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# Distinct DNA methylation changes following a superset and repeated sprint training intervention in youth male basketball players

**Submission date**
21/04/2026

**Recruitment status**
No longer recruiting

**Registration date**
24/04/2026

**Overall study status**
Completed

**Last Edited**
24/04/2026

**Condition category**
Other

[_] Prospectively registered
[X] Protocol
[_] Statistical analysis plan
[_] Results
[_] Individual participant data
[X] Record updated in last year

## Plain English summary of protocol

Background and study aims
Young athletes are often exposed to increasing training demands as they develop, especially in competitive sports such as basketball. This sport requires repeated high-intensity actions, including sprinting, jumping, rapid changes of direction, and physical contact, all of which place considerable stress on the body. If training is not well planned, these demands may exceed the athlete's ability to adapt, potentially increasing the risk of fatigue, injury, or poor development. Therefore, it is important to design training programmes that support safe and effective physical development.
When athletes train, their bodies gradually adapt to the demands placed on them. These adaptations are influenced by factors such as how often they train, how hard they train, and the type of exercises they perform. While improvements are usually seen in physical abilities such as strength, speed, and endurance, these changes are driven by biological processes inside the body. Training acts as a stimulus that challenges the body, triggering responses that help it become stronger and more efficient over time.
One of the ways the body regulates these adaptations is through processes that control how genes are expressed. DNA methylation is one such process. It does not change the genetic code itself, but it can influence whether certain genes are more or less active. This may affect how the body responds to training, including how muscles develop, how energy is used, and how the body recovers after exercise. Research in adults has shown that different types of training (such as strength training or high-intensity exercise) can lead to changes in DNA methylation. However, there is very limited research on how these biological changes occur in young athletes, whose bodies are still developing.
Understanding how different types of training influence both physical performance and underlying biological processes could help improve training methods for young athletes. In particular, training approaches that are time-efficient and sport-specific are highly relevant in team sports, where training time is limited and must be carefully managed.

This study aims to examine how two different types of training affect both physical performance and DNA methylation in young basketball players. The study compared superset training (a form of strength and power training using combined exercises) and repeated sprint training (a form

of high-intensity running involving short bursts of effort). Both methods are commonly used in sports and reflects the physical demands of basketball.

Who can participate?
Male youth basketball players aged approximately 13 to 18 years who were members of an elite basketball academy and had at least three years of structured training experience.

What does the study involve?
Specifically, the study aimed to:
(1) Assess changes in physical performance, including strength, speed, agility, and aerobic fitness;
(2) Examine changes in DNA methylation across the genome following each training method;
(3) Explore whether biological changes were related to improvements in performance; and
(4) Identify which biological pathways may be influenced by each type of training.
This research aims to provide new insight into how young athletes adapt to training, both physically and biologically, and to support the development of more effective and individualized training strategies in youth sport.

This study involved 62 young basketball players who were randomly divided into two groups. One group completed superset training, and the other completed repeated sprint training. All players continued their regular basketball training during the study, which included team practices and weekly matches. In addition, each group performed an extra 30-minute training session per week for 8 weeks, depending on their assigned training type.
Superset training (SST): involved strength and power exercises using basketball-specific movements such as pushing, pulling, accelerating, and jumping.
Repeated sprint training (RST): involved short, high-intensity sprints with changes of direction and short recovery periods.
Before and after the 8-week training period, players completed several tests to measure their physical performance. These included:
- Jumping ability (to assess explosive strength)
- Sprint speed
- Agility (ability to change direction quickly)
- Aerobic fitness (using a running test)

Saliva samples were also collected to analyse DNA methylation and understand biological changes related to training.

What are the possible benefits and risks of participating?
Participants may benefit from improved physical performance, such as better strength, speed, and fitness, as a result of the additional training sessions. They also contribute to research that may help improve training methods for young athletes in the future.
The risks involved in this study are low and similar to those normally associated with sports training. These may include muscle soreness, fatigue, or minor injuries (such as strains) that can occur during exercise. All training was supervised by qualified staff, and players followed their usual training routines to reduce risk. Saliva collection is non-invasive and does not pose any health risk.

Where is the study run from?
The study was conducted in Girona at the facilities of Basquet Girona. It was carried out in collaboration with the University of Girona and the EUSES University School of Health and Sport.

When is the study starting and how long is it expected to run for?
Players were familiarised with the testing procedures in September 2021. The main study,

including the training intervention, took place over 8 weeks during the competitive season, from February to March 2022.

Who is funding the study?
This study was funded by a Spanish Government National Research grant and was co-funded by the European Union through the European Regional Development Fund.

Who is the main contact?
Dr Anna Prats Puig, anna.pratspuig@udg.edu

# Contact information

### Type(s)
Principal investigator, Scientific, Public

### Contact name
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# Additional identifiers

### Spanish State Research Agency (Agencia Estatal de Investigación) grant
PID2021-124162OA-I00

# Study information

### Scientific Title
Distinct genome-wide DNA methylation responses to superset versus repeated sprint training in youth male basketball players

### Study objectives
Study objectives were to:
(1) examine changes (hypermethylation or hypomethylation) in DMPs in response to SST and RST interventions, alongside changes in explosive strength, aerobic fitness, speed and agility
(2) investigate associations between methylation and performance changes
(3) characterize the genomic context of DMPs for SST and RST, including their proximity to transcription start sites (TSS) and CpG features
(4) perform enrichment analysis and examine the biological pathways associated with each intervention

## Ethics approval required
Ethics approval required

## Ethics approval(s)
approved 01/12/2020, Research Committee of Dr. Josep Trueta Hospital (Avinguda de França, s /n (sense número) 17007 Girona, Catalunya (Espanya), Girona, 17007, Spain; +34 872 987 087 (Ext 302); ceic.girona.ics@gencat.cat), ref: 2020.193

## Primary study design
Interventional

## Allocation
Randomized controlled trial

## Masking
Open (masking not used)

## Control
Active

## Assignment
Parallel

## Purpose
Basic science

## Study type(s)

## Health condition(s) or problem(s) studied
Physical performance and molecular adaptations to exercise training in youth athletes

## Interventions
Participants were randomly assigned to one of two training groups: superset training (SST) or repeated sprint training (RST). Randomisation was performed after baseline testing using a computer-generated allocation sequence. To ensure a balanced distribution across developmental stages, participants were first stratified by age group (under-13 to under-18), and then randomly allocated within each age group to one of the two interventions.
The allocation process was conducted by a researcher not involved in the delivery of the training sessions, and group assignment was not disclosed to participants prior to allocation. Due to the nature of the interventions, participants and coaches were aware of the training performed after allocation.
Both interventions were delivered face-to-face in a group setting by qualified strength and conditioning coaches within the club's training environment.
The SST intervention consisted of strength and power-based exercises performed in paired sequences (supersets). Each session included three sets of six multi-joint exercises targeting basketball-specific movements such as pushing, pulling, accelerating, and jumping. Exercises were performed at moderate loads, with intensity individually adjusted to each player's capacity.
The RST intervention consisted of repeated short-duration sprints performed at maximal effort. Each session included two sets of six 10-second sprints with short recovery periods and incorporated changes of direction to reflect game-specific movements.

Both groups completed one additional 30-minute training session per week over an 8-week period alongside their regular basketball training and matches. Training intensity was adapted to each participant to match their physical capacity, and all sessions were supervised to ensure safety and correct execution.

### Intervention Type
Other

### Primary outcome(s)
1. Genome-wide DNA methylation levels measured using Infinium HumanMethylationEPIC v2.0 (900K) BeadChip microarray (Illumina), quantifying CpG methylation as β-values at baseline (pre-intervention) and post-intervention (after completion of the training program)

### Key secondary outcome(s))
1. Countermovement jump (CMJ) height measured using Chronojump software (Boscosystem) with contact platform at baseline and post-intervention

2. Aerobic fitness ($VO_2$max) measured using Yo-Yo Intermittent Recovery Test (Level 1 for U13–U14; Level 2 for U15–U18), with $VO_2$max estimated using standard prediction equations at baseline and post-intervention

3. 20-m sprint performance time measured using electronic timing gates (photocell system, Witty gate, Microgate) at baseline and post-intervention

4. T-test agility performance time measured using electronic timing gates (photocell system, Witty gate, Microgate) at baseline and post-intervention

5. V-cut agility performance time measured using electronic timing gates (photocell system, Witty gate, Microgate) at baseline and post-intervention

### Completion date
25/03/2022

## Eligibility

### Key inclusion criteria
1. No evidence of injury or illness prior the start of the study
2. Being an U-18 player at Basquet Girona club

### Healthy volunteers allowed
Yes

### Age group
Mixed

### Lower age limit
12 years

### Upper age limit
18 years

**Sex**
Male

**Total final enrolment**
62

**Key exclusion criteria**
1. Use of any medication affecting the outcomes of the study
2. Sustaining an injury during the testing or intervention period
3. Failing to complete a minimum of 7 out of 8 intervention sessions
4. Attending less than 85% of all training sessions and matches (equivalent to missing more than 3 activities) during the study period

**Date of first enrolment**
15/09/2021

**Date of final enrolment**
25/03/2022

# Locations

**Countries of recruitment**
Spain

# Sponsor information

**Organisation**
Universitat de Girona

**ROR**
https://ror.org/01xdxns91

**Organisation**
Bàsquet Girona

# Funder(s)

**Funder type**

**Funder Name**
Agencia Estatal de Investigación

**Alternative Name(s)**

Spanish State Research Agency, Spanish Agencia Estatal de Investigación, AEI

### Funding Body Type
Government organisation

### Funding Body Subtype
National government

### Location
Spain

### Funder Name
European Regional Development Fund

### Alternative Name(s)
Fondo Europeo de Desarrollo Regional, Europäischer Fonds für regionale Entwicklung, Европейски фонд за регионално развитие, Evropský fond pro regionální rozvoj, Fundo Europeu de Desenvolvimento Regional, ERDF, FEDER, EFRE, ЕФРР, EFRR

### Funding Body Type
Government organisation

### Funding Body Subtype
National government

### Location

# Results and Publications

### Individual participant data (IPD) sharing plan
The datasets generated during and/or analysed during the current study are/will be available upon request from anna.pratspuig@udg.edu. The DNA methylation data generated and analysed in this study are publicly available in the GEO under accession number GSE312992.

### IPD sharing plan summary
Available on request, Stored in non-publicly available repository

### Study outputs

| Output type | Details | Date created | Date added | Peer reviewed? | Patient-facing? |
|---|---|---|---|---|---|
| Other files | | | 24/04/2026 | No | No |
| Participant information sheet | version 2 | 28/10/2022 | 24/04/2026 | No | Yes |
| Protocol file | | | 24/04/2026 | No | No |