

# Validation of the Wet Bulb Globe Temperature criteria (ISO 7243) and Predicted Heat Strain (ISO 7933) for older adults

Published: 29-07-2019

Last updated: 09-04-2024

The aim of the current study is to investigate if the reference values of the WBGT in ISO 7243 should be adjusted for older adults. Also, the calculated PHS will be compared with the measured core temperature, sweat rate and exposure time.

<b>Ethical review</b>	Approved WMO
<b>Status</b>	Recruiting
<b>Health condition type</b>	Other condition
<b>Study type</b>	Interventional

## Summary

### ID

NL-OMON52579

### Source

ToetsingOnline

### Brief title

Heat strain older adults

### Condition

- Other condition

### Synonym

Heat strain, heat stress

### Health condition

geen aandoening

### Research involving

Human

## Sponsors and support

**Primary sponsor:** Vrije Universiteit

**Source(s) of monetary or material Support:** NWO

## Intervention

**Keyword:** Heat strain, older adults, PHS, WBGT

## Outcome measures

### Primary outcome

Ambient temperature, relative humidity, core temperature, skin temperature, heart rate, blood pressure, sweat rate, oxygen uptake, fitness level, thermal sensation, thermal comfort, rate of perceived exertion.

### Secondary outcome

Height and weight of the participant

## Study description

### Background summary

The climate is changing and more and more extreme weather events, like heat waves, are expected to occur in the near future. Models have shown that heat waves will happen more intensely, more frequently and will be longer lasting. These heat waves can lead to severe health effects and increase mortality. For example, more than 70.000 people died in the summer of 2003 due to the heat wave in Europe and most of these people were older adults. Older adults are more vulnerable to the effects of high temperatures because of intrinsic changes in the thermoregulatory system. For example, older adults start to sweat at a higher core temperature and the thirst sensation is reduced compared to younger individuals. Furthermore, older adults are often less physically fit and have more illnesses and disabilities what makes them also more susceptible to heat-related morbidity and mortality.

Individualized and timely advice on appropriate actions in thermal climate stress may reduce morbidity and mortality among vulnerable populations like

older adults. However, current methods to assess thermal strain in hot environments, like ISO 7243 and 7933, focus on normal, healthy adults. ISO 7243 is based on the Wet Bulb Globe Temperature (WBGT), which is a heat stress index. The value of the WBGT represents the thermal environment an individual is situated in. ISO 7243 provides reference values of the WBGT based on metabolic rate, acclimatization status and clothing ensembles. When the reference value of the WBGT is exceeded it is advised in ISO 7243 to reduce the heat strain or to carry out a detailed analysis of the heat stress using ISO 7933. ISO 7933 is based on the Predicted Heat Strain (PHS) model and calculates the increase in core temperature and sweat loss based on the thermal environment. The maximum exposure time to the thermal environment can be calculated with the strain criteria provided in ISO 7933. However, for older adults these reference values of the WBGT may be different than for normal, healthy adults. Also, the exposure time calculated with the PHS might be different for older adults.

## **Study objective**

The aim of the current study is to investigate if the reference values of the WBGT in ISO 7243 should be adjusted for older adults. Also, the calculated PHS will be compared with the measured core temperature, sweat rate and exposure time.

## **Study design**

Participants visit the university on three separate occasions, once for preliminary testing and twice for measurements in the climate chamber. During the preliminary testing an electrocardiogram (ECG) analysis is executed by the physician to detect any abnormalities in heart activity. Resting blood pressure is measured to make sure the participant is not hypertensive and an anamnesis questionnaire will be filled out. Based on these measurement the physician decides if the individual can participate in this study. If the decision is positive body height and weight is measured and the participant does a YMCA cycle test to determine physical fitness. At the end of the preliminary test participants are instructed to consume no caffeine or alcohol and to avoid any strenuous exercise 12 hours preceding the experimental trials. Participants are asked to consume 10ml/kg of body weight of fluid 0-3 hours before both experiments to make sure they are euhydrated. In addition, they were instructed to record their food and beverage intake during the preceding 24 hours and asked to replicate this for both experimental trials. Hydration status will be tested with a refractometer (Atago, Tokyo, Japan) prior to both measurements.

In the experimental trials two classes of metabolic rate of ISO 7243 are tested: class 0 (resting) and class 1 (low metabolic rate) as it is expected most activities of older adults are in one of these two classes. In class 0 the

participant sits still during the measurements, in class 1 the participant cycles on an ergometer at 10W which is considered to yield a metabolic rate of between 160W and 200W. The experimental trials are on separate days in random order, but at the same time of day. In both trials the participants wear shorts, a t-shirt, underwear, socks and shoes. The climate chamber (b-Cat B.V., Tiel, The Netherlands) is set at 38°C and 28% (cycling trial) or 32% (sitting trial) RH. When thermal balance is reached, determined by a stable core temperature and heart rate for 10 minutes, relative humidity will be increased every 10 minutes with 10%. The trials continue until core temperature increases with a loss of thermal balance (0.1°C increase per 5 minutes for 15 minutes). However, if this criteria is not met after spending 135 minutes in the climate chamber the experiment will be ended, as well as when core temperature reaches 39.0°C.

During the time in the climate chamber the core temperature is measured using a telemetry pill (BodyCap, Caen, France). Mean skin temperature is assessed using iButtons (DS1922L, Maxim Integrated Products Inc, Sunnyvale, CA, USA). Skin temperature is measured at eight different locations: Forehead, right scapula, left upper chest, right arm in upper location, left arm in lower location, left hand, right anterior thigh and left calf based on the ISO 9886 standard (16). Heart rate is measured with a wearable heart rate monitor (Polar Electro, Kempele, Finland, RCX3 watch Polar Electro, Kempele, Finland) and blood pressure is measured using a sphygmomanometer (Romed Holland, Wilnis, the Netherlands). Local sweat rate is measured using the ventilated capsule system. This system consist of a flowmeter (Omega Engineering, Stanford, CT, USA) and temperature and relative humidity sensor (HygroVUE10, Campbell Scientific, Logan, UT, USA). Heart rate is measured continuously and blood pressure is determined every ten minutes before increasing humidity. Oxygen uptake is measured with a metabolic card (COSMED, Quark CPET, Italy). Participants are weighted on a weighing scale (Platform scale, SATEX 34 SA-1 250, Weegtechniek Holland BV, Zeewolde, The Netherlands) seminude before and at the end of the measurement sessions so the amount of sweat loss can be calculated. The participants are asked to rate their thermal sensation and thermal comfort every ten minutes. Thermal sensation is assessed with a 9-point scale (from -4=very cold to +4=very hot) and thermal comfort with a 5-point scale (from 0=comfortable to +4=extremely uncomfortable)(17).

## **Intervention**

In the experimental trials two classes of metabolic rate of ISO 7243 are tested: class 0 (resting) and class 1 (low metabolic rate) as it is expected most activities of older adults are in one of these two classes. In class 0 the participant sits still during the measurements, in class 1 the participant cycles on an ergometer at 10W which is considered to yield a metabolic rate of between 160W and 200W. The experimental trials are on separate days in random order, but at the same time of day. In both trials the participants wear shorts, a t-shirt, underwear, socks and shoes. The climate chamber (b-Cat B.V.,

Tiel, The Netherlands) is set at 38°C and 28% (cycling trial) or 32% (sitting trial) RH. When thermal balance is reached, determined by a stable core temperature and heart rate for 10 minutes, relative humidity will be increased every 5 minutes with 1mmHg (2%). The trials continue until core temperature increases with a loss of thermal balance (0.1°C increase per 5 minutes for 15 minutes). However, if this criteria is not met after spending 135 minutes in the climate chamber the experiment will be ended, as well as when core temperature reaches 39.0°C.

### **Study burden and risks**

The participant can feel unwell due to the heat. During the experiment the investigator will monitor the participant continuously by checking core temperature and heart rate. Besides, blood pressure is measured every 10 minutes. Therefore the risk is small.

## **Contacts**

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## **Trial sites**

### **Listed location countries**

Netherlands

## **Eligibility criteria**

### **Age**

Adults (18-64 years)  
Elderly (65 years and older)

## Inclusion criteria

- Over 60 years of age
- Being able to get to the research facility

## Exclusion criteria

- Suffering from lung or heart disease
- Medication related to thermoregulation (e.g. beta blockers)
- Having spent over a week in a hot environment in the last two months
- Experienced exertional heat stroke

## Study design

### Design

Study type:	Interventional
Intervention model:	Crossover
Allocation:	Randomized controlled trial
Masking:	Open (masking not used)
Control:	Active
Primary purpose:	Treatment

### Recruitment

NL	
Recruitment status:	Recruiting
Start date (anticipated):	16-05-2022
Enrollment:	30
Type:	Actual

## Ethics review

Approved WMO

Date:	29-07-2019
Application type:	First submission
Review commission:	METC Erasmus MC, Universitair Medisch Centrum Rotterdam (Rotterdam)
Approved WMO	
Date:	18-08-2020
Application type:	Amendment
Review commission:	METC Erasmus MC, Universitair Medisch Centrum Rotterdam (Rotterdam)
Approved WMO	
Date:	11-02-2022
Application type:	Amendment
Review commission:	METC Erasmus MC, Universitair Medisch Centrum Rotterdam (Rotterdam)
Approved WMO	
Date:	09-05-2022
Application type:	Amendment
Review commission:	METC Erasmus MC, Universitair Medisch Centrum Rotterdam (Rotterdam)

## Study registrations

### Followed up by the following (possibly more current) registration

No registrations found.

### Other (possibly less up-to-date) registrations in this register

No registrations found.

### In other registers

Register	ID
CCMO	NL69479.078.19