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PERSPECTIVE

Thermal physiology is a (wo)man's world!

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Women undergo unique anatomical, physiological and hormonal changes across their lifespan. For example, consider the impact of the menstrual cycle, pregnancy and menopause, all of which are accompanied by both short- and long-term effects on women's body morphology (e.g. changes in breast size, hip angle, muscle development) as well as on their body temperature regulation, heat tolerance and thermal sensitivity and comfort.

Advancing our fundamental understanding of women's thermal physiology should be a research priority, to better inform the development of more user-centric approaches that promote thermal health, thermal safety and thermal comfort for all, at a time of climate change. Yet, women continue to represent a very small proportion of all participants tested in exercise thermoregulation research (Hutchins et al., 2021).

The issue of under-representation is particularly evident when one considers women-only studies, which continue to be rare in the field of thermal physiology. The interplay amongst developmental, endocrine and thermal physiology across women's lifespan is complex; as such, its understanding requires experimental approaches that go beyond simpler, sex-related comparisons in physiological responses between male and female participants.

It is somewhat undeniable that experimental considerations associated with the urge 'to control for' circulating hormone concentrations when testing women may have limited a wider and more inclusive participation of this group in thermal physiology studies (Stanhewicz & Wong, 2020). It is, therefore, no surprise that the recent findings of Kirby et al. (2024), which are presented in this issue of the *Journal of Physiology*, constitute an important advancement for the field of thermal physiology, both from fundamental and applied standpoints.

Leveraging the methodological power of direct calorimetry, Kirby et al. (2024) tackled the question of whether progestin-releasing intrauterine devices (IUDs) modulate heat loss during exercise-heat stress in physically active women, with and without hormonal IUDs. The progestin released by IUDs may negatively impact heat dissipation during exercise by blunting sweating (Stachenfeld et al., 2000). Given that IUD-use as a method of contraception amongst women aged 15−49 years old has now surpassed that of oral contraceptive pills worldwide, the study of Kirby et al. (2024) shed light on an important, yet unknown factor that could modulate heat exchange in women during exercise.

The key takeaway from the study of Kirby et al. (2024) is that physically active women with and without hormonal IUDs presented equivalent whole-body dry and evaporative heat loss, body heat storage and changes in oesophageal temperature during moderate- and high-intensity exercise in a warm, dry environment, indicating that IUDs had no physiologically meaningful impact on women's thermoregulation during exercise.

These negative findings demonstrate that the previous evidence that progestin-only contraceptives may exacerbate heat strain during exercise (Stachenfeld et al., 2000), cannot be directly extended to the use of IUDs. It follows that the use of hormonal IUDs as a selection criterion for enrolment of women participants may not be warranted in thermal physiology studies; a notion which could have important implications for widening female representation (Hutchins et al., 2021). Nevertheless, as recently noted by Stanhewicz and Wong (2020), investigators should pay attention to *when*, *why* and *how* to consider women's hormonal status in study design and enrolment; indeed, the study of Kirby et al. (2024) does also highlight the need to consider between-(women)participant differences in contraceptive type and use (e.g. oral pill *vs.* IUD) in the design of thermal physiology studies, given that these contraceptive practices may have non-equivalent effects on thermoregulation.

The considerations above further highlight the importance of publishing and widely sharing negative findings. Evidence for lack of (physiologically meaningful) differences can indeed be as informative and instrumental in driving a field forward as reporting positive findings, and the study of Kirby et al. (2024) is an excellent example of this concept.

The study by Kirby et al. (2024) also provides an opportunity to remind ourselves that autonomic thermoregulatory responses are only one of the two faces of human body temperature regulation, with the other one being behavioural thermoregulation. It is indeed reasonable to hypothesise that, whilst IUD-use may not impact women's autonomic thermoregulatory capacity, the same practice could impact women's sensorial responses to temperature and wetness, which has implication for women's heat tolerance and comfort during activities of daily living. The interplay amongst autonomic, perceptual and behavioural responses to heat, and its individual variability with age and hormonal status, is complex and remains understudied (Valenza et al., 2023).

Finally, this fundamental, physiological knowledge offers women evidence-based, applied insights pertaining to the menstrual cycle and the impact of both endogenous and exogenous hormones on their thermal physiology. Whether reaching the female athlete, the women working in active, labour-intensive jobs, or the women living in warmer climates, the findings from Kirby et al. (2024) have the potential to further empower women by aiding them in decisions related to contraceptive choices, be it contemplating a switch or deciding whether to use contraceptives at all, depending on their individual lifestyles and work demands.

In conclusion, the study of Kirby et al. (2024) represents an important milestone in our understanding of female physiology. It also reminds us that that the future of thermal physiology must be both a man and a woman's world.

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References

Hutchins, K. P., Borg, D. N., Bach, A. J. E., Bon, J. J., Minett, G. M., & Stewart, I. B. (2021). Female (Under) representation in exercise thermoregulation research. *Sports Medicine Open*, **7**(1), 43.

Kirby, N., Meade, R., Richards, B., Notley, S., & Kenny, G. (2024). Hormonal intrauterine devices and heat exchange during exercise. *The Journal of Physiology*. Advance online publication. https://doi.org/10.1113/JP285977

Stachenfeld, N. S., Silva, C., & Keefe, D. L. (2000). Estrogen modifies the temperature effects of progesterone. *Journal of Applied Physiology*, **88**(5), 1643–1649.

Stanhewicz, A. E., & Wong, B. J. (2020). Last word on point: Counterpoint: Investigators should/should not control for menstrual cycle phase when performing studies of vascular control that include women. *Journal of Applied Physiology (Bethesda, Md: 1985)*, **129**(5), 1138–1139.

Valenza, A., Blount, H., Bianco, A., Worsley, P. R., & Filingeri, D. (2023). Biophysical, thermo-physiological and perceptual determinants of cool-seeking behaviour during exercise in younger and older women. *Experimental Physiology*, **109**(2), 255–270.

Additional information

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Author contributions

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Supporting information

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