

# 運動トレーニングおよび暑熱馴化時の体温調節機能の亢進 における浸透圧調節系の役割

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## **Involvement of osmoregulatory adaptation in heat/exercise acclimation-induced enhancement of thermoregulatory function**

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### **ABSTRACT**

To gain better insights into the mechanisms of heat acclimation, we examined the relationship between osmotic shift in the body temperature thresholds for thermoregulatory responses, such as sweating and cutaneous vasodilation (CVD), and sweat sodium concentration ( $[Na^+]$ ), which decreases in heat acclimated subjects, in six subjects. The esophageal temperature ( $T_{es}$ ) thresholds for sweating and cutaneous vasodilation were determined during passive body heating following hypertonic (3% NaCl) or isotonic (0.9% NaCl) saline infusion. The passive body heating was induced by lower leg water immersion at 42 °C in a room temperature of 28 °C. The rise in  $T_{es}$  during passive heating was much higher following hypertonic saline infusion than isotonic one. The  $T_{es}$  required to elicit sweating and CVD were also higher following hypertonic saline infusion. Because  $T_{es}$  during passive body heating linearly correlated with the thresholds for sweating and CVD, plasma hyperosmolality inhibits thermoregulatory responses to increased body temperature by

elevating the thresholds for sweating and CVD. The osmotic shifts in the  $T_{es}$  thresholds for sweating and CVD linearly increased as sweat  $[Na^+]$  increased. Plasma vasopressin concentration increased with plasma osmolality, and the osmosensitivity for vasopressin secretion ( $[AVp]/Posm$ ) decreased as sweat  $[Na^+]$  increased. These results suggest that heat acclimation reduces osmotic inhibition of thermoregulatory functions but enhances osmoregulatory fluid retention by increasing osmosensitivity for vasopressin release. The osmoregulatory adaptation might be involved in the enhanced thermoregulatory function in heat acclimated subjects during prolonged exercise and/or heat exposure.

## 要 旨

暑熱馴化時の浸透圧調節系の適応を明らかにするために、浸透圧刺激性の体温調節反応の抑制と汗ナトリウム濃度との関係を求めた。浸透圧刺激性の体温調節反応抑制を定量化するために、高張性食塩水輸液後と等張性食塩水輸液後に下腿温浴を被験者に行わせ、発汗および皮膚血管拡張の深部体温閾値を求めた。さらに、バゾプレッシン分泌に対する浸透圧感受性と汗ナトリウム濃度の関係も求めた。

高張性食塩水輸液により温熱負荷時の体温上昇は有意に増加した。この体温の上昇は、主に発汗および皮膚血管拡張の深部体温閾値の上昇によるものであった。また、浸透圧上昇による発汗および皮膚血管拡張の深部体温閾値上昇は、汗ナトリウム濃度の高い被験者程大きかった。また、バゾプレッシン分泌の浸透圧感受性は汗ナトリウム濃度が高い被験者程低下した。

以上の結果より、暑熱馴化して汗ナトリウム濃度が低下したヒトでは浸透圧上昇の体温調節反応に対する抑制効果が減弱して、とくに長時間の運動や暑熱暴露時に、体温調節機能を高いレベルで維持することが可能となり、さらにバゾプレッシン分泌の亢進によって体液保持能力も高まっていることが示唆された。