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Effect of a 4-week extreme heat (100±2°C) sauna baths program in combination with resistance training on lower limb strength and body composition

Submission date
22/07/2025

Recruitment status
No longer recruiting

Registration date
22/09/2025

Overall study status
Completed

Last Edited
02/09/2025

Condition category
Other

[_] Prospectively registered
[_] Protocol
[_] Statistical analysis plan
[_] Results
[_] Individual participant data
[X] 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°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°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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Scientific

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Additional identifiers

Clinical Trials Information System (CTIS)
Nil known

ClinicalTrials.gov (NCT)
Nil known

Protocol serial number
Nil known

Study information

Scientific Title
Effect of a 4-week extreme heat (100±2°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±2°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±1°C and 24±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±2°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±1°C). The RH of both laboratory and sauna was 24±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
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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, 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

Study outputs

Output type	Details	Date created	Date added	Peer reviewed?	Patient-facing?
Participant information sheet	Participant information sheet	11/11/2025	11/11/2025	No	Yes