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EUROPEAN EDUCATION AND CULTURE EXECUTIVE AGENCY (EACEA)

EDATS - European Digital Assisted Training in Team Sports

Project acronym:

EDATS

D4.1 - TRAINING ON METHODOLOGY AND ICT SPORT

Project number: 101133614

Call: ERASMUS-SPORT-2023

Topic: ERASMUS-SPORT-2023-SCP

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DELIVERABLE INTRODUCTION

DOCUMENT DETAILS	
Project Title	EDATS - European Digital Assisted Training in Team Sports
Project Number	101133614
Work Package	WP4 – Training, pilot learning activities
Activity	T4.1 - Development of the training material T4.2 - Training on the methodology and ICT platform
Deliverable	D4.1 Training on methodology and ICT sport
Delivery Date	31/01/2026
Leading Partner	Alfieri
Implementation period	From 01/09/2024 to 31/01/2026
Dissemination Level	Public
Languages available	English

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INTRODUCTION

This deliverable reports on the training activities implemented within Task T4.1 and T4.2 of the EDATS project.

The document provides an overview of the training methodology, content, implementation modalities and preliminary results, in line with the project objectives.

The training activities described in this report represent a key step towards preparing coaches, trainers and sport staff for the subsequent pilot testing and validation phases of the EDATS methodology and ICT Sport Tool.

TRAINING DESIGN AND APPROACH

OBJECTIVES OF THE TRAINING

The main objectives of the training activities were to:

- Strengthen the skills of coaches and sport professionals in injury prevention and performance monitoring.
- Promote the use of digital tools and biomechanical data in training contexts.
- Support the practical adoption of the EDATS methodology and ICT Sport Tool.
- Enhance collaboration between sport professionals and digital/technical experts.
- Raise awareness on transversal topics such as psychological well-being, inclusion, gender equality and environmental sustainability in sport.

TRAINING DESIGN AND METHODOLOGY

The training activities were designed following a two-level approach, combining a centralised in-person session with decentralised local training activities, to maximise reach, effectiveness and contextual adaptation.

Introductory and simplified presentations were used during the training sessions to facilitate understanding and engagement. At the same time, comprehensive and in-depth training materials were provided to participants, consisting of (*Annex 1*):

- Deliverable D2.1 – Operation Manual for the Use of Sensors.
- Deliverable D2.2 – Guidelines on how to improve the psychological and social wellbeing of athletes in the sporting context.
- Additional training handbook and supporting materials developed within the project.

These materials ensured continuity, consistency and scientific robustness across all training activities.

In-person Training Session (Transnational Event)

The first phase of the training activities was delivered in presence in September 2025, in conjunction with the third transnational project meeting.

This timing was strategically selected to:

- Ensure the participation of a core group of project partners and sport professionals.

- Combine training activities with a wider dissemination event organised during the same period.
- Foster direct interaction, peer learning and hands-on demonstrations.

The in-person training adopted a mixed methodology combining:

- Theoretical inputs.
- Practical demonstrations.
- Interactive discussions and exchange of experiences among participants.

Local and Cascade Training Activities (Partner Countries)

Following the in-person training, a cascade training approach was implemented, following a similar structure to the In-person Training session of September 2025. Participants trained during the September session acted as local multipliers, delivering further training activities within their respective organisations and partner countries.

To ensure scientific and technical consistency across all local activities, continuous remote support and monitoring were provided by UNICA and DAUVEA. This support included:

- Availability for scientific and technical clarifications.
- Remote guidance on the correct use of tools and methodologies.
- Targeted interventions during selected local training sessions, when needed.

This approach allowed partners to autonomously deliver the training while maintaining alignment with the EDATS methodological framework and technical standards.

TRAINING CONTENT

The training activities were based on the main outputs of the EDATS project and covered the following topics:

- Injury prevention strategies in team sports, with a focus on youth athletes.
- Introduction to biomechanical data and their relevance for training and performance monitoring.
- Overview of wearable sensors and data collection methodologies.
- Presentation and practical introduction to the EDATS ICT Sport Tool.
- Interpretation of basic performance indicators and postural control data.
- Psychological and social well-being of athletes, including the coach–athlete relationship.

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- Transversal EU priorities such as inclusion, gender equality and environmental sustainability in sport.

The content was aligned with EDATS deliverables developed within WP2 and WP3 and tailored to the needs of the target groups.

IMPLEMENTATION OF TRAINING ACTIVITIES

Training activities were implemented through a two-step approach, detailed below.

IN-PERSON TRAINING SESSION REPORT

Dates	11 – 13 September 2025
Location	Békéscsaba Volleyball Academy (HU), Meeting Room
Format	In-person
Participants N°	22
Target group involved	• Coaches and trainers involved in youth team sports. • Sport managers and technical staff. • Sport professionals working in training, prevention and athlete development.
Brief Description of the training	The first part of the training programme was dedicated to the project overview. Initially, the overall objectives of the EDATS project were presented, followed by an in-depth introduction to the principles and guidelines on how to improve the psychological and social well-being of athletes in the sporting context, drawing on *Deliverable D2.2 – Guidelines on how to improve the psychological and social well-being of athletes in the sporting context*. The second part of the training focused on the presentation of the application developed for data acquisition. This session was structured into the following components: • Application description. • Application demonstration. During this phase, the development pathway of the tool was outlined, including the activities carried out to reach the current version of the application, the set of sensors selected for data acquisition and the rationale behind this choice, as well as the planned future development activities. Starting from the application functionalities, the sensor architecture and the software structure, participants were guided through the main operational procedures on the platform. These included user registration, sensor identification and configuration, and the procedures required to perform data measurements. In this phase, *Deliverable D2.1 –*

	Operation Manual for the Use of Sensors was used as a reference document to support the correct execution of technical procedures. All these operations were demonstrated through video simulations, in some cases using preloaded data available on the platform. Participants showed a high level of attention and interest throughout the session. The final part of the training session was based on the document "*Handbook of balance and jump performance analysis using Inertial Measurement Units*". During this phase, the exercises underlying the EDATS methodology were presented, specifically: • Analysis of Static Balance (ASB). • Vertical Jump Measurement (SJ–CSJ). • Analysis of Dynamic Balance – the "Time-to-Stabilization" (TTS) test. Through practical examples, also supported by the collaboration of BRSE athletes, the theoretical principles, sensor placement and correct execution of each exercise were illustrated. The group of coaches attending the session positively received the training content, demonstrating active participation and strong engagement throughout the activities.

LOCAL AND CASCADE TRAINING ACTIVITIES REPORT

Dates	Between 13 October 2025 and 21 January 2026
Location	At partner organizations' headquarters in Italy (Alfieri), France (RCC), Poland (UKS), Serbia (SK Volley) and Hungary (BRSE)
Format	In-person
Participants N°	50, combining the participants registered with attendance sheets (*Annex 2*).
Target group involved	Coaches and trainers involved in youth team sports, in line with the operational focus of club-level implementation.
Brief Description of the training	The cascade training activities were subsequently implemented at the different sports clubs involved in the project. These sessions were delivered by the tutors who had participated in the in-person training held in Hungary, with the objective of transferring, in a structured and operational manner, the competences acquired during the international meeting.

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	Similarly to the initial training phase, the sessions organised at club level focused both on the presentation of the data acquisition application and on the practical illustration of the EDATS evaluation methodology. In particular, the training pathway was structured into the following phases: • Project overview and local contextualisation. • Description of the application and its main functionalities. • Operational procedures for the use of sensors and the online platform. • Practical demonstrations and data acquisition simulations. At the beginning of each session, an overview of the project objectives was provided. Local trainers were introduced to the principles and guidelines on how to improve the psychological and social well-being of athletes in the sporting context, using *Deliverable D2.2* as a reference framework and contextualising the discussion through real-case examples related to each sport organisation. Subsequently, the purpose of the application was presented, with specific attention to contextualising its use within the operational setting of each sports club. Key concepts related to the selected set of sensors, the data acquisition workflow and the perspectives for future development were also recalled. The operational procedures to be performed on the platform were then illustrated in detail, including user registration, association and identification of the sensor set, configuration of measurement sessions and correct data acquisition procedures. In this phase, *Deliverable D2.1 – Operation Manual for the Use of Sensors* was actively used to support trainers during practical demonstrations, simulations involving athletes and, where necessary, the use of sample data. The second part of the cascade training activities was dedicated to the evaluation methodology based on the document "Handbook of balance and jump performance analysis using Inertial Measurement Units" and on the EDATS method. In this phase, the core exercises were presented: • Analysis of Static Balance (ASB). • Vertical Jump Measurement (SJ–CSJ). • Analysis of Dynamic Balance – the "Time-to-Stabilization" (TTS) test. Through practical exercises carried out with the direct involvement of athletes from the host clubs, the theoretical principles underlying the tests, the correct sensor placement and the execution modalities

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	of the exercises were explored in depth. Attention was paid to adapting the methodology to the specific operational needs of the different sporting contexts. Coaches and technical staff involved in the cascade training activities demonstrated a high level of interest and active participation, contributing to the sessions through questions, observations and discussions on the potential practical applications of the system in their daily training activities. These local activities were delivered by trained partners, with continuous remote support from UniCA and DAUVEA.

RESULTS AND OUTPUTS

QUANTITATIVE AND QUALITATIVE RESULTS

The training activities contributed to the following results:

- Number of trained participants:
  - In-person training session: 22 participants.
  - Local/cascade training activities: 50 participants.

- Profiles of trained participants:
  - Coaches and trainers involved in youth team sports.
  - Sport managers and technical staff.
  - Sport professionals working in training, prevention and athlete development.

- Skills and competencies acquired:
  - Increased awareness of injury prevention methodologies.
  - Understanding of biomechanical data in sport.
  - Ability to introduce wearable sensors in training contexts.
  - Familiarity with the EDATS methodology ICT Sport Tool.
  - Improved capacity to interpret performance-related data.
  - Increased sensitivity to psychological well-being, inclusion and sustainability in sport.

- Organizational impact:
  - Strengthened internal capacity of partner organizations.

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- Creation of local reference figures for digital-assisted training.
- Improved readiness for pilot testing activities.

FEEDBACK AND EVALUATION

A training evaluation questionnaire (*Annex 3*) was developed and distributed to participants to assess learning outcomes and the relevance of the training contents. The questionnaire is attached as an annex to this report. At the time of submission of this deliverable, responses have been collected (*Annex 3*) and are under analysis.

Preliminary feedback indicates a very positive overall evaluation of the EDATS training activities. The questionnaire, completed by 50 participants from different partner organisations and professional backgrounds, highlights a high level of satisfaction with both the training design and its relevance to daily professional practice.

Respondents evaluated positively the clarity of the training objectives (average score: 4.54/5), the coherence of the content with their professional needs (4.50/5) and the overall organisation of the course (4.54/5). The competences of the tutor-trainers were also highly appreciated (4.58/5), confirming the effectiveness of the training delivery.

The applicability of the acquired knowledge in real working contexts received a high score (4.44/5), indicating a strong perceived potential for practical implementation. Overall satisfaction with the EDATS project pathway reached an average score of 4.36/5, and 92% of respondents stated that they would recommend the training to other professionals.

Qualitative feedback from open-ended questions further confirmed the perceived added value of the training, particularly in relation to performance monitoring, injury prevention and the use of biomechanical data. Participants highlighted the usefulness of the EDATS tools for monitoring athletes' jump performance and postural control, as well as the potential for future enhancements such as multi-sensor acquisition, mobile usability and more advanced comparative analytics.

While several respondents indicated that the software is already intuitive and promising, some suggestions for improvement were provided, mainly related to system stability, speed of data acquisition and the possibility to use the tool on mobile devices.

CONTRIBUTION TO PROJECT OBJECTIVES

The training activities described in this deliverable contributed directly to the achievement of EDATS project objectives by:

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- Strengthening collaboration between sport professionals and digital technology experts.
- Increasing the capacity of coaches and trainers to adopt innovative, data-driven approaches.
- Supporting injury prevention and athlete well-being.
- Facilitating the uptake of the EDATS ICT Sport Tool in real training contexts.
- Embedding transversal EU priorities within sport education and capacity building activities.

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CONCLUSIONS AND NEXT STEPS

The training activities implemented under Task T4.2 represent a key milestone for the EDATS project. The next phase of the project will focus on:

- The start of piloting activities (Task T4.3) in real training environments.
- The evaluation of pilot results (Task T4.4), building on the skills and capacities developed through the training.

The training activities described in this report provide a solid foundation for the successful implementation of these upcoming tasks. By consolidating training content, operational procedures and shared practices across partner organisations, this deliverable plays a strategic role in reducing implementation risks and ensuring consistency during the piloting phase.

The implementation of Deliverable D4.1 directly enables the effective launch of Task T4.3, ensuring that all involved stakeholders share a common methodological and technical baseline for the application of the EDATS methodology and ICT Sport Tool.

The competences developed through the training activities will also support a structured and evidence-based evaluation of pilot results within Task T4.4, allowing feedback from real training environments to be systematically collected and translated into further methodological and technical refinements.

A comprehensive assessment analysis of the training effectiveness is currently in progress, based on the responses collected through the evaluation questionnaire.

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ANNEX 1 – TRAINING MATERIALS

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EUROPEAN EDUCATION AND CULTURE EXECUTIVE AGENCY (EACEA)

Project title:

European Digital Assisted Training in Team Sports

Project acronym:

EDATS

OPERATION MANUAL FOR THE USE OF SENSORS

Project number: 101133614

Call: ERASMUS-SPORT-2023

Topic: ERASMUS-SPORT-2023-SCP

DAUVEA

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DOCUMENT DETAILS	
Project Title	EDATS - European Digital Assisted Training in Team Sports
Project Number	101133614
Work Package	WP2 - Implementation of methodologies to detect and process biomechanical data
Activity	T2.3 - Definition and testing (in lab) of wearable sensors for data collection T2.4 - Definition of data collection methodology
Deliverable	D2.1 - OPERATION MANUAL FOR THE USE OF SENSORS
Delivery Date	31/03/2025
Leading Partner	University of Cagliari
Implementation period	From 01/06/2024 to 31/03/2025
Dissemination Level	Public
Languages available	English

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EDATS VERSION 1.0 – USER GUIDE

The guide "Operation manual for the use of sensors" explains the principal user flows for the first version of EDATS. All information and screenshots are to be considered valid for all user types (admin – coach – athlete) unless otherwise specified.

Deliverable D2.1 is a strategic component for achieving the objectives of the EDATS project, as it represents a synthesis between the needs of technical staff, the methodological research approach of the academic partner, and the IT expertise of the technical partner. Its goal is to enable the operationalization of an advanced technological solution considered fully functional for attaining the project's final purpose: the promotion and dissemination of a digital culture in youth athlete testing.

This deliverable compiles the operational and technical guidelines related to the use of the EDATS application and its integration with sensors. Specifically, the document provides:

- A detailed description of the application's functionalities and usage procedures for end users;
- Instructions for configuring and connecting compatible sensors;
- Technical specifications required to ensure proper communication between the application and external devices, including supported protocols and hardware/software requirements;
- Use case examples to support the adoption of the system in its intended operational settings.

The document is intended for both technicians responsible for integration and end users, with the aim of ensuring an effective implementation and a consistent, functional user experience.

The drafting of this deliverable was initially informed by exchanges among all project partners (carried out through regular online meetings), especially concerning:

- Operational procedures for administering the tests embedded in the application;
- Accessibility and usability of results (reporting, comparison with age- and skill-level benchmarks);
- Management of collected data for future processing or longitudinal analyses.

All in alignment with the project's core objectives: promoting the use of advanced tools for testing young athletes, both in terms of talent identification and injury prevention.

Subsequently, the partners most directly involved in the definition and implementation of biomechanical tests (UniCa and Dauvea) scheduled regular working sessions and testing activities aimed at verifying both the accuracy and consistency of the data generated by the

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hardware/software platform against laboratory gold standards and through comparisons with findings in the scientific literature. Once satisfactory results were achieved, the structure of the deliverable was shared, and joint drafting began.

Following the meeting held in Poland in February 2025—during which several of the above-mentioned aspects were addressed and the usability of the platform was tested in the field—a final revision of the document was carried out and shared with all partners.

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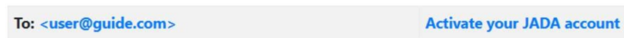
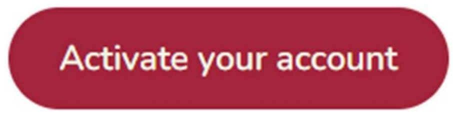
1. ACTIVATING YOUR ACCOUNT

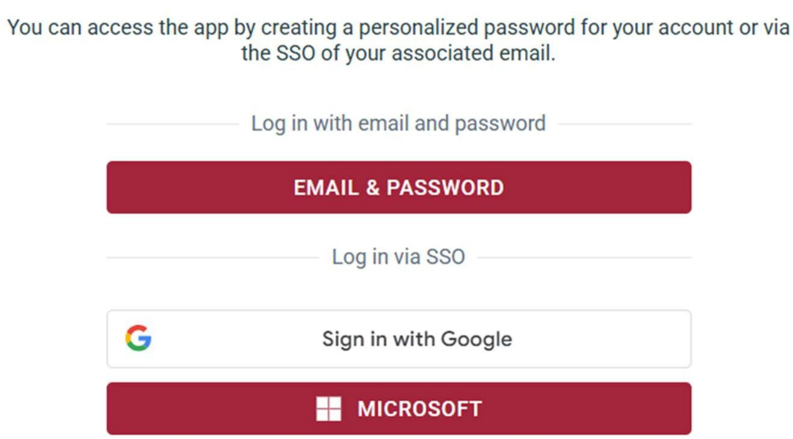
2. In the inbox of your email account, you'll find an email from 'supporto@dauvea.it' with the object "Activate your EDATS account".



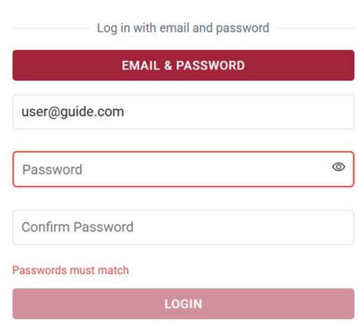
3. In the email, click the link to activate your account.



4. In the verification page, you can choose to register your account via email and a custom password that you choose, or verify your account via Microsoft SSO or Google.



BEWARE! To insert your custom password you can click the button "EMAIL & PASSWORD" to show the registration form.



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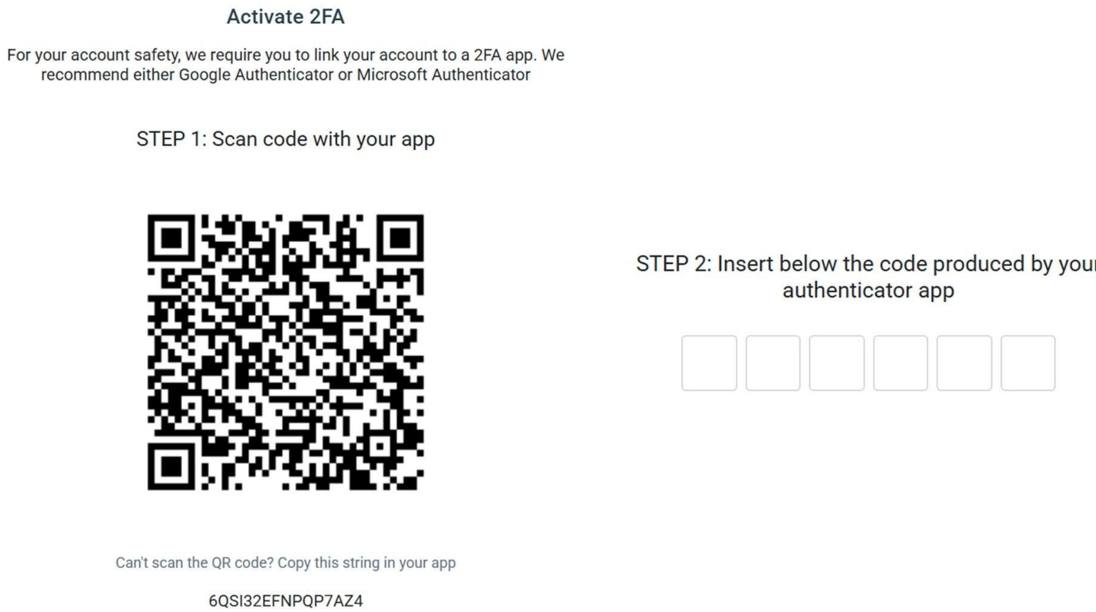
5. If you decide to verify your account via custom login, you will be required to add a second authentication via a 2FA app (e.g. Microsoft Authenticator or Google Authenticator).



6. Once the verification process is completed with successful completion, you will be redirected to the login page to log into the application.

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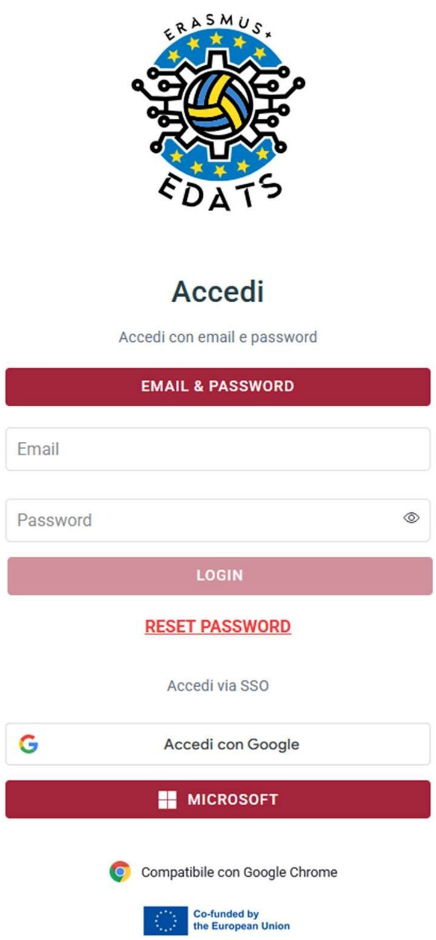
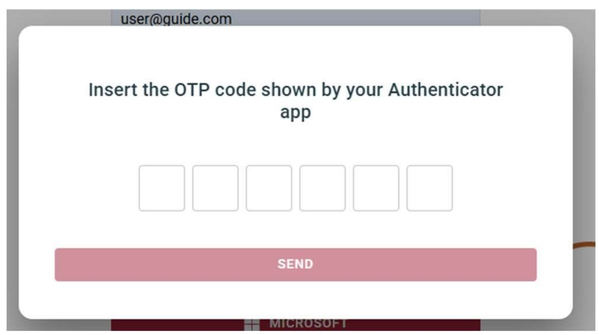
2. LOGGING IN

1. Log in at https://edats-project.dauvea.it/ using the method you chose during the verification process.

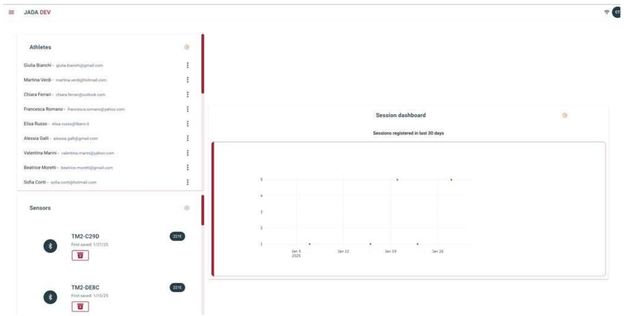


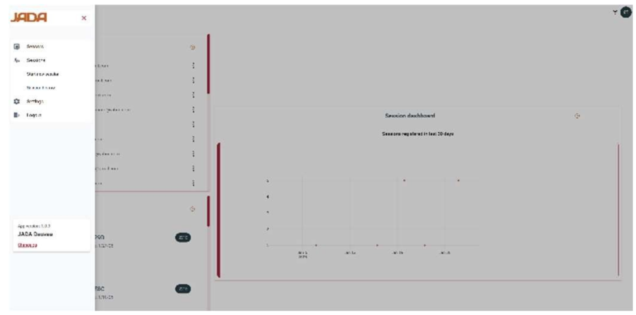
2. If you log in via custom login, you will be required to insert the OTP code from your authentication app.



3. HOME PAGE

a. ADMIN AND COACH ONLY

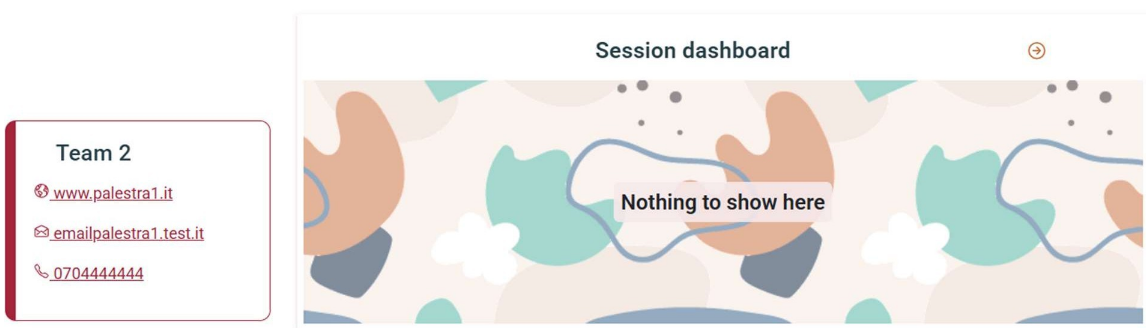




In the Home page you can find a synthetic review of all you app sections.

1. ATHLETES SECTION: here you can find a comprehensive list of all your athletes, either active or not. Clicking on the arrow next to the label will take you to the Team's settings (for details, see the dedicated section)
2. SENSORS SECTION: here you can see a list of the previously registered sensors. Clicking on the arrow next to the label will take you to the Sensors page (for details, see the dedicated section)
3. SESSION SECTION: the graph shows all sessions registered in the last 30 days. If you don't have registered any session yet, the graph will not be shown. As with the previous sections, clicking on the arrow next to the label will take you to the Session dashboard (for details, see the dedicated section)
4. MENU BUTTON: clicking on the hamburger button on the left of the header will open the side menu where you will find links to all key features of the application, a logout function and a link to the Changelog page, where you will find more information on the latest release of the EDATS app.

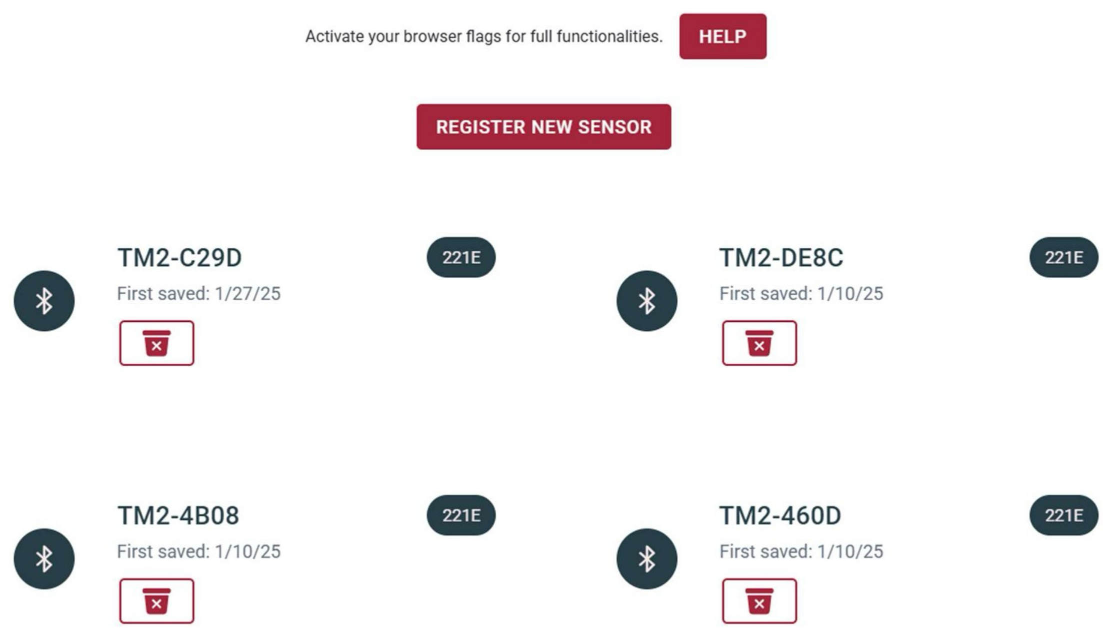
b. ATHLETES



The athletes' home page is slightly different. It contains only the data pertaining to the athlete who logged in (team info and session registered by them)

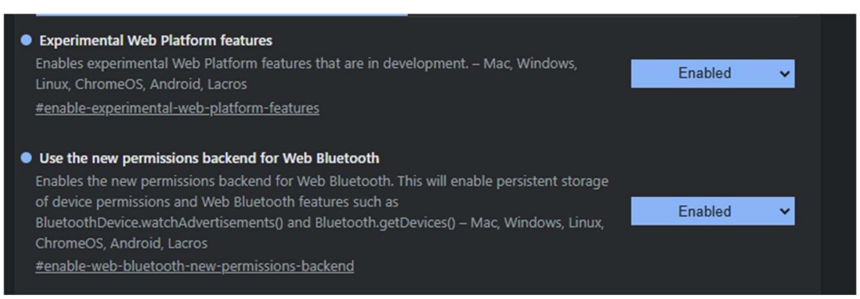
4. WORKING WITH YOUR SENSORS (ADMIN AND COACH ONLY)

This is your sensors' home. From this page you can save new sensors, connect your existing ones or delete them.



Before you start working with your devices, you need to activate some features in your browser. The process is quite simple and you will find a tutorial similar to this one from inside the application clicking on the HELP button on top of the page:

- From your Chrome browser, go to the page chrome://flags/
- In the page that opens, search and activate the following flags:
    - #enable-experimental-web-platform-features
    - #enable-web-bluetooth-new-permissions-backend: set it either to default



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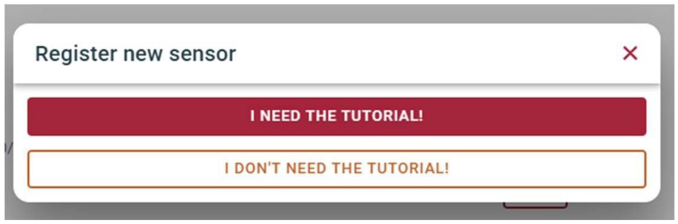
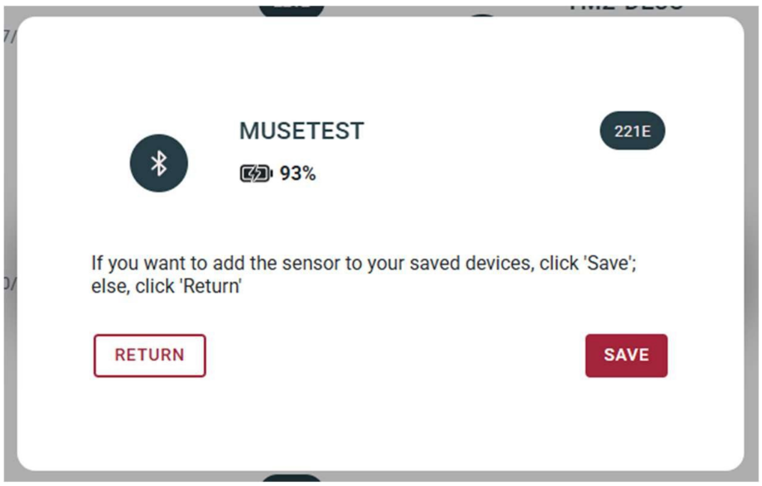
a. SAVE A NEW SENSOR

1. Click the button SAVE NEW SENSOR. A modal will appear where you can choose to go directly to the connection process or to see a brief tutorial that will guide you through the process.



2. Once the connection is established, you will se te sensor data and you can save the device in your sensor list by clicking the SAVE button.



3. Once the device is saved and renamed based on your team initials, you will see it connected in your list. You can identified the connected devices by the orange Bluetooth icon and the battery value indicator. When the sensor is disconnected instead, the icon is dark blue and no battery value is shown.

b. CONNECT AND DISCONNECT AN EXISTING SENSOR

You can connect and disconnect a previously saved device by clicking the Bluetooth icon shown above.

On mobile the Bluetooth button is a normal button with the same icon and underneath the sensor data, but the functioning is exactly the same.

c. DELETE A SENSOR

You can delete a sensor by clicking on the trash can button. If you confirm the deletion, the sensor will be renamed to the factory name and deleted from your sensor list. If you want to add it again, you can follow the instructions to save a new sensor again.

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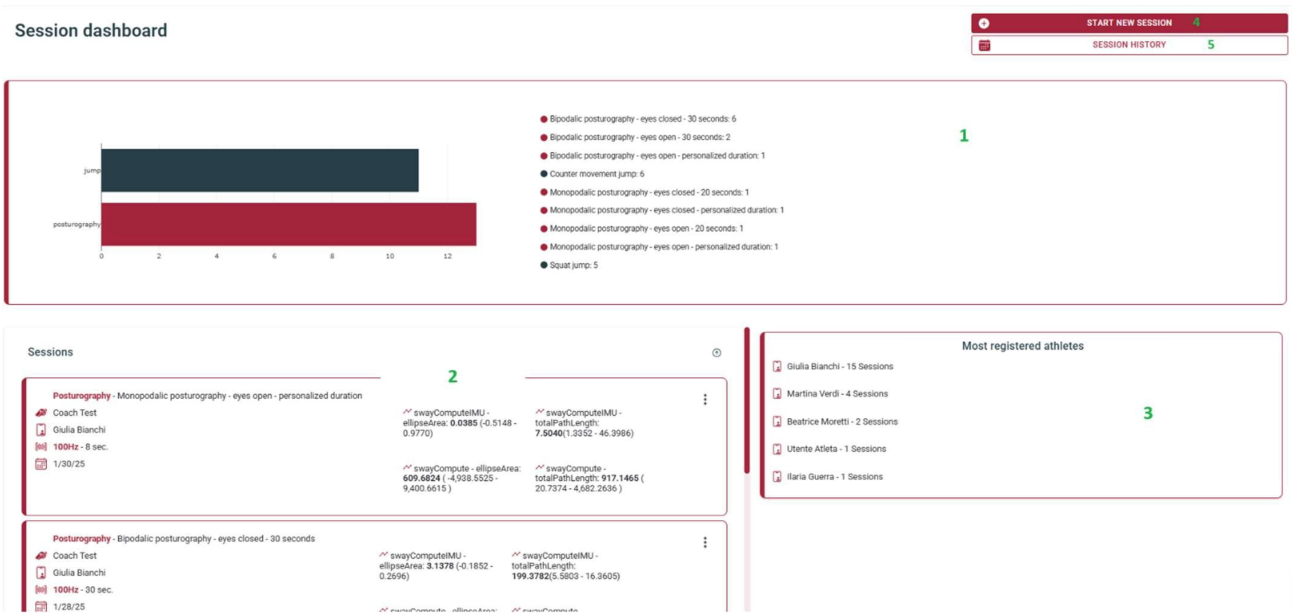
5. SESSIONS

a. SESSION DASHBOARD



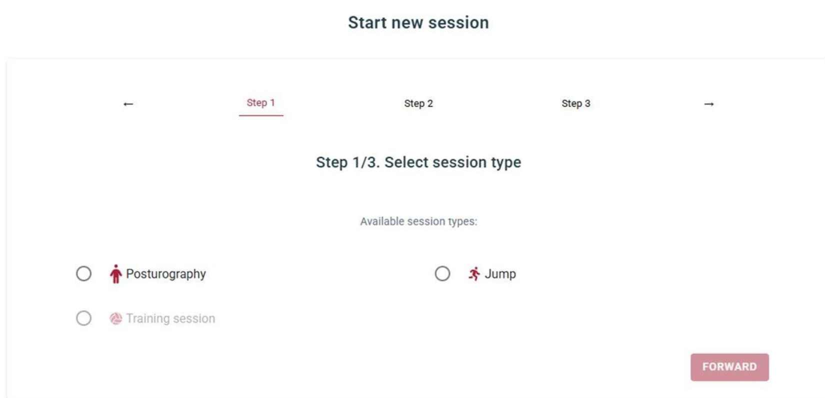
- Sections 1 and 3: some statistics on the sessions you registered in the past. On 1 you can see your sessions divided by type, on 3 you can see the athletes with most sessions registered
- Section 2: last 5 sessions saved; to see and search among your other sessions, click on 5
- Section 4: START NEW SESSION button; click to start a new session
- Section 5: SESSION HISTORY button, where you can search among all your registered sessions

b. REGISTER A NEW SESSION (ADMIN AND COACH ONLY)

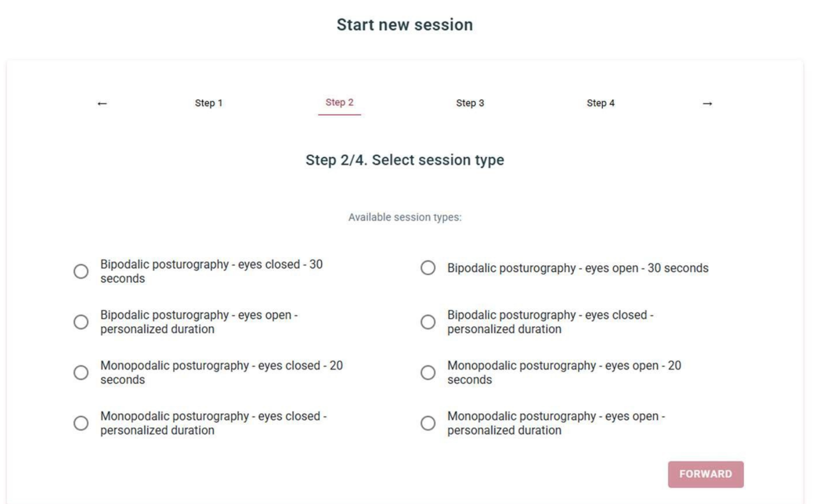
The new session wizard is accessible via the session dashboard described above, or via the sidebar menu by clicking 'New session'.

The wizard will guide you through the process.

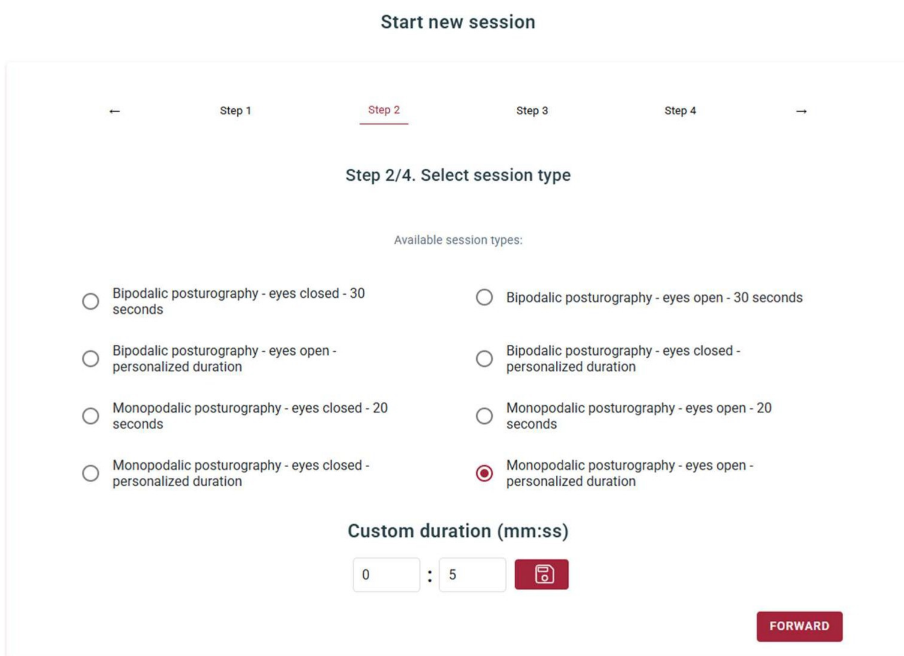
1. Select session type: the available sessions are Posturography (static) or Jumps. Training sessions are coming in a future release. The forward button will activate once you select your type.

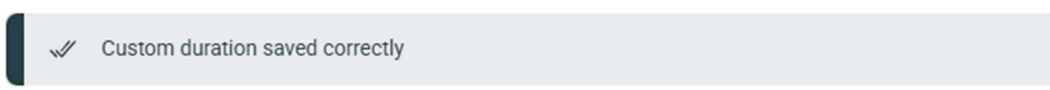


2. Select sub session type, based on the session type chosen before. The forward button will activate once you select your type.

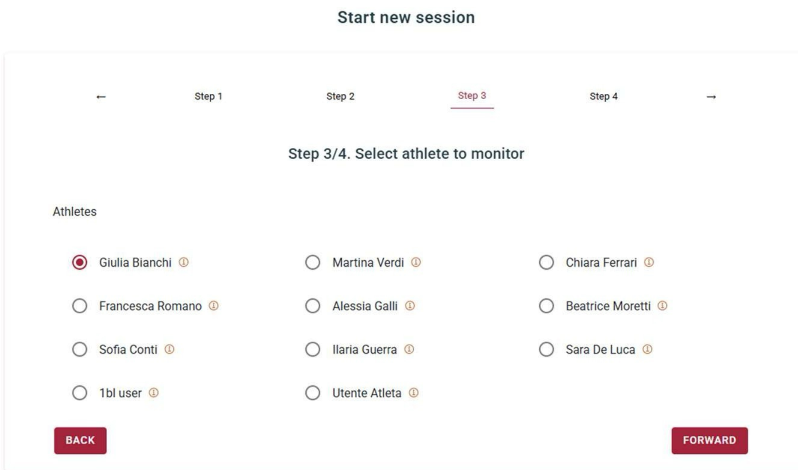


3. In case you select a personalized duration, you will have to compile the time duration forms that appears underneath the list, and click the save button to save the personalized duration. Once you receive the correct saving message you can continue to the next step.

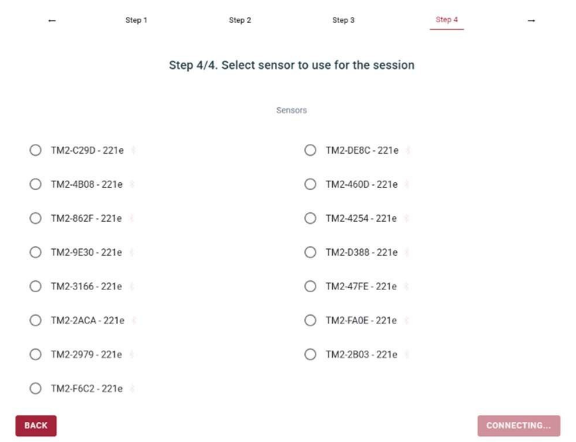


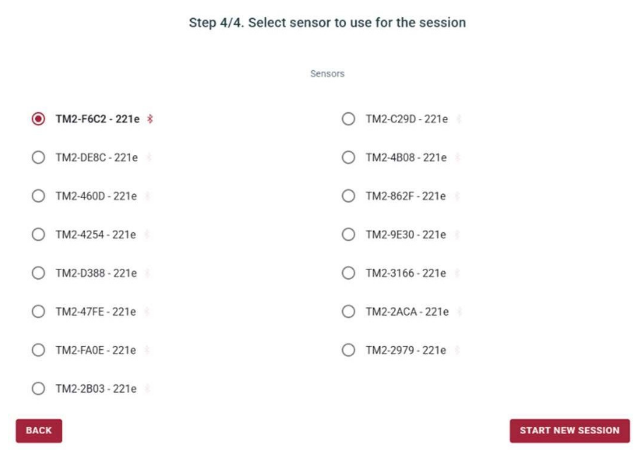


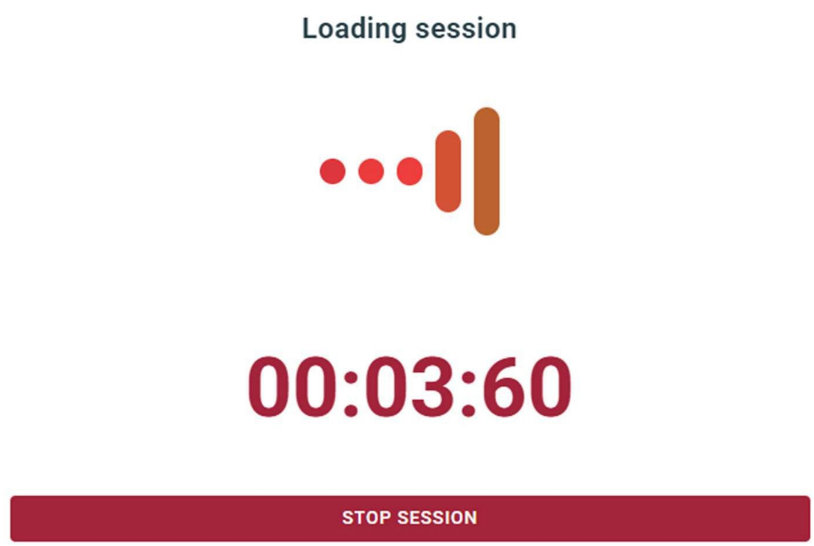
4. Select your athlete. For now, you can select any athlete on your team, but in future releases you will be able to select your athlete only among those that activated their account.



5. Select you sensor. If it’s disconnected, the browser’s popup will allow you to connect it.
   Once your sensor has blinked in yellow and has made a sound, you can start registering your session.

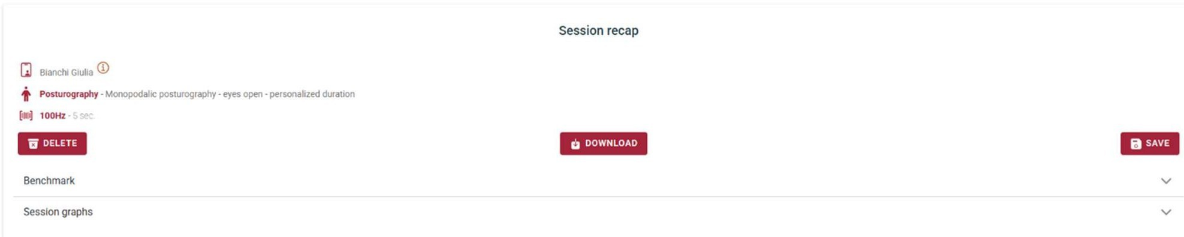





Loading session
00:03:60
STOP SESSION

c. YOUR SESSION'S RESULTS (ADMIN AND COACH ONLY)

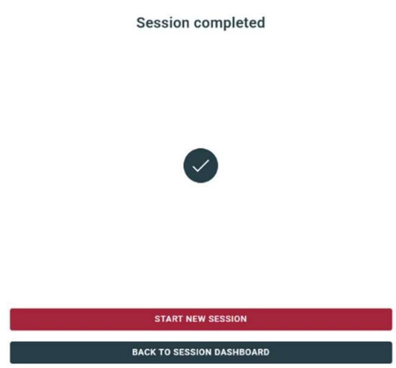
At the end of the countdown, you will see a recap of the session you just registered.



The recap contains:

- Your athlete's data
- The session's info (type, frequency,duration)
- Your action buttons:
  - DELETE deletes the session info and all sensor data registered during it
  - DOWNLOAD exports a file with the raw sensor data, useful for debugging purpose
  - SAVE saves your session and adds it to your session history to be accessed at a later date
- Benchmark drawer: opens to show your session data compared to a gold standard based on literature

- Session graphs drawer: opens to show your session graphs



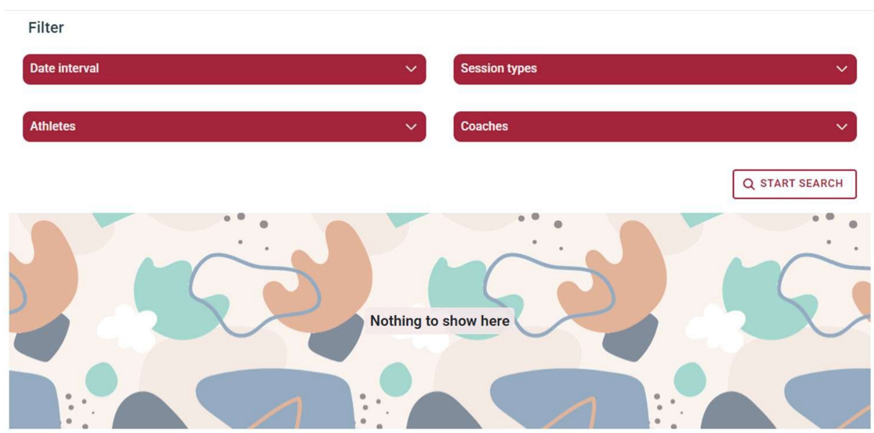
Once you confirm or delete your session, you can start over by registering another one or going back to your dashboard.

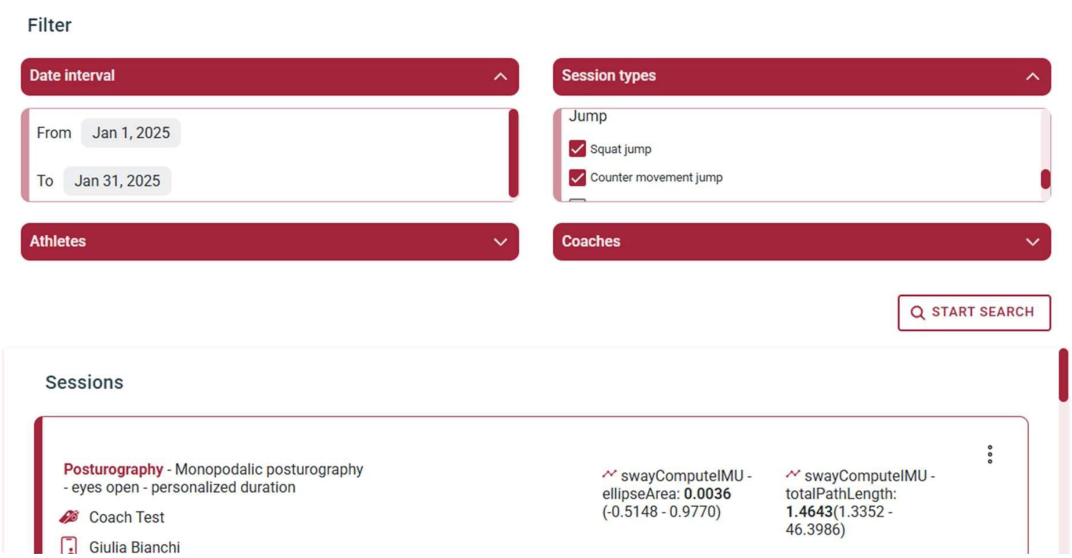
d. SEARCH IN YOUR SESSION HISTORY

You can access your sessions' history by the button on the session dashboard or from the side menu. The page presents at the top the available filters you can choose from by clicking on each one of them to expand it, a button to start your search and the result of your search at the bottom.

You can filter by:

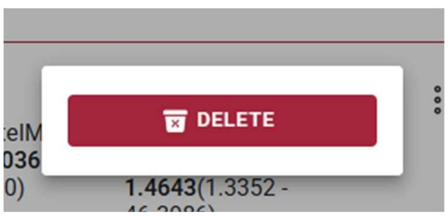
- Date interval (if an end date is not specified, it filters to today's date)
- Your team's athletes
- Session types
- Coaches who registered the session

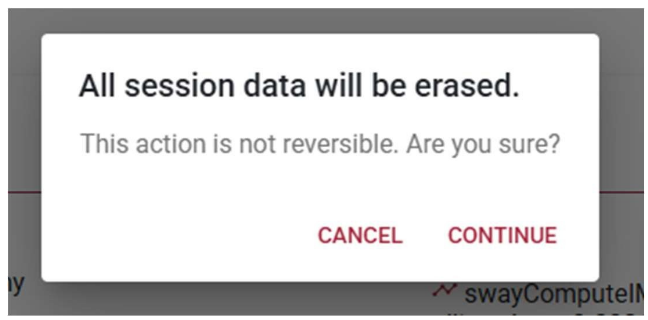



Filter
Date interval
From Jan 1, 2025
To Jan 31, 2025
Session types
Jump
Squat jump
Counter movement jump
Athletes
Coaches
START SEARCH
Sessions
Posturography - Monopodalic posturography - eyes open - personalized duration
Coach Test
Giulia Bianchi
swayComputeIMU - ellipseArea: 0.0036 (-0.5148 - 0.9770)
swayComputeIMU - totalPathLength: 1.4643(1.3352 - 46.3986)

e. DELETING A SESSION (ADMIN AND COACH ONLY)

Other than during the registration process, you can also delete a session from your session history clicking on the three dots on the right of the session card and clicking on the DELETE button.





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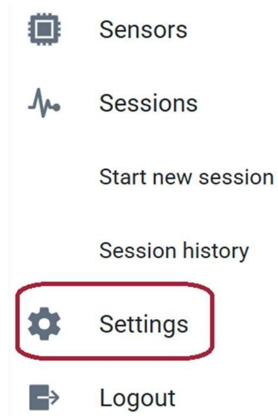
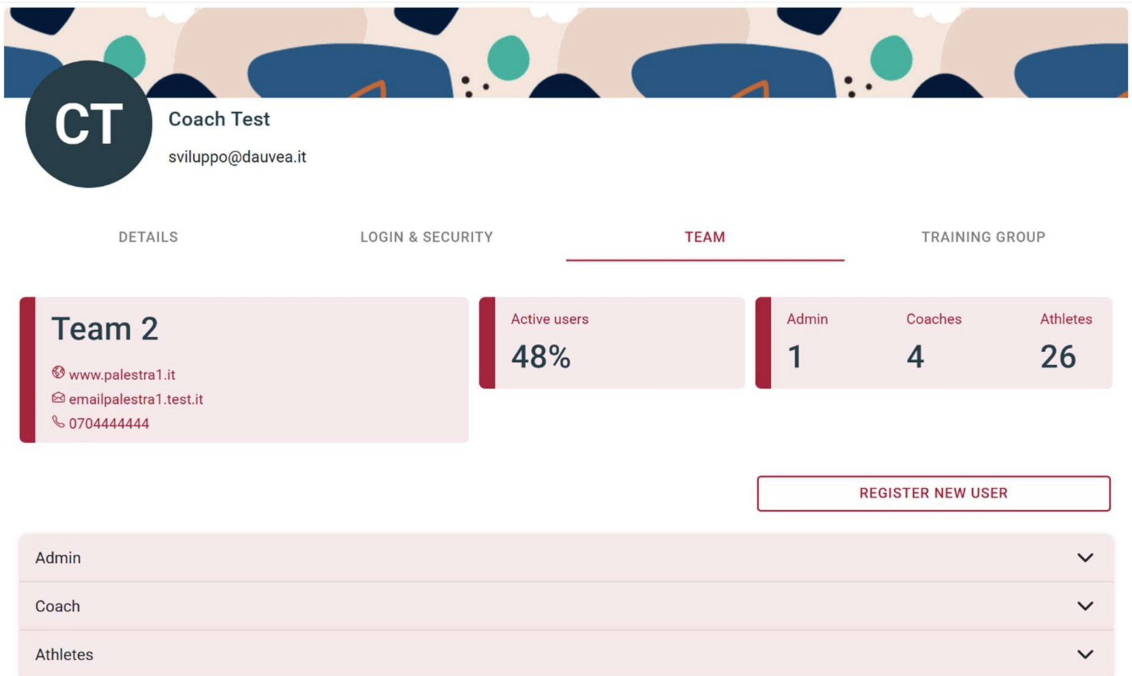
6. YOUR SETTINGS

You can access your team data either from the Home page from the button on top of your athletes list (for coaches and admins only) or from the Settings in the sidebar menu that you access from the menu button on the left of your header bar.

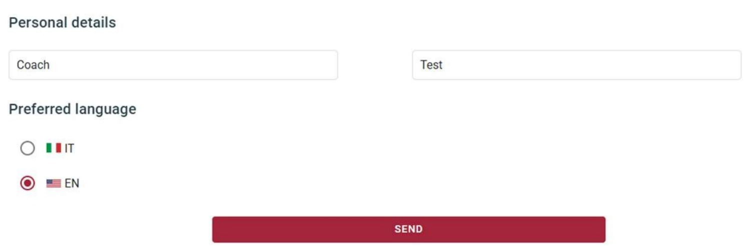


This is your settings area. From here you can access your account's data and a bird's eye view on all team members.

You can move between the different features by clicking on the tabs underneath your email address.



a. YOUR DETAILS



Here you can change your personal data. Athletes can also set their height and weight in this page.

b. YOUR SECURITY DETAILS

Here you can see more information onyou authentication method, reset your password if you are logging in with a custom form or delete your account. You can also change your authentication method by clicking the MODIFY button. If you choose to do so and change the authentication method to a custom one, you will receive an email notification to set your password.

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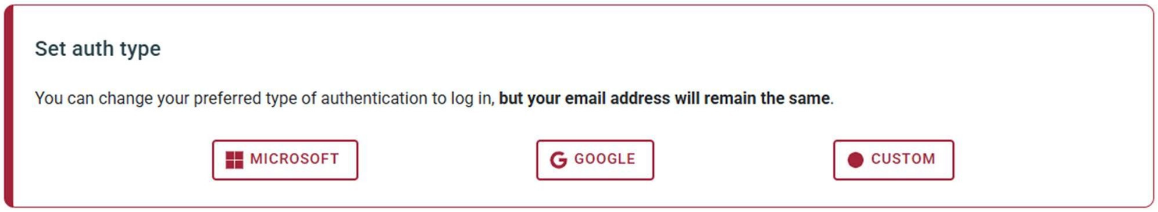
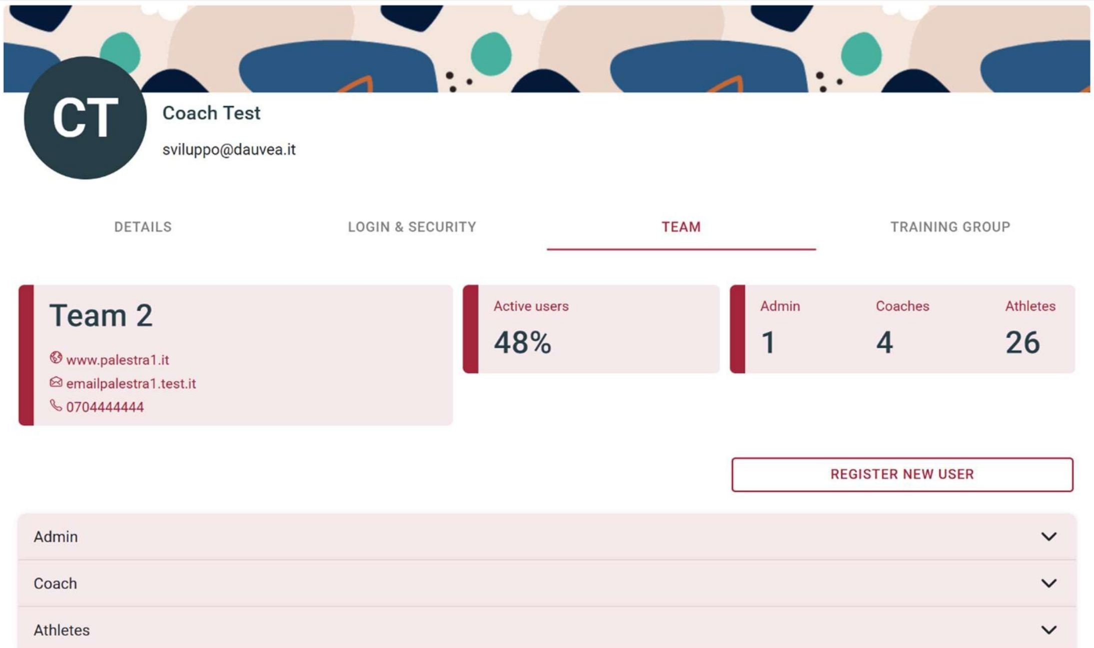

Set auth type
You can change your preferred type of authentication to log in, but your email address will remain the same.
MICROSOFT
GOOGLE
CUSTOM

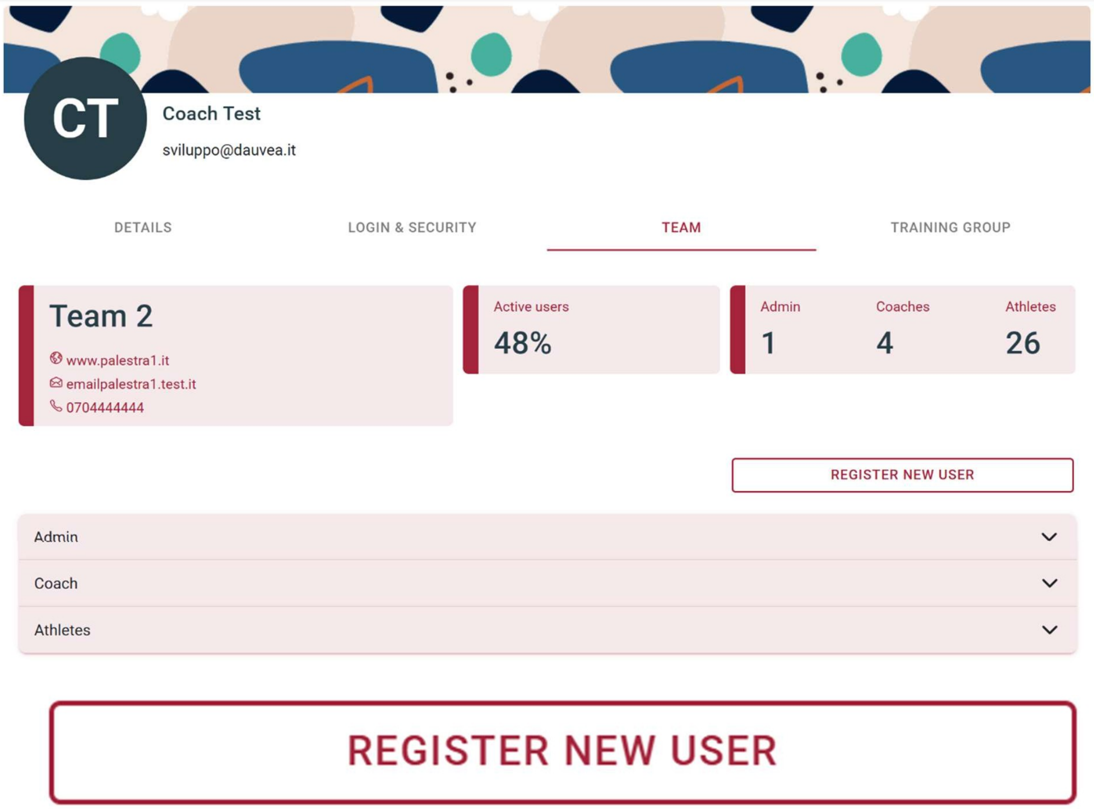
c. YOUR TEAM PAGE

The team page contains all important info and statistics pertaining your team. By opening and closing the drawers underneath the team's statistics, you can see the list of team members divided by role.

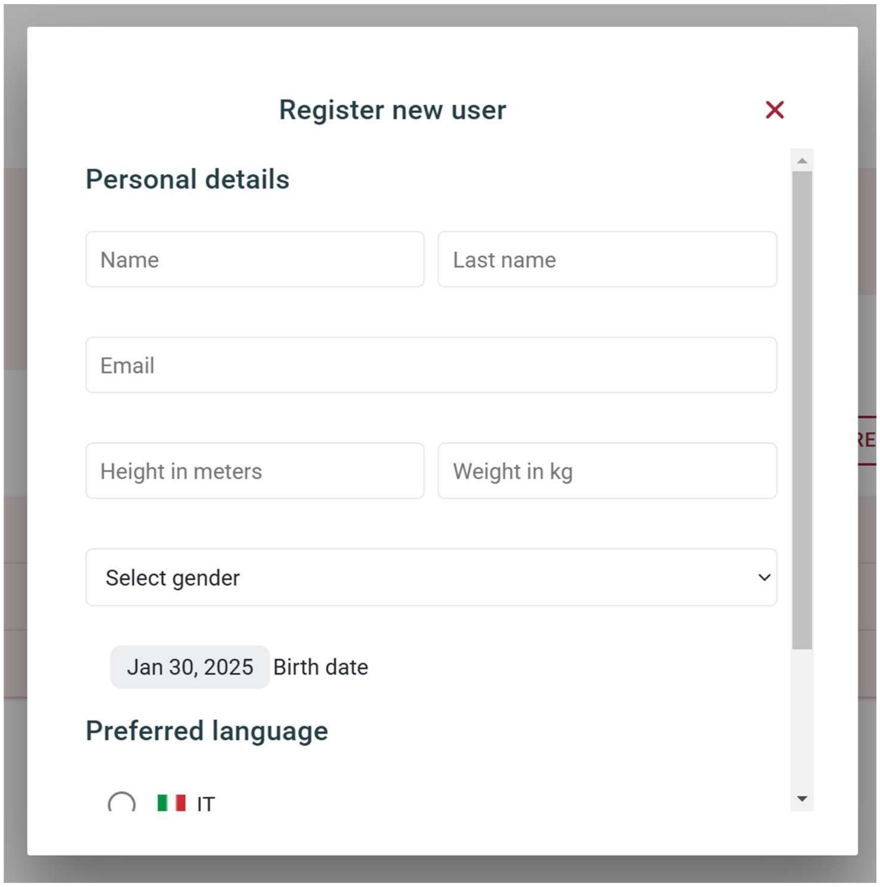


d. CREATE A NEW USER (COACH AND ADMIN ONLY)

1. From the team details section in your settings page, click on the "Register new user" button.



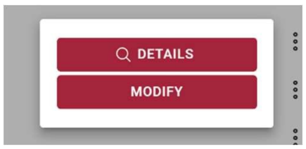
2. In the form that opens, insert the new user data. Keep in mind that the user will need a valid and unique email address to receive the email to activate their account.
   ONLY FOR ADMINS: you can also register coaches using the same form and selecting "coach" as user role.

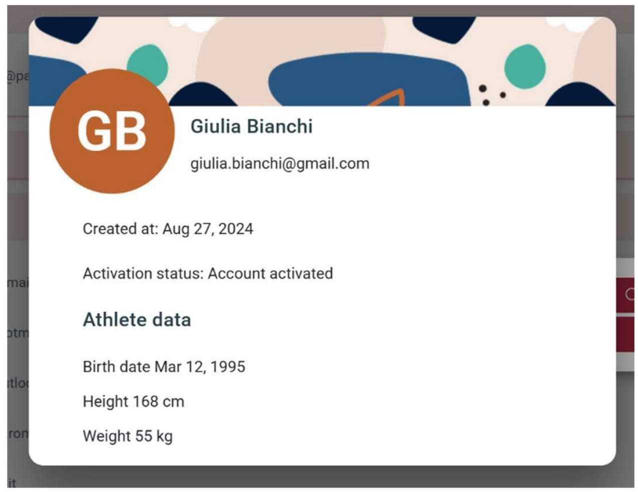


3. Once all data is correctly inserted, click on the SEND button.

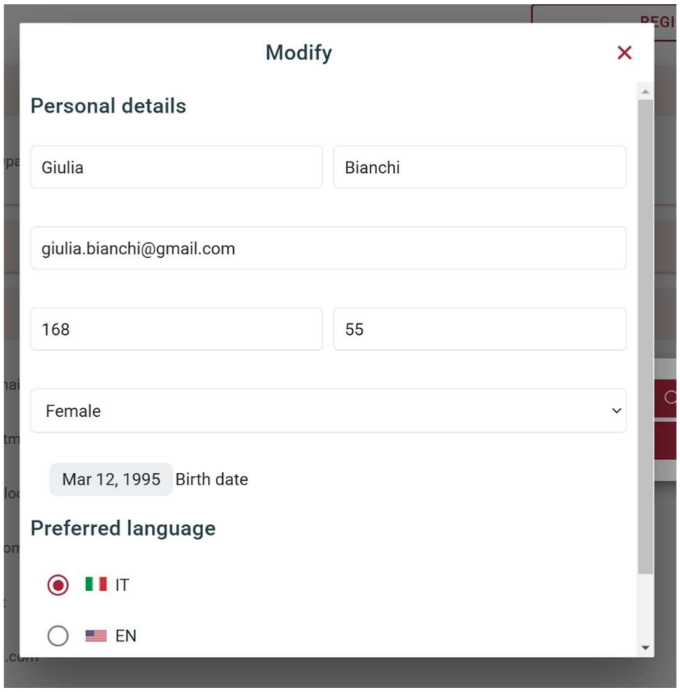
e. MODIFYING AN EXISTING USER (COACH AND ADMIN ONLY)

1. You can access the form to modify a user from the Home page or the team settings page, clicking on the three dots next to the user name. From there you can see the user details or modify the user's data.





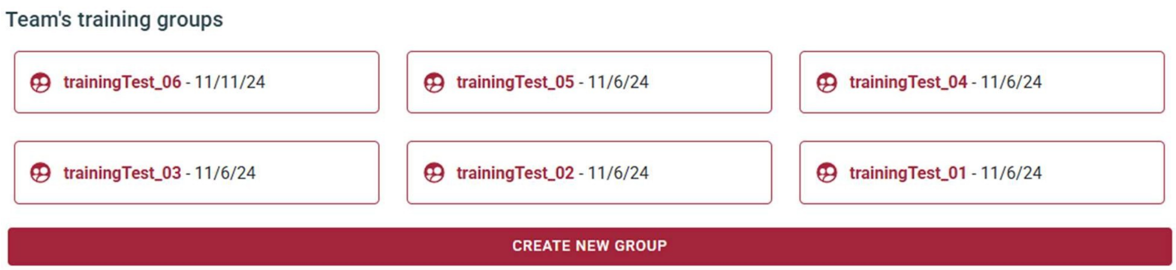
2. Click on the MODIFY button. A form with the user's info will open. Modify all the necessary fields, then click SEND at the bottom of the form.

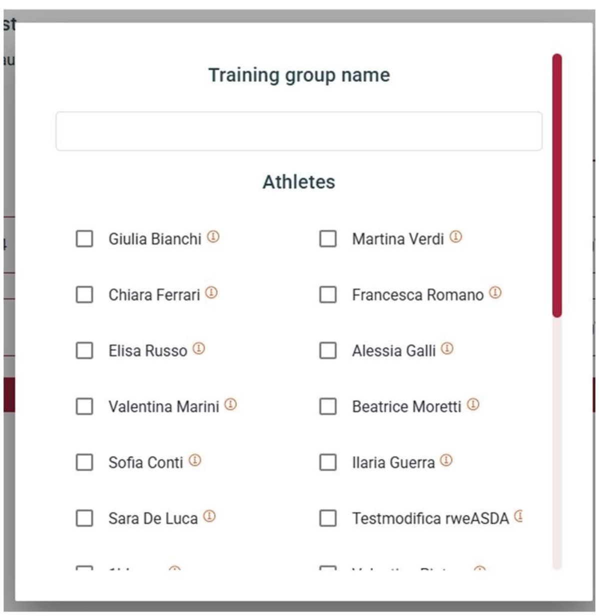


f. YOUR TRAINING GROUPS

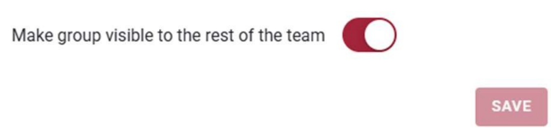
Here you can access all training groups you created, delete them or create new ones.

Training groups will be available to use in future implementations, but you can already create them now.





To create a new group, click on the CREATE NEW GROUP BUTTON and in the form that appears insert a name (mandatory), select your athletes and choose if you want the other team members to see your training group (yes by default).



Once you click SAVE the training group will be available to use.

Guidelines on how to improve the psychological and social well-being of athletes in the sporting context

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UNIVERSITÀ DEGLI STUDI DI CAGLIARI

DOCUMENT DETAILS	
Project Title	EDATS - European Digital Assisted Training in Team Sports
Project Number	101133614
Work Package	WP2 - Implementation of methodologies to detect and process biomechanical data
Activity	T2.2 - Best practice exchange and needs analysis in training definition methodologies
Delivery Date	29/11/2024 (D 2.2)
Leading Partner	Università di Cagliari
Implementation period	From March 2024 to November 2024
Dissemination Level	Public
Languages avallabile	English, French, Hungarian, Italian, Polish, Serbian

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1. Deliverable Introduction

The document "Guidelines on how to improve the psychological and social well-being of athletes in the sporting context", was drawn up thanks to the contribution of all the partners of the EDATS project and thanks to the professionalism present in each organization. Unica took care of the paragraph "Use of digital technologies in the sports context" thanks to the specialist contribution of Prof. Massimiliano Pau, the topics "Coach-athlete relationship" and "Gender equality and social inclusion" were edited by Dr. Andrja Geric, Sports Psychologist and Mental Coach (Sk Volley), while the "Environmental sustainability" section was written by Claudio Congiu (Alfieri) and Konrad Rechnio (UKS).

The drafting of the document was started in June 2024 and the drafting was completed in November 2024.

The document constitutes an initial analysis of needs and first basic research in relation to the well-being of the issues addressed, i.e. the health and well-being of athletes, injury prevention, the coach-athlete relationship, gender equality in sports environments and social inclusion.

The implementation phase of the project to which the document is linked concerns the implementation of methodologies to detect and process biomechanical data.

The target group of reference is made up of coaches, young athletes, sports managers and research professionals, for whom the paper will be useful to implement the subsequent training and awareness phases.

The "Guidelines" provide useful suggestions and guidance on how to improve the psychological and social well-being of athletes in the sports context, the coach-athlete relationship, how sport can be a tool for social inclusion, how technology can help sportsmen and how to promote gender equality in sport and environmental sustainability in sport. A specific section of the document has been dedicated to each of these topics.

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2. Preface

The main aim of the EDATS project is to support and encourage the professional and sporting careers of young athletes through the development and integration of digital technology that are accessible, easy-to-use and effective. This will be achieved through the pursuit of four specific goals:

1. By increasing collaboration between sports professionals and professionals experienced in applied digital technology;
2. By providing specific training on sport injury prevention to sports managers, coaches and young athletes;
3. By promoting the psychological and social well-being of athletes in sporting contexts;
4. By promoting awareness of environmental sustainability in sport and knowledge of European programs among young sportspeople and coaches.

The project approach is based on research and data collection, transnational and interdisciplinary dialogue through contributions from the partnership entities, testing of training programs, and implementation of tools to disseminate the results obtained and use them locally and internationally.

In the initial phases of the project, a series of activities aimed at realizing a greater increase in collaboration between sports professionals and professionals experienced in applied digital technologies. Based on such activities, the present document provides common guidelines on several aspects considered fundamental in the development of the EDATS initiative. In particular, the following areas have been covered:

1. How to improve the coach - athlete relationship;
2. How sport can represent a valid tool to enhance social inclusion;
3. How technology can help sportsmen and sportswomen;
4. How to promote gender equality and sustainability in sport.

Such activity has been carried out by considering, in the first place, the needs expressed by final users (particularly, trainers) using dedicated tools like questionnaires and focus groups.

3. Needs analysis and best practices in training methodologies.

3.1. Introduction

To develop a comprehensive understanding of what are the potential best practices in terms of biomechanical data collection for sports training, we employed a multi-phase methodology, which combines data obtained through questionnaires administered to stakeholders (i.e., trainers, strength and conditioning coaches, etc.) and extracted by collaborative discussions among project partners. This approach allowed for a diverse range of insights, addressing both technical and contextual factors critical to an effective biomechanical data collection protocol.

3.2. Questionnaire Development

The first step was to create a structured questionnaire, aimed at gathering detailed information on the current use of biomechanical data collection systems, particularly as regards the types of sensors employed, as well as the perceived benefits and challenges associated with the use of technology to obtain quantitative information about relevant biomechanical parameters. This questionnaire was designed to be administered to a wide range of users involved in different sport disciplines (not only volleyball) to ensure the broadest possible applicability of the findings. To create an effective survey, the project team identified core themes based on previous research and expert consultations, including injury prevention, training methodologies, sensor technology, environmental sustainability, gender equality, and social inclusion.

3.3. Data Collection

Once finalized, the questionnaire was distributed among athletes, coaches, and other sports professionals across various sports disciplines. The goal was to gather quantitative and qualitative data on the practical experiences as well as the opinions of respondents. In addition to questions on technical aspects of data collection systems and sensors, the survey included open-ended questions that allowed respondents to discuss challenges, recommend improvements, and share insights on inclusivity and sustainability in sports.

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3.4. Discussion and Analysis among Project Partners

Following data collection, the results were shared and discussed in a series of collaborative sessions planned among the project partners. These discussions served two main purposes:

3.4.1. Data Interpretation

Project partners analyzed the aggregated data to identify common challenges, effective practices, and emerging trends.

3.4.2. Needs Assessment

Insights from focus group discussions informed a needs analysis focused on injury prevention, coach-athlete dynamics, digital technology integration, sustainability, and inclusivity. These sessions enabled the team to align on shared goals, prioritize key findings, and explore potential applications across different sports environments.

Through this methodology, the project aimed to establish a common protocol for biomechanical data collection that is informed by real-world insights and collaborative expertise. The following sections present the findings and recommendations derived from this structured approach.

4. Biomechanical Data and Sensor Use in Sports

The primary objective of this initiative is to identify best practices in biomechanical data collection for sports beyond volleyball. Data gathered from the questionnaire highlights a variety of current experiences with biomechanical systems and identifies challenges, particularly around the selection and effective use of sensors.

4.1. Participants Profile

As shown by Figure 1 and 2, most respondents (predominantly coaches) come from the countries which compose the consortium, namely: Italy, Hungary, France, Poland and Serbia, thus providing a true European perspective on sports training and data collection needs. The analysis of age range data, which indicates an average around 40, suggests a mix of experience levels, likely providing insights from both established and emerging practices in the field. As shown by Figure 3, the varied background helps ensure that the findings reflect diverse viewpoints, especially those of coaching professionals who are pivotal in implementing training methodologies and data practices.

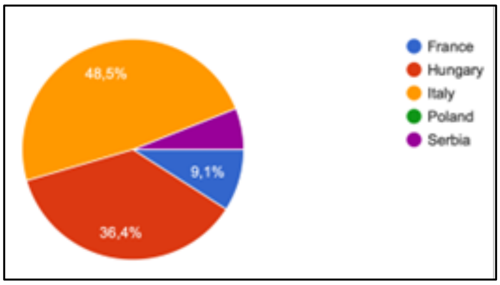

Figure 1: Nationality of respondents

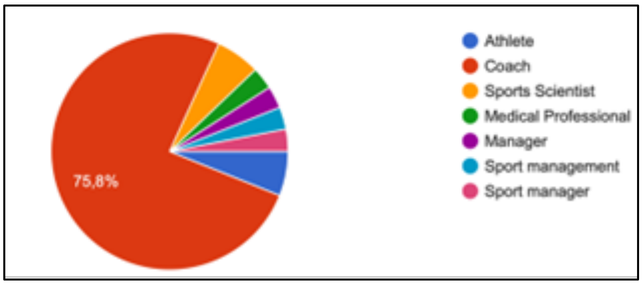

Figure 2: Professional profile of respondents

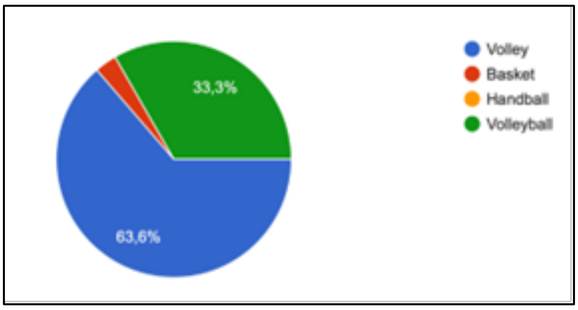

Figure 3: Sport background of respondents

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4.2. Experience with Biomechanical Data Collection Systems

Responses indicate that nearly half of the participants (45%) currently use biomechanical data collection systems in their training or professional practice. This suggests moderate adoption, with a notable portion of respondents (55%) either not using these systems or lacking familiarity with them. The relevant percentage of the latter is probably due to the cost of the systems (often considered not affordable especially for small clubs), resource requirements, and expertise needed to effectively integrate the results obtained from the biomechanical systems into the daily training planning routine, especially for sports practitioners who might prioritize practical training methods over technology-driven analytics.

4.3. Sensor Types and Preferences

Among those using biomechanical systems, accelerometers and force plates are the most employed devices, due to their versatility in measuring kinematic (i.e. accelerations, speed and trajectories) and kinetic (i.e., forces) parameters. Such preferences highlight a focus on tracking biomechanical parameters that are universally applicable across many sports. However, a few responses mention the use of in-body sensors and motion capture systems, signaling an interest in more advanced or specialized data. This variety in sensor choice may reflect both the financial and logistical considerations of adopting complex tools in different sports contexts.

4.4. Perceived Effectiveness of Data Extracted by Biomechanical Systems

Most participants find biomechanical data collection systems effective in terms of contribution to improve their training programs, with a significant number of respondents labeling them "effective" (50%) or "very effective" (20%). Only a few report a neutral stance, suggesting that while users generally see value in these tools, some may struggle to fully leverage their potential. The enthusiasm for these systems likely stems from their ability to provide precise feedback, though there appears to be room for improvement in training on system use and data interpretation.

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4.5. Key Challenges in System Utilization

The main challenges revolve around **ease of use**, **cost**, **system integration**, and **data interpretation**. For many respondents, the cost remains a prohibitive factor, particularly in sports environments where budget constraints are common. The complexity and integration with other training systems also pose issues, making it difficult for users to combine data from multiple sources or apply it in real time. This highlights the need for further "low-cost" affordable, user-friendly technologies and emphasizes the importance of developing best practices for data integration and interpretation, potentially through standardized protocols and training resources.

4.6. Injury Prevention Priorities

As shown in Figure 4, a substantial portion of respondents emphasize the importance of **proper warm-up and cool-down routines** and **strength conditioning** as pillars of injury prevention. Recovery techniques are also frequently highlighted, indicating a broad recognition of the value of holistic approaches to athlete care. This reflects a preventive approach to sports training that combines physical preparation, recovery strategies, and biomechanical assessments, aligning with modern understandings of injury mitigation.

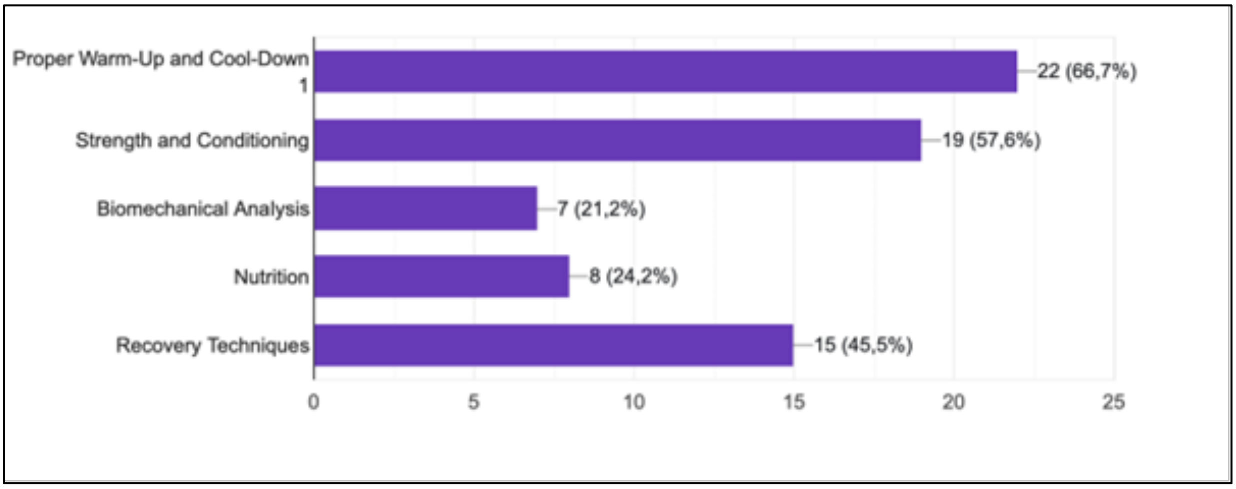

Figure 4: Replies on the most critical aspects of injury prevention in sport training

4.7. Digital Technologies in Training

The application of digital technologies in training is quite widespread, with **video analysis tools** and **training apps** as the most widely employed. These tools offer valuable visual feedback and structured progress tracking, enhancing athletes' and coaches' abilities to monitor and refine performance. Wearable devices, although not as prevalent, provide more individualized data, often used alongside other digital platforms. This enthusiasm for digital tools reflects a growing appreciation for data-driven coaching, even in smaller or less funded training environments.

4.8. Environmental Sustainability Perspectives

Three-quarters of respondents consider sustainability either important or very important, indicating a growing awareness of environmental impact within sports contexts. Suggestions for improvement, like using energy-efficient facilities and sustainable equipment, illustrate a movement toward integrating eco-friendly practices within sports organizations. This priority aligns with broader societal trends and points toward an emerging responsibility for sports professionals to consider their environmental footprint.

4.9. Conclusion

This project findings provide a solid foundation for enhancing collaboration between sports professionals and technology experts, advancing biomechanical data collection practices, and creating an ICT platform to support athlete well-being and performance. The insights gathered through the questionnaire highlight key areas of alignment and opportunity to address the project's goals.

4.9.1. Strengthening Collaboration Across Disciplines

The responses reveal a gap in shared knowledge and access to biomechanics-focused resources among sports professionals. Although many coaches and athletes recognize the benefits of biomechanical data, challenges regarding cost, complexity, and data interpretation indicate a need for interdisciplinary collaboration. By connecting sports professionals with technology experts, it would be possible to create a knowledge-sharing network that demystifies biomechanical data, aligns technology choices with practical training needs, and facilitates real-world applications.

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Collaborative workshops, training modules, and shared resources will empower coaches, trainers, and sports scientists to effectively apply biomechanical insights, enhancing the coach-athlete relationship through improved understanding of individual needs and performance indicators.

4.9.2. Selecting Sensors and Defining a Data Collection Methodology

The survey shows a preference for widely accessible sensors, such as accelerometers, force plates, and motion capture systems, particularly for measuring movement, force, and speed. These tools are commonly associated with injury prevention and training optimization, aligning well with project goals.

Based on the user feedback, a clear methodology can be developed that focuses on standardized data collection practices for injury prevention and performance improvement. This methodology should outline:

- **Sensor selection guidelines** based on sport-specific needs, cost-effectiveness, and ease of use;
- **Data collection protocols** that prioritize ease of interpretation, enabling coaches and athletes to make quick, evidence-based adjustments in training;
- **Integration steps** to combine biomechanical data with digital training tools like video analysis and wearables, fostering a seamless, data-informed approach to coaching.

This systematic approach can serve as a benchmark for data collection, ensuring consistency, reliability, and broader applicability across sports environments.

5. Improving Coach-Athlete Relationships in Sport

The relationship between a coach and an athlete is one of the most important factors that influence athletic performance, development, psychological state of athlete and overall well-being. This bond, built on trust, communication, and mutual respect, shapes the athlete's experience in sport and impacts their ability to perform under pressure. A strong coach-athlete relationship is not only essential for success but also for the athlete's motivation, psychological well-being, and long-term growth. However, like any relationship, the coach-athlete dynamic requires effort, self-awareness, and intentional strategies to ensure it remains positive and productive. Key strategies to improve the coach-athlete relationship in sport are communication, trust-building, emotional intelligence, and individualized coaching.

5.1. The Role of Communication

Effective communication is the cornerstone of any successful coach-athlete relationship. In sport, clear, honest, and consistent communication is essential for setting expectations, providing feedback, and offering emotional support. According to Jowett and Ntoumanis (2004), open communication helps both coaches and athletes understand each other's perspectives, which fosters mutual respect and enhances cooperation. It allows coaches to convey their training methods and strategies while enabling athletes to express their needs, concerns, and feedback.

One of the key aspects of communication in the coach-athlete relationship is feedback. Coaches should provide both positive and constructive feedback to guide the athlete's improvement. Positive reinforcement is critical for building confidence, especially in younger or less experienced athletes, while constructive feedback provides the athlete with specific areas to work on without undermining their self-esteem. Importantly, coaches should be mindful of how they deliver feedback, ensuring it is clear, non-judgmental, and aimed at improving performance.

Furthermore, active listening is an often-overlooked component of effective communication. Coaches should not only speak but also listen to their athletes, giving them space to express their thoughts, emotions, and concerns. This creates an open environment where athletes feel valued and understood, which in turn promotes a positive relationship. Research indicates that athletes who feel listened to by their coaches are more likely to feel motivated, trust their coach's decisions, and remain engaged in their sport (Mageau & Vallerand, 2003).

5.2. Building Trust

Trust is a fundamental element in any coach-athlete relationship. Without trust, the relationship is likely to be marked by tension, miscommunication, and dissatisfaction. Trust in a coaching context involves the athlete's belief that the coach has their best interests at heart, is knowledgeable, and is committed to helping them succeed. Coaches must earn this trust by being consistent, fair, and transparent in their actions and decisions.

One way to build trust is through consistency. When athletes know what to expect from their coach, whether it be in terms of behavior, feedback, or training philosophy, they are more likely to trust the coach. A coach who frequently changes their expectations, approach, or demeanor may create uncertainty and confusion, leading to a breakdown in trust.

Fairness is another important component of trust. Athletes need to feel that they are being treated equitably compared to their teammates, regardless of their skill level or status on the team. Coaches who show favoritism or fail to provide equal opportunities for development can damage the trust they have built with their athletes. Fairness also extends to how a coach handles mistakes and setbacks. A coach who is understanding and supportive in these situations is more likely to foster a trusting relationship than one who reacts harshly or punitively.

Lastly, transparency in decision-making helps build trust between coaches and athletes. Athletes often have strong emotional investments in their performance and playing time. When a coach makes decisions, such as adjusting an athlete's role on the team or changing a training regimen, it is important to explain the rationale behind these choices. This openness helps athletes understand the coach's reasoning and ensures they do not feel unfairly treated or confused by decisions that affect their athletic development.

5.3. Emotional Intelligence and Empathy

Emotional intelligence (EI) is another critical factor in the coach-athlete relationship. EI refers to the ability to understand, manage, and respond to one's

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own emotions and the emotions of others. A coach with high emotional intelligence is better equipped to navigate the emotional landscape of their athletes, especially in the high-pressure environment of competitive sports.

Empathy, a key component of emotional intelligence, allows coaches to connect with their athletes on a personal level. By recognizing and validating the emotions and challenges that athletes face, coaches create a supportive environment where athletes feel safe to express themselves. Empathy also helps coaches identify when an athlete may be struggling mentally or emotionally, even if they are not directly expressing it. This awareness allows coaches to intervene with appropriate support, whether it be through one-on-one conversations, adjustments to training, or referrals to a sports psychologist if necessary.

In addition to fostering emotional support, coaches with high emotional intelligence can better manage their own emotions in stressful situations. Sports can be highly charged environments, and coaches who are able to remain calm and composed in the face of setbacks, mistakes, or losses demonstrate emotional resilience. This composure not only sets a positive example for athletes but also creates a more stable and supportive team environment.

5.4. Individualized Coaching

One-size-fits-all coaching is no longer considered an effective approach, especially in modern sports environments where athletes differ in terms of personality, motivation, learning style, and development stage. Individualized coaching involves tailoring one's coaching approach to meet the unique needs of each athlete, which is essential for building a strong coach-athlete relationship.

Research has shown that athletes respond differently to various motivational styles (Vallerand, 2007). Some athletes may thrive on positive reinforcement and a collaborative coaching style, while others may prefer more structured guidance and direct feedback. Recognizing and adapting to these differences helps coaches connect with each athlete on a personal level, thereby fostering mutual understanding and trust.

Individualized coaching also involves considering the personal and emotional needs of athletes. For example, some athletes may require more emotional support during times of personal stress or after a poor performance, while others may prefer to be left alone to process their emotions independently. Coaches who take the time to understand the individual personalities and emotional needs of their athletes are better able to provide the right type of support at the right time.

In addition, goal setting is an area where individualized coaching can have a significant impact. Coaches who work with athletes to set personalized, achievable goals that align with their long-term aspirations show that they are invested in the athlete's development. These goals should be specific, measurable, and tailored to the athlete's current level of skill and performance, allowing for steady progress and motivation.

5.5. Conclusion

The coach-athlete relationship is a vital component of success in sports, and improving this relationship requires intentional strategies that focus on communication, trust-building, emotional intelligence, and individualized coaching. By fostering open communication, coaches can ensure that athletes feel heard and valued, while building trust through consistency, fairness, and transparency creates a stable foundation for development. Emotional intelligence and empathy allow coaches to support athletes through emotional challenges, while individualized coaching ensures that each athlete's unique needs and motivations are met.

Ultimately, a strong coach-athlete relationship not only enhances athletic performance but also promotes long-term psychological well-being and personal growth for athletes. Coaches who invest time and effort into developing these relationships will not only see improved outcomes on the field but will also contribute to the overall development of confident, motivated, and resilient athletes.

5.6. References

- Jowett, S., & Ntoumanis, N. (2004). The coach-athlete relationship questionnaire (CART-Q): Development and initial validation. *Scandinavian Journal of Medicine & Science in Sports*, 14(4), 245-257.
- Mageau, G. A., & Vallerand, R. J. (2003). The coach–athlete relationship: A motivational model. *Journal of Sports Sciences*, 21(11), 883-904.
- Vallerand, R. J. (2007). Intrinsic and extrinsic motivation in sport and physical activity. *Handbook of Sport Psychology*, 3, 59-83.

6. Use of digital technologies in the sports context

In sports, like many other fields of human living, technology plays a pivotal role as it influences both the way games are played as well as the degree of involvement and enjoyment by fans. Of course, the technological advancements affect different aspects of sports world. At first, it can certainly be observed that the evolution in terms of sensors, materials and improved knowledge of human physiology and genetics strongly support the enhancement of athlete performance. Indeed, in recent years the availability at affordable cost of wearable technology allowed athletes and coaches to have available real-time data on several physiological metrics such as heart rate and heart rate variability, oxygen saturation, quantity and quality of sleep, as well as biomechanical data on acceleration and speed of body segments which are essential in characterizing the human movement. Moreover, devices like GPS trackers and accelerometers allow for precise monitoring of an athlete's movements, enabling coaches to optimize training programs and minimize the risk of injuries.

In addition to performance enhancement, technology plays a crucial role in ensuring the safety and well-being of athletes. For instance, in contact sports like football and hockey, concussions and other traumatic brain injuries are of significant concerns. To address this issue, researchers have developed innovative helmet designs equipped with sensors that can detect and measure the impact of collisions in real-time. This data enables medical professionals to assess the severity of head injuries more accurately and implement appropriate treatment protocols. It is also noticeable that, to date, there are many options in terms of medical screening and treatments to protect athletes' health and promote their wellbeing. For instance, diagnosis and treatment of injuries are greatly facilitated by imaging tools such as MRI, TC and ultrasound. Because of the huge available amount of data they provide, it is possible to accurately characterize virtually any kind of musculoskeletal injuries, thus supporting clinicians in planning optimized and tailored rehabilitation plans for athletes. At last, it should be remarked how the development of soft exoskeletons and advanced prosthetics allows disabled individuals to compete at the highest level, thus showcasing the potential of technology to overcome physical limitations.

Technology is also gradually modifying the way fans interact with their favorite sports and athletes. Besides the explosion of social media platforms like X, Instagram, and TikTok, which have become invaluable tools for athletes to connect

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with their fans as they provide behind-the-scenes insights, fostering a sense of community, virtual and augmented reality technologies have opened up new possibilities for immersive fan experiences, allowing viewers to feel like they are part of the action from the comfort of their homes. Also, the availability of real-time data coming from the athlete just while he/she is performing (think about heart rate in F1 races or cycling, jump height in volleyball, speed in track and field, traveled distance and shooting accuracy in soccer, etc.) greatly improves in the audience the sense of presence while the action takes place, and make fans aware of the more appealing details associated with the performance.

6.1. Technological solutions

As specifically regards volleyball, the most mature and/or promising technological solutions include:

6.1.1. Video analysis

Footage of training sessions and matches can now be analyzed in detail (even with the support of AI tools) to obtain data about ball trajectory and speed as well as athlete's movement. In this context, video analysis is essential for coaches to identify strengths, weaknesses, and areas for improvement and thus subsequently develop more effective training plans.

6.1.2. Wearable devices

Wearable devices for training and conditioning: as previously mentioned, wearable devices can provide coaches with valuable data on a player's performance. Some of the information that can be gathered with miniaturized non-invasive devices include heart rate, speed, and distance covered during training and games, jump heights. This data can then be used to tailor training programs to individual players' needs and help reduce the risk of injury.

6.1.3. Data analytics

The ever-growing impact of AI on our society, reflects also on complex sports like volleyball. Indeed, using dedicated machine learning models, teams can predict player performance, strategize rotations, and analyze vast amounts of match data quickly. These insights are invaluable for crafting match-winning strategies.

7. Environmental sustainability

In a world increasingly aware of the environmental and social challenges we face, sustainability has become a central theme in almost every aspect of our lives. And sport is no exception. In this chapter, we will explore why sustainability in sports is crucial, the benefits it offers, the types that exist, and what environmental sustainability is in the sports industry.

Sustainability is fundamental because it responds to the need to protect our planet and its resources for future generations. In the context of sport, this importance is amplified, as sport has a significant impact on the environment, health, society and the economy. Some key reasons why sustainability in sport is crucial include:

7.1. Threats of sustainability

7.1.1. Environmental responsibility

Sports activities often have a high consumption of natural resources, such as water and energy, and generate waste. Sustainability in sport seeks to reduce this negative impact on the natural environment.

7.1.2. Social Impact

Sport has a powerful social reach and can affect the community in a variety of ways. Social sustainability refers to the promotion of equal opportunities, inclusion and access to sport for all.

7.1.3. Economic profitability

Economic sustainability in sport involves the responsible management of financial resources, ensuring that sports projects are feasible and that long-term benefits are generated.

7.2. Opportunities in relation with sustainability

On the other hand, sustainability in sport offers several benefits, both for the environment and for society and the economy.

7.2.1. Environmental benefits

Through measures such as reducing energy and water consumption, waste management and promoting sustainable mobility.

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7.2.2. Social benefits

Through measures such as accessibility to sports facilities, inclusion of disadvantaged groups, promotion of physical and environmental education and injury prevention.

7.2.3. Economic benefits

Through measures such as reducing operating costs and improving brand image. Even the most important planetary organizations include sustainability among the main topics of discussion

7.3. Connectivity to EU directives

The UN 2030 Agenda for Sustainable Development is an action program for people, the planet and prosperity signed in September 2015 by the governments of the 193 member countries of the United Nations. It encompasses the 17 Sustainable Development Goals.

Sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs. To achieve sustainable development, it is important to harmonize three fundamental elements: economic growth, social inclusion and environmental protection.

The role of sport is important in achieving the Sustainable Development Goals (SDGs) as its universal language unites peoples, cultures and genders. In 2017, UNESCO, during the 6th International Conference of Ministers and Senior Officials responsible for Physical Education and Sport (Mineps VI), made the Kazan Plan, a global agreement that combines sports policies and the Sustainable Development Goals, operational.

Specifically, sport intervenes on many of the goals set:

- It ensures a healthy life and promotes the well-being of all;
- Guarantees quality education, gender equality;
- Promotes economic growth and decent work;
- Reduces inequalities between countries;
- It makes cities resilient, safe and sustainable;
- Promotes peaceful societies.

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7.3.1. Objectives related to sport

The possible role of sport in achieving each of the 17 goals might be:

- **SDGs 1. Ending poverty / SDGs 8.** Work and economic growth: sport is obviously also economy and work; In fact, the sports sector encompasses types of employment at different levels, capable of offering ample job and income opportunities even for the less well-off social categories.

- **SDGs 2. Achieving zero hunger**, achieving food security, improving nutrition and promoting sustainable agriculture: sport can raise awareness of the importance of buying sustainable food, food security, healthy nutrition and sustainable agriculture.

- **OSS 3. Health and well-being:** sports activity improves well-being, health and prevents diseases and is an excellent tool for education to an active and healthy lifestyle. In addition, the variety of existing sports ensures that sports can be practiced at all ages and in all physical conditions and at all income levels.

- **SDGs 4. Providing quality education/ SDGs 5.** Gender equality: sport and physical education can motivate children and young people to attend and engage in education, and through the practice of sport, key skills and values such as tolerance and inclusion can be taught, sending a positive message for the elimination of gender differences even in broader contexts.

- **SDGs 6. Sustainable water management /SDG 7. Clean energy:** sports contexts such as water sports can promote and bring about improvements in water quality by reducing pollution and waste. Water use efficiency and energy efficiency also need to be improved in sports facilities by applying relevant standards and regulations.

- **OSS 9. Promoting innovation and resilient infrastructure:** sport can provide innovative and accessible sports spaces, supporting the construction and renovation of infrastructure, including sports facilities.

- **SDG 10. Reducing inequalities between countries:** Sport is an effective tool for addressing inequality in hard-to-reach areas and for empowering individuals and communities.

- **SDG 11 Sustainable cities and communities:** sport encourages a green economy, the resilience of cities, the healthiness of environments. A healthy sporting activity requires the search for clean spaces, whether they are outdoors or indoors. Sport can help remove obstacles and barriers in the environment, transport and public services to ensure access for all, including persons with disabilities.

- **SDGs 12-13-14-15 Sustainable development:** sport can support sustainable consumption and production and nature-friendly lifestyles, reducing the environmental impact of sporting events (e.g. plastic-free stadiums and stadiums with photovoltaic panels, recycling of sports equipment, eco-sustainable uniforms, separate waste disposal). In addition, sports and sporting events, especially aquatic sports, can be excellent platforms for promoting the conservation and sustainable use of the oceans and seas.

- **SDGs 16-17 Peace, Justice and Strong Institutions and Partnerships:** sport offers a powerful communication platform to spread values such as respect, fair-play and teamwork. The global reach and universal character of sport make it a fundamental tool for pooling resources, creating synergies and creating multi-stakeholder networks and partnerships to foster sustainable development and the achievement of peace goals.

7.4. Sustainability of sport events in global context

In terms of sustainability, an important contribution is made by the organization and implementation of sporting events. Sporting events often consume significant resources and have a significant impact on the environment, involving aspects such as stadium construction, spectator influx management, carbon emissions, waste generation and much more.

According to a study by the United Nations Organization (UN Environment Emissions Gap Report), the sports sector produces between 1% and 2% of global greenhouse gas emissions. In some countries, including Italy, there is a positive trend in action to reduce these emissions.

An effective control and planning tool is given by the ESG (Environmental, Social and Governance) strategy, which is taking on an increasingly central role in the panorama of sporting events. Within sport events, this strategy refers to the approach taken by organizers to manage and integrate environmental, social and governance considerations into their activities and decisions. This approach aims to promote sustainability, social inclusion, accountability and transparency in the organization and conduct of sporting events. It includes actions such as reducing the environmental impact of events, promoting diversity and inclusion, protecting human rights, and improving corporate governance and ethics. ESG strategy is essential to ensure that sporting events are managed responsibly and sustainably, respecting the environment, the people and the communities involved.

Sport represents a privileged channel through which to act and communicate sustainability and it is precisely on this aspect that the medium and long-term plans of many sports organizations are focusing. The IOC (International Olympic Committee) and the United Nations share the goal of making the world a more peaceful and sustainable place. For the IOC, this means ensuring that sport plays a vital role in promoting education, peace, social inclusion and a healthy lifestyle. And when in 2015 sport was officially recognized as an important stimulator of sustainable development and was included in the United Nations 2030 Agenda, the IOC developed its strategy, placing Sustainability as one of the three pillars of the Olympic 2020 Agenda, together with Credibility and Youth. The Olympic Agenda 2020+5 is the new plan that regulates the next 5 years and adds some key trends to the five main areas (infrastructure and natural sites, procurement and management of resources, mobility, workforce and climate): Solidarity, Digitalization, Sustainability, Credibility, Economic and Financial Resilience. As the leader of the Olympic Movement, the IOC uses its influence to encourage the entire Olympic Movement – including National Olympic Committees, International Sports Federations and athletes – to make sport more sustainable.

The European Commission has also contributed to the debate on the subject, through recommendations on green and sustainable sport. The result of a shared work within the Expert Group on Green and Sustainable Sport created by the European Commission in conjunction with the provisions of the fourth EU Work Plan for Sport 2021-2024, of which the Department for Sport has been an integral part since 2021, the recommendations aim to understand the landscape of "green sports" within the EU and map the projects, existing initiatives and practices.

7.5. European strategies in relation with sustainability

Aimed mainly at European and national public authorities responsible for sport and organizations in the sports sector, the recommendations are divided into 4 sections:

- Innovative cross-industry solutions;
- Sustainable sports infrastructure;
- Sustainable sporting events;
- Education and promotion of sustainable sports practices.

They represent a concrete common strategy aimed at encouraging the different actors operating in the world of sport to adopt measures, practices and actions that have a lower impact on the environment, supporting consumption, sustainable production and lifestyles that respect nature. The policies and actions of policymakers in EU Member States, international and national sports federations, professional and grassroots sports clubs, the fitness sector, the sporting goods industry, the sports tourism sector, but also consumers, leisure athletes and, finally, fans, have a significant impact on the climate and the environment.

Member States are invited to:

- Developing national strategies for sustainable sport;
- Make public funding to national governing bodies in the sports sector conditional on the achievement of sustainability objectives.

Sports organizations are invited to:

- Establish the carbon footprint, i.e. the measure of the amount of greenhouse gas emissions released into the atmosphere by activities for one's sport;
- Develop environmental sustainability plans as part of the development strategy of their sport.

The Commission's recommendations represent a clear picture of the strong desire of the sports world to act on issues related to environmental sustainability to which sport is also called upon to contribute and are consistent with the international and European standards of the Green Deal and the United Nations 2030 Agenda.

In addition, the call for expressions of interest to take part in the Community of Practice on Green and Sustainable Sport SHARE 2.0 has been launched, whose members will work on the implementation of the recommendations of the Expert Group on Green Sport. This community will be open to all former members of the Group and all those interested in playing an active role in making sport more sustainable.

7.5.1. Sport for Climate Action initiative

The Sport for Climate Action initiative is another initiative towards environmental sustainability. Promoted in 2016 by the UNFCCC (United Nations Framework Convention on Climate Change) and other institutions to unite the efforts of the sports community towards environmental sustainability. The goal is to involve the world of sport in the fight against climate change, with a focus on reducing CO_2 emissions and climate education, promoting sustainable and responsible consumption and encouraging concrete climate action through communication.

7.5.2. Possible solutions to make sports more sustainable for the environment

There are numerous start-ups and initiatives committed to making sports activities and practice increasingly carbon free. Let's see some of the possible innovations to alter the bio-physicality of the planet less and less.

For traditional sports that are already popular, there are multiple ways to increase their sustainability. The implementation of energy-efficient lighting systems in sports facilities, the use of recycled water to maintain playgrounds, and the promotion of recycling and waste reduction during sporting events are just some of the viable solutions.

Additionally, promoting local sporting events can significantly reduce the carbon footprint associated with travel. Encouraging the use of sustainable means of transport, such as bicycles and public transport, by spectators and athletes, further contributes to this goal.

The involvement of sports federations, athletes and fans is crucial to promoting a sports culture that values sustainability. Through collaboration, it is possible to develop initiatives that make sport not only a means of keeping individuals physically active but also a vehicle for environmental protection.

Technological advancement and sustainable innovation are opening up new avenues to make sports more environmentally friendly. Recycled and recyclable materials are becoming increasingly common in sports equipment, from clothing to accessories, reducing the ecological footprint of athletes.

7.5.3. Sustainable materials in focus

The use of eco-friendly materials to produce sports equipment is a fundamental step towards a more sustainable sport. Surfboards made from renewable materials, soccer balls made from recycled materials, and sportswear made from sustainable fibers are examples of how the sports industry is embracing sustainability.

The sustainable management of sporting events is another key area. This includes everything from reducing waste and water consumption to using renewable energy to power events. Carbon offset programs for major international sporting events are becoming increasingly common, helping to neutralize the environmental impact of such events.

Encouraging athletes and fans to use sustainable means of transport is essential. This can be achieved through offering affordable and efficient public transport options for sporting events, as well as promoting the use of cycling and walking as eco-friendly alternatives.

Education plays a crucial role in promoting more sustainable sport. Raising awareness among athletes, fans and organizers about the environmental impacts of sport and sustainable practices can spur significant change. Awareness campaigns and educational programs can encourage more responsible behavior and conscious choices among sports fans.

In conclusion, while we strive to make environmentally sustainable sports a widespread reality, success depends on collaboration between the sports industry, athletes, fans and communities. Through innovation, education and active participation, we can ensure that sport continues to bring joy and togetherness, while minimizing its impact on the environment.

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8. Gender Equality, Social Inclusion, and Injury Prevention in Young Athletes

8.1. Introduction

The development of young athletes is influenced by several factors, including their physical health, access to resources, and social environment. Ensuring gender equality and promoting social inclusion in youth sports is not only essential for fair participation but also plays a critical role in injury prevention. The physical differences, training opportunities, and access to injury prevention resources can vary greatly between young male and female athletes, and between athletes from different socioeconomic and cultural backgrounds. Addressing these disparities is essential to fostering an inclusive sporting environment where all young athletes are equally protected from injury risks.

8.2. Gender Differences and Injury Risk in Youth Sports

Gender plays a significant role in determining injury risks for young athletes. Biological differences between boys and girls—such as muscle strength, joint flexibility, and hormonal factors—can affect the types of injuries they experience and their susceptibility to certain injuries. For example, young female athletes are at a higher risk of developing anterior cruciate ligament (ACL) injuries compared to their male counterparts, particularly in sports that involve jumping and pivoting, such as soccer, basketball, and volleyball. This increased risk can be attributed to factors such as anatomical differences (e.g., wider hips leading to greater knee stress), hormonal fluctuations, and muscle imbalances.

Our project focuses on improving the technique of jumping and landing to minimize the risk of injury to the ankles and knees of young athletes. By correcting their jump mechanics, we aim to ensure safer landings and reduce stress on these vulnerable joints, ultimately promoting long-term physical health and injury prevention.

Despite these known differences, injury prevention programs are often not tailored to address the specific needs of young female athletes. This gap can result in higher rates of injuries among girls and young women, which not only affects their athletic performance but may also contribute to long-term health problems. An inclusive approach to injury prevention in youth sports must recognize these differences

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and provide gender-specific training and injury prevention programs that reduce the risk of common injuries in both boys and girls.

Moreover, gender inequality in access to sports resources, such as training facilities, qualified coaches, and medical care, can further increase injury risks for young female athletes. In many cases, girls' sports programs receive less funding and support than boys' programs, which limits their access to high-quality training and injury prevention resources. Addressing these disparities is essential to promoting gender equality and ensuring that all young athletes have equal protection from injury risks.

8.3. Social Inclusion and Injury Prevention

Social inclusion is equally critical in the context of injury prevention, as young athletes from marginalized communities often face higher risks of injury due to lack of access to adequate training, medical care, and injury prevention education. Children from low-income families, for example, may not have access to professional coaching, proper sports equipment, or facilities that are designed to minimize injury risks. These athletes may be more likely to participate in unsupervised or informal sports, where injury risks are higher due to inadequate safety measures.

Additionally, young athletes from underrepresented racial or ethnic groups may face cultural or language barriers that limit their access to injury prevention resources. For example, they may have less access to healthcare or rehabilitation services, and their coaches may lack the cultural competence to effectively communicate important injury prevention strategies. These factors increase the likelihood of preventable injuries among these athletes, perpetuating cycles of inequality in youth sports.

Athletes with disabilities also face unique injury risks that are often overlooked in mainstream sports programs. Adaptive sports programs that cater to the needs of athletes with disabilities are often underfunded and lack the necessary resources to prevent injuries. These athletes may also encounter social barriers, such as stigma or exclusion, which can discourage them from seeking proper medical care or injury prevention guidance.

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8.4. Inclusive Coaching and Its Role in Injury Prevention

Coaches play a crucial role in preventing injuries among young athletes, and their approach to inclusivity can significantly influence injury rates. Inclusive coaching focuses on understanding the individual needs of each athlete, considering factors such as gender, physical ability, and background when designing training programs. By adopting an inclusive approach, coaches can tailor injury prevention strategies to address the specific risks faced by different groups of athletes.

For young female athletes, this may involve incorporating strength training exercises that target muscle imbalances around the knees to reduce the risk of ACL injuries, as well as educating them about the importance of proper landing techniques and agility drills. For athletes from low-income or underrepresented communities, inclusive coaching might involve ensuring that they have access to affordable or donated equipment that meets safety standards, as well as providing injury prevention education in a culturally sensitive manner.

Moreover, inclusive coaching promotes open communication between coaches and athletes, which is vital for injury prevention. Athletes who feel valued and included are more likely to report injuries or discomfort early on, allowing coaches to address potential problems before they become more serious. This proactive approach can significantly reduce the risk of chronic injuries or long-term damage.

8.5. Access to Resources and Medical Care

Access to resources, including proper training facilities, equipment, and medical care, is essential for effective injury prevention. However, disparities in resource allocation often lead to unequal injury risks for different groups of young athletes. For example, girls' sports teams may have limited access to strength and conditioning programs, which are essential for preventing injuries like ACL tears. Similarly, athletes from low-income families may not have access to proper medical care, making it difficult to address injuries promptly and effectively.

To promote injury prevention and social inclusion, it is crucial to ensure that all young athletes, regardless of gender or socioeconomic background, have equal access to resources. Schools and sports organizations should invest in injury prevention programs that cater to the specific needs of different groups of athletes. This includes providing gender-specific injury prevention training, offering affordable healthcare options for low-income athletes.

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In addition, sports organizations should collaborate with healthcare providers to offer regular medical screenings and injury prevention education for all young athletes. These programs can help identify athletes who may be at higher risk of injury and provide them with the necessary resources to reduce these risks. For example, pre-season screening programs can assess an athlete's physical condition and identify muscle imbalances or weaknesses that may predispose them to injury. By addressing these issues early, coaches and healthcare professionals can develop personalized injury prevention plans for each athlete.

8.6. Proposed Strategies for Promoting Equality and Injury Prevention

To effectively promote gender equality, social inclusion, and injury prevention in youth sports, a multi-faceted approach is needed. First, there should be increased investment in injury prevention programs that are tailored to the needs of different groups of athletes. This includes gender-specific training programs for young male and female athletes, adaptive sports programs for athletes with disabilities, and affordable injury prevention resources for athletes from low-income families.

Second, schools and sports organizations should prioritize diversity and inclusion training for coaches, ensuring that they are equipped to address the unique injury prevention needs of all young athletes. Coaches should be trained in culturally competent communication, as well as in recognizing and addressing the specific injury risks associated with different gender and social groups.

Third, sports organizations should implement policies that ensure equal access to injury prevention resources for all young athletes. This includes providing funding for gender-specific programs, offering scholarships or financial assistance for low-income athletes, and ensuring that athletes with disabilities have access to adaptive equipment and facilities.

Finally, public awareness campaigns should be launched to highlight the importance of injury prevention in youth sports, with a focus on promoting gender equality and social inclusion. These campaigns can help challenge harmful stereotypes, promote positive attitudes toward diversity in sports, and encourage young athletes to prioritize their physical health and well-being.

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8.7. Conclusion

Promoting gender equality and social inclusion in youth sports is essential not only for fairness and equity but also for injury prevention. By addressing the unique injury risks faced by different groups of young athletes, we can create a safer and more inclusive sporting environment for all.

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Handbook of balance and jump performance analysis using Inertial Measurement Units

Application in Volleyball Athletes for Performance Assessment and Injury Risk Monitoring

Prepared by:

Laboratory of Biomechanics and Industrial Ergonomics

Department of Mechanical, Chemical and Materials Engineering

University of Cagliari

on behalf of the EDATS project consortium

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Analysis of Static Balance

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1. ANALYSIS OF STATIC BALANCE

1.1. Rationale: why do we need to measure balance in volleyball players?

Balance measurements in volleyball players offer significant advantages for both performance enhancement and injury prevention. A strong sense of balance, encompassing both static and dynamic stability, is crucial for executing complex volleyball actions like jumping, landing, spiking, blocking, setting, and receiving. By assessing balance, coaches can identify deficits and tailor training programs to improve postural control, which directly translates to more efficient movement patterns, greater power generation during jumps, and enhanced agility for quick directional changes on the court. Furthermore, higher effectiveness of the postural control system is associated with a reduced risk of non-contact lower limb injuries, particularly ankle sprains, which are prevalent in volleyball due to the repetitive jumping and landing demands. Therefore, incorporating balance measurements and targeted balance training can lead to improved overall athletic performance and a healthier playing career for volleyball athletes.

Assessing balance in young athletes during childhood and adolescence is crucial for several interconnected reasons, impacting both their athletic development and long-term health. Firstly, balance is a foundational motor skill that underpins almost all physical activities, from everyday tasks like walking and running to complex sports movements. As children and adolescents mature, their balance control systems are still developing, with significant improvements occurring up to late adolescence. Regular balance assessments allow coaches and parents to monitor this development, identify any deficits or asymmetries, and tailor age-appropriate training interventions to foster optimal motor control and coordination.

1.2. Instrumental assessment of static balance

Even among top-level clubs and national teams, field-based methods for balance assessment are still widely used, as they offer practical, accessible, and cost-effective ways to evaluate stability in various sporting environments. Common examples include the Star Excursion Balance Test (SEBT) and its modified version, the Y-Balance Test (YBT), which assess balance by requiring athletes to maintain single-leg stance while reaching with the contralateral limb in various directions. Another widely used test is the Balance Error Scoring System (BESS), which objectively quantifies static postural stability by counting errors across different stance positions on both firm and foam surfaces with

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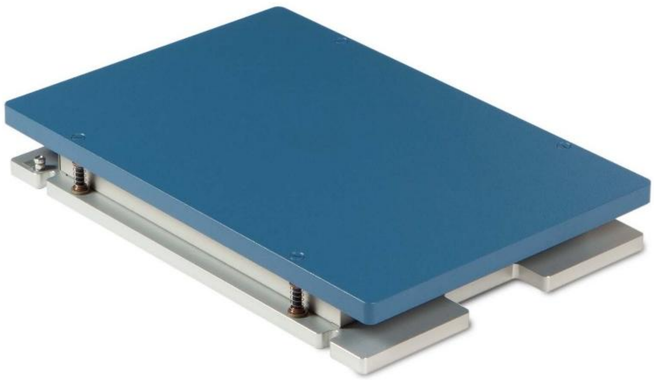
eyes closed. However, while these approaches are invaluable for identifying balance deficits, monitoring rehabilitation progress, and screening athletes for increased risk of lower extremity injuries, they often lack of accurate quantitative data that would be of superior quality to develop training and injury prevention strategies.

For such reasons, in recent times the use of instrumental techniques, in particular those which exploit the capabilities of force plates and Inertial Measurement Units (IMU) received increasing interest.

Force plates (also known as force platforms) are sophisticated measuring instruments designed to quantify the ground reaction forces (GRFs) exerted by a body standing on or moving across them. Think of them as highly sensitive scales that can measure not just your weight, but also the forces you apply in different directions (vertical, horizontal, and lateral) and how these forces change over time. They typically contain multiple sensors (such as strain gauges or piezoelectric sensors) that detect minute strains when force is applied, converting the effect associated with the application of mechanical forces into measurable electrical signals.



A force platform

For balance assessment in athletes, force plates provide highly objective and precise data that cannot be captured by the naked eye or simpler field tests. Here's how they are used: Force plates (also known as force platforms) are sophisticated measuring instruments designed to quantify the ground reaction forces (GRFs) exerted by a body standing on or moving across them. Think of them as highly sensitive scales that can measure not just your weight, but also the forces you apply in different directions (vertical, horizontal, and lateral) and how these forces change over time. They typically contain multiple sensors (such as strain gauges or piezoelectric sensors) that detect minute distortions when force is applied, converting these mechanical forces into measurable electrical signals.

For balance assessment in athletes, force plates provide highly objective and precise data that cannot be captured by the naked eye or simpler field tests. Here's how they are used:

- **Static Balance (Postural Sway):** Athletes stand still on the force plate(s) for a set period (e.g., 30-60 seconds), often in various stances (e.g., two-feet, single-leg, eyes open/closed). The force plate records the continuous fluctuations of the **Center of Pressure (COP)**, which is the point where the GRF acts on the support surface. Analysis of COP metrics—such as total excursion (the distance the COP travels), mean velocity (the average speed of COP movement), and ellipse area (the 95% confidence ellipse area enclosed by the COP trajectory)—provides insights into how much an athlete sways and how efficiently they control their posture. Smaller values generally indicate better static balance.

- **Dynamic Balance:** Force plates can also assess dynamic balance during movements like jumping, landing, or performing specific agility drills. For example, during a jump, they can measure the forces generated during the push-off and the forces experienced during landing. By analyzing the force-time curves, parameters like peak force, rate of force development (RFD), and impulse can be derived. In a landing task, a force plate can quantify how well an athlete absorbs impact, providing insights into their stability and control during dynamic movements crucial for injury prevention.

- **Asymmetry Detection:** With dual force plate systems (where two separate plates measure each limb independently), practitioners can identify asymmetries in force production or balance control between the left and right limbs. This is particularly valuable for athletes recovering from unilateral injuries, as it helps determine if symmetrical loading and stability have been regained before returning to sport.

- **Objective and Quantitative Data:** The primary advantage of force plates is their ability to provide objective, quantitative data on balance. This allows for precise

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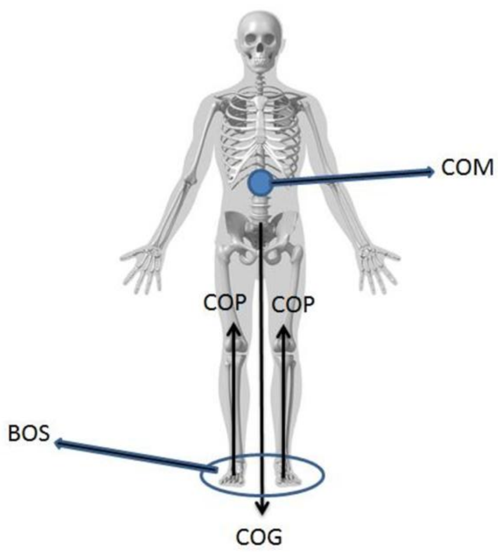
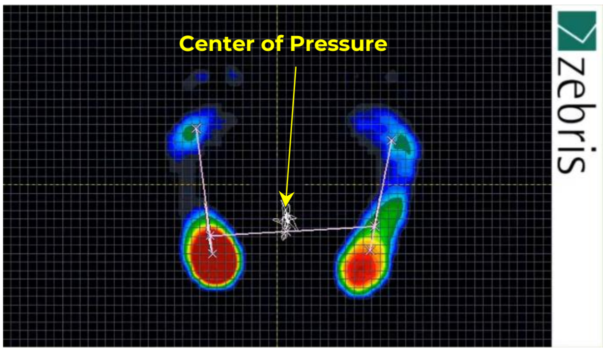
monitoring of changes over time (e.g., during rehabilitation or training cycles), identification of subtle balance deficits that might not be visible clinically, and the development of highly individualized training programs. While expensive and typically confined to laboratory or specialized clinic settings, force plates are considered the "gold standard" for detailed balance and movement analysis in sports science and rehabilitation.

	
Key variables of the postural control: COM:center of mass, COG: center of gravity (vertical projection of the COM to the ground), COP; center of pressure	*Center of Pressure is located between our feet. Its position continuously changes during a quiet upright stance*

1.3. A focus on postural sway analysis

Postural sway refers to the constant, small, and unconscious oscillations or movements your body makes to maintain an upright position while standing. Even when you believe you are standing perfectly still, your body is continuously making tiny adjustments to keep your center of gravity (that is, the verticla projection to the ground of your Center of Mass, COM) within your base of support and prevent you from falling over. This subtle movement is a dynamic process involving the complex interplay of sensory information (from your visual system, inner ear's vestibular system, and proprioceptors in your joints and muscles) and motor responses from your central nervous system

The quantitative analysis of postural sway is crucial for several reasons:

- **Objective Quantification of Stability**: Postural sway provides a quantifiable and objective measure of static balance. While an observer might subjectively notice someone "swaying," force plates and other sensors can precisely measure the amplitude (how much you sway), velocity (how fast you sway), and area of the body's COP movement. These metrics are direct indicators of how effectively an individual is controlling their posture

- **Sensitivity to Balance Deficits**: Increased postural sway often indicates reduced balance control. This can be due to various factors, including fatigue, injury (e.g., concussion, ankle sprain), or more serious neurological conditions. By measuring sway, clinicians and researchers can detect subtle impairments that might not be apparent during a quick visual assessment.

- **Identification of Sensory Reliance**: By altering sensory input (e.g., having an athlete stand with eyes closed or on an unstable surface), changes in postural sway can reveal which sensory systems an individual relies on most heavily for balance. For instance, increased sway with eyes closed suggests a greater reliance on visual input for balance control. This helps in targeting specific training or rehabilitation strategies.

- **Monitoring Progress and Risk**: Tracking changes in postural sway over time can be crucial for monitoring rehabilitation progress after an injury or for evaluating the effectiveness of balance training programs. Significant increases in sway may also serve as a predictive biomarker for an increased risk of falls, particularly in older adults or individuals with certain conditions

In essence, postural sway is not just a side effect of standing; it's a window into the efficiency and robustness of an individual's balance control system, making it a fundamental parameter in comprehensive balance assessments.

1.4. Yes, but in practice? How do we measure postural sway in laboratory and what parameters can I get from a sway analysis?

Measuring postural sway using a force plate involves a standardized protocol to ensure reliable and comparable data. Here's a typical procedure:

1) **Preparation of the Force Plate and Environment:**

The force plate is set up on a level, stable surface to prevent external vibrations from affecting measurements. It's calibrated according to the manufacturer's instructions to ensure accuracy.The software connected to the force plate is launched and configured to record GRF at a suitable sampling rate (e.g., 50-1000 Hz, depending on the required detail of analysis).Usually a frequency of 30 Hz is sufficient for most cases. The testing area is cleared of any distractions, and sufficient space is provided for the athlete to stand comfortably.

2) **Subject Preparation:**

The athlete is asked to remove shoes and socks to ensure direct contact with the force plate and minimize any interference from footwear. Of course, test can be performed even when shoes are present, if it is desirable to reproduce more ecological conditions, but having athletes barefoot helps to compare results between different laboratories and studies. Standardized instructions are given regarding the stance to adopt. Considering that the size of the base of support is known to affect balance (i.e., thelargest the distance between feet, the more stable the body is) it is recommended a standardized position with feet axis oriented at 30° and intermalleolar distance of 8-10 cm. The athlete is instructed to stand as still as possible, focusing on a fixed point ahead (3m distance, at eyes level) to minimize head movements.

3) **Measurement Protocol:**

Once the athlete assumes the designated position, a verbal cue indicates the start of the data acquisition. During a period of time of 30-60 s, he/she must avoid any voluntary movement and touch of the hands on the legs. Thirty second is the usual time requested to obtain reliable data when a simple quiet upright bipedal stance is tested. Fore more cchallenging positions (i.e., single-leg stance) 20 s can be acceptable. In this latter case, there are no standardized position, but often the athlete is required to suspend the limb not in contact with the ground at standing leg malleolus height. In other cases, the suspended limb can be placed by pressing firmly the back of the foot against the popilteal fossa of the supporting limb. The execution of at least three trials for each tested condition is recommended, so that the average of the trials can be used as representative of the athlete in a cartain condition/timepoint.

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Athlete position on the pressure/force plate. Left: bipedal standing, right: unipedal standing

4) Sensory Conditions:

Measurements are typically performed under different sensory conditions to assess how the body utilizes various inputs for balance control: in the **Eyes Open (EO)** condition, the athlete stands with their eyes open, looking straight ahead. This condition utilizes visual, vestibular, and somatosensory information. In the **Eyes Closed (EC)** condition, the athlete stands with their eyes closed. This condition removes visual input, forcing greater reliance on vestibular and somatosensory systems. Sometimes, a foam pad or other unstable surface is placed on the force plate to challenge the somatosensory system further.

5) Data Acquisition:

During each trial, the force plate continuously records the forces exerted by the athlete's feet on its surface in three dimensions (vertical, anterior-posterior, and medial-lateral). From these forces, the software calculates the instantaneous position of the Center of Pressure (COP).

6) Data Analysis:

Once the data is collected, specialized software analyzes the CoP trajectory over time. **Key parameters derived from the COP include**: total Excursion/**Path Length** (the total distance the COP travels during the trial, reflecting the amount of sway, expressed in mm), **mean COP Velocity**: the average speed of the COP movement (mm/s), **sway area** (e.g., 95% Confidence Ellipse Area): The area covered by the COP trajectory, indicating the dispersion of sway.

1.5. OK now I know all the theory! Explain me how I can use the DAUVEA sensor kit to test my athletes

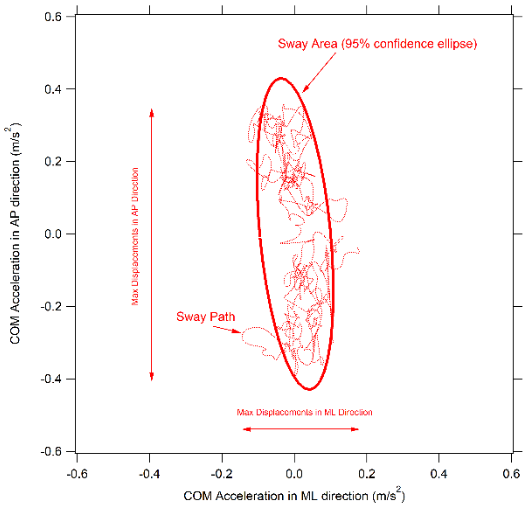
As mentioned before, the use of force plates is typically restricted to the laboratory. But **there is another way to perform a postural sway analysis, using small, lightweight, inexpensive systems like IMU**. Basically, the IMU is a device able to measure accelerations and angular velocities. By placing an IMU close to che center of mass of the body, we can capture the body accelerations. Be aware that a COM acceleration is different by a CoP trajectory, so that the two measures cannot be compared directly. However, previous studies confirmed that COP-derived parameters and IMU/COM-derived parameters are strictly correlated so that is absolutely correct, from a scientific point of view, to assess postural sway using IMUs.

To test your athletes, **the IMU should be placed, using an elastic belt, close to the Center of Mass, that is approximately at L5-S1 vertebrae location. It is very important that the sensor is firmly attached to the body since undesired relative movements between the sensor and the body can alter the results**

Once fixed the sensor, ask your athlete to assume a relaxed standing position with the feet oriented at 30° and intermalleolar distance of approximately 8-10 cm. A paper mask with two properly drawn footprints might help in ensuring a common reference position

During the test, breathing should be normal, voluntary movements avoided and arms should be placed along the body side but not in touch with legs

After 30 seconds, the test is over and we can have a look at the results. The DAUVEA software provide the following parameters (see Figure xx for details)



Sway Area (m²/s⁴): elliptical area containing 95% of the sway path points. Overall indicator of the postural control system performance (i.e. the smaller the value, the better the postural control)

Sway Path (m/s²): length of the sway path. Informative regarding the correction performed to maintain balance (i.e., shortest path, less corrections)

Maximum COM accelerations in AP and ML direction: define the shape of the ellipse. If one of the two axis is much longer than the other, the subject has a preferential plane of obscillation

The interpretation of the results should take into account several important factors such as:

- **Age of the tested subject**. Postural control develops durinch childhood and adolescence. It remains relatively stable from 16-17 to 25-40 years of age, then slowly tends to worsen
- **Sex of the tested subject**: in young athletes, girls have usually a better postural control than boys. From 16-17 and older, performance becomes similar
- **Fatigue**: postural control should be tested in rest conditions. Of course you can define specific protocols to assess the influence of fatigue on postural control performance
- **Ankle instability or other lower limb injuries**: postural control worsen in case of musculoskeletal disorders or acute injuries. Use this test to assess the recovery from knee/ankle injuries

In the following table are reported some reference values obtained from tests performed at the Laboratory of Biomechanics and Industrial Ergonomics of the University of Cagliari on more than 100 adults aged 18-50. A value should be considered altered when > 2 Standard Deviations with respect to what indicated.

	Bipedal stance	
Condition	**Sway Area**	**Sway Path**
Eyes Open	0.0234	10.3546
Eyes Closed	0.0422	10.9703

	Unipedal stance	
Condition	**Sway Area**	**Sway Path**
Eyes Open	0.2311	23.8669

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Vertical Jump Measurement

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2. VERTICAL JUMP MEASUREMENTS

2.1. Rationale: vertical jump as proxy of lower limb strength

Assessing vertical jump performance in volleyball players is essential due to the sport's inherently explosive and vertical nature. Actions such as spiking, blocking, and jump serving all require athletes to propel themselves off the ground quickly and powerfully to achieve maximum height and precision. The vertical jump serves as a reliable indicator of lower-body power, neuromuscular coordination, and overall athleticism, which are critical for high-level volleyball performance. By regularly measuring vertical jump height, coaches and trainers can gain valuable insights into a player's physical capabilities, identify strengths and weaknesses, and make informed decisions about training programs. For example, an athlete with a below-average vertical may benefit from targeted plyometric or strength-based interventions to enhance power output, while a player showing significant asymmetry between legs may require corrective strategies to reduce injury risk. Additionally, tracking vertical jump over time allows for objective monitoring of performance progress and recovery from injury. It can also serve as a motivational tool, helping athletes see tangible improvements and set performance goals. In elite volleyball, where fractions of a second and inches of height can determine the outcome of a match, optimizing and assessing vertical jump performance is not just beneficial—it's a competitive necessity.encompassing both static and dynamic stability, is crucial for executing complex volleyball actions like jumping, landing, spiking, blocking, setting, and receiving. By assessing balance, coaches can identify deficits and tailor training programs to improve postural control, which directly translates to more efficient movement patterns, greater power generation during jumps, and enhanced agility for quick directional changes on the court. Furthermore, higher effectiveness of the postural control system is associated with a reduced risk of non-contact lower limb injuries, particularly ankle sprains, which are prevalent in volleyball due to the repetitive jumping and landing demands. Therefore, incorporating balance measurements and targeted balance training can lead to improved overall athletic performance and a healthier playing career for volleyball athletes.

Basic information regarding lower limb explosive strength can be obtained by simple aspecific tests like the squat jump (SJ) and countermovement jump (CMJ), wchich are highly useful in evaluating the explosive power and neuromuscular efficiency of volleyball players. Both tests assess vertical jump performance but offer distinct insights into the athlete's physical condition. **The squat jump**, performed from a static, crouched position without any preliminary movement, isolates pure concentric muscle power and is useful for identifying baseline lower-body strength. **In contrast, the countermovement jump**

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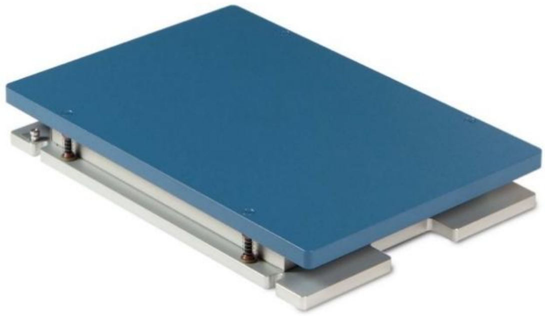
incorporates a rapid downward motion before the jump, engaging the stretch-shortening cycle and providing information about how effectively the athlete utilizes elastic energy and coordination. Comparing SJ and CMJ results allows coaches to assess the athlete's ability to convert stored energy into explosive force, which is critical in volleyball for quick, powerful movements like spiking and blocking. Discrepancies between the two scores may also highlight neuromuscular deficiencies or imbalances, guiding targeted interventions in strength and conditioning programs. Thus, together, the SJ and CMJ tests provide a comprehensive profile of a volleyball player's jump performance and readiness for high-intensity play.several interconnected reasons, impacting both their athletic development and long-term health.

2.2. Instrumental assessment of SJ and CMJ

Instrumental assessment of squat jump (SJ) and countermovement jump (CMJ) provides a comprehensive and highly accurate evaluation of an athlete's explosive strength, power output, and neuromuscular function. This method goes beyond simple field measurements by using **technologies such as force platforms, contact mats, accelerometers, or optical timing systems** to collect detailed kinetic and kinematic data during jumping tasks. These devices allow practitioners to analyze parameters including jump height, ground contact time, flight time, peak force, peak power, rate of force development (RFD), and impulse—all of which contribute to a deeper understanding of an athlete's performance profile.

In the squat jump, the athlete starts from a static position with knees bent (typically at 90-100 degrees) and holds this posture for a few seconds to eliminate any elastic energy contribution. The jump is then executed vertically without a preparatory dip, making the SJ a pure measure of concentric muscular power. **In contrast, the countermovement jump** involves a quick dip or downward motion before jumping, utilizing the stretch-shortening cycle (SSC) to store and release elastic energy. This dynamic movement mimics the natural jumping mechanics used in sports like volleyball, making it particularly relevant for performance analysis.

In laboratory setting, both SJ and CMJ are typically measured using force plates (also known as force platforms) are sophisticated measuring instruments designed to quantify the ground reaction forces (GRFs) exerted by a body standing on or moving across them. Think of them as highly sensitive scales that can measure not just your weight, but also the forces you apply in different directions (vertical, horizontal, and lateral) and how these forces change over time. They typically contain multiple sensors (such as strain gauges or piezoelectric sensors) that detect minute strains when force is applied, converting the effect associated with the application of mechanical forces into measurable electrical signals.



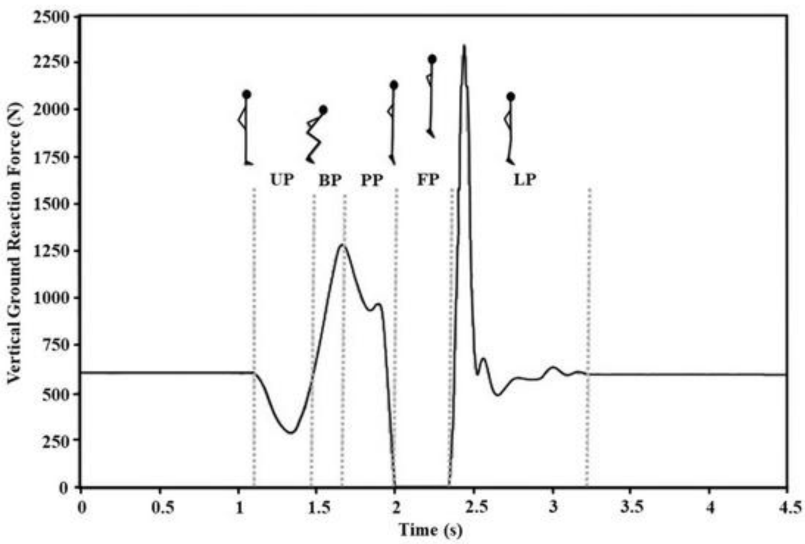
A force platform

A force-time curve obtained during a CMJ using a force platform provides a detailed graphical representation of the vertical ground reaction force (GRF) produced by the athlete throughout different phases of the jump. This curve allows for precise analysis of neuromuscular performance, including timing, magnitude of force production, and power output.

As visible from the following figure, the curve can be subdivided in regions indicating the different phases of the movement:

1) **Standing Baseline:** The athlete stands still on the force plate, producing a force equivalent to his/her body weight (BW). Here the force curve is flat and constant at approximately BW.
2) **Unweighting Phase (UP):** The athlete begins the countermovement by rapidly dipping downward. The force decreases BW as the center of mass descends.
3) **Braking Phase (BP):** As the athlete decelerates the downward movement, force rapidly increases above BW. This phase reflects eccentric muscle action and energy storage via the stretch-shortening cycle.
4) **Propulsion Phase (PP):** the athlete reverses direction and starts pushing off the ground. Force continues to rise and peaks just before take-off. This is where peak force, rate of force development (RFD), and impulse are measured.

5) **Flight Phase (FP):** once the athlete leaves the ground, force drops to zero (there is no contact with the platform). The **"time of flight"** time (duration of zero force) is used to estimate jump height.
6) **Landing Phase (LP)** (if included): Upon landing, there is a sharp spike in force as the athlete contacts the platform again.



Typical Force-Time curve obtained from a CMJ

By comparing SJ and CMJ performance, practitioners can derive valuable metrics such as the **eccentric utilization ratio (EUR)—the ratio of CMJ to SJ jump** height or power—which indicates how effectively an athlete uses stored elastic energy during movement. **A higher EUR generally reflects better neuromuscular coordination and elastic energy utilization, which are essential qualities for explosive movements in volleyball**, such as spiking, blocking, and serving. Furthermore, force-time curve analysis can reveal asymmetries between limbs, delays in force production, or fatigue-related changes, which are crucial for injury prevention and rehabilitation.

Overall, instrumental assessments of SJ and CMJ offer a scientific, data-driven approach to evaluating and enhancing volleyball performance. They help coaches and sports scientists identify specific physical limitations, monitor training progress, and design individualized interventions that target an athlete's unique needs. This level of precision makes these assessments an indispensable part of modern athletic development and high-performance training environments.

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2.3 Use of Inertial Measurement Units to assess SJ and CMJ

Inertial Measurement Units (IMUs) are compact, wearable sensors that combine accelerometers, gyroscopes, and sometimes magnetometers to measure linear acceleration, angular velocity, and orientation. Their application in sports science has grown significantly, particularly for assessing explosive movements like the SJ and the CMJ. As previously mentioned, traditionally, such assessments relied on force plates (or motion capture systems), which are expensive and confined to laboratory environments. IMUs offer a portable, cost-effective alternative that enables data collection in field settings, such as training grounds or gyms. When positioned on strategic body segments—commonly the lower back, thigh, or shank—IMUs can capture detailed kinematic data during jump execution. For both SJ and CMJ, they can provide key performance metrics including jump height.

Moreover, advancements in signal processing and biomechanical modeling have improved the accuracy and reliability of IMU-derived data, making them suitable not only for performance monitoring but also for injury risk screening and rehabilitation tracking. Overall, IMUs represent a powerful tool for objective, accessible, and versatile assessment of jump mechanics across a range of athletic and clinical populations.

7) Subject Preparation:

In the case of the EDATS study, **it is required to the place the IMU approximately at L5-S1 vertebrae position** (i.e., close to his/her Center of Mass). **The device should be firmly fixed against the athlete's body** because any relative motion between device and body can introduce errors in the measuerment. A semi-elastic belt, a suitable pocked located in the shorts or a small rigid clip can ensure that this condition is fulfilled.

8) Measurement Protocol:

Ensure the participant performs a standardized warm-up (e.g., light aerobic activity and dynamic stretches). Then, instruct them to stand upright with feet shoulder-width apart and hands on hips (to minimize arm swing influence).**For SJ, the participant should begin from a static semi-squat position** (around 90°-100° knee flexion) and hold it for 2–3 seconds to eliminate the countermovement. The participant should jump vertically with maximal effort, keeping hands on hips, and land in the same spot with knees slightly bent. Ask atheletes to repeat the jump 3–5 times with 30–60 seconds rest between each to reduce fatigue.

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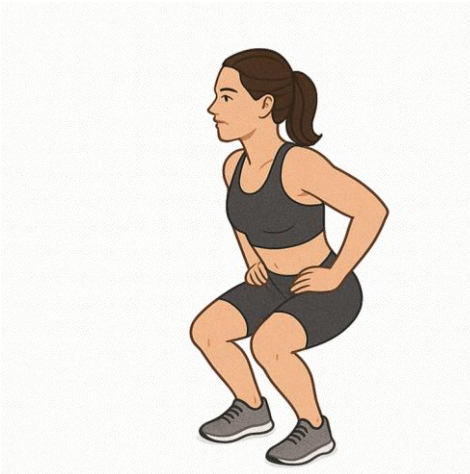
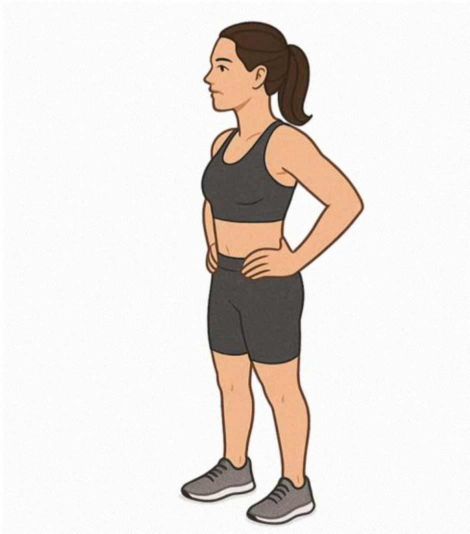
In case of a CMJ, instruct the participant to begin from a standing position (similar to what previosuly described), perform a rapid downward movement (eccentric phase) followed immediately by a maximal vertical jump (concentric phase). Be sure that him/her land in the same position, maintaining balance with a soft knee bend. Emphasize the fact that the movements should be continous and smooth (i.e., no pause between the downward and upward phases)

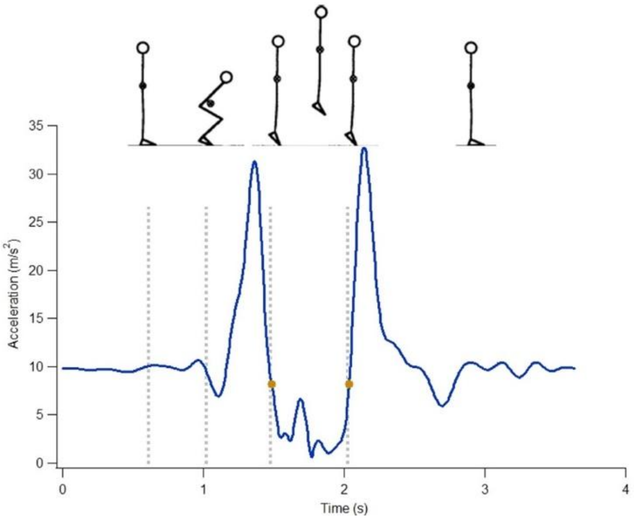




Athlete position on the pressure/force plate. Left: Squat Jump, right: Countermovement Jump

9) Result of the test

Differently from what obtainable in case of a force platform, IMU provide acceleration-time curve that, though, can be processed similarly to what previously described.



Typical Acceleration-Time curve obtained from a CMJ

2.4 Reference values

Jump height is, of course, affected by many variables including sex and age of the athlete, experience and level of competition, so that is not possible to provide „normal" reference values. However, the following table reports values reported in the literature for volleyball players and other populations (values are expressed as mean (Standard Deviation))

Level/experience	Sex	SJ (cm)	CMJ (cm)
Professional volleyball players (national top level)	M	42.45 (4.68)	46.26 (4.78)
	F	27.15 (4.40)	30.8 (4.70)
Young adults non-athletes (age 20-22)	M	28.33 (6.23)	29.87 (8.89)
	F	18.07 (4.49)	19.1 (4.70)
Adolescents (14-15 years old)	M	18.4 (3.53)	20.78 (3.53)
	F	16.15 (4.95)	16.64 (2.88)
Children (9-10 years old)	M	14.6 (5.19)	16.61 (3.80)
	F	13.47 (4.11)	15.15 (2.78)

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Analysis of Dynamic Balance:
The ”Time-to-Stabilization” (TTS) test

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3. ANALYSIS OF DYNAMIC BALANCE: TIME TO STABILIZATION

3.1 Rationale: why we need to assess dynamic balance in volleyball players?

Volleyball is a high-intensity sport characterized by frequent jumps, rapid changes of direction, and sudden landings, often performed on a single leg. These dynamic actions expose athletes to a high risk of lower-limb injuries, particularly at the ankle and knee joints . In this context, good postural control after landing plays a crucial role in injury prevention and overall performance.

In volleyball, the initial ground contact after a jump often occurs on a single leg.

The *Time to Stabilization* (TTS) is a validated parameter that quantifies how quickly an individual can return to a stable posture following a perturbation, such as a jump landing. It serves as an indirect indicator of neuromuscular control, proprioceptive integration, and effectiveness of sensorimotor strategies.

Measuring TTS in volleyball players is relevant for several reasons:

- **Injury risk monitoring**: Delayed stabilization times have been associated with chronic ankle instability and with increased likelihood of non-contact ACL injuries, especially in female athletes.

- **Detection of asymmetries**: Side-to-side differences in TTS may reveal functional deficits that are not evident during clinical tests or static balance assessments.

- **Performance profiling**: TTS can help discriminate between different levels of neuromuscular readiness, providing insights into fatigue, rehabilitation status, or adaptation to training

3.2 Instrumental assessment of dynamic balance

Dynamic balance can be assessed in various ways, one of which involves evaluating the ability to restore postural stability following a perturbation, such as a jump landing or a change in direction. In sports like volleyball, where players frequently perform explosive and unpredictable movements, this approach is particularly relevant for identifying motor control deficits, preventing injury, and monitoring functional recovery.

The gold standard for assessing dynamic balance is the use of force platforms, which allow for the quantification of postural stabilization through the analysis of ground reaction forces (GRF) in the vertical, anterior-posterior (AP), and medio-lateral (ML) directions. One of the most common dynamic parameters derived from force platforms is the Time to Stabilization (TTS)—a measure of how quickly an individual can return to a stable posture after a perturbation such as a jump landing.

However, the extensive use of force platforms is limited by several practical constraints:

- High cost and need for dedicated laboratory space;
- Limited portability and ecological validity;

To address these limitations, inertial measurement units (IMUs) have been proposed as a valid, low-cost, and field-deployable alternative. These wearable sensors, typically placed over the L5/S1 spinal segment, can capture three-dimensional linear accelerations and angular velocities. By computing the norm of the acceleration vector over time, it is possible to derive a surrogate measure of TTS (often referred to as accelerometric TTS or aTTS), which represents the time needed for the acceleration signal to stabilize within a defined threshold (e.g., ±5% of the baseline value).

Thanks to their portability, ease of use, and reliability, IMUs represent a powerful tool for monitoring dynamic balance in both laboratory and field settings. They support continuous tracking of fitness levels and athletic performance, inform return-to-play decisions, and facilitate performance assessments in volleyball players and other athletic populations.

3.3 A focus on Time To Stabilization

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As mentioned, TTS is a quantitative measure of the time required to regain postural stability following a dynamic perturbation, such as landing from a jump. It reflects the efficiency of the neuromuscular system in absorbing impact and re-establishing balance, and it is widely used in both clinical and sport science contexts.

Definition and theoretical background

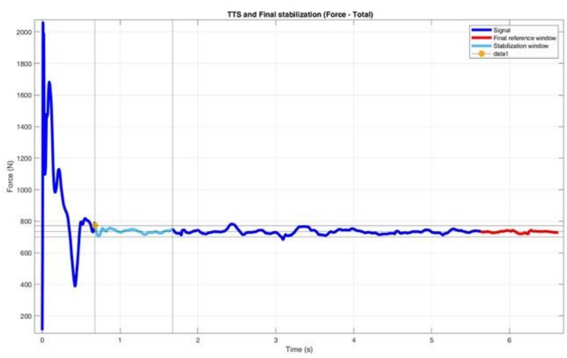
TTS represents the latency from the moment of ground contact (landing) to the moment when body motion parameters—typically ground reaction forces or body accelerations—stabilize within a predefined threshold range. It reflects the dynamic control of posture and provides insight into motor control strategies, including:

- Proprioceptive feedback,
- Reflexive and volitional responses,
- Feedforward motor planning.

Longer TTS values may indicate impaired neuromuscular control and have been associated with fatigue, lower limb injury (e.g., ACL reconstruction, chronic ankle instability), and sub-optimal motor performance.

TTS estimation with force plates

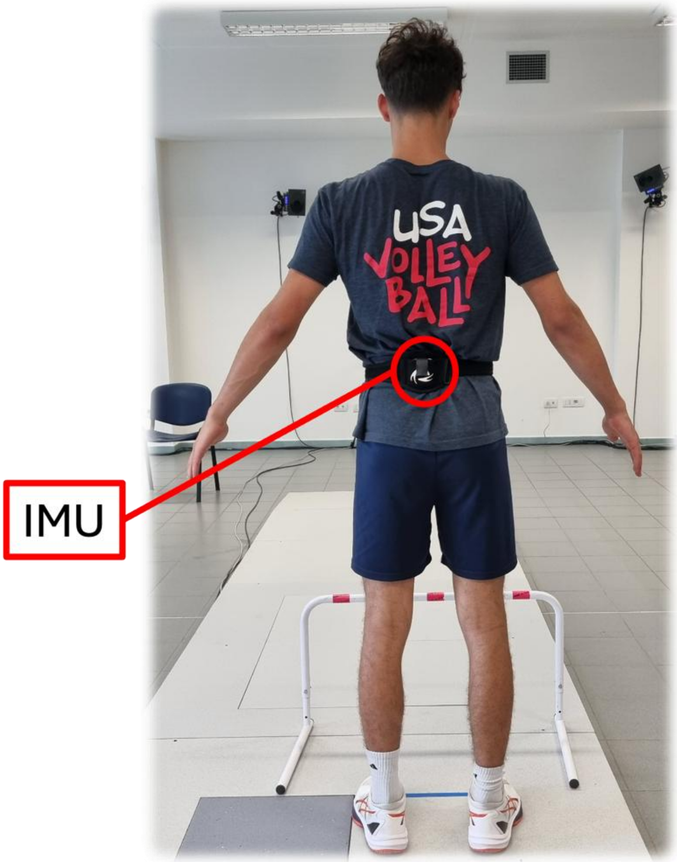
The traditional method uses force platforms to measure the vertical (vGRF) and horizontal (AP, ML) GRFs. The stabilization is defined when the GRF returns to a stable range—commonly within ±5% of body weight for vertical force for at least 1 continuous second.



TTS is the time required to the GRF to stabilize within 5% of the body weight after landing.

Accelerometric TTS (aTTS) estimation with IMU

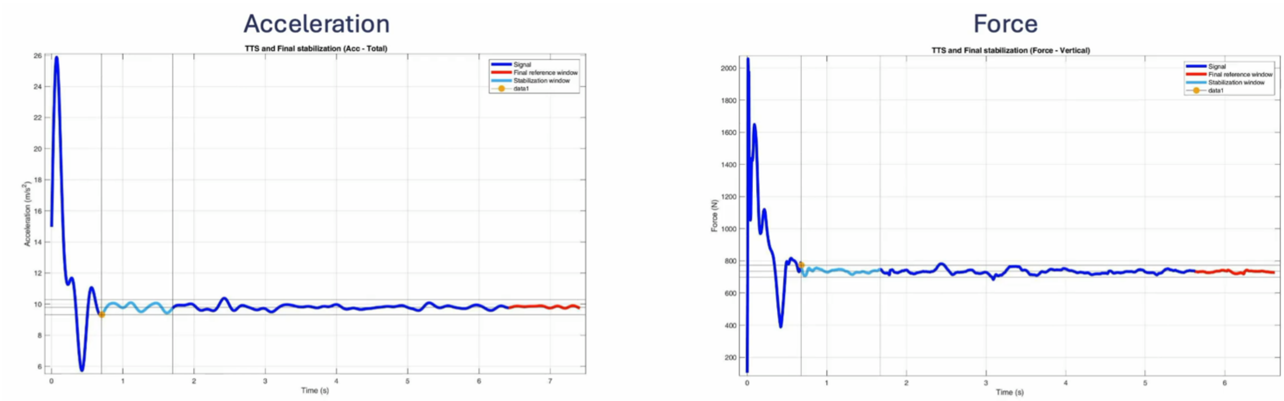
When using an IMU placed at the L5/S1 level, the TTS can be estimated by analyzing the norm of the tri-axial acceleration vector. After landing, this signal shows a transient oscillation that gradually decreases as the subject stabilizes.



The IMU is placed at the lower back (L5/S1) via a semi elastic belt

The aTTS (or IMU TTS) can be defined, similarly to the GRF derived version, as the time from landing to the point where the norm of acceleration remains within ±5% of the baseline (pre-landing) for at least 1 second.

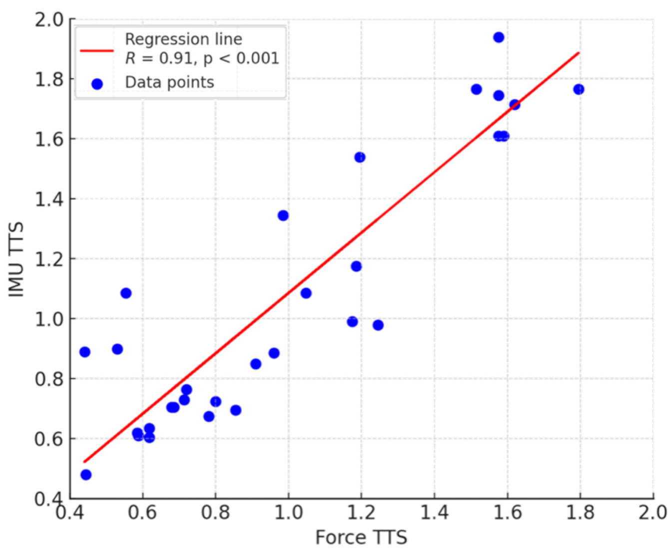
In practice, the raw acceleration signal is pre-processed with low-pass filtering, and landing is identified via a rapid peak in the acceleration norm. From that point, stabilization is computed using a sliding window technique to detect the threshold-crossing segment.



Comparison between the accelerometric and force signals during the TTS task. The yellow marker identifies the TTS.

Comparison and reliability

Preliminary tests show strong agreement between force plate TTS and IMU-derived aTTS. IMUs offer a viable alternative for on-field assessments, remote monitoring, and return-to-play evaluations, while retaining meaningful sensitivity to neuromuscular control deficits.

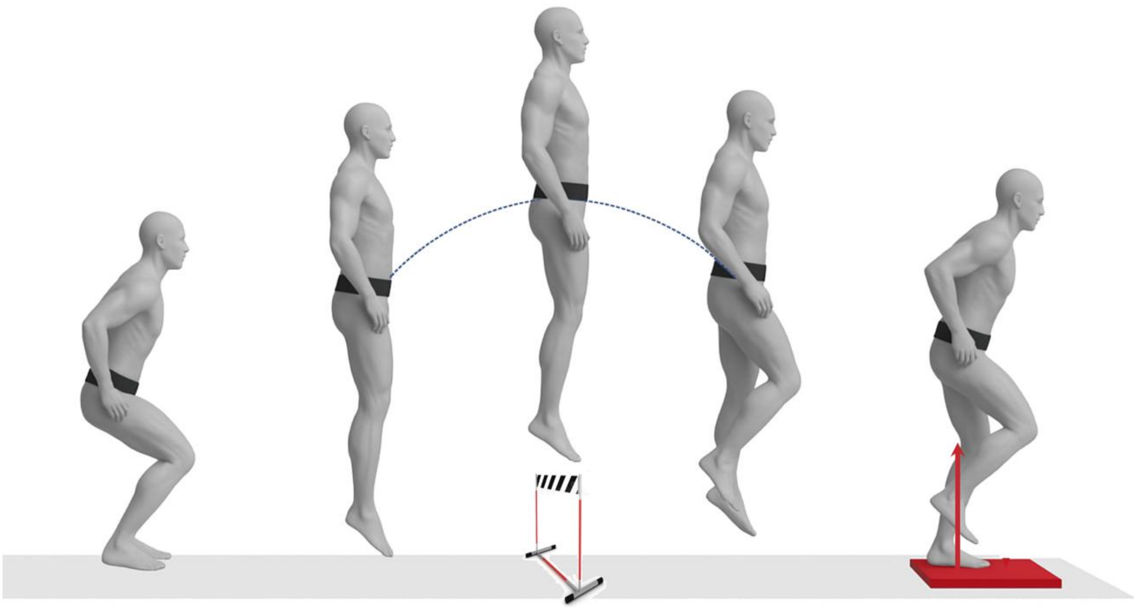


Correlation between IMU- and Forceplate-derived TTS.

3.4 In practice how do we measure TTS?

While the theory behind TTS is essential, what really matters to coaches and practitioners is how to implement this in practice. So, let's walk through a standard laboratory procedure for assessing TTS and see which parameters we can get from a single-leg landing test!

The test is simple: the athlete performs a forward submaximal jump over a 35 cm hurdle from a starting line placed at a distance equal to 40% of their height from the starting point of the landing platform, and lands on a single leg. Upon landing, they are instructed to stabilize as quickly as possible and maintain the final position for at least 5 seconds until a verbal cue signals the end of the trial. The task mimics a common sporting action—jump and land—and challenges the body's ability to rapidly regain postural control. The test is typically performed under standardized conditions, either barefoot or wearing sports shoes, depending on whether the goal is laboratory reproducibility or ecological validity. Three valid trials per limb are usually recorded.



Schematic illustration of the single-leg landing task used for Time to Stabilization (TTS) assessment. Participants jumped forward from a standardized height and landed on the dominant leg on a force platform. Ground reaction forces were recorded to compute the TTS, defined as the time required to achieve and maintain dynamic postural stability following landing.

Using an IMU to calculate aTTS (in seconds): the main outcome. Shorter times = better postural control we can also obtain information on

- Jump height (optional): estimated from the flight time.
- Stabilization curves: useful to check trial quality and individual landing behavior.
- Symmetry: if you test both legs, you can compare aTTS right vs left and look for functional imbalances.

Why is this useful?

Because longer stabilization times may indicate:

- fatigue,
- neuromuscular inefficiency,
- past injuries (especially ankle or ACL),
- or just a need for more proprioceptive training.

The bottom line? You can use TTS testing to:

- track progress over time,
- support return-to-play decisions,
- identify hidden balance deficits in otherwise fit athletes,
- or simply monitor training effects on postural control.

3.5 OK now I know all the theory! Explain me how I can use the DAUVEA sensor kit to test my athletes

As detailed in previous sections, the TTS is a valuable parameter to assess dynamic balance. While traditional force plates offer a reliable measurement, their cost and limited portability restrict their use to lab environments. Thanks to wearable systems like the DAUVEA sensor kit, we can now bring dynamic balance assessment directly into the field, training rooms, or sports facilities—without compromising accuracy.

The kit includes a lightweight IMU that records body acceleration in three directions and angular velocities. By placing the IMU close to the body's center of mass (roughly over L5–S1), we can obtain an indirect measure of how long it takes to regain a stable posture after a dynamic perturbation, such as a jump landing.

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To perform the test:

- Position the sensor on the athlete's lower back using the elastic belt provided.
- Make sure the sensor is tightly secured to minimize artefacts due to skin/sensor slippage.
- Instruct the athlete to perform a submaximal forward jump starting with a two-legged take-off and landing on one leg (single-leg landing).
- Ask them to stabilize as quickly as possible after landing and maintain their position for 5 seconds.

The DAUVEA software will process the acceleration signal automatically and return the following parameters:

- aTTS (accelerometric Time to Stabilization): the time it takes for the signal to return within ±5% of the baseline for at least 1 second, starting from the moment of landing. This is the main indicator of dynamic balance performance.
- Jump height (optional): estimated from flight time using vertical acceleration data.
- Symmetry: by testing both legs, right vs left aTTS can be compared for functional imbalances.

Important tips for valid and reproducible testing:

- Ensure the athlete is not fatigued, as neuromuscular performance may be altered.
- Repeat the test three times per leg, and use the average value for interpretation.
- Make sure the athlete understands the importance of a controlled landing and quick stabilization.
- Record any unusual behaviors or loss of balance for each trial.

Like in postural sway testing, TTS should be interpreted based on individual factors such as:

- Age and sex (young athletes may stabilize faster; males and females may differ depending on sport and training age),
- Fatigue level (compare pre/post training or match),
- Previous injuries (e.g., ACL, ankle sprains),
- Dominant vs non-dominant leg.

Reference values are currently being developed within specific athletic populations. However, based on preliminary laboratory studies, healthy young adults typically stabilize in less than 1.2 seconds, with elite athletes showing even shorter times (e.g., 0.9 s). Longer times (>2.0 s) may indicate a motor control deficit or need for targeted neuromuscular training.

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ANNEX 2 – ATTENDENCE SHEETS

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EDATS Training / felmérések

Participant Register / Résztvevők listája

Club / Egyesület:	Békéscsabai Röplabda Sportegyesület
Location / helyszín:	Békéscsabai Röplabda Akadémia, 5600 Békéscsaba, Dobozi út 1.
Tutor / Felelős:	Borbola István György
Date / Dátum:	Season 2025 / 2026. szezon

N°	Name / Keresztnév	Surname / Családnév	Role / beosztás	Sign / Aláírás
1	Zita	Kovács-Pásztor	physiotherapist	
2	László András	Somos	physiotherapist	
3	Beáta	Gyuricza	physiotherapist	
4	Attila	Nagy	coach	
5	Sándor	Toma	coach	
6	Roland	Csányi	coach	
7	Doroti	Takács	coach	Takács Dorottya
8	Kristóf	Arató	coach	Arató Kristóf
9	Krisztián	Stefanovics	coach	
10	Ferenc	Németh	coach	Németh Ferenc
11	Fanni	Mester	coach	Mester Fanni
12	István György	Borbola	operative director	
13				
14				
15				

ERASMUS+ EDATS

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EDATS Training
Participant Register

Club	ASD PALLAVOLO ALFIERI
Location	CAGLIARI, PALA CONI B
Tutor	CLAUDIO CONGIU
Date	13.01.2026

N°	Name	Surname	Role	Sign
1	LUCA	MASU	COACH	Luca Masu
2	LUIGI	VENTURA	COACH	[illegible]
3	LUCA	MELONI	COACH	[illegible]
4	PIERGIORGIO	BITTICHESU	COACH	[illegible]
5	ANDREA	LOI	COACH	[illegible]
6	ANDREA	ZEDDA	COACH	[illegible]
7	MATTEO	COGODI	COACH	[illegible]
8	TIZIANO	VACCA	COACH	[illegible]
9	LISANDRO	PORCU	COACH	[illegible]
10	PAOLO	CHIAPPORE	COACH	[illegible]
11				
12				
13				
14				
15				

DAUVEA

UNIVERSITÀ DEGLI STUDI DI CAGLIARI

ERASMUS+ EDATS

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EDATS Training

Participant Register

Club	RC CANNES
Location	CANNES FRANCE
Tutor	CHRISTOPHE TOURET / SIMON CAYRON
Date	14/01/2026

N°	Name	Surname	Role	Sign
1	CAYRON	Simon	Volley Ball trainer	
2	SORTI	Rafael	Physical trainer	
3	COLL	Cécilia	Physical trainer	
4	EBELY	Sylvaine	Volley Ball trainer	
5	CONTI	Eleonora	Volley Ball trainer	Conti Eleonora
6	BELHASSEN	Lionel	Volley Ball trainer	
7	LAFALIZE	Eric	Volley Ball trainer	
8	DESMEDT	Marie Luce	Volley Ball trainer	
9	HOUDOT	Elea	Volley Ball trainer	
10	LABAIGT	Margot	Volley Ball trainer	
11	FANG	Yan	Volley Ball trainer	
12	JIOSHVILI	Alex	Volley Ball trainer	
13				
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15				

ALFIERI CAGLIARI

RACING CLUB 1922 CANNES

DAUVEA

VOLLEY

UNIVERSITÀ DEGLI STUDI DI CAGLIARI

Co-funded by the European Union

EDATS Training
Participant Register

Club	SK VOLLEY
Location	NOVI SAD
Tutor	ANDRIJA GERIĆ
Date	13/10/2025

N°	Name	Surname	Role	Sign
1	VASA	MIJIĆ		
2	SLOBODAN	VELEMIR		
3	NIKOLA	EMER		N. Emer
4	UROŠ	MALEŠEVIĆ		
5	DRAGAN	STOJIĆ		
6	TAMARA	MILINOVIĆ		
7	MITAR	BANJAC		
8	DRAGAN	GRUJIČIĆ		
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the European Union

EDATS Training
Participant Register

Club	UKS JAGIELLOŃCZYK
Location	BIAŁA PODLASKA POLAND
Tutor	MARCIN ŚCIWA
Date	28. 12. 2025

N°	Name	Surname	Role	Sign
1	KONRAD	RECHNIO	COACH	Rechnio Konrad
2	BARTOSZ	WYKRĘT	COACH	Bartosz Wykręt
3	KRYSTIAN	SURYŚ	COACH	Suryś Krystian
4	HUBERT	JADWIZYC	COACH	Jadwizyc Hubert
5	IZABELA	ŁUKASZUK	COACH	Izabela Łukaszuk
6	KACPER	NOWICKI	COACH	Kacper Nowicki
7	MAGDALENA	STOPA	COACH	Stopa Magdalena
8	KAROLINA	ROMAN	COACH	Karolina Roman
9				
10				
11				
12				
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15				

ANNEX 3 – QUESTIONNAIRE and REPLIES

Co-funded by
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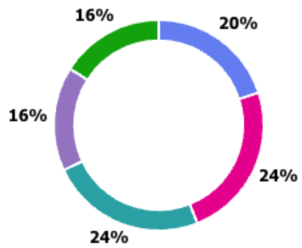
Response Overview

Active

Answers	Average time	term
50	06.49	33 Days

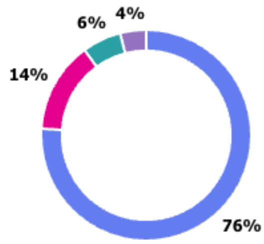
1. Club

Alfieri	10
Brse	12
RC Cannes	12
SK Volley	8
Uks	8



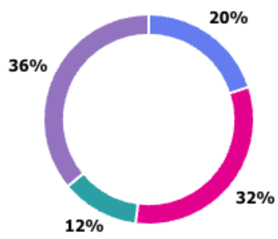
2. Role

Coach	38
Athletic trainer	7
Physiotherapist	3
Other	2



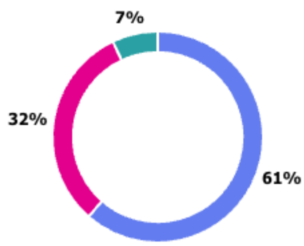
3. Level of experience in the role

0–2 years	10
3–5 years	16
6–10 years	6
Over 10 years	18



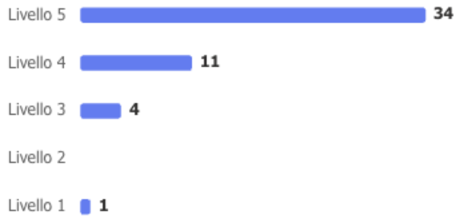
4. Prevailing work context

Youth sector	35
High level / competitive	18
Amateur	4
Other	0



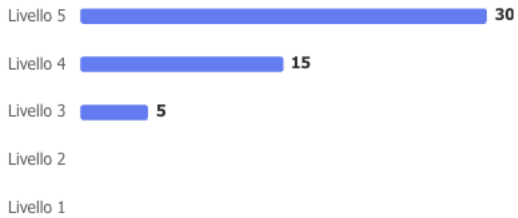
5. Were the objectives of the EDATS training course clear from the beginning?

4.54
Average rating



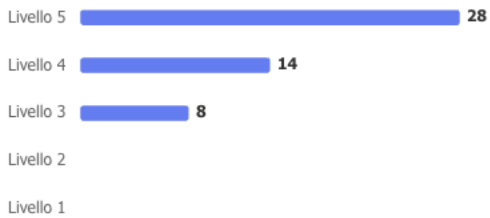
6. Was the content consistent with the needs of your role?

4.50
Average rating



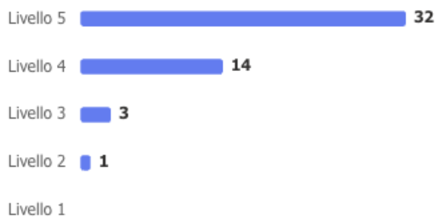
7. Was the level of depth adequate?

4.40
Average rating



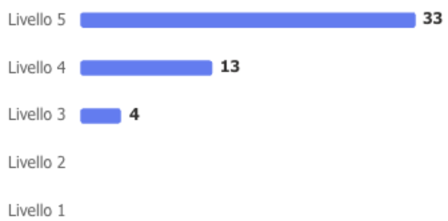
8. Was the overall organisation of the course effective?

4.54
Average rating



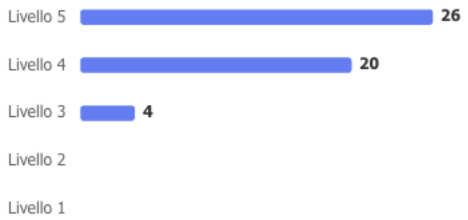
9. Were the skills of the tutor-trainers adequate?

4.58
Average rating



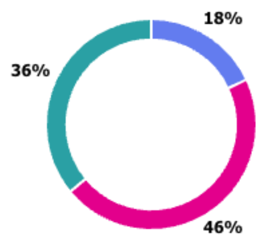
10. How applicable is what you have learned in your work context?

4.44
Average rating



11. Have you already applied EDATS tools or content?

- Yes 9
- No 23
- In part 18



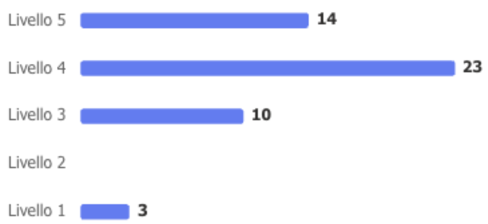
12. If yes, which ones?

15
Answers

Most recent replies
...

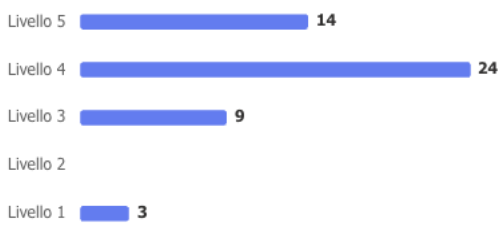
13. Is the software intuitive and easy to use?

3.90
Average rating



14. Does it improve your daily workflow?

3.92
Average rating



15. What could improve your workflow?

50
Answers

Most recent replies
"Understand how to improve the work and the train of our trainees"
"Monitor the résults and improve"
"The performance of our athletes"
...

16. What are the possible additional tools useful?

50
Answers

Most recent replies
"Yes, a lot."
"Especially useful!"
"Yes"
...

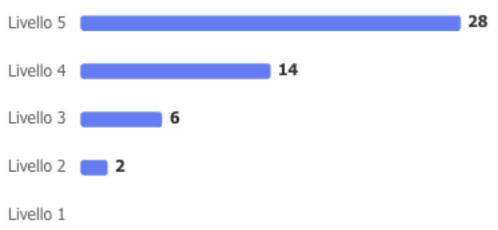
17. Suggestions for improving the software?

50
Answers

Most recent replies
"None"
"No"
"/"
...

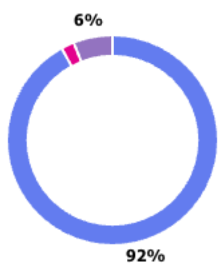
18. How satisfied are you with the EDATS path?

4.36
Average rating



19. Would you recommend this route to others?

Yes	46
No	1
	0
Maybe	3



20. Other comments or remarks

20
Answers

Most recent replies
...

ANSWERS TO OPEN QUESTIONS

ID	Question 12: If yes, which ones?	Question 15: What could improve your workflow?	Question 16: What are the possible additional tools useful?	Question 17: Suggestions for improving the software?	Question 20: Other comments or remarks
1		making it easier for new players to log into the system	compatibility with mobile devices	I don't have it at the moment	
2		Better organization of tasks, clearer priorities, and the use of more efficient tools could improve my workflow.	Project management software, automation tools, and better collaboration platforms could be useful additional tools.	Improving the user interface, adding more customization options, and enhancing performance and stability would be helpful.	
3		to make sensors read data in same moment	to make sensors read data in same moment	Simultaneous reading of 5 sensors	great tool to follow players better jumping
4		To make sensours read data in the same moment	Very useful	I dont have	
5		-	-	-	
6		to make sensors read data in same moment	to make sensors read data in same moment	Simultaneous reading of 5 sensors	great tool to follow players better jumping
7		to make sensors read data in same moment	to make sensors read data in same moment	Simultaneous reading of 5 sensors	great tool to follow players better jumping
8		to meke sensors read data in the same moment	to meke sensors read data in the same moment	Simultaneous reading of 5 sensors	young athletes really love it , just sometimes system stuck and we have to reset it
9		to make sensors read data in same moment	to make sensors read data in same moment	Simultaneous reading of 5 sensors	great tool to follow players better jumping
10		To make sensors read data in same moment	to make sensors read data in same moment	Simultaneous reading of 5 sensors	No
11		L'analisi dell miglioramento fisico dell'atleta, porta vantaggio anche nel rendimento tecnico	Non saprei, gia' così e' un ottimo software	Per me e' gia' un buon software	
12		Maggiori personalizzazioni	Non saprei	Maggiore grafica specifica	Si dovrebbe riuscire a coinvolgere un numero maggiore di società
13		More training	More intuitive	No suggestions	
14		New insights from athletes	Other fonctions	.	
15		ability to work on a tablet or smartphone	I don't have the experience to point out anything yet	no	no
16		Łatwiejszy dostep	Brak	Brak	Brak
17		Ewerythink is ok	No	No	No
18		Morę details	Brak	Brak	No
19		I dont have opinion what can improve	I dont know	No	No
20		I Think it work very good	I dont know	No	
21	IMU sensors and the concerned website.	Easy search and comparison between nattional and international data.	Parallel use of more IMU-s during matches.	better visualistaion of postural standing	This is a very usefull and promising project! Well done ERASMUS+!
22	we tested the children	simpler software	sensor to be in sports shoes and to be tracked while practicing volleyball	to speed up the work and correct the errors because there are a lot of bugs	
23	IMU sensors with the help of the phisiotherapist.	Regular feedback.	Yes	No suggestion.	
24		-	-	-	-
25	I've tried jumps measuring, both squat and counter-movement jumps	In this moment, for what I've tried, I don't know what could improve the workflow. It seems very easy and useful to me.	One tool useful would be something like a "jumps counter" to use and monitor the athletes during the training.	I think that the dev team is already doing great with the sw. I would like to have a mobile app to optimise the time of the measurements.	
26		Player's jump skills	CMJ and SJ jump height measurement	Yes	
27		Vedo quando sono stanche e posso avanzare	Non so rispondere	Non so rispondere	Molto interessante
28	Sensors	more precise data	tutorial video	mobile app	I like it.
29	measuring jumps	more quick measuring	more IMUS	more wuick measuring	It is promising.
30	measuring jumps with IMU-s	More data that we could compare to each other.	yes	it is Ok	
31	Postural control and jumps	Better measuring. There are somtimes problems with the results. It should be often remeasured.	System that could measure the jumps during the game.	System that could measure the jumps during the game. Alarm system if someones effectivity is getting really bad.	
32	jumping and postural control	It is not in daily use. It should be more reliable.	Faster measuring, more punctuality.	It should be more fast to measure. and the results should be more reliable.	It will be very usefull if we could see and compare the results from all participating partners!
33	capteurs	new tools to apply	information on athletes	more intuitive design	
34	jumping	good feedback, but I can see the talent without any tools	no recommendations	no recommendations	
35	measuring with IMU-s	More feedback and analysis according to trends and comaprison with the results of similar players.	Using IMU-s during games.	Prapering automatic feedback for players about their results compared to the avarage.	It would be useful if direct feedback would be provided fot the coaches and for the players also. This should refer to their performance compared to the avarage of their own club / national average / international average.
36	Measuring jumps and stability (single leg stance)	If the software would be easier to use, more quick and accurate	To make the measurements more precised, for example be able to measure 3 jumps in a row and see an avarage result	Same	
37		A more reliable software	-	It often freezes or not showing the results immediately, it would be good to correct this.	
38		Non ho ancora applicato gli strumenti	Non ho ancora applicato gli strumenti	Non ho ancora applicato gli strumenti	
39		New test to implement	Yes	The pairing simpler	
40	Sensors for measuring the jump	Cyclical use to verify the athlete's improvement	Use during the game	I would not know	
41	Plateforme	Yes	Yes	I don t know	
42		Prevent physical deseas	Overall body	It's a good start	
43		speed and avoiding useless processes	n/a	n/a	
44		Yes, the software is fairly intuitive, with a user-friendly interface that allows for easy navigation and quick access to essential features	Yes, it has been beneficial in improving workflow by simplifying tasks related to data entry, reporting, and monitoring progress	A potential improvement could be to add more customizable features	
45		the implementation of real-time data syncing across all devices and platforms, ensuring all team members are working with the most up-to-date information	It would be beneficial to add an automated reporting tool	none	
46		Incorporating task prioritization features, where tasks can be tagged by importance and urgency	A time-tracking tool would be a great addition to better monitor the time spent on tasks	customizable dashboards	
47		That's fine	I have no proposals	No	Fundamental and very useful experience, especially for exchanges between different realities
48		The performance of our athlètes	Yes	/	
49		Monitor the résults and improve	Especially useful!	No	
50		Understand how to improve the work and the train of our trainees	Yes à lot	None	