

Study Protocol

Validation of heat stress limit values for the athletic
performance (HSL-AP)

Version V2.0 12August23

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FULL TITLE	An Experimental Investigation of Physiological Responses in Semiprofessional Athletes: Comparing the Impact of Climatic Conditions, Physical Activity, and Gender
SHORT TITLE	Validation of heat stress limit values for the athletic performance (HSL-AP)
Protocol version/date	Version V2.0 12August23
Methodology	Experimental research design
Study Duration	6 months
Study Centres	Thermal Environment Laboratory, Department of Design Sciences, Faculty of Engineering (LTH), Lund University
Main Objectives	<p>Primary Outcome Measure</p> <p>Objective 1: Rate of change of skin temperature (T_{sk}) of semi-professional athletes during walking 5km/hr and Jogging 8km/hr for 70 minutes in hot wet (T_a 40 C & 70% RH) and hot dry (T_a 31C & 20% RH) test conditions.</p> <p>Objective 2: Rate of change of core body temperature (T_{core}) of semi-professional athletes during walking 5km/hr and Jogging 8km/hr for 70 minutes in hot wet (T_a 40 C & 70% RH) and hot dry (T_a 31 C & 20% RH) test conditions.</p> <p>Objective 3: Rate of change of Heart Rate (HR bpm) of semi-professional athletes during walking 5km/hr and Jogging 8km/hr for 70 minutes in hot wet (T_a 40 C & 70% RH) and hot dry (T_a 31 C & 20% RH) test conditions.</p> <p>Objective 3: Consumption of oxygen (VO^2 Max ml/min/kg) of semi-professional athletes during walking 5km/hr and Jogging 8km/hr for 70 minutes in hot wet (T_a 40 C & 70% RH) and hot dry (T_a 31 C & 20% RH) test conditions.</p> <p>Secondary Outcome Measures</p> <p>Objective 4: Gender based comparison of physiological basis semi-professional athletes in performing walking 5km/hr and Jogging 8km/hr for 70 minutes in hot wet (T_a 40 C & 70% RH) and hot dry (T_a 31 C & 20% RH) test conditions.</p> <p>Objective 4: Comparison of Physiological Heat Strain (PHS) and Wet Bulb Globe Temperature (WBGT) index for evaluating heat stress in sports settings based on the physiological responses from semi-professional athletes.</p>
No. of Participants	Six semiprofessional athletes including three males and three females with a mean age of (24.7 ± 2.1 years) and a body surface area mean of (1.8 ± 0.2 m ²) participated in this study.

Main Eligibility Criteria	<p>Inclusion Criteria</p> <ul style="list-style-type: none"> • Semiprofessional aged 22-27 years of both genders. • Body surface area between 1.5 to 2.5 m² • Semiprofessional participating in regional competition level, receive monetary compensation for their sports participation, participating in sports activity in the last six year, and skill level. • Semiprofessional demonstrating a higher level of skill and performance than recreational or amateur participants. <p>Exclusion Criteria</p> <ul style="list-style-type: none"> • Subjects should not have any known heart disease or circulatory disorder. • No known respiratory disease or heat allergy. • No habitual smoker or drug user.
Statistical Methodology and Analysis	<p>The Boruta package is available from the comprehensive R archive network at https://cran.r-project.org/web/packages/Boruta/index.html and was used in the R studio for statistical analysis. Regression analysis and ANOVA statistical model will be applied to analyze the data.</p>

Informed Consent Form

Validation of Heat Stress limits Values for athletic performance in Sports

Importance of Study

Defining thermal limitations, recording physiological profiles of athletes under various environmental situations, and researching the effects of clothing and physical exercise on thermoregulation will help in anticipating unfavorable events in hot environments. This would reduce the number of cases of heat illness at sporting activities.

Purpose

This study aims to examine the physiological thermoregulatory responses using the PHS model parameters skin temperature (T_{sk}), core body temperature (T_{core}), body temperature (T_b), heart rate (HR), and oxygen uptake (V_{O2max}) among semi-professional athletes of both genders during physical activity of walking (6 km/hr) and jogging (8 km/hr) in different climatic conditions (hot wet and hot dry) accounted for WBGT 28 °C.

Description of test

Each person will perform a test inside the climatic chamber of the Thermal Environment Laboratory in the Department of Design Sciences, Faculty of Engineering (LTH), Lund University – Sweden. The test includes the measurement of height, weight, heart rate, sweat evaporation rate, skin temperature, and core body temperature variation under hot environmental conditions. The temperature inside the climatic chamber will be set at 40 °C and 31 °C at a relative humidity of 20% and 70% respectively to count for a WBGT level of 28 °C. The subject will have activities of walking at 5 km/h and jogging at 8 km/h for less than 2 hours inside the chamber. During the test, we will measure various physiological and subjective variables periodically. Body temperature, skin temperature, and heart rate were recorded for at least 10 seconds. Energy turnover will be determined by measuring the oxygen consumption during the first 10 minutes of experiments. Subjectively perceived exertion and heat stress are recorded every ten minutes. Sweat evaporation and water loss are determined by weighing personnel and equipment before and immediately after the test. You have the right to cancel the test at any time and skip the trial without giving any reason

Information for volunteers

You must not drink alcohol 24 hours or smoke or drink coffee or tea 2 hours before the experiment. We request that you should not eat or exert yourself (sports) for two hours before the experiment.

Procedure

1. Subjects will be given the information about the test (20 minutes before the start of the test) and sign the written consent form. The subject's weight and height will be recorded.
2. The subject is requested to insert the rectal probe.
3. The subject is weighted, and instrumented with skin temperature sensors and Polar Sports Tester.
4. The subject will be dressed in sportswear and shoes.
5. The subject will be weighed with all equipment.
6. The subject will enter the chamber, is connected to the recording system, recordings start and the subject starts walking or jogging.
7. Every subject will perform four Climatic chamber experiments: combinations of hot-dry and hot-wet environments with 5 km/h walking and 8 km/h jogging. Each experiment lasts maximally for 70 minutes.
8. After the test subject will be weighed again with all equipment, de-instrumented, and then weighted without the clothes (Just Having Brief). The experiment is accomplished.

Measurements

1. Deep body temperature (YSI rectal probe, 10 cm above anal sphincter).

2. Skin temperature (sensors will be attached to the left side of the body at four locations i.e. chest, lateral upper arm, anterior thigh front, and posterior calf).
3. Heart rate (Polar Sports Tester).
4. Oxygen uptake (Cortex Metamax I gas analysis equipment).
5. Weighing the subject and clothing (Mettler-Toledo, accuracy 2 g).
6. Subjectively perceived exertion and heat stress (scales).

Test Conditions				
Variable	Test Condition 1	Test Condition 2	Test Condition 3	Test Condition 4
WBGT	28 °C	28 °C	28 °C	28 °C
Clothing	High Visibility	High Visibility	High Visibility	High Visibility
Air Temperature	40 °C	40 °C	31 °C	31 °C
RH %	20 %	20 %	70 %	70 %
Vapor Pressure	2.3 kPa	2.3 kPa	3.1 kPa	3.1 kPa
Walking Speed	5 km/h	Jogging 8 km/h	5 km/h	Jogging 8 km/h
Time	70 min	70 min	70 min	70 min

Experimental conditions

There will be four test conditions to which a subject will be exposed please see Table 1 for complete test conditions. The subject will expose to one condition at a time in a day.

Table 1: Test Conditions

Table 2: Feasible Test Time

Date	Time	Date	Time
1		3	
2		4	
5		6	

Our telephone number at the university:
073-871 3363 Muhammad Salman Butt (Investigator)

I, agrees to participate in the above-described experiments.

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Subject signature -Date

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Investigator Signature-Date