

# Rest at MD+2 promotes player freshness across the microcycle in professional soccer

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## Headline

The competitive microcycle, defined as the period from the day after a match to the next match, is the dominant unit of work in the in-season calendar of an elite team. Within it, every decision a practitioner makes about the placement, content and intensity of each session contributes to the overall load profile that players will experience, and therefore to both their performance on match day and their availability across the season (Verheijen, 2014). Squad availability is itself a strong determinant of competitive success and of financial outcome (Eirale et al., 2013; Eliakim et al., 2020), which makes the choices made inside the microcycle directly relevant to results that matter at boardroom level.

Despite the importance of these decisions, the research base that practitioners can draw on remains limited. Much of what is currently done in elite microcycle planning is shaped by experience, by tradition, by the preferences of individual coaches and by what neighbouring clubs are seen to be doing. The body of empirical evidence is growing but is still much smaller than the practice base it is supposed to inform. A recent synthesis of the available data, structured around eleven evidence-informed and inferred principles of microcycle periodisation, has summarised the state of the field and made clear how much rests on inference rather than on direct evidence (Buchheit et al., 2024). One of the structural choices addressed in that synthesis is the placement of the post-match rest day, which is most often scheduled either one day after the match (MD+1) or two days after the match (MD+2). Survey data from more than 100 elite practitioners have shown that MD+1 placement is roughly four times more common than MD+2 placement in seven-day turnarounds (Buchheit et al., 2021), even though injury surveillance evidence from 56 team-seasons across 18 elite European clubs suggests that MD+2 placement is associated with a substantially lower noncontact injury rate (Buchheit et al., 2023).

The mechanism by which rest-day placement exerts this protective effect has not been directly tested at the level of the daily training response. The most plausible explanation operates through what happens at MD+1 (Verheijen, 2014). When the rest day is scheduled at MD+2, MD+1 becomes a working day at the club: starters complete a supervised recovery session and any treatment of minor injuries or niggles, while substitutes complete a structured and comprehensive compensation session that maintains their training stimulus. When the rest day is instead scheduled at MD+1, none of this happens. Starters recover on their own, away from the medical and performance staff, and substitutes do not train at all. Team training then restarts at MD+2 with starters not yet fully recovered and substitutes carrying a deficit from their

lack of match exposure. Additionally, the rest day placement generally changes coaches intentions and the distribution of mechanical and cardiovascular load across the training week, and the physiological state in which players arrive at the heaviest sessions (i.e., MD-3). If this is the case, then the placement decision should leave a visible signature on the training-load data of the days that follow it, and that signature should reveal something about how rested or fatigued the squad is when it begins each session (Buchheit et al., 2023). The present report uses a multi-modal training-load framework to test this idea in a professional squad that operated under both placement strategies within the same competitive period.

## Aim

To examine, in a professional soccer squad, how rest-day placement (MD+1 vs MD+2) affects the mechanical and cardiovascular load delivered on the three main training days of the post-match week, and to use the external-to-internal load relationship as an indirect indicator of player readiness on each of these days.

## Methods

Twenty-two male outfield players from a Turkish professional club (mean  $\pm$  SD age  $24.6 \pm 4.1$  y, height  $181 \pm 6$  cm, body mass  $76.4 \pm 7.2$  kg) were monitored across a 12-week competitive in-season block. During the first six weeks the team rested at MD+1 and during the second six weeks at MD+2; all other features of the microcycle were held constant. Only one-match weeks were retained for analysis (Malone et al., 2015). We analysed the three main on-pitch training days of the post-match week: MD-4, MD-3 and MD-2. The study was conducted in accordance with the Declaration of Helsinki and ethical approval was obtained from the local institutional review board. Mechanical load was recorded using 10-Hz Polar Team Pro GPS units. The four primary external metrics retained were total distance covered (TDC, m), high-speed running (HSR, m at 19.8–25.2 km/h), sprint distance (SpD, m above 25.2 km/h) and the sum of high-intensity accelerations and decelerations (SumA:D, count above  $2 \text{ m/s}^2$ ). HSR and SpD are recognised markers of high-intensity locomotor demand, while explosive eccentric actions captured by SumA:D have been linked to muscle damage and post-match neuromuscular fatigue in soccer and other field sports (Raastad et al., 2010; Young et al., 2012; Silva et al., 2014). Cardiovascular load was recorded with heart-rate (HR) chest straps integrated with the GPS unit, and Edwards' TRIMP was computed from

time in five HR zones (Z1: 50–60% HRmax; Z2: 60–70%; Z3: 70–80%; Z4: 80–90%; Z5: 90–100%) (Buchheit, Akubat et al., 2025).

To integrate the four mechanical metrics into a single number we used the multi-modal composite approach proposed by Owen et al. (2017). Each metric was first expressed as a percentage of a typical elite-soccer match value (TDC 10,500 m; HSR 700 m; SpD 250 m; SumA:D 90 events); the four percentages were then averaged to give a Mechanical Volume composite. The same operation was applied to the per-minute versions of each metric, expressed as a percentage of typical per-minute match values, to give a Mechanical Intensity composite. The Volume composite captures total work delivered; the Intensity composite controls for session duration.

While the optimal approach would have been to quantify total mechanical work using the GPS 3.0 framework (Buchheit et al., 2026), this was not feasible with the variables available in the present dataset, and we therefore adopted the Owen multi-modal composite as the least imperfect alternative.

The rationale for analysing the relationship between external and internal load, rather than reporting external metrics in isolation, deserves explicit comment. On any given training day, and especially on MD-4, what the coaching staff prescribes is conditioned by what the players have done in the preceding 24 to 48 hours: under Rest at MD+1, players arrive at MD-4 from the MD+2 training session, while under Rest at MD+2 they arrive from a rest day. The two conditions therefore do not place players at the same physiological starting point, and the same prescribed session can produce a different internal response. Examining the ratio of external to internal load offers a practical, non-invasive way to witness this difference, by treating the amount of mechanical output a player can deliver per unit of cardiovascular cost as an indirect indicator of readiness on the day. The Owen multi-modal composite supports this comparison by normalising each locomotor demand against its competitive match value, which allows volume of work delivered to be expressed on a common scale across conditions. This is the central methodological move that makes the comparison interpretable. It comes, however, with a strong assumption: by averaging the four normalised components into a single Volume score (and a single Intensity score), the framework treats running, high-speed running, sprinting and acceleration-deceleration actions as having roughly equivalent contribution to the overall mechanical demand once each is expressed relative to its own match reference. The physiological cost of these actions is not equivalent in absolute terms, and weighting them equally in a composite is a simplifying choice that should be borne in mind when interpreting the results. The same caveat applies to any composite built in this fashion (Jaspers et al., 2017).

To visualise the integrated external-to-internal load relationship, the Mechanical composites and TRIMP were z-scored across the six session-condition combinations (3 training days  $\times$  2 rest strategies) and plotted as scatter points in a Cartesian plane. The diagonal of the plane corresponds to the line of equal z-score between the external and internal axes and is included as a visual reference: when a point sits above this line, the cardiovascular cost of the session is higher relative to the mechanical output than for the average session in the dataset; when it sits below, the cardiovascular cost is lower relative to the mechanical output. The diagonal is therefore a frame for reading the points, not a prediction of where they should fall. Arrows connect the Rest at

MD+1 to the Rest at MD+2 point for each training day to make the strategy-induced movement visible. This approach is consistent with proposals to combine external and internal load indicators when monitoring training in professional soccer and using the relationship between them as a witness of player readiness (Jaspers et al., 2017; Buchheit, 2014).

Data are presented as mean  $\pm$  95% confidence interval (CI) of the team mean, with CI half-width computed as  $1.96 \times SD \div \sqrt{22}$ . For the Mechanical composites, the underlying-metric SDs were propagated through the averaging operation assuming a between-metric correlation of 0.5. Between-condition comparisons follow the paired analyses of the original dataset.

## Results

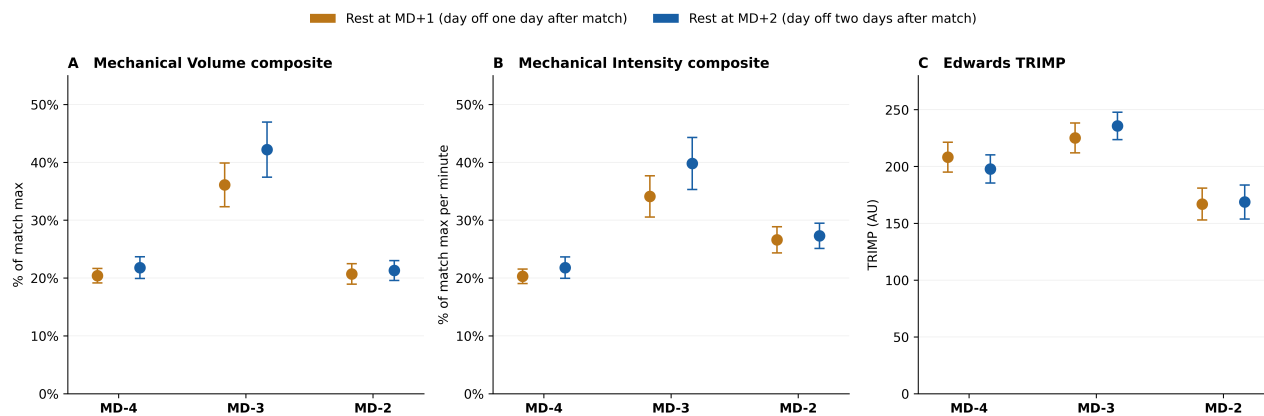
Figure 1 shows the descriptive picture across the three load dimensions. On MD-4 (Panels A and B), mechanical Volume and Intensity composites were modestly higher under Rest at MD+2 (Volume:  $21.8 \pm 1.9$  vs  $20.4 \pm 1.3\%$  of match; Intensity:  $21.8 \pm 1.9$  vs  $20.3 \pm 1.3\%$ ). On MD-3, the largest between-strategy effect emerged, with both composites markedly higher under Rest at MD+2 (Volume:  $42.2 \pm 4.8$  vs  $36.1 \pm 3.8\%$ ; Intensity:  $39.8 \pm 4.5$  vs  $34.1 \pm 3.6\%$ ). These MD-3 values are consistent with the position of MD-3 as the heaviest mechanical day in elite-soccer microcycle datasets (Buchheit et al., 2021; Owen et al., 2017; Malone et al., 2015). On MD-2, both composites were essentially equal between conditions.

Edwards' TRIMP (Panel C) moved in opposite directions on the two main training days. On MD-4 it was lower under Rest at MD+2 ( $198 \pm 12$  vs  $208 \pm 13$  AU), whereas on MD-3 it was higher ( $236 \pm 12$  vs  $235 \pm 13$  AU). On MD-2 TRIMP was equivalent between conditions. The 95% confidence intervals for TRIMP overlapped on all three days at the team-mean level, but the directional pattern was preserved.

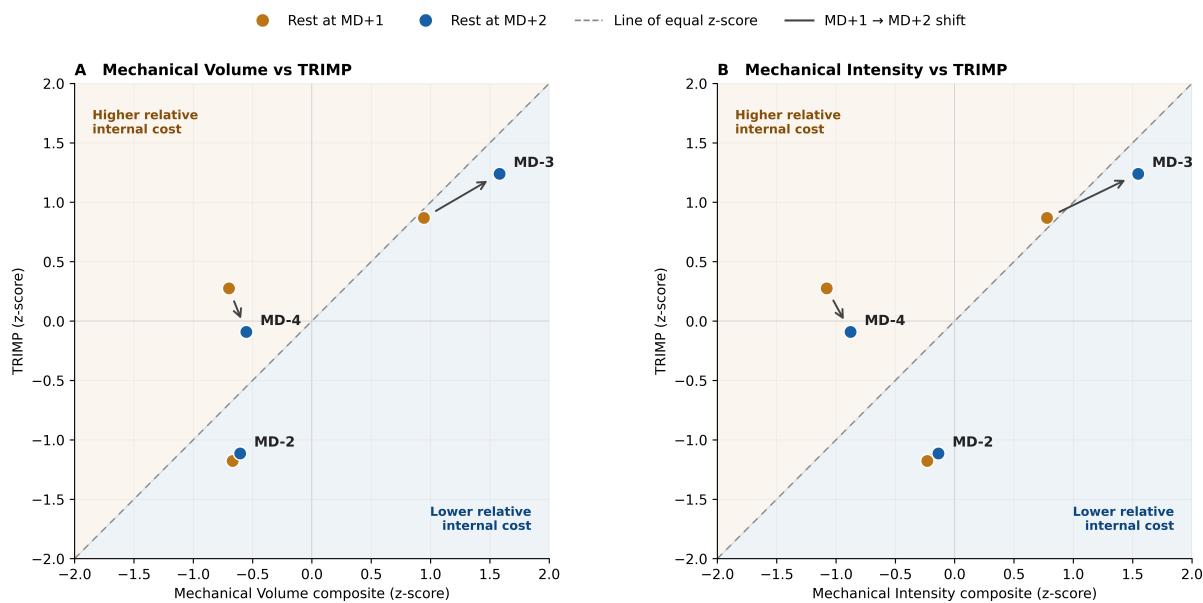
Figure 2 presents the integrated external-to-internal relationship using z-scored composites against z-scored TRIMP. Three patterns emerge, one for each training day.

On MD-4, the arrow points downward and to the right under both Volume and Intensity. Under Rest at MD+1 the point sits above the line of equal z-score, indicating higher cardiovascular cost relative to the mechanical output than the dataset average. Under Rest at MD+2 it crosses below the line, indicating lower cardiovascular cost relative to the mechanical output. This pattern is consistent with a freshness signature: under the better-placed rest day, the squad produces more external work at lower internal cost, which is the type of response expected when players arrive to training in a more rested state. On MD-3, both points sit on the same side of the reference line in the upper region of the plane, and the arrow points upward and to the right along the line rather than across it. Under Rest at MD+2 the squad reaches a substantially higher position on both axes, but the relationship between external and internal load remains broadly proportional. This pattern is consistent with a tolerance signature: the rest strategy enables more work to be delivered, and the cardiovascular response scales with that additional work rather than decoupling from it.

On MD-2, both points sit firmly below the reference line under both conditions, and the arrow is small. MD-2 is structurally a low-cardiovascular-load day; the rest-strategy effect is minimal. The Intensity panel shows the same overall pattern with a slightly larger movement on MD-3, ruling out a pure session-duration explanation.



**Fig. 1.** Descriptive load profile across the post-match training week. Panel A: Mechanical Volume composite (mean  $\pm$  95% CI). Panel B: Mechanical Intensity composite (per-minute, mean  $\pm$  95% CI). Panel C: Edwards' TRIMP (mean  $\pm$  95% CI). CIs are propagated under the assumption of a between-metric correlation of 0.5 for the Mechanical composites; exact CIs should be recomputed on the raw player-level data.



**Fig. 2.** Integrated external-to-internal load relationship using z-scored composites against z-scored TRIMP. Panel A: Mechanical Volume vs TRIMP. Panel B: Mechanical Intensity vs TRIMP. Each point is one training day under one rest-day strategy. The dashed line is the line of equal z-score between the two axes and serves as a visual reference for reading the points: above it, cardiovascular cost is higher relative to mechanical output than the dataset average; below it, lower. Arrows connect Rest at MD+1 to Rest at MD+2 for each training day.

### Discussion and Conclusion

The three days of the post-match training week respond to rest-day placement through distinct mechanisms. MD-4 shows a freshness signature: with the rest day placed at MD+2, players approach this session in a more recovered state and produce slightly more work for measurably less cardiovascular cost. MD-3 shows a tolerance signature: the squad reaches a substantially higher level of mechanical output, both in absolute volume and per minute, but the cardiovascular cost rises broadly proportionally. The two responses point in the same practical direction (more work delivered across the training week) but operate differently and would be missed by single-

metric analyses. These findings extend earlier work showing that meaningful variation can be introduced into mechanical and physiological output across the microcycle (Buchheit et al., 2021; Owen et al., 2017; Impellizzeri et al., 2004) and offer a concrete worked example of how the external-to-internal relationship can be used as a witness of player readiness on training days that matter most.

Two methodological choices made the mechanisms visible. First, integrating four mechanical metrics into a single Owen composite reduced the noise that arises when individual variables, particularly HSR and SpD, are interpreted in isolation; both metrics show large match-to-match variability driven by

tactical and contextual factors (Gregson et al., 2010) and the same applies to training data. Second, presenting the external-to-internal relationship as a quadrant rather than as separate panels exposed the freshness-tolerance distinction. On MD-3, looking at TRIMP alone would have suggested the Rest at MD+2 strategy was "more taxing"; looking at the mechanical composites alone would have suggested it was "more productive"; the quadrant view shows that both are true and that the relationship between them remains broadly balanced.

It is worth noting that the lower TRIMP observed on MD-4 under Rest at MD+2 runs against the direction usually reported in the submaximal heart-rate literature, where a rest day is typically followed by an elevated heart-rate response, largely due to plasma volume contraction (Buchheit, 2014). The freshness effect captured here is therefore likely to be more substantial than the raw values suggest, since it is acting against a counter-current.

The MD-4 freshness signature is mechanistically consistent with the protective effect of Rest at MD+2 reported in injury surveillance (Buchheit et al., 2023; Buchheit et al., 2024). Players who arrive at the first hard mechanical session of the week in a fresher state are likely to perform high-speed and high-acceleration actions with better neuromuscular control. Given the recognised muscle-damage signature of repeated explosive eccentric actions (Raastad et al., 2010; Silva et al., 2014), small differences in freshness on the first hard day of the week could plausibly translate to differences in tissue tolerance accumulated across a season. The MD-3 tolerance signature is complementary: a better-rested squad earlier in the week can sustain a heavier MD-3 load without an excessive cardiovascular cost, which fits broader periodisation logic that progressive overload requires preceding recovery to be effective (Issurin, 2010). Both responses sit within the broader logic of training smarter rather than just harder (Gabbett, 2016).

Several limitations must be acknowledged. The design was sequential rather than randomised: Rest at MD+1 was used in weeks 1–6 of the competitive block and Rest at MD+2 in weeks 7–12. Any systematic seasonal change (fitness progression, fixture density, climatic conditions) is confounded with the rest-strategy comparison; the findings should therefore be interpreted as exploratory and hypothesis-generating rather than confirmatory. The match benchmark values used in the Mechanical composites were taken from published elite-soccer literature rather than from the team's own match data; absolute percentages should be recomputed against the team's own values once those are available, although the relative pattern between conditions is not affected by this choice. The SumA:D threshold in this dataset ( $\geq 2 \text{ m/s}^2$ ) is lower than the threshold used in the original Owen framework ( $>4 \text{ m/s}^2$ ), which inflates the SumA:D component of the composite. And as discussed in the Methods, the equal weighting of the four locomotor demands in the Owen composite is a simplifying assumption.

Finally, a more refined approach would have been to compute total mechanical work using the GPS 3.0 framework (Buchheit et al., 2026), which weights locomotor demands by their estimated neuromuscular cost rather than treating them as equally contributing once normalised to match values.

Taken together, placing the post-match rest day at MD+2 rather than MD+1 leaves a coherent and interpretable signature on the load profile of the subsequent training week. The pattern is consistent with the surveillance evidence that Rest at MD+2 is associated with lower noncontact injury incidence, and provides a mechanistic worked example that can inform microcycle design decisions where the fixture calendar allows the choice to be made.

## Practical applications

- Placing the rest day at MD+2 (rather than MD+1) brings the whole squad into the club on MD+1: starters can complete a proper supervised recovery session and substitutes can complete a compensation session to maintain their training stimulus. Resting at MD+1 instead means neither group gets what they need, since starters do not benefit from supervised recovery and substitutes do not train.
- When compared with resting at MD+1, placing the rest day at MD+2 changes the load profile in a way that benefits the rest of the week. Players arrive at MD-4 in a fresher state and are likely to train with better quality, then can sustain a substantially heavier MD-3 session at similar relative cardiovascular cost. The combination of a better MD-4 and a heavier MD-3 should help coaches prepare the team more thoroughly during the post-match week.
- Training-load monitoring decisions should not rely on a single metric. The external-to-internal load relationship, treated as an indirect indicator of player readiness, exposes patterns that average HR or TRIMP alone conceal (Jaspers et al., 2017; Buchheit, 2014).

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