

Understanding Athlete Training Load



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Crack the Body's Physiological Code

How do you measure a training session? By the hours you put in? Maybe the distances racked up? Or asking an athlete for verbal feedback? Useful guides for sure, but how much does this information really tell you about how each athlete's body reacts to the training schedule it is being put through?

That's where training load data comes in.

Monitoring training load lets you appreciate the physiological impact of any training session on an individual player and team level. Adjusting intensity in real time, recognizing trends, and making sure training replicates game intensity are just some of the benefits.

The Firstbeat Sports method for tracking training loads and recovery is built on an advanced analysis of heart rate and heart rate variability data. Better insight means better decisions. Firstbeat Sports helps you optimize training, reduce injuries, and keep players on the fast track to reaching their full potential.

Getting results in sports is increasingly decided by ever-decreasing margins. Being able to see accurate, personalized and useable training load data is one way to ensure you stay ahead of the pack.

Book a Demo firstbeat.com/demo



Glossary

EPOC

Excess Post-Exercise Oxygen Consumption, expressed in ml/kg. Used to quantify training load of a single session.

TRAINING EFFECT (TE)

An interpretation of EPOC describing the impacts of the training session on 0.0 to 5.0 scale.

AEROBIC TRAINING EFFECT

Describes the impact of the training session on cardiorespiratory fitness.

ANAEROBIC TRAINING EFFECT

Describes the impact of the training session on anaerobic performance using Firstbeat's algorithms to identify and interpret high-intensity activity.

MOVEMENT LOAD

This is used to quantify the movement of an athlete during a session, the External Load equivalent of TRIMP.

TRIMP

Training Impulse, a measure to quantify training load.

TRIMP/min

Shows the rate at which training load (measured as TRIMP) is accumulated over a period of time.

ACUTE TRAINING LOAD

The sum of TRIMP scores over the last 7 days representing the current short-term load of an athlete.

CHRONIC TRAINING LOAD

The training load average over the last 28 days describing the typical training load of an athlete.

ACUTE VS CHRONIC TRAINING LOAD

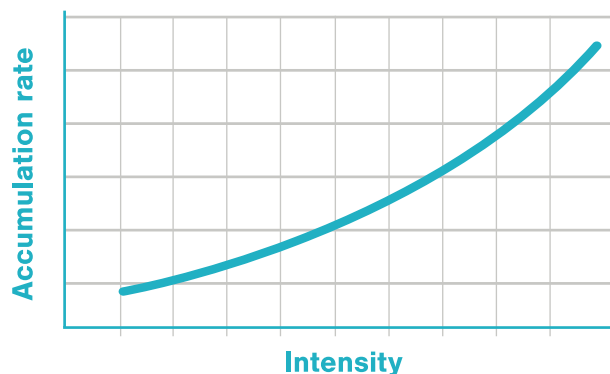
An analysis of the balance between the athlete's acute (short-term) and chronic (long-term) load.

Understanding the Key Metrics

Firstbeat Sports is built on over 20 years of scientific research and work in professional sports. Our metrics provide the most comprehensive internal load monitoring analyses to help you measure the impact of, and response to, training and workouts.

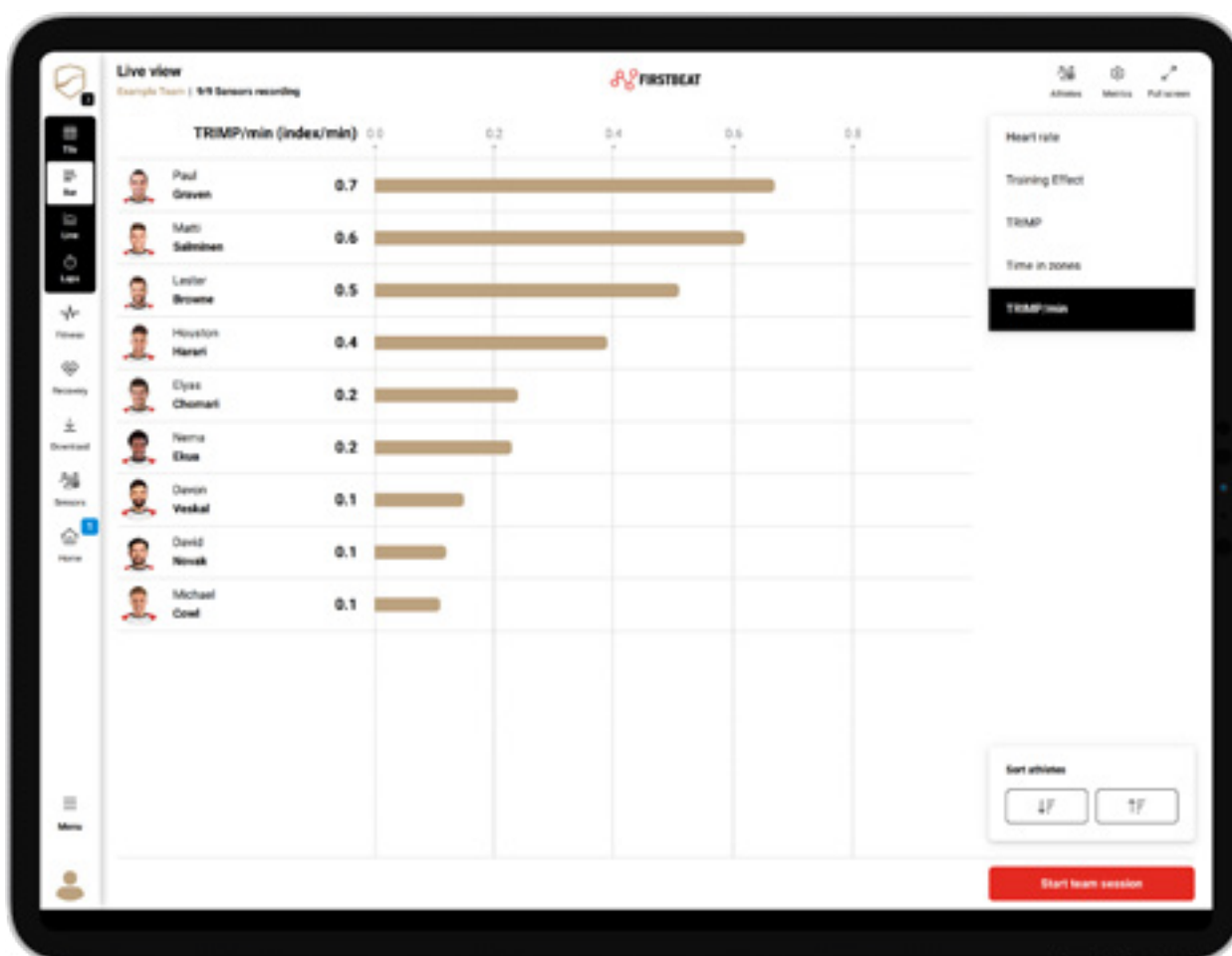
TRIMP

Training Impulse (TRIMP) is used to describe training load as a single number. The original TRIMP calculation was developed by Dr. Eric Banister in 1991, and was based on an integration of time, intensity and relative weighting of the intensity of exercise. Since then, numerous authors have presented modified methods to calculate TRIMP.



TRIMP accumulation rate models lactate accumulation rate increasing exponentially to intensity

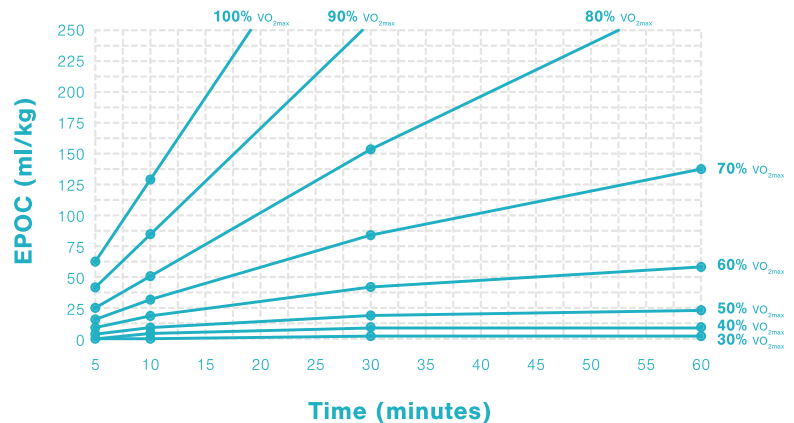
The TRIMP calculation in Firstbeat Sports is based on Banister's original TRIMP calculation with some modifications. Instead of using the mean heart rate across a workout, Firstbeat uses beat-to-beat heart rate data to update TRIMP scores more frequently. This ensures more accurate training load assessment in interval type training. Firstbeat has also set a lower intensity limit for the TRIMP accumulation to ensure that TRIMP number is derived only from training.



Firstbeat Sports Coach App (iPad) – Live Chart View (TRIMP/min)

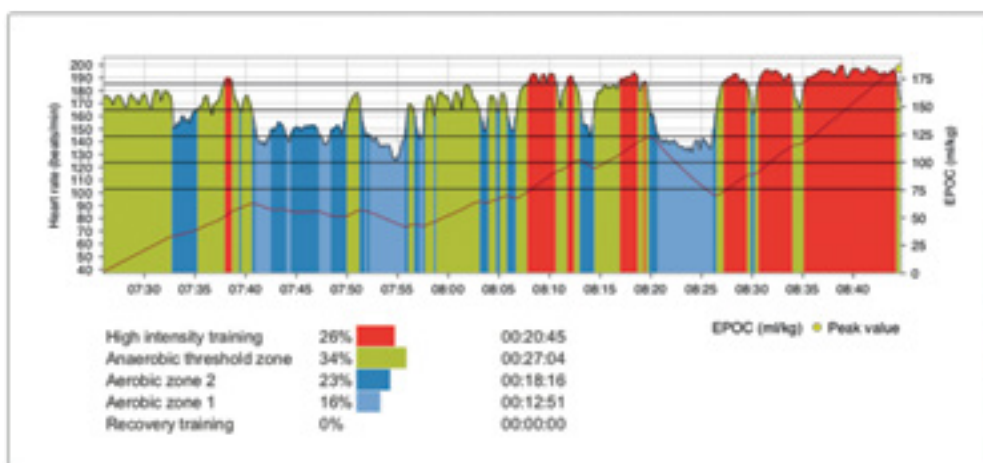
EPOC

EPOC stands for Excess Post-Exercise Oxygen Consumption, and it reflects how far the body's oxygen uptake is elevated from resting levels due to recovery needs after exercise. Firstbeat uses EPOC as a representation of the disturbance of a body's homeostasis, and analysis of EPOC can be used to measure the load of individual training sessions.



The original method for EPOC measurement involved capturing respiratory gases in laboratory conditions after exercise. While highly informative, the laboratory method was impossible to perform in real-world conditions. Recognizing the importance of EPOC for effective training programming and the limitations posed by laboratory testing, Firstbeat developed an algorithm capable of effectively predicting EPOC during the ongoing exercise using heart beat data.

EPOC is predicted dynamically based on current exercise intensity (%VO₂max) and time spent at that intensity. The crucial point of EPOC modelling is to accurately measure exercise intensity, which, in the Firstbeat model, is performed by neural networks utilizing heart rate, heart rate variability-derived respiration rate, and on/off-kinetics information describing the different physiological responses in changing exercise intensities. The model can predict the amount of EPOC at any given moment and no post-exercise measurement is needed.



The EPOC accumulates dynamically during the exercise. It increases rapidly during the high intensity phase and decreases during easy periods.

When put into context using an athlete's Activity Class or a combination of aerobic fitness level and activity history, EPOC scores are used to calculate Training Effect.

Training Effect

Firstbeat's method of providing Training Effect feedback is based on a deep understanding and research of human physiology and research performed using elite athletes from various sports.

The resulting algorithms form a comprehensive system which can track which physiological performance characteristics, and to what extent, have been trained, i.e. aerobic and anaerobic Training Effects. Used in combination, they will help you see and understand the relationship between specific training activities and the development of future performance capacity, and give you the information you need to adjust training load towards training targets.

Aerobic Training Effect

Aerobic Training Effect describes the impact of a training session on the development of VO₂max and aerobic endurance capabilities. Its quantification is based on the highest level of EPOC achieved aerobically during the session reflecting the peak of homeostasis disturbance.

As active and fit individuals need harder training than less active and less fit individuals to improve their fitness the activity class of an individual must be known in order to effectively assess aerobic Training Effect.

The activity class value represents the activity level of the previous month and is key to individualizing Training Effect scores. Professional athletes will likely fall within the 7.5 to 10 activity class values.



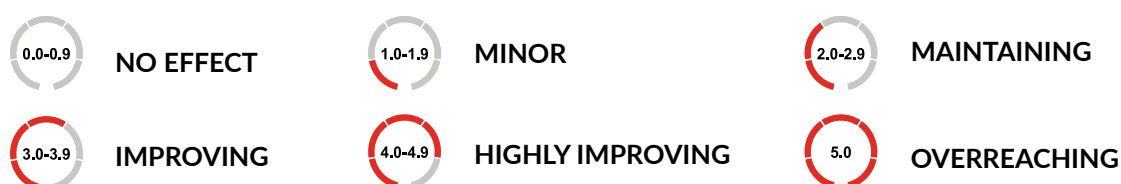
Training Effect is reported on a 0.0 to 5.0 range, which reveals whether a session highly improved, improved, maintained, or had a minor to non-existing effect on performance capacities. Very high scores indicate overreaching exercise stimulus which may require paying special attention to recovery.

Anaerobic Training Effect

Anaerobic Training Effect describes the impact of a training session on the development of repeated sprinting abilities and anaerobic performance capacity.

The calculation is based on identifying and analyzing high intensity periods (intervals) where the anaerobic energy system has been stressed, increasing the oxygen deficit. The method considers aspects relevant to anaerobic metabolism including; intensity and speed of intervals, duration of intervals, recovery status before intervals and fatigue accumulated during the session.

As the intensity of work performed during the anaerobic periods such as sprinting can be as high as 150% of VO₂max, but intensity as percentage of HRmax is limited to 100%, heartbeat dynamics are utilized to assess Anaerobic Training Effects.



Training Effect scale

Acute vs Chronic Training Load

Ensuring there is a balance between short and long-term training load helps to reduce injury risk and maintain and improve fitness and performance.

A sudden spike in an athlete's weekly training load can lead to a higher risk of injury. Conversely, an acute training load that is well below the 'norm' can hinder performance and reduce fitness as the body is not pushed enough to facilitate change. In this situation, the athlete is losing their tolerance to training which, again, can increase risk of injury. Monitoring the acute and chronic training load helps make sure they are in balance and flags up situations where load is changing too dramatically.

Firstbeat Sports' Acute vs Chronic Training Load metric does this by analyzing the acute vs chronic workload ratio (ACWR) and presenting the data in a color-coded gauge. The ratio, combined with training load values, indicate when a player is in a well-prepared state, or at an increased risk of getting injured.

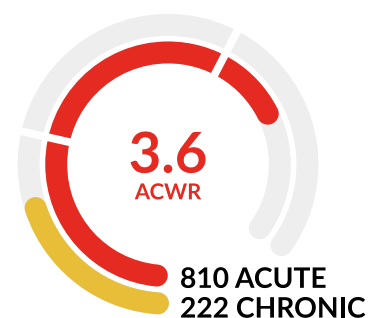
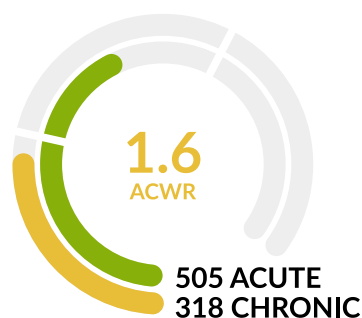
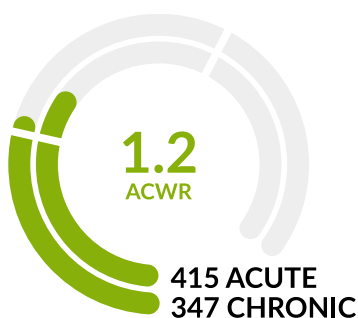
The ranges for each individual are continuously scaled based on their measurement history. This ensures the results factor in an individual player's physiology and are always relevant.

Acute vs Chronic Training Load Key

Green - Good ACWR

Yellow - Moderate ACWR

Red - Poor ACWR



Three examples of the Acute vs Chronic Training Load as shown on the Firstbeat Sports dashboard. Player 3 has a high acute load, but low chronic load so is at an increased risk of injury, whilst Player 1 is in the training 'sweet spot' with an ACWR of 1.2.

Getting Results with Training Load Data

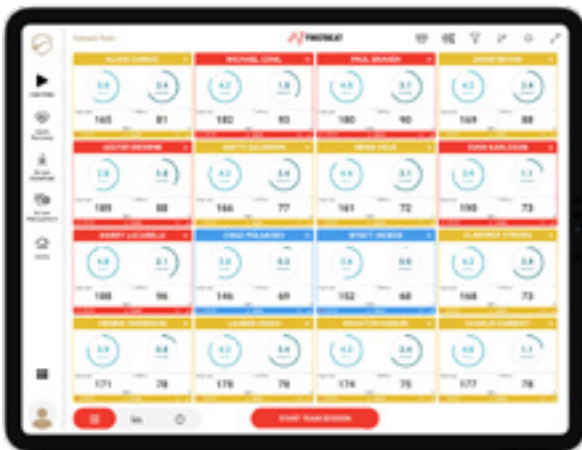
Firstbeat Sports puts accurate physiological data into your hands
- allowing you to make important training decisions on an
individual and team level. To do this effectively, it is important to
understand how the data provided can be put to practical use.

Monitor Players in Real-Time

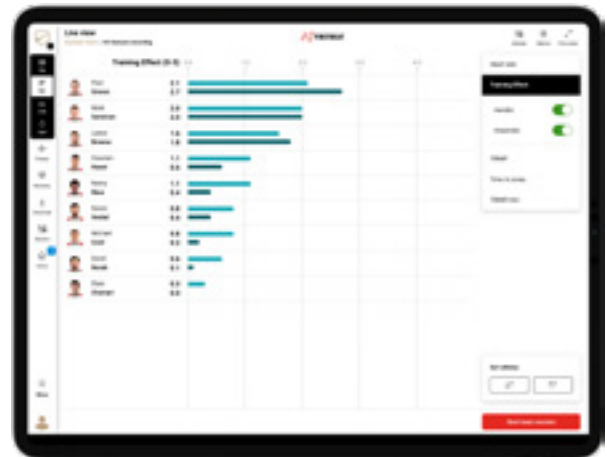
Real-Time Tile View

Real-time monitoring offers insights into your team's training that let you adjust the intensity and plan of the ongoing training session in order to meet your targets. Real-time feedback is also a great tool to inform players about their effort, motivate individuals, and turn insights into immediate actions.

With the Firstbeat Sports live tile view you can monitor a variety of intensity and volume based metrics, seeing how they change and accumulate in real-time.



Firstbeat Sports Real-Time Tile View

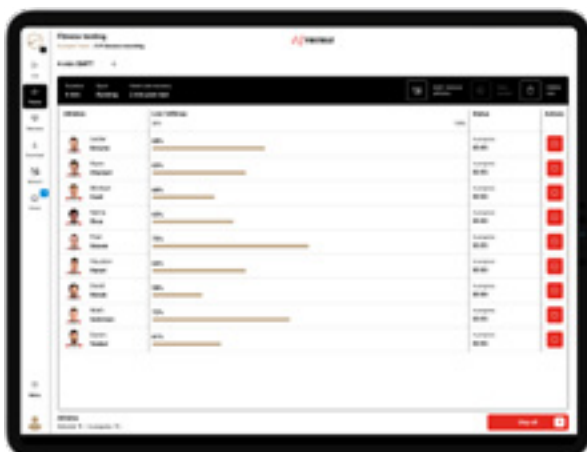


Firstbeat Sports Real-Time Bar Chart View

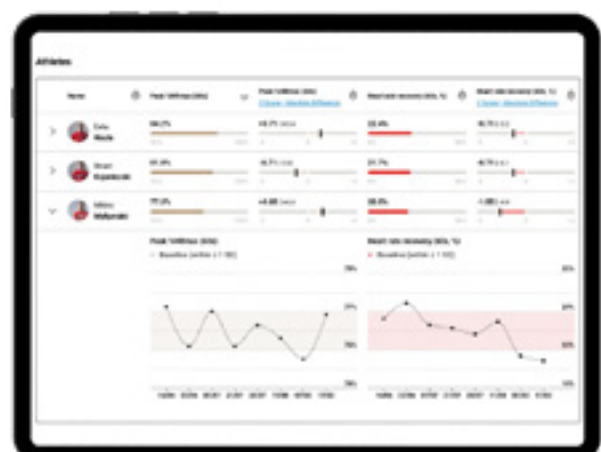
Submaximal Fitness Testing

Submaximal Fitness Testing is a powerful tool to track your players' progress and any changes in aerobic fitness. With the recent update you can now track Submaximal Fitness Test progress in real-time, seeing how your players heart rates are changing throughout your chosen protocol, and then how they recover during the optional recovery period.

Upon completion of the test, you are able to quickly access automatically generated reports for greater depth of analysis and comparison to historical performance.



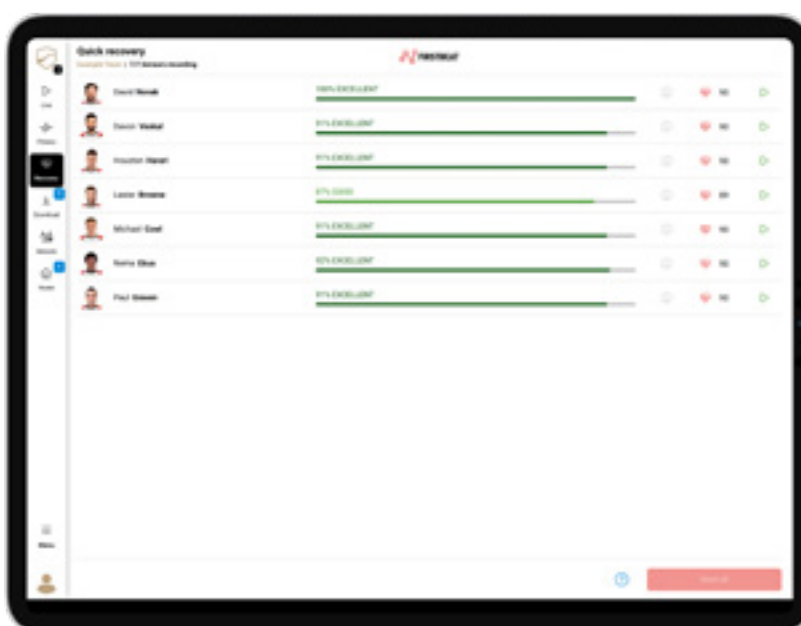
Firstbeat Sports Real-Time Fitness Testing View



Firstbeat Sports Fitness Testing Results

Recovery Testing

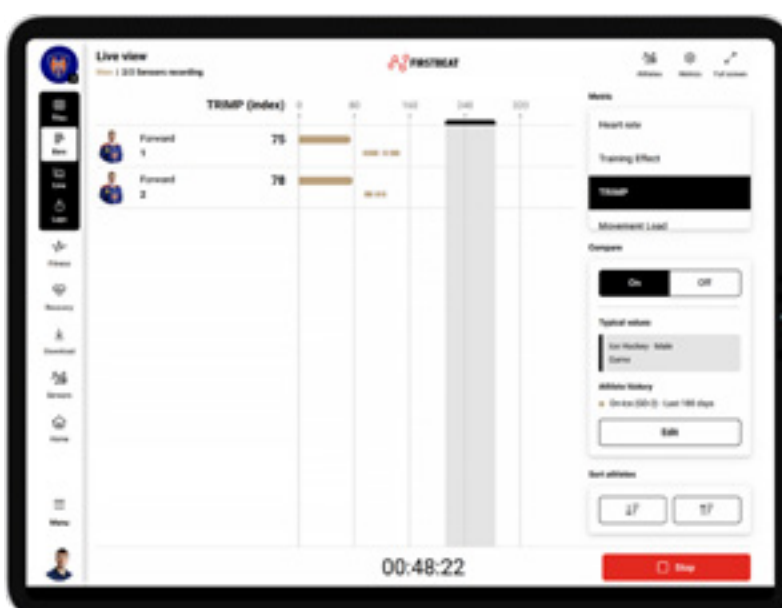
The Firstbeat Sports Quick Recovery Test provides insights into your players' recovery status and readiness to train. Utilizing this feature in the Coach App before training shows you the progress during this resting test. Upon conclusion you immediately receive the results from the current test, adjusted to each individual's baselines. See an unexpected value? Maybe that player needs a modified session to facilitate a bit more recovery, or perhaps they can do a little extra to maximize the gains from a good day!



Firstbeat Sports Quick Recovery Test (QRT)

Compare to Reference Values or Athlete's History

The reference values feature in the Firstbeat Coach App provides instant context for measurement results, enabling coaches to quickly assess how the session compares to typical values in the Firstbeat database, or to compare an athlete's response to his/her own results in the past.



Firstbeat Sports Reference Values Live View

What is Movement Load?

Movement Load from Firstbeat uses the accelerometer within our Firstbeat Sports Sensor to quantify the movement (External Training Load) of your athletes. Movement Load accumulates over the course of a session, capturing the movement of the athlete in any direction and providing you with a value for External Training Load that has been completed within the session.

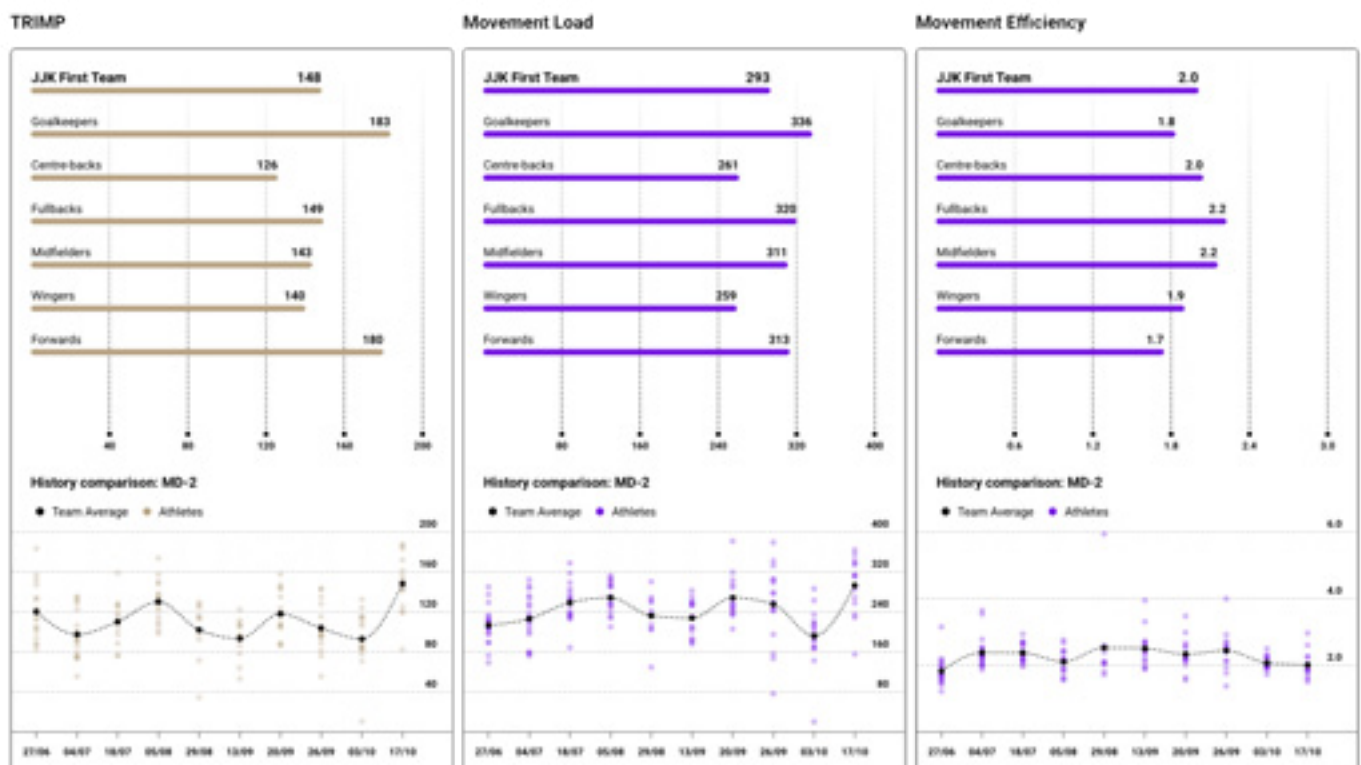
This is useful because it provides more context to the Internal Training Load (TRIMP, EPOC, Training Effect) that we are also collecting for our players.

By looking at the relationship between internal and external load regularly using Movement Load and TRIMP you can constantly get a picture of how your athletes are doing. Below are some reference values for Movement Load to give you an idea of what might be normal.

It is worth keeping in mind here that there can be quite a bit of variation between players as everyone moves slightly differently and will therefore accumulate ML at different rates.

This is where we see the greatest difference between men and women for that very reason. It is also why we have included some overlap in the figures, because of that variation between individuals.

As an example, one male player might accumulate 210ML in an easy session, whereas another who moves more smoothly might only have 190ML from a moderate session. Therefore, it is important to consider ML in the context of TRIMP, and whether the relationship between them have changed significantly. By this we mean, has a player been able to move more/less for the same 'cost' (TRIMP).



Track Progress and Plan Ahead

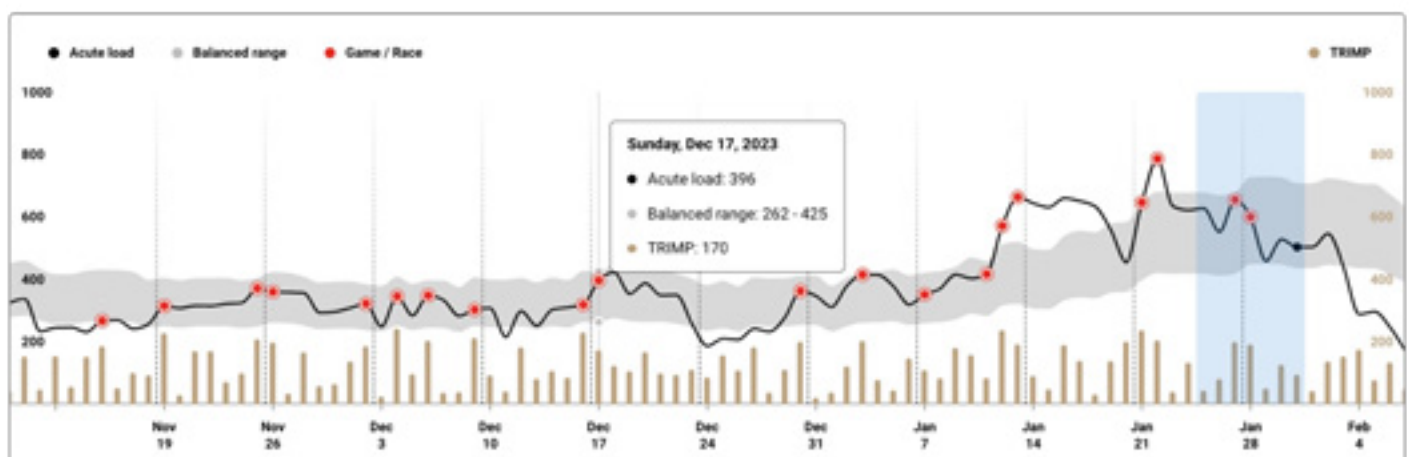
Training Load data provided by Firstbeat Sports makes it easy for you to track your athletes progress and make your short and long-term training plans. Shown on an easy-to-use dashboard and in our insightful, context rich reporting tool, you can easily see recent and longer terms trends, both week-by-week and session-by-session. The key performance indicators shown allow you to recognize your training trends, ensure players are at their best physiologically for key moments, and safely guide players back from injury.



Long-Term Loads Trends

Our Weekly Training Summary Report* shows your load progression over the previous 12 weeks, giving you an overview of how you got to your current position. It helps answer questions such as: 'Have we built up training loads in a controlled way? Could we increase volume a bit further, or do we need a bit of a de-load week?'

Team Training History

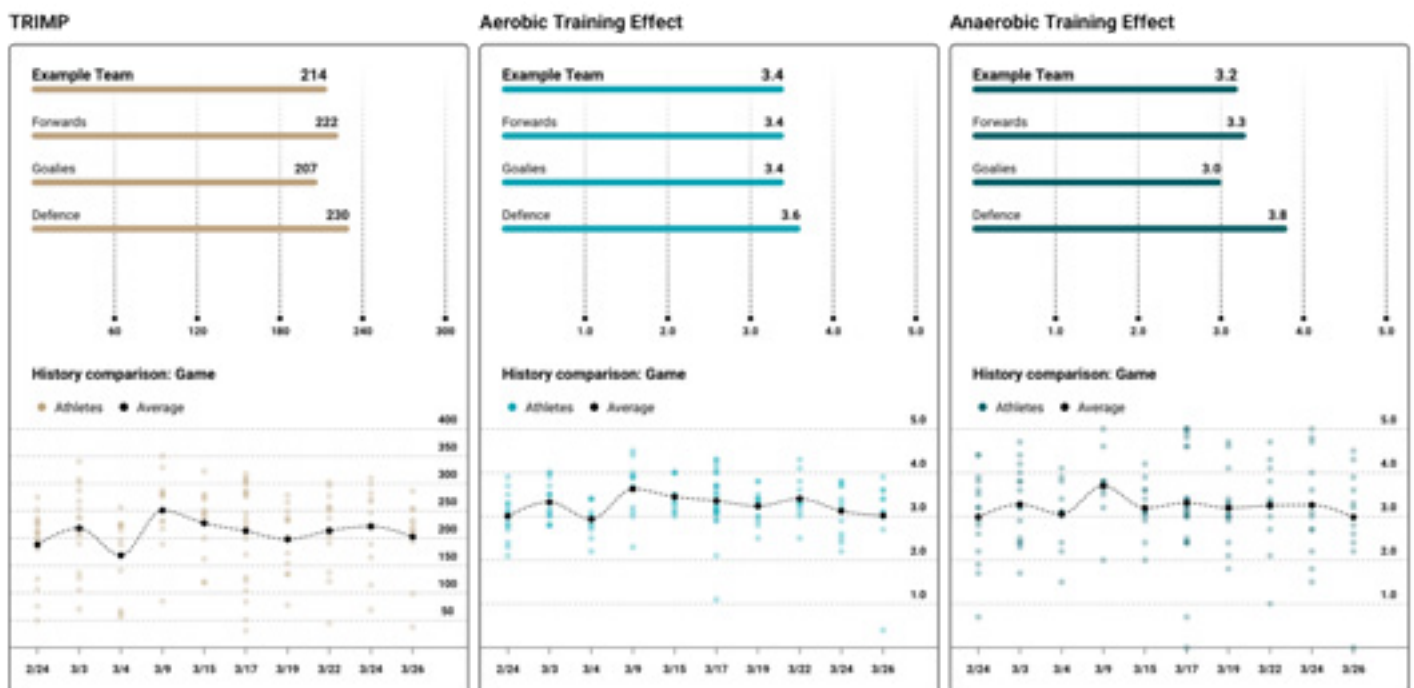


Weekly Training Summary Report – Team Training History

Historical Comparison

Our training session report not only tells you about what has happened today, but also how today's session compares to previous ones. With the option to filter sessions by title, type, and weekday, you can see how today compares to the same type of session in the past. This allows you to quickly identify if your session went as planned, for example do your team like to do similar things on Match Day -1 to help them mentally and physically prepare. This means you instantly know if you need to adjust tomorrow to ensure you meet your longitudinal goals.

*(Premium+ feature)



Athlete Ranking



Weekly Training Summary Report – Historical Comparison and Athlete Ranking

Post-Session Analysis of Training Load Data

After a session is over, you have a chance to look more closely at the data, examine it, and contextualize it in ways that unlock additional meaning. Data collected during real-time monitoring is automatically synchronized to the Firstbeat Sports Cloud, where you can access it for review and analysis.



Once in the Firstbeat Sports Cloud, data can be easily shared with the individual athletes, coaching staff, trainers, physiotherapists and nutritionists - provided they have been given the proper permission to access the data.

You can also have training reports automatically sent via email at the end of each session. Stored on a single platform that combines training load and recovery data - a setup unique to Firstbeat - results from the most recent session can be compared to findings from one week, one month and beyond, going as far back as when you began measuring. With the Firstbeat Sports Cloud premium package, it is also possible to export selected variables to Microsoft Excel for deeper analysis.



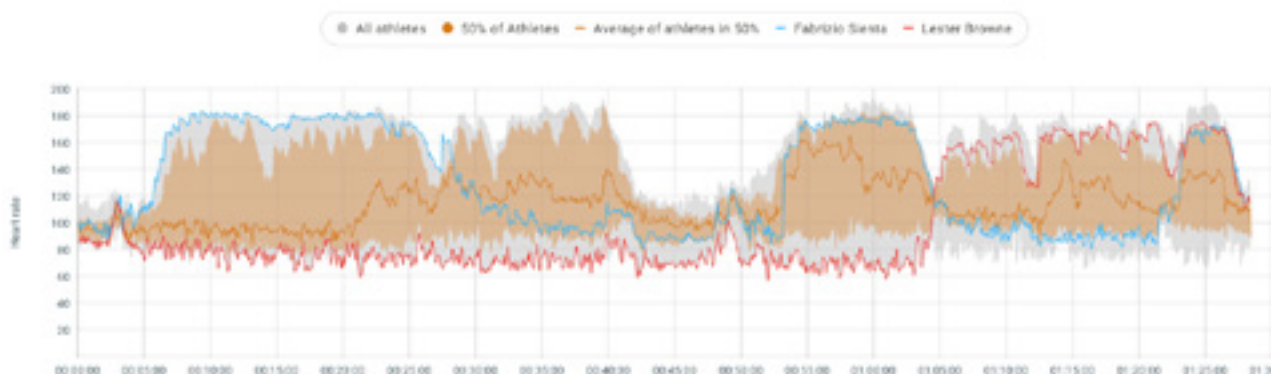
Firstbeat Sports Weekly Training Summary Report, Training Session Report and Athlete Report

Typical uses:

- **SINGLE PLATFORM:** Easily present “full picture” findings to head coaches and decision-makers.
- **CUSTOMIZE:** Sort players in the dashboard based on selectable training load and recovery variables.
- **COMPARISONS:** Overlay up to five athletes’ heart rate data on the same chart.
- **BROAD PERSPECTIVE:** Identify single-session anomalies, red flags and discover trends.
- **SELECTED VARIABLES:** Analyze data based on individual needs and agreed targets.
- **FEEDBACK REPORTS:** Review specific position groups or players via coach-friendly group and individual reporting.



Athlete comparison by variable.



Comparison of two athletes' heart rate data.

“

I always like to call Firstbeat a very lean system that doesn't swamp you with parameters that you basically don't use. It's accessible from anywhere and the dashboard design is very clear and flexible. You can choose your key metrics and customize the online view to your personal needs.



**Domenik Theodorou, Performance Coach,
RASTA Vechta**

“

Firstbeat is my 'go to' tool when it comes to measuring heart rate in professional soccer. I find the real-time software to be the best in the market, and the Training Effects metrics to be insightful.



**David Tenney, Director of High Performance
(MLS)**

Individualize Training Plans

Every athlete's physiological profile is different. Without taking individual training responses and recovery needs into account, an athlete will not reach their full potential. Managing this reality in a team environment is extremely challenging, making it an area where technology can be very helpful.

Firstbeat Sports offers an individualized view of training load data - allowing you to see each individual player's physiological status during a session, and map individual reactions to drills over time.

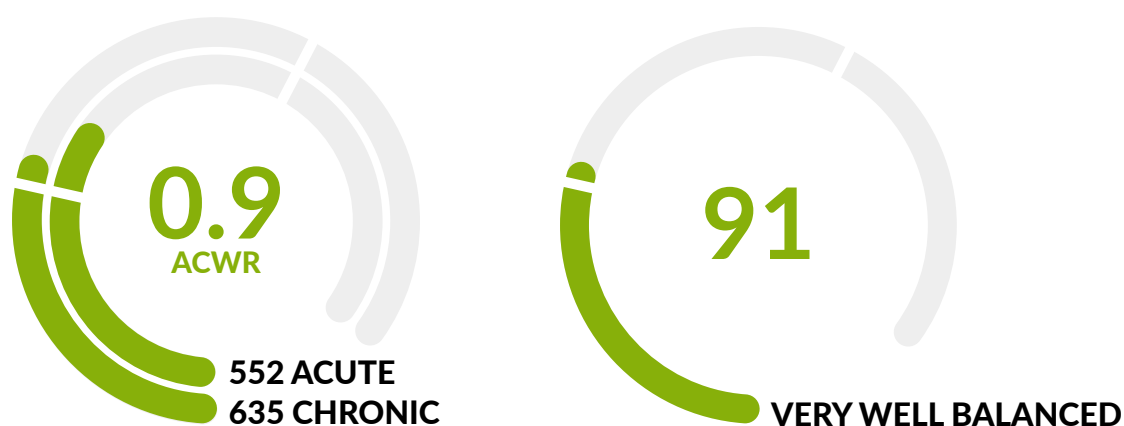


From the Firstbeat Sports dashboard, you can see Aerobic and Anaerobic Training Effects, TRIMP and Training Zone scores build and change in real time for every player wearing a heart rate belt. Combined with post-session analysis, you can determine the specific needs of each player (or position group) and modify training regimes accordingly. This gives you the freedom to guide individual training based on position, or even a desired style of play.



Typical uses:

- **INTERVENTION:** Identify players who should be taken out of a session to prevent overtraining, or who could be encouraged to push harder.
- **CHANGES:** Establish individual training norms and track a player's physiological reaction to similar drills over time.
- **RISK MANAGEMENT:** Adjust individual training intensity if training load data indicates a player is becoming increasingly at risk of injury.
- **MANAGE RETURN-TO-PLAY SCENARIOS:** Apply the right loads at the right times to get players back up to game speed quickly and safely.



Examples of Acute : Chronic Workload Ratio and Training Status in the Firstbeat Sports Dashboard

Being able to see the full range within a team provides context to guide specific athletes towards the team average. To fully understand different scores amongst individuals, it is also crucial to recognize the difference between natural factors and things that can be altered:

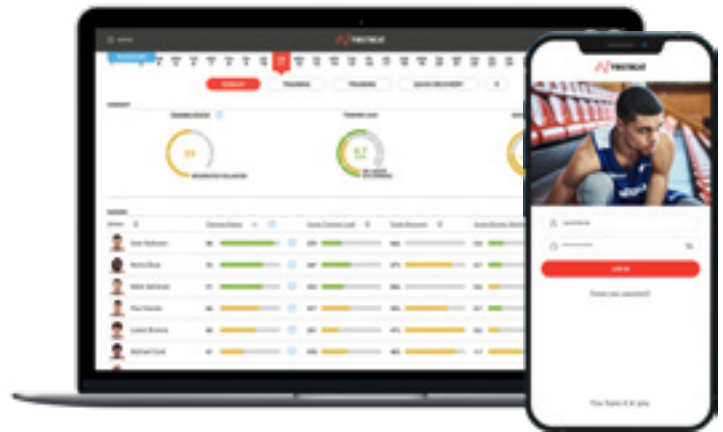
Natural factors: Skills, style of play, age, heritage/genes, training history

Things that can be altered: Motivation, estimated HRmax, responses to different drills

Communicate Results to Athletes and Colleagues

Firstbeat Sports helps you present clear, easy-to-understand findings to players and fellow coaches.

The Firstbeat system is there to help make your job easier. One way this is achieved is by providing automatic reports to coaches, whilst still allowing you to send individually tailored reports manually if required.



We know each team communicates results differently and that's why we try to make our system as flexible to your needs as possible. For instance, the adjustable nature of the dashboard means you can tailor what is displayed depending on your needs and who you are communicating the findings to.

We do believe players should be involved in the process as much as possible in order to enhance player buy-in and engagement. Firstbeat helps make this achievable by making their individual data available to the player themselves.

Typical uses:

- **REPORTS:** Send team training reports to coaches automatically at the end of a session. You can also send individual reports to coaches and players manually.
- **ATHLETE ACCESS:** Players can log in to see their own data. This access boosts player buy-in and engagement.
- **EDUCATIONAL:** Firstbeat can create specific educational materials (posters etc.) to suit team needs and help get colleagues and players invested.
- **ATHLETE-FRIENDLY:** Easy to interpret results (e.g. color-coded zones) make a good educational tool for players.
- **EXPOSURE:** Making real-time results easily visible encourages players to ask further questions.

Soccer

Reference Values

MEN

Use these ranges to interpret and plan training sessions

Metric		EASY	MODERATE	HARD	GAME
 TRIMP		40 - 65	77 - 115	133 - 194	171 - 278
 TRIMP/min		0.5 - 0.8	0.9 - 1.3	1.4 - 1.8	1.3 - 1.9
 Zone 5 Duration		0.0 - 0.0	0.0 - 3.4	5.9 - 19.3	3.2 - 26.2
 Movement Load		128 - 206	188 - 283	262 - 397	341 - 553

WOMEN

Metric		EASY	MODERATE	HARD	GAME
 TRIMP		42 - 73	82 - 129	153 - 241	235 - 333
 TRIMP/min		0.5 - 0.8	0.8 - 1.2	1.3 - 1.8	1.3 - 1.8
 Zone 5 Duration		0.0 - 0.0	0.0 - 3.7	7.9 - 24.6	14.4 - 36.6
 Movement Load		101 - 186	146 - 242	223 - 369	358 - 521

Basketball

Reference Values

MEN		Use these ranges to interpret and plan training sessions			
Metric		EASY	MODERATE	HARD	GAME
 TRIMP		39 - 70	82 - 129	142 - 209	190 - 251
 TRIMP/min		0.5 - 0.8	0.8 - 1.2	1.2 - 1.6	1.1 - 1.4
 Zone 5 Duration		0.0 - 0.0	0.0 - 2.8	4.9 - 15.1	10.7 - 20.9
 Movement Load		112 - 208	172 - 290	243 - 384	344 - 467

WOMEN					
Metric		EASY	MODERATE	HARD	GAME
 TRIMP		43 - 78	89 - 144	159 - 235	232 - 301
 TRIMP/min		0.4 - 0.8	0.9 - 1.3	1.3 - 1.8	1.2 - 1.5
 Zone 5 Duration		0.0 - 0.0	0.1 - 4.2	6.2 - 20.4	14.8 - 27.6
 Movement Load		84 - 170	142 - 240	202 - 318	306 - 409

Ice Hockey

Reference Values

MEN

Use these ranges to interpret and plan training sessions

Metric		EASY	MODERATE	HARD	GAME
 TRIMP		39 - 72	77 - 133	139 - 234	212 - 284
 TRIMP/min		0.5 - 0.8	0.8 - 1.1	1.0 - 1.4	1.0 - 1.3
 Zone 5 Duration		0.0 - 0.0	0.1 - 3.1	5.1 - 14.8	7.5 - 16.9
 Movement Load		61 - 128	93 - 176	136 - 230	189 - 259

WOMEN

Metric		EASY	MODERATE	HARD	GAME
 TRIMP		45 - 75	82 - 133	140 - 246	229
 TRIMP/min		0.5 - 0.8	0.8 - 1.2	1.1 - 1.6	1.1 - 1.4
 Zone 5 Duration		0.0 - 0.0	0.1 - 2.9	6.5 - 16.9	9.5 - 19.2
 Movement Load		53 - 91	73 - 126	104 - 192	170 - 240

Tennis

Reference Values

MEN		Use these ranges to interpret and plan training sessions			
Metric		EASY	MODERATE	HARD	GAME
 TRIMP	TRIMP	42 - 79	86 - 146	162 - 236	191 - 297
 TRIMP/min	TRIMP/min	0.6 - 0.8	0.9 - 1.2	1.3 - 1.7	1.2 - 1.6
 Zone 5 Duration	Zone 5 Duration	0.0 - 0.0	0.0 - 0.9	1.6 - 10.8	1.3 - 6.0
 Movement Load	Movement Load	101 - 234	181 - 306	257 - 387	369 - 569

WOMEN					
 TRIMP	TRIMP	45 - 86	85 - 146	168 - 283	238 - 365
 TRIMP/min	TRIMP/min	0.6 - 0.8	0.9 - 1.2	1.2 - 1.7	1.4 - 1.8
 Zone 5 Duration	Zone 5 Duration	0.0 - 0.0	0.0 - 1.2	3.1 - 15.5	3.3 - 19.6
 Movement Load	Movement Load	72 - 183	139 - 234	213 - 361	292 - 444

American Football

Reference Values

MEN		Use these ranges to interpret and plan training sessions			
Metric		EASY	MODERATE	HARD	GAME
 TRIMP	TRIMP	49 - 84	84 - 133	136 - 200	350 - 461
 TRIMP/min	TRIMP/min	0.5 - 0.8	0.9 - 1.2	1.2 - 1.6	1.2 - 1.6
 Zone 5 Duration	Zone 5 Duration	0.0 - 0.0	0.0 - 1.2	2.7 - 11.2	11.0 - 29.4
 Movement Load	Movement Load	103 - 185	130 - 225	169 - 264	255 - 317

Rugby

MEN					
Metric		EASY	MODERATE	HARD	GAME
 TRIMP	TRIMP	30 - 50	59 - 85	94 - 127	104 - 251
 TRIMP/min	TRIMP/min	0.5 - 0.9	1.1 - 1.5	1.6 - 2.1	1.4 - 1.9
 Zone 5 Duration	Zone 5 Duration	0.0 - 0.1	0.3 - 3.6	6.3 - 14.0	8.6 - 23.3

Field Hockey

Reference Values

WOMEN

	TRIMP	44 - 79	88 - 144	166 - 253	233 - 283
	TRIMP/min	0.5 - 0.8	0.9 - 1.2	1.3 - 1.8	1.5 - 1.8
	Zone 5 Duration	0.0 - 0.0	0.0 - 3.3	7.6 - 23.2	6.7 - 25.2
	Movement Load	73 - 141	116 - 210	200 - 334	295 - 364



The Next Step

You have gained insight into the key metrics behind monitoring training load, and the ways it can be optimized to get genuine results. So why us?

Firstbeat as Your Physiology Platform

- ✓ Physiological data that you can always trust
- ✓ Science-based physiological metrics
- ✓ Streamlined live monitoring
- ✓ Actionable dashboards and reporting
- ✓ Easy adoption and team-sport support

These capabilities support day-to-day coaching throughout the season:

INDIVIDUALIZE TRAINING

**IMPROVE PERFORMANCE
CONSISTENCY**

**REDUCE FATIGUE-RELATED
SETBACKS**

How do I learn more?

Watch expert webinars on sports performance, coaching, and athlete monitoring with Firstbeat:

firstbeat.com/en/webinars/?blog_category=sports

Read success stories from teams and organizations using Firstbeat in sports coaching and performance:

firstbeat.com/en/user-stories/?blog_category=sports

Explore educational sessions designed to help coaches and teams get more from Firstbeat:

firstbeat.com/en/trainings/?blog_category=sports

MORE INFO: firstbeat.com/en/team-solutions/



We are using Firstbeat and can speak to the positive changes it's made to our season. From individualized internal monitoring for team sessions to RTP to fatigue monitoring.



**Georgia Brown, Sport
Scientist, San Diego Wave**

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