SEX-BASED VARIATIONS IN LOCAL SWEAT RESPONSE TO SUNSCREENS DURING WARM WEATHER EXERCISE

Julián C. Garzón-Mosquera, M.Sc., Luis F. Aragón-Vargas, Ph.D., FACSM
University of Costa Rica (UCR), Human Movement Science Research Center (CIMOHU-UCR)

UNIVERSIDAD DE COSTA RICA

CIMOHU Centro de Investigación en Ciencias del Movimiento Humano

Icahn School of Medicine at Mount Sinai

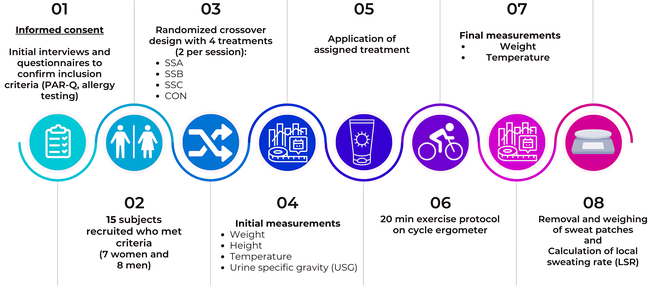
Abstract

Thermoregulation through sweating is vital during physical activity to maintain thermal homeostasis and prevent hyperthermia. **PURPOSE.** This study aimed to compare the effects of three sunscreens on localized sweat rate (LSR) during moderate exercise in a warm and humid environment. **METHODS.** Fifteen physically active subjects (8 males, 7 females) underwent a randomized crossover trial evaluating 4 conditions: control (no sunscreen), sunscreen A (organic), and sunscreens B and C (inorganic). LSR was quantified by sweat patches on the scapular region during 20 min of cycling at 65-75% max HR in 32°C and 55% RH. **RESULTS.** The control exhibited significantly higher LSR (182 µL/min·dm2) versus sunscreen A (142 µL/min·dm2), B (158 µL/min·dm2), and C (159 µL/min·dm2) overall (p<0.05). In males, sunscreen A reduced LSR compared to control, B, and C (p<0.05). In females, control was superior to all sunscreens for LSR (p<0.001), with no differences between sunscreen conditions (p>0.05). Sunscreens inhibited LSR during exercise in warm and humid environment relative to control, especially sunscreen A in males and all sunscreens in females. The organic sunscreen A uniquely contained the silicone dimethicone alongside other potentially occlusive agents absent in sunscreens B and C. **CONCLUSION.** These results suggest that certain supplementary sunscreen ingredients like silicones may induce a dermal occlusive effect that impairs effective sweating. Although localized sweat rate was similar between sexes without sunscreen, sunscreen use significantly reduced sweating in females more than males. This suggests physiological sex differences modulate the effect of some sunscreens on thermoregulatory sweating during exercise in heat. Applying sunscreen is essential during outdoor exercise, but some products with high concentrations of occlusive ingredients can interfere with the body's ability to cool itself by sweating. More research is needed to understand how different sunscreen formulas affect body temperature regulation when exercising in heat. This will help choose sunscreens that protect skin while allowing sweating and staying cool during outdoor activities in warm conditions.

Sweating and evaporation are crucial for regulating body temperature during exercise, but sunscreen application recommended for outdoor activity may interfere with this process. Studies show conflicting results on sunscreen's impact, with some finding reduced sweating rates or impaired evaporative cooling, while others show no effect. These disparities necessitate further research into the effects of sunscreens on sweating and thermoregulation during physical activity. The present study aims to compare three sweat-resistant sunscreens on local sweating rates during exercise in warm, moderately humid conditions.

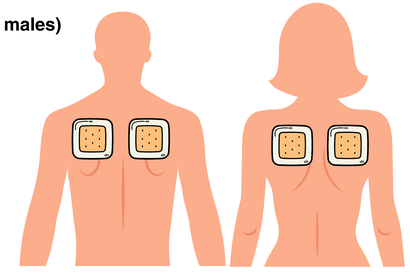
METHODS

The protocol involved a randomized crossover trial with four treatment conditions: three commercially available sweat-resistant sunscreens (SSA, SSB, and SSC) and a control (CON) without sunscreen application.



Controlled environmental conditions: 35° C and 55% relative humidity

A total of 15 healthy subjects (7 females and 8 males)



Females

- Age: 22.8 ± 4.0 years (mean ± SD)
- Height: 157.5 ± 4.0 cm
- Weight: 57.2 ± 6.0 kg

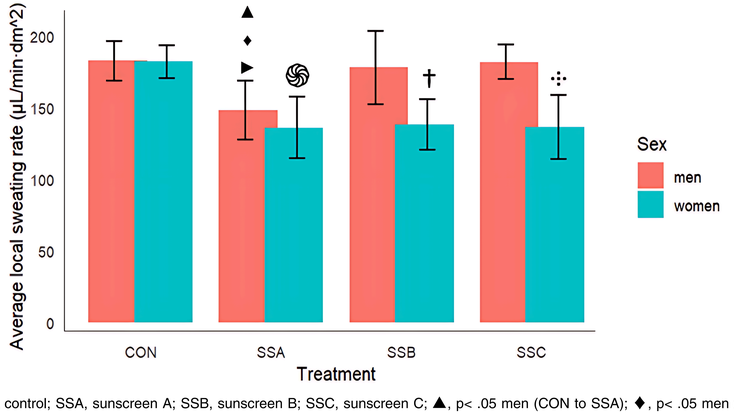
Males

- Age: 26.2 ± 5.1 years (mean ± SD)
- Height: 174.3 ± 7.4 cm
- Weight: 72.4 ± 10.5 kg

The local sweating rate (LSR) at the scapular region was assessed using the absorbent patch technique, with pre and post-exercise patch weights recorded to calculate sweat volume per unit area and time (µL/min·dm2)

RESULTS

Local sweating rate between treatments and sex showed a significant interaction (p = .027).



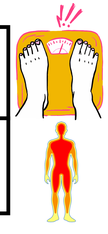
Note: CON, control; SSA, sunscreen A; SSB, sunscreen B; SSC, sunscreen C; ▲, p< .05 men (CON to SSA); ♦, p< .05 men (SSA to SSC), ►, p< .05 men (SSA to SSB); ֍, p< .05 women (CON to SSA); †, p< .05 women (CON to SSB); ⁖, p< .05 women (CON to SSC).

SUNSCREEN A, B, C AND CONTROL

Initial

During

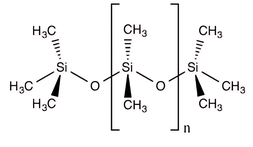
P = .594 (1.014 - 1.014 - 1.014 - 1.014)	**P = .082** (65.28 - 65.30 - 65.39 - 65.46)
P = .797 (134.0 - 134.2 - 134.9 - 134.0)	**P = .114** (36.78 - 36.71 - 36.70 - 36.67)



Initial

Initial

Note: the order of the values in parentheses is sunscreen A, B, C and control.



The unique combination of dimethicone and additional occlusive ingredients exclusive to SSA enables it to form a more effective barrier on skin but it decreases localized sweating during physical activity compared to SSB and SSC

CONCLUSION

The application of a sunscreen with SPF 50 (SSA) during heat exercise (20 minutes) markedly reduces local sweating, especially in women, which is possibly attributed to occlusive ingredients such as dimethicone rather than UV filters. Balancing the benefits of sunscreens with the risks of occlusive ingredients is crucial for thermoregulation, especially in acute outdoor exercise. Further research on whole-body sweating during prolonged exercise is needed to better understand the effect of sunscreens on thermoregulation.

References

- Aburto-Corona, J., & Aragon-Vargas, L. (2016). Sunscreen use and sweat production in men and women. *Journal of athletic training*, 51(9), 696-700. https://doi.org/10.4085/1062-6050-51.11.01
- Fisher, K. G., Cottle, R. M., Kenney, W. L., & Wolf, S. T. (2024). Sunscreen does not alter sweating responses or critical environmental limits in young adults (PSU HEAT project). *Journal of Applied Physiology*, 136(2), 322–329. https://doi.org/10.1152/japplphysiol.00756.2023
- House, J. R., & Breed, M. (2013). Sunscreen use reduces sweat evaporation but not production. *Environmental ergonomics*. Queenstown. New Zealand: Int Soc Environ Ergon, 117.
- Wells, T. D., Jessup, G. T., & Langlotz, K. S. (1984). Effects of sunscreen use during exercise in the heat. *The Physician and Sportsmedicine*, 12(6), 132-142. https://doi.org/10.1080/00913847.1984.11701879