1% initial) and there were no effects on the SR Ca²⁺ release rate. Importantly, these data demonstrate a strong association between low Gly levels and muscle E-C coupling even after long recovery periods where adenosine nucleotides levels may be normalised. Additionally, SR function is estimated in vivo under constant energy levels. Thus, although related to muscle Gly levels, the impaired SR function is not due to a diminished energy metabolism at low Gly levels.

In line with this, transmission electron microscopy (TEM) reveals that Gly is located in distinct compartments close to different sites of E-C coupling (Marchand et al. 2002). We have shown that 72±3% of intramuscular Gly is located in the intermyofibrillar space (between the myofibrils) and 28±3% in the intramyofibrillar space. Additionally, in single fibres the intramyofibrillar Gly content is positively correlated with fatigue resistance capacity, and intermyofibrillar Gly is inversely correlated with tetanic half relaxation time.

Together, these results demonstrate that two distinct subcellular populations of Gly have different roles in controlling single muscle fibres. This is consistent with the idea that the Gly localisation modulates the E-C coupling, thereby affecting muscle contractility and fatigue resistance.

References


15:15 – 16:45

Oral presentations

OP-ST01 Sports 1

EFFECTS OF MATURATION ON THE RELATIONSHIP BETWEEN SPEED AND ENDURANCE IN CIRCUM-PUBERTAL SOCCER PLAYERS

MENÉDEZ-VILLANUEVA, A.
ASPIRE ACADEMY FOR SPORTS ACADEMY

Effects of maturation on the relationship between speed and endurance in circum-pubertal soccer players

Méndez-Villanueva, A., Kullonen, S., Pellola, E., Poortman, R.K., Simpson, B.J., Perrett, A., and Aspire Academy for Sports Excellence (Doha, Qatar)

Introduction: Morphological and physiological considerations suggest that sprinting ability and endurance capacity put conflicting demands on the design of a human's locomotor apparatus and therefore cannot be maximized simultaneously (Van Damme et al., 2002). However, in children the ability to demonstrate this specialization is less apparent (Rowlands, 2002). That is, children who perform well in sprinting tasks also perform well in endurance activities. In this regard, it has been suggested that specialization into endurance or sprinting "types" occurs during late pubertal stages (Falk and Bar-Or, 1993). However, few studies have assessed these associations in children and adolescents of different maturation levels spanning a wide circum-pubertal spectrum. Moreover, the ability to demonstrate this specialization has yet to be tested in young soccer players where players are expected to be selected and/or trained to develop both qualities (i.e., speed and endurance) (Reilly et al., 2000). In the present study we aimed at determining whether maturation affects the relationship between sprinting speed and endurance in a group of circum-pubertal soccer players.

Methods: Speed and endurance capacity were measured in 14 early-pubertal male soccer players (16.9 ± 0.7 yr old; mean ± SD), mid-pubertal male soccer players (15.3 ± 0.9 yr old) and 26 late-pubertal male soccer players (18.3 ± 0.7 yr old). Each player performed an incremental field test to exhaustion for the determination of maximal aerobic speed (MAs; i.e., endurance capacity) and a 40-m running sprint test for the assessment of maximum sprinting speed (MS). Relationships between size-corrected MAs and MS measures were examined.

Results: MAs was correlated with MS (r = 0.66, p < 0.05). 95% confidence limits, moderate to very large. The MAs/MS ratio did not differ among the three groups: early-pubertal soccer players (1.16 ± 0.06; mean ± SD), mid-pubertal soccer players (1.18 ± 0.07) and late-pubertal soccer players (1.16 ± 0.06)

Discussion: Within this cohort of highly trained young soccer players, which spans a wide circum-pubertal spectrum, speed and endurance capacity are related, and the relationship between sprinting speed and endurance capacity does not appear to be constrained by the need of endurance capacity and vice versa

References

EFFECT OF EXTREME ENVIRONMENTAL CONDITIONS ON PHYSICAL ACTIVITY PATTERNS OF SOCCER PLAYERS

ÖZGÜNEN, K., KURDAK, S., OĞDEM, Z., KORKMAZ, S., YAZICI, Z., ERSÖZ, G., BINNET, M.

CÜKÜROVA UNIVERSITY, TURKEY; ANKARA UNIVERSITY, TURKEY

Soccer teams sometimes play under difficult environmental conditions. Activity patterns of players of different standard have been analyzed by time-motion analysis, but there is dearth of knowledge how the players’ match performance is affected by environmental conditions.

Purpose: This study aimed to evaluate changes in the activity patterns during a soccer match played in different conditions of environmental temperature and humidity.

Methods: Non-acclimatized soccer players (n=10), the goalskeeper was excluded. 20 ± 2 y, VO2max=53±7 ml/min/kg played 2 matches in different environmental conditions. Players ingested telemetric core temperature (Tc) sensors prior to each match and wore a heart rate (HR) and global positioning system (GPS) monitor during the match. A computer based analysis program was used to evaluate heart rate and speed changes during the match. The following locomotor categories were used: standing (0 - 0.4 km/h), walking (0.5 - 7.5 km/h), jogging (7.6 - 14.5 km/h), low – moderate running (14.6 - 19.5 km/h), high speed running (19.6 - 25.5 km/h) and sprinting (>25.6 km/h). These were later divided into five categories: (1) standing; (2) walking; (3) jogging; (4) running; and (5) sprinting, consisting of high speed running and sprinting.

Results: The average ambient temperature for the June 2007 match was 34 ± 1 °C and 83% humidity for 38 ± 2 °C. In the July 2007 match, ambient temperature was recorded as 36 ± 0 °C and 3.4% humidity of 61 ± 1%. Peak Tc values recorded for June and July matches were 39.1 ± 0.4 °C and 39.6 ± 0.3 °C respectively. Total distance covered during June and July matches was 8.6 ± 0.6 and 8.1 ± 0.7 km respectively. The Tc values were 4.4 ± 0.4 and 4.2 ± 0.3 km for June and 4.3 ± 0.5 and 3.8 ± 0.4 km for July matches. The different between the 24 hours of the July match was significant. The running distance covered in the second half of the July match was significantly shorter than first half of July and second half of June matches (p < 0.05).

Conclusion: In soccer match played in high environmental temperature and humidity, the physical performance of the players may decrease due to high thermal stress. In the present study, the players increased body core temperature at half time was followed by a decrease in total distance covered in the second half of the game. This may point to a centrally-driven performance reduction.

COOLING INTERVENTION AND SOCCER UNDER EXTREME HEAT CONDITIONS

KURDAK, S.S., ÖZGÜNEN, K.T., MAUGHAN, R.J., ZEREN, C., KORKMAZ, S., YAZICI, Z., ERSÖZ, G., SHIRREFFS, S., DVORAK, J., BINNET, M.S.

1. CÜKÜROVA UNIVERSITY, TURKEY; 2. Loughborough University, United Kingdom; 3. Ankara University, Turkey; 4. Swiss Army Medical Center, Switzerland.

Whole body pre-cooling with fluid ingestion had been discussed as one of the main interventions to improve athletic performance in extreme heat conditions. Extensive research had been performed to evaluate the effect of precooling on athletic performance and body core temperature, but the influence on a soccer match had not been investigated. Purpose: The aim of this study was to investigate the effect of short-term cooling intervention on athletic performance and body core temperature during a competitive soccer game. Methods: 11 soccer players aged 21 ± 2 y (mean ± SD) were divided into two groups with VO2max 59.8 ± 4.0 ml/kg/min volunteered to play two matches without – C) and with cooling intervention (CI) for this study. The ambient temperature and humidity was 34.3 ± 0.6 °C and 64 ± 2 % for the first and 34.0 ± 0.56 °C and 62 ± 0 % for the second game CI respectively. Players had opportunity to consume either 0.6% NaCl solution during the C, plain water or sports drink by choice during CI study. A cooling tent and icy water filled buckets placed beside the soccer field were used for cooling intervention. Match activity was recorded by a global positioning system. Thermosensor pills were used for body core temperature (Tc) measurements. Blood samples were withdrawn from an antecubital vein 5 hours before and immediately after the game to determine hematocrit (Htc), hemoglobin content (Hb), lactate plasma volume loss, and changes of serum electrolytes. ANOVA and paired sample T-test was used to evaluate the level of significance, and p values < 0.05 were accepted as significant. Results: The Tc values were 4.4 ± 0.4 km for the first half and 4.2 ± 0.3 km for the second half. The difference between the two matches was significant (p < 0.05). Pre- and post-match Htc (48.9 ± 3.3 g/dl and 49.2 ± 3.3 g/dl) and Hb (161 ± 14 g/dl and 163 ± 13 g/dl each) were used to calculate % plasma volume loss. The plasma volume loss (% PVC) was calculated as: PVC = 1 - Htc/100. The PVC was 0.1 ± 0.05 % for the CI group. Plasma volume loss (% PV) was calculated as: PVC = 1 - Htc/100. The PVC was 0.1 ± 0.05 % for the CI group. The PVC was 0.1 ± 0.05 % for the CI group and 0.1 ± 0.05 % for the CI group. The PVC was 0.1 ± 0.05 % for the CI group and 0.1 ± 0.05 % for the CI group.

Conclusion: Cooling intervention was not sufficient to reduce Tc and Improve match performance significantly. Slight reduction of Tc that observed with whole body cooling may be important to prevent heat related problems that occur in extreme heat conditions.

PLAYING FOOTBALL -Soccer- under extreme heat conditions – Effect of Acclimatisation

ERSÖZ, G., KURDAK, S.S., ÖZGÜNEN, K.T., MAUGHAN, R.J., ZEREN, C., KORKMAZ, S., YAZICI, Z., BINNET, M.S.

1. Ankara University, Turkey; 2. Çukurova University; 3. Loughborough University

Exercise intensity is an important factor to induce thermal strain, and soccer is a challenge for the players who have to play under extreme heat conditions. Acclimation is an important intervention to improve thermal tolerance and endurance capacity.

Purpose: We aimed to evaluate effect of acclimation on sportive performance during a game played under extreme heat conditions.

Methods: 11 male acclimated soccer players (age 23 ± 1 yr, 184 ± 6 cm, 90 ± 4 kg). Each player played one season (24 weeks) of training in a controlled climate chamber (temperature 22 ± 2 °C, relative humidity 45 ± 10%, mean radiant temperature 22 ± 1 °C) and four weeks (16 ± 2 days) of training in a non-controlled climate. The training sessions were conducted at the same time of day (14:30-16:30 h) and at the same intensity level. Each training session consisted of 75 minutes of game-like activities with 5-10 minutes of recovery periods. The training protocol included a warm-up phase (20 minutes), a game-like phase (50 minutes), and a cool-down phase (15 minutes). The mean heart rate during each training session was 170 ± 10 beats per minute (bpm).

Results: The VO2max values were 51.6 ± 4.2 ml/kg/min (pre-acclimation) and 50.2 ± 4.1 ml/kg/min (post-acclimation). The heart rate during the game-like phase was significantly lower post-acclimation (170 ± 10 bpm) compared to pre-acclimation (174 ± 12 bpm) (p < 0.05). The distance covered during the game-like phase was significantly lower post-acclimation (400 ± 60 m) compared to pre-acclimation (450 ± 70 m) (p < 0.05). The number of sprints per minute was significantly lower post-acclimation (4.2 ± 0.5 sprints/min) compared to pre-acclimation (4.8 ± 0.6 sprints/min) (p < 0.05). The number of high-intensity efforts (120-240 bpm) was significantly lower post-acclimation (12 ± 2 efforts) compared to pre-acclimation (15 ± 3 efforts) (p < 0.05).

Conclusion: Acclimation to heat stress significantly improved performance during a soccer game, as evidenced by reduced heart rate, increased distance covered, and lower number of sprints and high-intensity efforts. These findings suggest that acclimation may be an effective strategy to improve performance during soccer games played under extreme heat conditions.