# Training-load monitoring system applied to combat athletes: A low-cost practical proposal for young judokas

Mathías LÓPEZ-CÓRDOBA[1], Guillermo MADRUGA-SANTOMÉ[1], Paulo VARELA-AMBOAGE[1], Diego PENA-PÉREZ[1], Álvaro RAMÓN-ÁVALOS[1], Natalia MORENO-FROJÁN[1], Eduardo CARBALLEIRA[2]

[1] Universidade da Coruña, Faculty of Sports Science and Physical Education: mathias.lopez.cordoba@udc.es; g.madruga@udc.es; p.amboage@udc.es; diego.pena1@udc.es; alvaro.ramon1@udc.es; natalia.moreno@udc.es

[2] Universidad de La Laguna, Faculty of Education, Department of Specific Didactics, Area Physical Education and Sport. ecarball@ull.edu.es

## 1. Introduction*

Effective load management is key to optimizing performance and preventing injuries. However, many coaches still rely on intuition rather than systematic monitoring, limiting their ability to detect and address training issues. When injuries, overtraining, or stagnation occur, identifying the underlying causes becomes challenging, increasing the risk of athlete dropout. In combat sports such as judo, where high-intensity efforts, neuromuscular fatigue, and substantial recovery demands are central, monitoring is especially critical (Campos et al., 2023).

Training load monitoring integrating the four pillars — external and internal load parameters, wellness metrics, and performance indicators — is now essential for adapting training to individual responses and minimizing overtraining (Gabbett et al., 2017). Recent studies highlight the importance of structured systems to optimize load distribution throughout the season (Yoshida & Hayashida, 2023; Campos et al., 2023).

Despite the growing demands on youth athletes due to early professionalization, access to advanced monitoring technologies remains limited in talent development settings. Addressing this gap, this study proposes a low-cost, dashboard-based monitoring system designed for young judokas. By offering an affordable, customizable, and data-driven solution, it aims to support effective load management, recovery, and performance tracking tailored to their unique needs and constraints.

## 2. Aims

This study presents a low-cost system to monitor the four pillars for young judokas, supporting load management. It provides coaches with a customizable tool to track responses, guide training adaptations, and enhance performance and recovery in combat sports.

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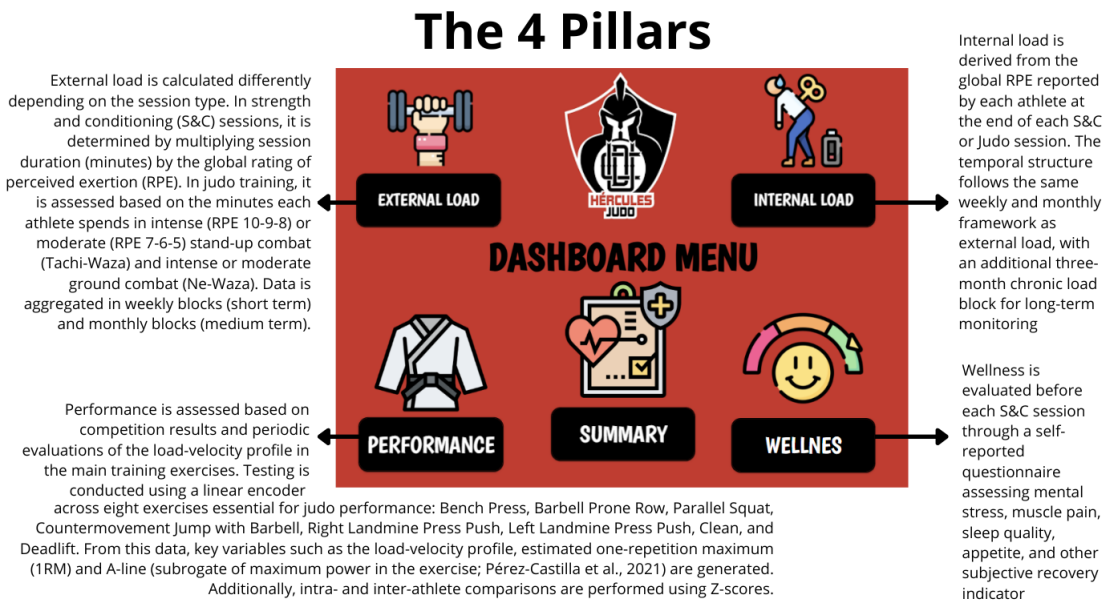
## 3. Methods

This practical proposal was developed using free, open-access Google tools: Looker Studio for data visualization, Google Sheets for data management, and Google Forms for athlete input. Looker Studio transforms large datasets into interactive dashboards, simplifying interpretation without raw data analysis. The system, managed by a strength and conditioning coach, four judo coaches, and a physician, has been used by eight youth judokas continuously since early October.

The monitoring system is structured according to Gabbett's four pillars (Figure 1): external load, internal load, wellness, and performance (Gabbett et al., 2017).

**Figure 1.** Dashboard menu with an explanation of the metrics contained in each of the 4 pillars based on the Gabett's model (Gabett et al., 2017)




Coaches and athletes can use a menu interface to access each pillar, selecting individual variables or summaries for real-time tracking and athlete comparisons (Figure 2). In the future, conditioning assessments and technical-tactical evaluation using rubrics will be integrated into the performance section of the monitoring system.

Looker Studio is directly linked to Google Sheets, enabling automatic report updates with each new data entry. Cloud-based storage ensures access from any device at any time. Data is stored in two Google Sheets: one for evaluations and one for athlete inputs via Google Forms, where processing and management occur. This setup allows seamless integration of data collection and analysis, supporting efficient monitoring of training load and athlete well-being.

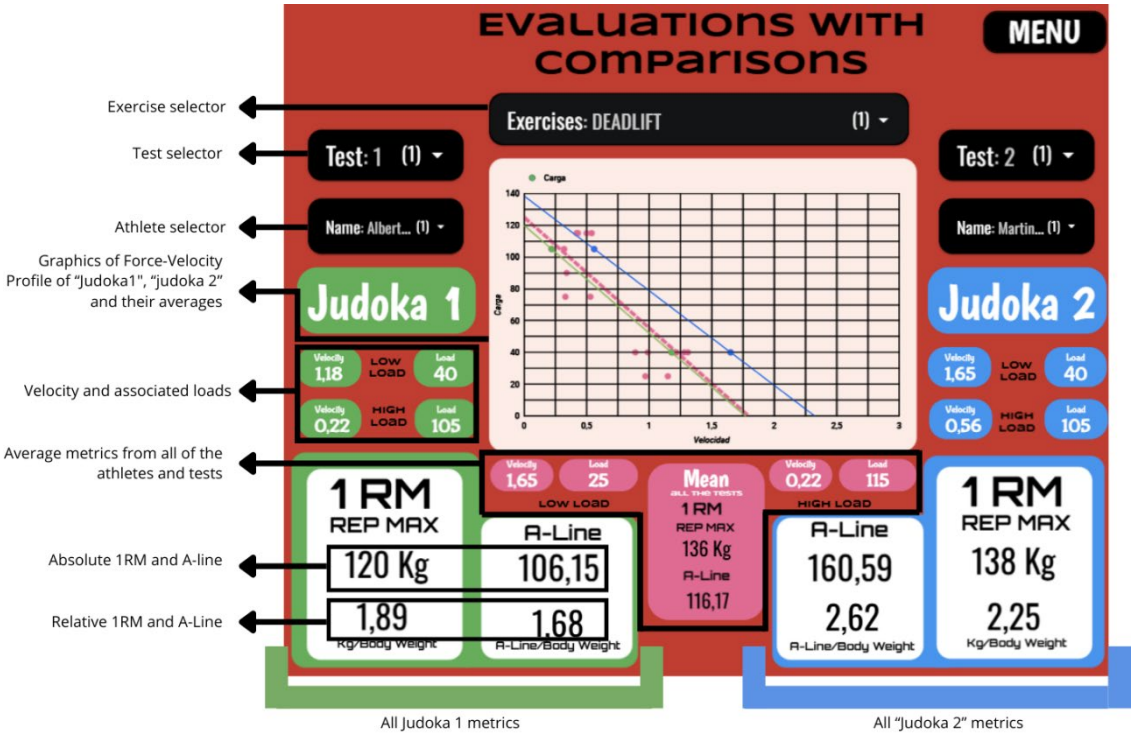
To gather relevant data on young judokas' responses to training sessions and their cumulative effects, athletes (N=8) complete three short questionnaires:

- Before the first training session of the day: Wellness questionnaire is administered to assesses key recovery and wellness indicators, including the Perceived Recovery Status (PRS) Scale (1–7), Fatigue, Muscle Pain, Mental

Stress, Motivation, Hours of Sleep, Sleep Quality, and Appetite (Hooper & Mackinnon, 1995; Laurent et al., 2011).

- After each session type:
    - The S&C questionnaire records global RPE (1–10), perceived effort (1–7), and enjoyment (1–7),
    - The judo session questionnaire captures global RPE (1–10) and the minutes spent in intense or moderate Tachi-Waza and Ne-Waza.

**Figure 2.** Performance pages of the dashboard with load-velocity the metrics.




This structured data collection process enables real-time tracking of athletes' responses to training, allowing coaches to make informed, data-driven decisions for training adjustments and optimizing athlete adaptation, performance, and recovery.

## 4. Results and discussion

This proposal aims to improve understanding of athlete behavior, progression, and discrepancies between expected and actual performance. By collecting and visualizing key training variables across the four pillars, the system supports more informed decision-making in training management. Furthermore, it also provides valuable insights into load progression and athlete adaptation, while helping maintain internal load within safe and effective thresholds (Gabbett et al., 2017).

This tool functions like a thermostat, allowing coaches to adjust training based on key performance indicators. It enables individualized programming by estimating an athlete's power-strength needs and tracking how external loads change relative to fixed velocities, ensuring precise load prescription. Analysis of the load-velocity profile

and A-Line indicator (Pérez-Castilla, Jukic, & García-Ramos, 2021)—derived from theoretical maximal velocity ($V_0$) and load ($L_0$)—provides the area under the force-velocity curve as a power marker, guiding emphasis on strength or power development. Although the current system focuses on general physical monitoring, we plan to integrate judo-specific tests such as the Special Judo Fitness Test (SFJT) (Franchini, Sterkowicz, Szmatlan-Gabrys, Gabrys y Garnys, 2011) and the Judo Specific Maximal Aerobic Power Test (MAS-Hikidashi test) (Shiroma, Julio y Franchini, 2019) in future applications of the dashboard.

## 5. Conclusions

A dashboard-based monitoring system is being developed to improve training adaptations, workload management, and recovery in young judokas. By integrating internal and external load metrics, wellness indicators, and performance measures, it aims to support data-informed decision-making and individualized training. Although formal data analysis is pending, preliminary use suggests potential utility.

Future research will assess its effectiveness through mixed-method surveys evaluating athlete and coaches' perceptions. Planned developments include the incorporation of technical–tactical rubrics and conditioning assessments.

Beyond judo, this system provides a scalable, evidence-based tool for combat sports, bridging the gap between sports science and practice to promote sustainable athlete development and safer training progression.

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