Perspective in comparisons of skin versus muscle blood flow

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TO THE EDITOR: On grounds of their observations of elevated muscle blood flow in heated muscle, Heinonen et al. (2) call for reconsideration of how cardiac output is apportioned in hyperthermic humans. I hope those doing the reconsidering will bear in mind that venous occlusion plethysmography (VOP), the basis of our quantitative understanding of cutaneous blood flow, records volume accumulation in a limb during venous occlusion in terms of milliliters per minute per 100 milliliters of limb, whereas muscle blood flow (MBF) is expressed as milliliters per minute per 100 milliliters of muscle.

How then to compare data from Heinonen et al. (2) for muscle at 37°C with, say, Barcroft and Edholm's (1) classical VOP data? For forearm skin temperatures (Tsk) of 35 and 38°C, blood flow in the forearm (FBF) was 4 and 7 ml·min⁻¹·100 ml⁻¹, respectively. For 37°C, we might interpolate 5 ml·min⁻¹·100 ml⁻¹, at first glance, a level 2.5 times Heinonen et al.'s MBF of ~2 ml·min⁻¹·100 ml⁻¹.

But, if FBF increased from, say 2 to 5 ml·min⁻¹·100 ml⁻¹ with Tsk 37°C and constant MBF, then the 5 ml/min rate comprises a steady 2 ml/min in the proportion of the forearm that is muscle and some higher value in the fraction that is skin. If the proportions were 80% muscle and 20% skin, we have 5 = 0.8 times 2 plus 0.2 times x, from which x = 17 ml·min⁻¹·100 ml⁻¹ of skin (SkBF). Even allowing a doubling of MBF, 5 = 0.8 *4 plus 0.2 times x, and SkBF = 9 ml·min⁻¹·100 ml⁻¹.

Estimates of relative skin volume vary. For the forearm it may be as low as 10% (doubling the above estimation of SkBF). Even at the conservative 20% estimate, though, the responsiveness of cutaneous vasculature smooth muscle to local temperature stands out as greatly exceeding that of the vasculature of skeletal muscle.

Moreover, consider the full potential for SkBF revealed at the extreme that occurs with local Tsk at 42°C. FBF in different individuals reached maxima from 16 to 38 ml·min⁻¹·100 ml⁻¹ of forearm in a study of the reproducibility of this response (3). These levels, multiplied by the inverse of the skin:forearm fraction are the basis of estimates of the potential fraction of cardiac output taken up by the skin mentioned by Heinonen et al. (2). They highlight the great difference in sensitivity to local temperature in the vasculatures of skin and muscle. Even in a study (4) in which diathermy elevated temperature to 42°C, MBF was not elevated above baselines similar to levels reported by Heinonen et al. (higher levels were reported for higher temperatures, but this is the range in which thermal injury is expected).

In conclusion, reconsideration of how cardiac output is distributed in hyperthermic humans is undoubtedly a valuable endeavor but one in which the different ways that the data are expressed need to be kept in mind.

DISCLOSURES
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REFERENCES

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