

# Effect of a 4-week extreme heat ( $100\pm 2^{\circ}\text{C}$ ) sauna baths program in combination with resistance training on lower limb strength and body composition

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<b>Registration date</b> 22/09/2025	<b>Overall study status</b> Completed	<input type="checkbox"/> Statistical analysis plan <input type="checkbox"/> Results
<b>Last Edited</b> 02/09/2025	<b>Condition category</b> Other	<input type="checkbox"/> Individual participant data <input checked="" type="checkbox"/> Record updated in last year

## Plain English summary of protocol

### Background and study aims

This study aims to evaluate whether four weeks of exposure to extreme heat (approximately  $100^{\circ}\text{C}$ ) through passive sauna bathing can enhance the effects of resistance training on maximal muscular strength and body composition.

### Who can participate?

Healthy adult male volunteers aged 18 to 25 years

### What does the study involve?

Participants will be randomly assigned to one of two groups: a training-only control group, and a group that, following each resistance training session, undergoes sauna exposure at approximately  $100^{\circ}\text{C}$  for 10 minutes, twice weekly over four weeks. The intervention includes assessments at baseline, during, and after the training period to measure muscle strength, body composition, and other relevant health variables.

### What are the possible benefits and risks of participating?

Participants may experience gains in muscular strength and improvements in body composition. Risks are minimal but could include discomfort or dehydration related to heat exposure; therefore, the study will be supervised by healthcare professionals to ensure participant safety throughout the protocol.

### Where is the study run from?

The University of Extremadura in Cáceres, Spain

### When is the study starting and how long is it expected to run for?

January 2020 to July 2022

Who is funding the study?  
The Regional Government of Extremadura, Spain

Who is the main contact?  
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## Additional identifiers

## Study information

**Scientific Title**  
Effect of a 4-week extreme heat ( $100\pm 2^{\circ}\text{C}$ ) sauna baths program in combination with resistance training on lower limb strength and body composition

**Study objectives**

The study objective is to evaluate the effect of a 4-week passive sauna bathing program to extreme heat ( $100\pm 2^{\circ}\text{C}$ ) as a support for resistance strength training program on the development of maximum strength and body composition in young physically active subjects. Considering current evidence, it can be hypothesized that the use of extreme heat sauna baths, in combination with resistance training, may be a beneficial strategy to improve body composition and strength.

### **Ethics approval required**

Ethics approval required

### **Ethics approval(s)**

approved 16/03/2020, Bioethics and Biosecurity Commission of The University of Extremadura (Comisión de Bioética y Bioseguridad de la Universidad de Extremadura) (Avenida de Elvas s/n, Badajoz, 06071, Spain; +34 924289305; vrinvestigacion@unex.es), ref: 32//20

### **Study design**

Randomized controlled study

### **Primary study design**

Interventional

### **Study type(s)**

Other

### **Health condition(s) or problem(s) studied**

No diseases

### **Interventions**

The study was conducted over 13 weeks. The first week involved a familiarization phase, during which all participants visited the facilities where the research would take place. In the laboratory, they were introduced to the sauna and assessment instruments, while in the weight training room, they performed a warm-up similar to that of the experimental phase and familiarized themselves with the machines used for assessments and training. Subsequently, participants were randomly assigned to either the Hyperthermia Group (HG) or the Normothermia Group (NG). Group randomization was performed using a specialized online tool (<https://www.randomizer.org>). To maintain blinding conditions, participants received a specific informed consent form tailored to their assigned group and their participation status in the sauna program. During the study, participants from different groups were scheduled on separate days to prevent overlap at the facilities and minimize the risk of participants becoming aware of the activities performed by other groups.

Following a one-week break, the initial assessment was conducted, consisting of an evaluation of the level of physical activity, anthropometric parameters, body composition, and assessment of lower limb strength in both isometric and counter-resistance conditions. In the third week of the study, after another week of rest, both the counter-resistance strength training and the sauna bathing program began. These programs spanned 4 weeks, with a frequency of 2 sessions per week, allowing 48 hours of recovery between sessions. Both groups followed the same training program. Additionally, the HG engaged in a passive sauna bath immediately after each training session. One week after completing the training and sauna programs, the assessments carried out in the initial evaluation were repeated, adhering completely to the same protocol, test order, and assessment schedules, which remained consistent for each participant in both

assessments. To avoid negative interaction effects derived from circadian chronobiology, the hours of evaluation did not vary along the survey.

Each training session began with a warm-up, similar to that performed in the assessments. Subsequently, 4 sets of 8-10 repetitions were performed in the guided half squat exercise on the multipower station, followed by 4 sets of 8-10 repetitions on the leg press. Recoveries were passive, with a duration of 1.5 minutes between sets and 3 minutes between exercises. The load was initially set at 75% of the initial 1RM and increased by 5% weekly, finishing the last week with 90% of the initial 1RM. To reduce contamination from technique, each participant maintained the same position and configuration for both the machine positions and joint angles used in the initial assessment, remaining constant throughout the entire study. The training sessions were conducted at room temperature of  $23\pm 1^{\circ}\text{C}$  and  $24\pm 1\%$  relative humidity (RH).

Sauna bathing program:

Participants in the HG completed a sauna session immediately after each workout, totaling 2 sessions per week. Sauna sessions were passive, with participants sitting inside the sauna. The sauna was set to  $100\pm 2^{\circ}\text{C}$  with normal ambient relative humidity, and participants completed 4 sets of 10 minutes each, with passive breaks of 5 minutes at room temperature ( $23\pm 1^{\circ}\text{C}$ ). The RH of both laboratory and sauna was  $24\pm 1\%$ . The sauna was preheated in advance to ensure that participants completed the entire exposure time at the desired temperature.

### **Intervention Type**

Behavioural

### **Primary outcome(s)**

Muscle strength measured using the 1RM test in squat and leg press exercises, and isometric strength measured using an isokinetic dynamometer, at baseline and after 8 and 13 weeks

### **Key secondary outcome(s)**

Body composition measured using bioelectrical impedance and anthropometric methods at baseline and after 8 and 13 weeks

### **Completion date**

31/07/2022

## **Eligibility**

### **Key inclusion criteria**

1. Male participants aged between 18 and 25 years
2. No diseases or contraindications for resistance training
3. No pharmacological and/or nutritional treatment in the 12 months before the study
4. No engagement in any strength or resistance training program in the 12 months before the study
5. No consumption of coffee, tea, or caffeine during assessments and training
6. No intake of sports nutritional supplements or dietary changes during the study

### **Participant type(s)**

Learner/student

### **Healthy volunteers allowed**

No

**Age group**

Adult

**Lower age limit**

18 years

**Upper age limit**

25 years

**Sex**

Male

**Total final enrolment**

30

**Key exclusion criteria**

1. Suffering from a musculoskeletal injury at the beginning or during the research phase
2. Consuming any doping substances or anabolic supplements
3. Initiating any pharmacological or nutritional treatment during the study
4. Changing the type of diet or dietary regimen during the study
5. Not attending any of the training or acclimatization sessions
6. Experienced experimental dropout

**Date of first enrolment**

15/09/2021

**Date of final enrolment**

16/07/2022

**Locations****Countries of recruitment**

Spain

**Study participating centre**

**Sport Sciences Faculty, University of Extremadura**

Campus Universitario, Av. de la Universidad, S/N

Cáceres

Spain

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**Sponsor information****Organisation**

Universidad de Extremadura

**ROR**

<https://ror.org/0174shg90>

## **Funder(s)**

**Funder type**

Government

**Funder Name**

Junta de Extremadura

**Alternative Name(s)**

Regional Government of Extremadura

**Funding Body Type**

Government organisation

**Funding Body Subtype**

Local government

**Location**

Spain

## **Results and Publications**

**Individual participant data (IPD) sharing plan**

The datasets generated during and/or analysed during the current study will be available upon request from Dr. Ignacio Bartolomé, [ibartolomesa@upsa.es](mailto:ibartolomesa@upsa.es), [ignbs.1992@gmail.com](mailto:ignbs.1992@gmail.com).

- The data to be shared will be the data published in the article (anthropometric characteristics, age, sex, performance variables, and strength).
- Data will be available starting August 1, 2025.
- Consent was requested and obtained from all participants.
- The data were anonymized at all times.
- There are no legal or ethical restrictions.
- There are no additional comments.

**IPD sharing plan summary**

Available on request