Modeling Body Temperature of Rats Exercising on Treadmills

Exercise is emphasized today as obesity becomes one of the largest threats to our health, although exercise itself can pose threats such as heat shock from exertion in hot environments. Therefore, it is important to understand how our thermoregulation system works during exercise. We measured the core body temperature of rats (T_c) running on treadmills with varied speeds (0, 6, 12, and 18 m/min) for 15 minutes in two ambient temperatures (T_a=25°C and 32°C). Then we developed a mathematical model that describes rates of temperature changes in the core and the muscles by quantifying heat production in two compartments. P_m is the amount of additional heat produced by the muscles from running, and P_0 is a change of the heat production in the core body counteracting the P_m to keep T_c at its equilibrium(T_0). We assume that P_m depends only on the speed of running, and the influence from T_0 is taken into account in P_0 which represents the metabolic adjustment of the core. Calculations showed that during running at T_a=25°C, P_0 decreased as the speed increased. This adjustment was observed even when the treadmills were off. However, at T_a=32 °C, the change of P_0 was not statistically significant. Therefore, we discussed limitations in the reduction of P_0 that compensates for increases in P_m due to higher T_a. Also, we developed this point to further discuss the relationship between metabolic adjustments to running and stress-related circuitry.