

Heat stress may affect the muscles for longer than we think

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People who experience heat stress during exercise may need more recovery time to let their muscles heal, according to a new mouse study published ahead of print in the *American Journal of Physiology*-

Regulatory, Integrative and Comparative Physiology.

[The study](#) is titled "Exertional heat stroke causes long-term skeletal muscle epigenetic reprogramming, altered [gene expression](#), and impaired satellite cell function in mice."

Exertional [heat stress](#)—becoming severely overheated during physical activity—can be a life-threatening condition with lasting consequences. Complications from exertional heat stress can include a higher risk of heart or kidney disease, problems with the central nervous system or compromised immunity. Although [muscle injury](#)—including [muscle cramps](#)—is often an early sign of heat stress, the mechanisms behind heat-related muscle injury and prolonged complications such as loss of muscle are not clear.

Researchers studied a mouse model of exertional heat stress to determine how it affects the muscles in the long term. Female mice—chosen because males have a lower tolerance to heat—ran at moderate intensity in a hot (99.5°F). One month after the exercise session, the research team examined samples from the animals' calf muscles. These muscles were "chosen because [they are] highly activated during running and it represents a well-distributed mix of fast and slow muscle fiber types," the researchers wrote.

Compared with a control group of mice that exercised in a temperate environment between 71°F and 73°F, the heat stress group's muscles showed changes in 137 genes, including some related to muscle structure and function, stress response and encoding heat shock proteins.

Cells produce heat shock proteins in response to heat or cold stress and are involved in wound healing. Although muscle contractile function remained stable after recovering from heat-induced injury, after 30 days the ability of the muscles to produce [satellite cells](#) (muscle stem cells)

had decreased. Satellite cells are important for muscle repair.

"The important implication of this is that although [skeletal muscle](#) contractile function remains intact [over time, following exertional heat stress], this does not necessarily mean that it has fully recovered. If applicable to humans, this may have significance for understanding the need for extended recovery times in some patients with [exertional heat stress] before safe return to physical activity," the authors wrote. "This is particularly relevant to athletes and active military, where decisions are made regarding the timing for return to play or duty."

More information: Kevin O. Murray et al, Exertional heat stroke causes long-term skeletal muscle epigenetic reprogramming, altered gene expression, and impaired satellite cell function in mice, *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology* (2023). [DOI: 10.1152/ajpregu.00226.2023](https://doi.org/10.1152/ajpregu.00226.2023)

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