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Critical Environmental Limits for Middle-Aged Adults (PSU HEAT Project)

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Critical environmental limits are the combinations of temperature and humidity above which heat balance cannot be maintained for a given metabolic heat production. Our lab has previously established critical environmental limits for young and older adults; however, these limits have yet to be established for middle-aged adults. **PURPOSE:** The purpose of the present study was to (1) identify critical environmental limits for middle-aged adults, and (2) investigate age-related differences in critical environmental limits at a low metabolic rate reflecting activities of daily living across the adult age spectrum. **METHODS:** Twenty-six older (71±5 yrs, 14F/12M), 30 middle aged (54±8 yrs, 23F/7M), and 27 young adults (23±3 yrs, 13F/14M) were exposed to progressive heat stress in a controlled environmental chamber during minimal activity. Progressive heat stress for the determination of critical environmental limits comprised either (1) constant dry-bulb (T_{db}) temperature at 34°C with progressively increasing water vapor pressure (P_a) by 1 mmHg every 5 minutes (P_{crit} trial), or (2) constant P_a at 12 mmHg with progressively increasing T_{db} by 1°C every 5 minutes (T_{crit} trial). **RESULTS:** Critical environmental limits in hot-dry environments were higher in young compared to middle aged (49.3±2.3 °C vs. 45.1±4.0 °C; $p < 0.001$) and older adults (49.3±2.3°C vs. 43.2±4.1°C; $p<0.001$), but were not different between middle aged and older adults (45.1±4.0 °C vs. 43.2±4.1°C; $p=0.21$). Critical environmental limits in warm-humid conditions were lower in older adults compared to young (23.1±5.8 mmHg vs 31.7±1.6 mmHg, $p < 0.001$) and middle aged (23.1±5.8 mmHg vs 27.9±5.5 mmHg, $p = 0.034$), but were not different between the young and middle aged (31.7±1.6 mmHg vs 27.9±5.5 mmHg, $p = 0.08$). Age was correlated with critical environmental limits in T_{crit} ($R^2=0.34$; $p<0.001$) and P_{crit} ($R^2=0.50$; $p<0.001$) trials based on linear and curvilinear regression, respectively. **CONCLUSION:** Critical environmental limits for middle aged adults performing minimal activity in warm-humid and hot-dry environments are intermediate to young and older adults. These data demonstrate an age-related decline in critical environmental limits that can be characterized by linear decline in hot-dry environments and by curvilinear decline in warm-humid environments. **SIGNIFICANE/NOVELTY:** These results are the first to identify critical environmental limits for the maintenance of heat balance in middle-aged adults. These findings provide important empirical data that may be used in the development of safety guidelines and alert-based communication to mitigate heat-related morbidity and mortality during impending heat waves.

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