

# SWEAT RATE AND SWEAT-ELECTROLYTE COMPOSITION IN ATHLETES EXPERIENCING RECURRENT MUSCLE CRAMPS VERSUS MATCHED CONTROLS

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## BACKGROUND AND PURPOSE

- Exercise-associated muscle cramps are intense, painful contractions of skeletal muscles that occur during or immediately following physical exertion
- There are 2 prevailing theories to explain the etiology of exercise-associated muscle cramps<sup>2</sup>
  - 1) Overuse, or neuromuscular fatigue<sup>2</sup>
  - 2) Dehydration and/or abnormal electrolyte concentrations<sup>2</sup>
- Depletion of electrolytes sodium (Na<sup>+</sup>) and chloride (Cl<sup>-</sup>) are associated with muscle cramps<sup>1</sup>
- Muscle cramps and electrolyte depletion can be managed through proper fluid replacement<sup>4</sup>
- The purpose of this study was to compare sweat rate (SR) and sweat electrolyte concentrations between cramp-prone (CP) to matched-control (MC) athletes

## PARTICIPANT CHARACTERISTICS

- Twenty-four (12 CP; 12 MC) competitive and recreational male athletes participated
  - High school football (n=14), college football (n=6), cross-country (n=2), cycling (n=2)
- CP defined as athletes who had experienced recurrent cramps over the previous 12 months
- Available MC athletes matched as closely as possible to CP athletes
  - Age, body mass, % body fat, gender, sport, position, and heat-acclimatization status

	CP		MC	
Age (years)	21	8	21	8
% Body Fat	13.5	3.5	13.9	3.6
Body Mass (kg)	94.7	20.5	96.8	19.7

Table 1. Participant Characteristics



Figure 1. Sweat patch

## METHODS

- Testing performed in climate-controlled location or at assigned practice facility
  - Pre-exercise body mass assessed using a standard scale (Tanita Arlington Heights, IL)
  - Right proximal forearm cleaned using 70% isopropyl alcohol and allowed to dry
  - Sterile gauze pad placed on forearm and covered with transparent dressing (Figure 1)
  - Subjects then exercised for a minimum of 45 minutes (sport-specific activities)
    - Exercise regimen identical for each matched pair of athletes for a given session
  - Post-exercise body mass measured
- $SR = (\text{pre-exercise body mass} - \text{post-exercise mass} + \text{fluid consumed}) / \text{exercise duration}$
- Following exercise, gauze removed and centrifuged to extract sweat
- Sweat-electrolyte concentrations (mEq·L<sup>-1</sup>) determined using ion-specific electrode analysis
  - EasyLyte Plus Na/K/Cl Analyzer (Medica Corporation, Bedford, MA)
- Data analyzed by independent t-tests ( $\alpha = .05$ ), receiver operating characteristic (ROC) analysis, Fisher's exact test, sensitivity (Sn), specificity (Sp), and odds ratio (OR)

## RESULTS

- One CP and one MC removed due to MC outlier sweat [Na<sup>+</sup>] (>2 SD above group mean)
- Independent t-test results:
  - No significant difference between groups for SR ( $p=.398$ ) or sweat [K<sup>+</sup>] ( $p=.142$ )
  - CP significantly greater than MC in terms of sweat [Na<sup>+</sup>] ( $p=.025$ ) and sweat [Cl<sup>-</sup>] ( $p=.040$ )
- Dichotomized univariable analysis results:
  - Group membership (CP vs. MC) associated with SR, sweat [Na<sup>+</sup>], and sweat [Cl<sup>-</sup>]
    - CP approximately 8 X more likely than MC to have  $SR \geq 1.23 \text{ L}\cdot\text{h}^{-1}$
    - CP 15 X more likely than MC to have a sweat [Na<sup>+</sup>]  $\geq 29.38 \text{ mEq}\cdot\text{L}^{-1}$
    - CP 15 X more likely than MC to have a sweat [Cl<sup>-</sup>]  $\geq 24.13 \text{ mEq}\cdot\text{L}^{-1}$

Group	SR (L·h <sup>-1</sup> )	Na <sup>+</sup> (mEq·L <sup>-1</sup> )	Cl <sup>-</sup> (mEq·L <sup>-1</sup> )	K <sup>+</sup> (mEq·L <sup>-1</sup> )
CP	2.13 0.99	48.03 27.69	38.65 25.03	5.74 0.84
MC	1.82 0.80	26.09 15.28	20.48 14.32	6.49 1.40

Table 2. Means and Standard Deviations

Variable	Cut-point	Sn	Sp	OR	OR 90% CI
SR (L·h <sup>-1</sup> )	1.23	90.7%	41.7%	7.86	1.10 – 56.32
Na <sup>+</sup> (mEq·L <sup>-1</sup> )	29.38	75.0%	83.3%	15.00	2.79 – 80.57
Cl <sup>-</sup> (mEq·L <sup>-1</sup> )	24.13	75.0%	83.3%	15.00	2.79 – 80.57

Table 3. Results of Univariable Analyses

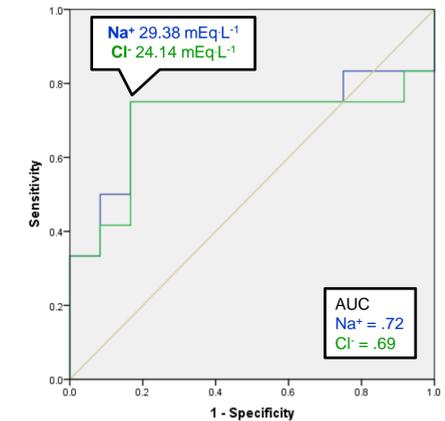


Figure 2. ROC Curve

## CONCLUSIONS

- The results suggest that increased sweat [Na<sup>+</sup>] and sweat [Cl<sup>-</sup>] predispose athletes to cramps
- Sweat-electrolyte concentration strongly discriminates CP athletes from MC athletes
- SR appears to have less predictive power for identification of recurrent muscle crampers
- NaCl supplementation may attenuate recurrent exercise-associated muscle cramps

## REFERENCES

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