Exercise Protocol: Exercise in the Heat

Appropriate Applications

Testing of subjects in a warm, humid environment can provide insight into the acute and chronic effects of exercising in the heat. Studies are performed to investigate the acute effects of exercise in the heat on the cardiovascular, metabolic, or thermoregulatory systems as well as the effects of acclimation on these systems to extreme environmental conditions.

Test Description

Subjects may exercise in the environmental chamber in the SDSU exercise physiology laboratory (ENS 255) for up to 2 hours per day. In heat acclimation studies, subjects may perform up to 10 days of exercise in the heated chamber. Air temperature will range from 32 to 43 ºC (90 to 110 ºF) at a relative humidity of 30-80%. During a test, heart rate, sweat rate, skin blood flow, sweat gland density, and core body temperature may be followed. Heart rate is measured using a heart rate monitor received from a transmitter strapped around the chest. Sweat rate is determined by pre- and post-exercise body weights. Skin blood flow is estimated using either a laser Doppler technique or venous-occlusion plesmography. A laser Doppler probe is positioned on a forearm from which the signal is converted to units of blood flow. Venous-occlusion plesmography estimates blood flow from the tension measured from a strain gauge positioned around the forearm while applying a brood pressure cuff to the upper arm. Sweat gland density is calculated by applying iodine-impregnated paper to the skin. Core body temperature can be measured in a variety of ways: The three most commonly used methods in our laboratory are tympanic, rectal, and esophageal measurements. Tympanic temperatures are measured with an infrared sensor inserted into the ear. When tympanic temperatures are performed, though, the design of the sensor prevents it from being inserted too far and injuring the ear. Rectal temperature is measured from a sanitized temperature probe inserted by the subject approximately 10 cm past the anal sphincter. Esophageal temperature is measured using a single-use temperature probe inserted by the subject through a nostril to a length approximately 25% of the subject's height.

Training/Supervision Needed

Graduate students in the M.S. program in Exercise Physiology take coursework and have lab experiences to prepare them for these assessments. These individuals will have been prepared for giving instructions to subjects for inserting probes.

Risks

The rectal or esophageal probe may produce mild discomfort while inserted. The risk of a cardiac event from exercising in the heat is lower than it would be for maximal testing, however, the exact risk is not known. Any exercise bout may produce light-headedness, fatigue, possibly nausea, and delayed-onset muscle soreness. These side effects are usually minimized in fit subjects. They are also minimized by having a gradual warm-up as well as cool-down (at least 5 minutes each) and by having the subject refrain from eating for at least 2-3 hours before their test.

Risk Management

Core body temperature will be monitored during the exercise test. If a subject's core temperature exceeds 39.5 ºC, the test will be terminated and the subject removed from the environmental chamber. Only single-use probes will be used to measure esophageal temperature.

A negative pregnancy test is required of all female subjects before beginning an exercise experiment in the heat. SDSU students may take a urine pregnancy test at the SDSU Student Health Center; she will need to provide the investigator with a copy of the test results. If the subject is not a SDSU student, we will provide a urine pregnancy test that will be administered and read in the lab.

Consent Content “What Will Happen in the Research?” section

You are being asked to exercise in the environmental chamber, which will be set to XX ºF and a relative humidity of XX%, for XX minutes (and for XX consecutive days). In order to monitor that you are not becoming overly heated, your tympanic (or rectal or esophageal) temperature will be followed. Tympanic temperature is measured by inserting a temperature probe in the ear and holding it for a few seconds until the temperature is registered. (Rectal temperature is measured with a probe inserted in your rectum. You will do this yourself in the privacy of the changing room by inserting the probe to the mark indicated on the cable and/or esophageal temperature is measured with a probe inserted through a nostril into the esophagus to the point indicated on the cable.) Before and after the exercise, your weight will be recorded. To measure blood flow, a laser Doppler will be attached to your forearm and/or a strain gauge sensing device will be placed around your forearm and a blood pressure cuff around the upper arm.

Consent Content “What are the Risks or Discomforts Involved in the Research?” section

The rectal or esophageal probe may produce mild discomfort while inserted. If an esophageal probe is used, you may experience discomfort and briefly gag when the esophageal probe is inserted. You may also experience mild irritation of the nose and throat both during and after the experiment. Should your temperature exceed 39.5 ºC (103.1º F) we will terminate the test and remove you from the chamber. If you feel uncomfortable during any part of this study, you may choose to terminate your participation.

If you are removed from the heat chamber because his/her temperature reaches 39.5 º C(103.1º F), you will be monitored continuously to watch for a decrease in temperature (which usually occurs very quickly when seated in the lab, which is kept at 23 C(73  F) .If your core temperature does not decrease after 10 minutes of rest in 23 C(73  F), a fan and ice will be applied to their arms and legs, and they will continue to be monitored until their temperature drops below 38 C (100.4   F).