Data everywhere, now timing matters: a day-by-day implementation of the quadrant-based monitoring framework in elite football

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Headline

Over the past decade, professional football teams have increasingly adopted a wide range of tools to monitor players' load and response. Yet there has never been more data with so little added clarity. Despite the expanding number of tools and datasets (Cardinale & Varley, 2017; Seshadri et al., 2021), confusion around terminology, purpose, and application keeps growing. Part of the problem is that monitoring tools are too often evaluated globally, as a single category (McGuigan et al., 2021; Woolmer et al., 2025), as if every tool served the same purpose, which leads to frequent misuse: tools designed to measure how much work a player has performed (load) are used to judge how the body has reacted to that work (response), and the reverse. Importantly, player responses themselves can be considered across two distinct time scales. They can be divided into short-term responses, referred to as readiness, such as next-day pain, soreness, or changes in neuromuscular status (e.g., acute fatigue), and medium- to long-term responses, referred to as adaptations, including muscle hypertrophy and measurable physiological or performance improvements (Thorpe et al., 2017; Buchheit & Hader, 2025). While some monitoring tools provide information on both, others are more specific to one category. For example, perceived soreness is primarily used to assess readiness, whereas submaximal heart rate responses are typically used to monitor longer-term metabolic adaptations. Even recent frameworks that set out to organise this space stop short of the practical step that matters, mapping the right tool and metric to each side of the training equation and to the correct biological system (Rebelo et al., 2026). As new technologies and datasets continue to emerge each year, it becomes harder for practitioners to decide which tools to use, when they are worth using, how often to use them to keep player and coach buy-in, and for what specific purpose.

Beyond this load-versus-response confusion, common industry labels such as subjective vs objective or internal vs external often create more confusion than clarity. In practice, these categories do not help much when the real question is which biological system needs to be recovered, protected or developed (i.e., neuromuscular vs metabolic). Decisions about load management and recovery should therefore be system-driven, not metric-driven. Any metric can be useful if it helps inform the right system, although internal markers should always be prioritised when available, as they are more directly linked to the underlying biology (Buchheit & Hader, 2025).

In response to this persistent challenge, we previously introduced a quadrant-based framework that categorizes monitoring tools along two fundamental axes: Load vs. Response (what was done vs. how the athlete reacted) and Metabolic vs. Neuromuscular (the biological systems being assessed) (Figure 1, Buchheit & Hader 2025). This visual model was designed to offer performance staff a structured lens through which to align tools with their specific roles, emphasizing a minimum viable toolkit built around validated, practical, and cost-effective measures. This includes GPS, HR and RPE for monitoring load, and force plate, bar-velocity tools, submaximal runs and subjective training-effect measures for monitoring response and adaptation.

Across all of this, one principle should anchor every decision: the goal of monitoring is not to pull players from training. It is to understand how they respond so that load can be adjusted proactively, week by week, to improve adaptation, maintain capacities, and reduce injury risk - while keeping players on the pitch as much as possible.

Aim

The aim of this manuscript is to outline how the quadrant model (Buchheit & Hader, 2025) can be operationalized across a standard one-match week, detailing the timing, frequency, and intended use of each key monitoring tool. More precisely, the present framework should guide performance staff toward both a minimum viable toolkit and an optimal complementary monitoring setup, built on practical, reliable, and cost-effective measures. A minimum setup is not meant to be comprehensive: optimal complementary layers can always be added for more precision, but each one moves the decision into a cost and burden versus benefit trade-off. We start by describing how this model can be applied across a typical 7-day microcycle, with a day off on D+2 (Verheijen, 2014; Buchheit et al., 2024), which has been highlighted as the most optimal programming approach to promote freshness (Çiçek et al., 2026) and minimise muscle-injury risk (Buchheit et al., 2022). We then discuss the adjustments that may be required when the day off is scheduled on D+1, a more commonly adopted approach in elite football (Buchheit et al., 2021).

Typical training-week structure

Before detailing the monitoring choices day by day, it is useful to first lay out the structure of the typical 7-day microcycle (Table 1), as the load level and the system stressed on each day directly inform which tools should be used and when.

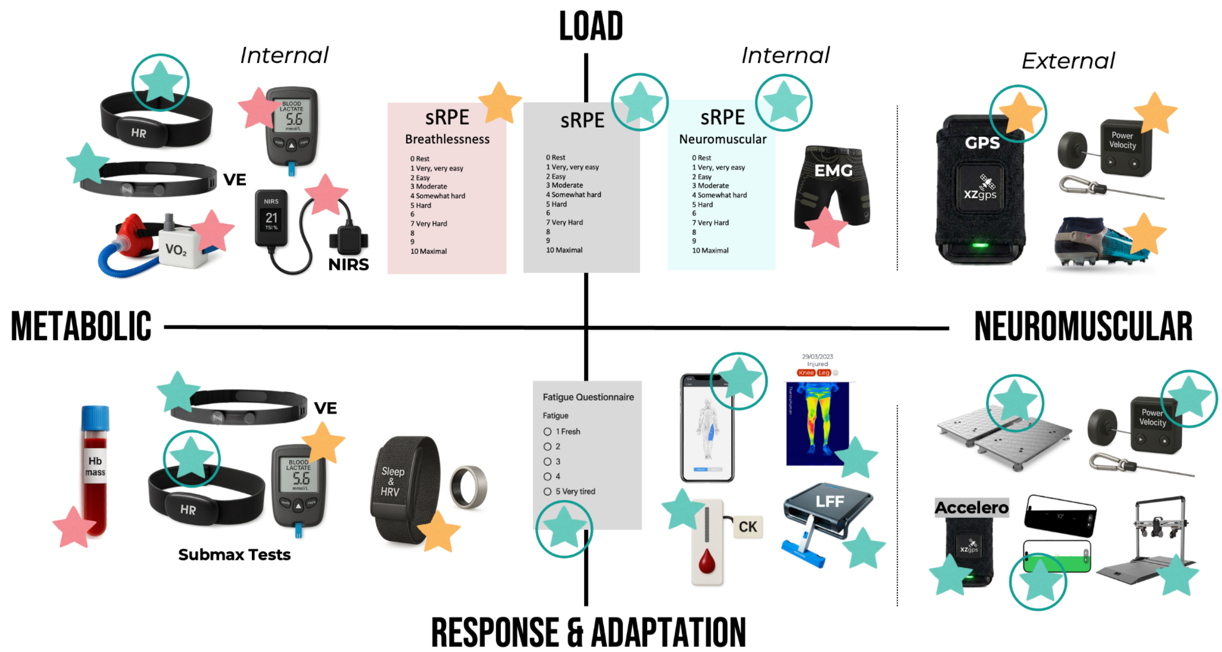

Fig. 1. Tools available are mapped according to the quadrant-based monitoring framework that distinguishes load from response and metabolic from neuromuscular domains. GPS stands in the upper-right quadrant as (only) a proxy of neuromuscular load. The colour of the stars reflects a combination of validity, practicality, and cost, ranging from green (ideal) to red (impractical and/or limited) (for more explanations, see Tables 2-5 in Buchheit & Hader 2025). Stars with a circle indicate the recommended practical minimum setup. Non-biological system-specific subjective ratings such as sRPE (load) and sleep, fatigue, mood, or recovery (response) are positioned between quadrants, as they likely reflect, influence or are associated with both metabolic and neuromuscular domains. While sleep is neither a direct metabolic nor neuromuscular response, it serves as both an indicator of overall wellness and a modulator of training response. Poor sleep is typically associated with increased fatigue and reduced training quality, which can ultimately affect the magnitude and direction of adaptation. CK: creatine phosphokinase, EMG: electromyography, GPS: global positioning system, Hbmass: hemoglobin mass, HR: heart rate, HRV: heart rate variability, LF Fatigue: low-frequency fatigue, NIRS: near-infrared spectroscopy, sRPE: session rating of perceived exertion, SMFT: submaximal fitness testing, SSG: small-sided games, VE: minute ventilation, VO_2: oxygen uptake. Adapted from Buchheit & Hader 2025, with the addition of breath-by-breath ventilation signals (VE).

Table 1. Structure of a typical 7-day football microcycle with a day off on D+2. Each day is characterized by its main focus, load level, and primary physiological system stressed. This structure is the reference framework on which the day-by-day monitoring strategy is built.

Day	Main focus of the day	Load level	Primary system stressed
D+1 (starters)	Off-feet recovery	Rest	None
D+1 (substitutes)	Compensatory session in small areas of play, plus high-speed running and maximal speed exposure	High	Both (neuromuscular + metabolic)
D+2	Day off	Rest	None
D+3/D-4	Small-sided games and scenarios; high accel/decel and changes of direction	High	Neuromuscular (dominant) + metabolic
D-3	Large spaces; highest number of football-specific high-intensity and high-speed runs	High	Metabolic (dominant) + neuromuscular
D-2	Tapering session; volume reduced; intensity depends on staff approach	Low to moderate	Low overall
D-1	Tactical rehearsal, set pieces, short position-specific drills, quickness and agility	Low to moderate	Neuromuscular priming
MD	Match	Match load	Both systems maximal

Choosing among the many: a day-by-day rationale for monitoring decisions

With the microcycle structure established (Table 1), the next question is which monitoring tools to use on each day, and why. The number of available options is large, but the load level and the system stressed on each day, combined with practical constraints such as compatibility with the session content and player buy-in, substantially narrow the field. Each tool is read in the role assigned to it by the quadrant framework (Buchheit & Hader, 2025), so that load tools inform load and response tools inform response, within the correct biological system. The following section walks through each day and explains the rationale behind every recommended measurement, for both load and response/adaptation, from the choice of tool and metric to its timing and frequency.

How to read this section

Each day is presented in the order the day is actually lived. We start with player response and readiness, because that is what tells us what the player can do today, and only then move to player load, what the session imposes. Within both response and load, we always follow the same system order: neuromuscular, then metabolic, then overall (subjective). For load monitoring we look at the gym before the pitch, because the day most often starts in the gym.

Within each system, the tools are presented in a consistent order: we start with the cheapest, lowest-friction measures that belong to the minimum setup every club should run, and build up toward measures requiring more intent, more technology, and more cost, which are optimal complementary options that add resolution when resources allow. How far up this ladder we climb on a given day is set by the day's intent, stated as the first line of each system: on a recovery or protect day we stay low on the ladder and use passive measures only, because active maximal-intent testing is incompatible with recovery; on a load day we climb the full ladder, including the active objective markers, because the maximal efforts are happening anyway and can be assessed through them.

A note on terminology runs through the section: the broad concept being assessed is always neuromuscular load and response, but on the pitch we can only capture it through external mechanical measures (GPS-derived mechanical work and exposure), which carry well-known limitations as proxies of the underlying neuromuscular state. We therefore reserve "mechanical" for the GPS layer and keep the wider discussion framed around the neuromuscular system.

One asymmetry runs through the whole section and is developed later with Figure 2, but it is more subtle than a simple split. The neuromuscular signal works on two horizons: it can change today's content (e.g., the game response read on D+3/D-4 or D+4/D-3 adjusting session content and a player's participation), and it is also read as a multi-week trend. A player may pass several microcycles with no same-day change, yet a consistent trend over a couple of weeks, for instance a substitute gradually losing explosiveness or strength, becomes a signal to add work, in exactly the same logic as a metabolic top-up. The metabolic signal, by contrast, is essentially trend-only: it is a slow process that almost never changes what we do the same day. Both systems therefore drive chronic decisions; only the neuromuscular side also drives same-day ones. Finally, Table 2 ties the whole week together: variables written plainly are the minimum setup, and variables in brackets are the optimal complementary add-ons. The day-by-day text below is, in essence, the justification of that table.

Reading the numbers: interpreting change

Throughout the day-by-day section, deciding whether a change in any monitoring variable is meaningful (rather than noise) depends on a within-player threshold specific to that tool. We do not repeat the statistics here: the full rationale and the per-tool thresholds (smallest worthwhile change + typical error (SWC + TE), 2×TE, or a 1.2 Z-score, depending on the variable) are given together with Table 3 at the end of the paper (Reliability and thresholds for meaningful change section). The operating principle is simply to react to confirmed trends, not to isolated readings.

D+1

D+1 splits by playing status. Starters are on off-feet recovery. Substitutes complete a compensatory session that is not limited to small areas of play: it also includes high-speed running and maximal speed exposure, so they tick all the load boxes the match did not provide, alongside an important gym strength block (high load, both systems; see Table 1). The monitoring choices differ accordingly.

Player response and readiness

Neuromuscular. This is a recovery/protect day for starters: no active testing. For starters, monitoring relies on passive measures only, since active maximal-intent testing would compromise recovery. For substitutes, who remain fresh, response monitoring is not the priority.

For starters, assessing the response to the match still offers value, as it can reveal an abnormally high match-related cost and identify players who may need a greater emphasis on recovery than is typically programmed. Because the focus is restoration, monitoring relies on passive measures that need neither maximal effort nor conscious intent, which also helps buy-in.

- **Minimum Effective Set Up:** Soreness (Likert) is a time-efficient, free and passive assessment of the neuromuscular response to the match. It is shown to track both neuromuscular (CMJ) and metabolic (creatine kinase, CK) fatigue (McLean et al., 2010). It is highly individual, so it is read against the player's own rolling baseline (e.g., 28-day; Table 3). On its own it gives context rather than a verdict, which is why we build on it.
- **Complementary Set Up:** CK provides complementary muscle-damage information: post-match levels peak around 24h and can remain elevated at 48-72h, particularly after high match exposure or congested schedules (Pérez-Castillo et al., 2023). Read against the player's own baseline rather than population norms, it adds an objective and individual read of match cost (Carling et al., 2018).
- **Complementary Set Up:** Thermography is a further passive add-on for local inflammatory or physiological stress. Skin temperature in lower limb muscles rises significantly at 24h post-match, mirroring the CK time course, and does not fully return to baseline by 48h in elite players (Fernandes et al., 2025); players with higher match running demands show greater thermal responses (Escamilla-Galindo et al., 2025).
- **Complementary Set Up:** Low-frequency fatigue (LFF) is a promising passive, non-invasive objective add-on to assess starters' response to the previous match. It positions each player's neuromuscular function relative to their individual baseline (e.g., pre-match values around 77-80 AU; Tito et al., 2026), independent of motivation or subjective bias. Although evidence from elite youth players suggests low-frequency fatigue (LFF) recovers to baseline within 24 h post-match (Tito et al., 2025), individual variation may be larger in senior players exposed to higher match loads, and the clearest evidence for its monitoring utility comes from a return-to-play context (Buchheit, Barba Balda et

al., 2026) or following various HIIT exercises (Buchheit & Laursen 2026).

Metabolic. No metabolic response testing. Not relevant on a recovery day.

Overall. Passive measure, subjective wellness only. Sleep, fatigue and stress (5-7-point Likert) add context when a neuromuscular reading falls outside its expected range, improving confidence in the decision (Saw et al., 2016). Not a standalone trigger. Stress scores in particular may reflect non-training drivers (psychological, social, travel, contract, media, family) that influence the dose-response relationship even when objective measures appear normal (Saw et al., 2016; Thorpe et al., 2017b).

Player load

Opportunity exists to quantify neuromuscular load for both groups, recognising that on the pitch we can only capture its mechanical proxy through GPS (Buchheit, Lopez Sagarra et al., 2026). The prescription diverges: starters focus on upper-body strength maintenance (Sabag et al., 2021) and lower-body preventive strength work in the gym (Lovell et al. 2018), whereas substitutes combine the same gym strength work as the starters with field-based running and speed exposure to satisfy compensatory demands.

Neuromuscular - gym. Proxies of neuromuscular load where gym work is done.

- RPE-Neuro (Buchheit & Laursen, 2026) is most useful around lower-limb eccentric work, which a global RPE underrates.
- Additionally, change in mean bar velocity (via an encoder) act as proxies of neuromuscular load. The greater the bar-velocity loss within a gym session, the greater the acute neuromuscular and metabolic stress (Sánchez-Medina & González-Badillo, 2011); 20% VL induces moderate fatigue with full recovery within 24-48 h, whereas 40% VL results in substantially greater neuromuscular impairment, metabolic stress, and slower recovery (Pareja-Blanco et al., 2019; Walker et al., 2022; Jukic et al., 2023).

Neuromuscular - field. Substitutes only: confirm the compensatory running and mechanical work (the on-pitch proxy of neuromuscular load).

- GPS is used to verify that substitutes complete sufficient mechanical work (MW, in terms of volume and intensity of peak periods, i.e., intensity exposure time), GPS 3.0 (Buchheit, Lopez Sagarra et al., 2026); or, more traditionally, totals of various locomotor activities) to compensate for reduced match exposure. Combined MD and D+1 exposure may represent ∼50-60% of match-derived values (Lacome et al., 2018), and helps distribute compensatory load between post-match and D+1 sessions (Buchheit et al., 2021).

Metabolic - field. **Substitutes only: protect against chronic under-exposure.**

- HR monitoring ensures ∼15-20 min >85-90% HRmax are reached for substitutes (Table 3; Buchheit, Akubat et al., 2025; Buchheit, Parak et al., 2026).

Overall. **Global RPE for substitutes only.**

- RPE used to check whether the substitutes' compensatory session provided an adequate intensity and global load, with values typically around 7-8 (RPE)(Impellizzeri et al., 2024) and 300-350 AU (sRPE).

D+2

Day off. No session scheduled (Table 1), so no monitoring is conducted.

D+3/D-4

D+3/D-4 is the first high-load day and the most neuromuscularly demanding session (Table 1), built around small-sided games and scenarios with a high number of accelerations, decelerations and changes of direction. Because the day is built on strength and maximal efforts, the gym is central, and it is the best opportunity of the week to assess neuromuscular response through those efforts. The readiness check run in the gym before the session directly could help decide whether a player takes the full session or a reduced version.

Player response and readiness

Neuromuscular. As this is the main neuromuscular loading day, the session is fully compatible with active objective monitoring.

- **Minimum Effective Set Up:** Range of motion and dynamic mobility monitoring at D+3/D-4 serves two related but distinct purposes. The first is tracking passive joint mobility at the hip and ankle, which degrades progressively across the season with cumulative training and match exposure: hip extension ROM decreases significantly from pre-season to mid-season, hip internal rotation asymmetry increases, and external rotation ROM shows similar trends in players with already-restricted ROM (Moreno-Pérez et al., 2022; De-la-Cruz-Torres et al., 2020). Hamstring passive stiffness follows a comparable pattern (Satkunskiene et al., 2020), and reduced quadriceps flexibility is an established injury risk factor in football (Witvrouw et al., 2003). Practical tools include the knee-to-wall test for ankle dorsiflexion and passive goniometry or inclinometry for hip IR/ER. The second purpose is assessing dynamic pelvic-femoral control, which reflects how the lumbopelvic system coordinates movement rather than the range available at a single joint. The modified Thomas test (hip flexors only) or the static "Jurdan Test" detects hip flexor restrictions that drive anterior pelvic tilt and alter hamstring mechanics (Mendiguchia et al., 2024), and the Jurdan Sprint table test provides a dynamic pelvic-femoral read under load (Buchheit et al., 2026). Substantial or progressive reductions in either layer trigger physiotherapy input and targeted exercise aimed at restoring individual baseline before the next high-load day.
- **Minimum Effective Set Up:** Soreness (Likert) expected within the 2-3/5 range, is the read of the day.
- **Minimum Effective Set Up:** CMJ on force plates is the primary objective marker, the most commonly used neuromuscular test in elite football (e.g., Vald Performance, 2025). The mean of 3-4 maximal jumps (hands on hips) is among the most sensitive to both fatigue and adaptation (Cormack et al., 2008b; Gathercole et al., 2015b; Lonergan et al., 2022). Read it multi-metric: a jump-height-only read can hide neuromuscular fatigue that force-time metrics reveal (Marques et al., 2026), so combine one time-based metric (FT/CT or RSImod) with one force- or power-based metric (e.g., concentric impulse at 100ms), and select metrics and jump types deliberately for the question being asked (Cohen et al., 2024; Cohen et al., 2026).
- **Minimum Effective Set Up**: Bar velocity is the lower-cost objective alternative to the force plate, via a standardised lower-limb movement typically performed with fixed submaximal loads (approximately 40–60% 1RM) executed

with maximal concentric intent, e.g., deadlift at ∼1 m/s; Sanchez-Medina et al., 2011). We track change in mean bar velocity as the freshness signal. Offering players the choice between CMJ and bar velocity can improve buy-in (Sánchez-Medina & González-Badillo, 2011).

- **Minimum Effective Set Up:** Adductor squeeze is a targeted, low-fatigue check, prioritized for players with a history of groin symptoms, adverse screening profile, or high mechanical exposure (Moreno-Perez et al., 2019). The bilateral squeeze is the practical minimum: a pain-free post-match drop is expected physiology and recovers within 48-72h in most players (Buchheit et al., 2017; Wollin et al., 2018; van Klij et al., 2021), but a drop that persists, or one accompanied by pain, warrants a structured response. When force is low or dropping, the next step is to add hip abduction force and then progress to unilateral and range-specific testing, which allows distinction between a pain-driven output, a direct adductor deficit, and an indirect systemic contributor - and that distinction determines the intervention (Buchheit & King, 2026).
- **Minimum Effective Set Up:** Isometric strength (and, increasingly, rate of force development). Isometric tests via strain gauge, hand-held dynamometer or force plates (e.g., the 90°hip:20°knee posterior-chain test for the hamstrings) are a practical, low-cost check of force-generating capacity. A key nuance: peak isometric force (MVIC) works, but evidence increasingly shows that rate of force development (RFD), especially early RFD, is the more sensitive marker. After a match, hamstring MVIC torque can recover by MD+3 while early RFD (0-50 and 0-100 ms) remains depressed, so RFD detects residual fatigue that peak force misses (Cosio et al., 2025). Where the equipment allows, prefer early RFD over MVIC alone.
- **Complementary Set Up:** LFF is a promising passive objective add-on (Tito et al., 2025 and 2026; Buchheit & Laursen 2026; Buchheit, Barba Balda et al., 2026). CK and thermography are further add-ons for muscle-damage and local stress status. Monitored weekly at MD-4 across a 12-week competitive period, thermal asymmetries in thighs and hamstrings are associated with fatigue, soreness, and sleep quality (Majano et al., 2023) and a thermography-based monitoring protocol reduced injury incidence during preseason in professional soccer (Gómez-Carmona et al., 2020). That said, its use as a reliable standalone marker of recovery in elite football remains incompletely validated (Masur et al., 2024; Escamilla-Galindo et al., 2025), and it is best treated as a complementary signal alongside CK (Pérez-Castillo et al., 2023) and LFF rather than a primary decision driver.

Metabolic. No metabolic response testing on this day: residual match fatigue would add noise to a submaximal test without informing a same-day decision (Buchheit, Shushan et al., 2025). The submaximal test is run on D-3.

Overall. Subjective wellness markers such as perceived fatigue (eg, 1-3/5), sleep quality and stress provide context to the overall response read without adding any load.

Player load

Neuromuscular - gym. Same gym logic as D+1 (RPE-Neuro and bar velocity). Strength-focused day, with a gym session typically scheduled (73% of practitioners run gym sessions on D+3; Buchheit et al., 2021).

Neuromuscular - field. GPS quantifies the day's mechanical exposure, expected high and close to match-like.

Where directional load matters (accel/brake/COD), GPS 3.0 metrics (mechanical work-MW, mechanical power-MP) capture far more true load than simple raw accel/decel counts (Buchheit & Lopez Sagarra 2026; Buchheit, Lopez Sagarra et al., 2026); GPS 2.0 is the least-bad fallback. Day-specific value: typically ∼0.8 of match MW and intensity exposure time, though this figure reflects habitual practice rather than a data-informed optimum, and GPS norms should be read as descriptive references, not targets (Little & Buchheit, 2025). RPE-Neuro (7-9) cross-checks the GPS read.

Metabolic - field.

- **Minimum Effective Set Up:** HR is essential to verify cardiovascular load as this session represents one of the two most cardiovascularly demanding days of the week (Buchheit et al., 2026). SSGs naturally push HR above 85-90% HRmax. Against a weekly aim of ≥30 min >85-90% HRmax (Buchheit, Akubat et al., 2025), this day contributes ∼15 min >85-90% HRmax (Buchheit, Parak et al., 2026), supporting aerobic adaptation while matching the tactical plan. Optional individualised top-up (e.g., football-specific drills or generic runs on the pitch (Buchheit 2019a, 2019b) or stationary bike workouts post-session) can be added for players flagged from prior submaximal tests, aiming to accumulate time in zone across the week.
- **Complementary Set Up:** Where available, breath-by-breath minute ventilation (VE) can complement HR as a continuous proxy of metabolic load during training (Greco et al., 2024). Wearable chest-strap technology now makes field-based VE monitoring feasible during team sessions (Tymewear VitalPro vs Cosmed K5: r = 0.97; Tymewear, 2026), though dose thresholds equivalent to those established for HR zones in football have not yet been defined. At this stage VE should be treated as an exploratory add-on rather than a primary load metric.

Overall. Global RPE (7-9) & sRPE (600-700 AU) confirms the subjective load agrees with the objective markers on this high-load day.

D-3

D-3 is the second high-load day (Table 1), characterized by large spaces and the highest number of football-specific high-intensity and high-speed runs (metabolic-dominant). It is the cleanest day of the week for the formal submaximal HR test since increasing running volume matches the overall extensive focus of the day.

Player response and readiness

Neuromuscular. This is a protect day for the neuromuscular system: reduced neuromuscular stimulus and possible residual fatigue from D+3 mean active testing would add unwanted load. Passive measures only.

- **Minimum Effective Set Up:** Soreness (Likert), expected within the 2-3/5 range, is the read of the day.
- **Complementary Set Up:** LFF is a promising passive add-on, useful to identify players accumulating hidden neuromuscular fatigue despite acceptable GPS or CMJ/bar-velocity values on D+3, especially those exposed to high sprint or neuromuscular loads or reporting pain without clear injury signs (Tito et al., 2026; Buchheit, Barba Balda et al., 2026). Thermography, on a similar passive footing, can complement this read by flagging local inflammatory or physiological stress.

Metabolic. This is the day to perform the submaximal running test. Feedback informs medium-term decisions, not the same week: it detects deconditioning, adaptation, and cardiovascular fitness gains. Use a consistent testing day.

- **Minimum Effective Set Up: Submax Run:** Ideally integrated within the warm-up (∼800-1000 m low-intensity aerobic work) or an activation block (e.g., stationary bikes), so there is minimal or no disruption to the tactical focus (Buchheit, Shushan et al., 2025). Average HR of the last minute of the run, expressed in %HRmax (Buchheit, Shushan et al., 2025).
- **Complementary Set Up:** Where VE monitoring is available, the ventilatory response to the same submaximal run can be recorded alongside HR (Greco et al., 2024). As with HR, an elevated or increasing VE response over successive weeks to the same standardised effort may reflect deconditioning. This remains exploratory, but the signal is physiologically plausible and now technically measurable in the field (Tymewear, 2026).
- **Complementary Set Up:** Lactate concentration at fixed submaximal intensity is a further complementary option for the same monitoring purpose: a rightward shift in the lactate-speed curve indicates improved fitness, and a leftward shift signals deconditioning. However, the invasiveness and cost of repeated lactate testing make it a supplementary rather than routine tool, best reserved for periodic fitness audits rather than weekly monitoring.

Overall. Subjective wellness for context only, as on D+3, to improve confidence when metabolic or neuromuscular readings fall outside expected ranges.

Player load

Neuromuscular - gym. Same gym logic as D+3 (RPE-Neuro and bar velocity); D-3 is the second most common day for gym sessions (Buchheit et al., 2021).

Neuromuscular - field. GPS tracks the day's high-speed and sprint exposure.

- Cumulated across the microcycle, HSR can reach ∼0.8 match load, associated with lower hamstring-injury rate (Buchheit et al., 2023).
- Sprint exposure is primarily programmed on D-3 for most practitioners (55%; Buchheit et al., 2021); GPS also tracks peak-velocity exposure, with ≥95% max sprint speed 2-3×/week appearing optimal for robustness.
- GPS supports individual adjustments for what was already achieved on D+3/D-4. An applied progression toward GPS 3.0 shifts from accumulated distance in speed zones to time at high locomotor intensity (e.g., % anaerobic speed reserve, Intensity Exposure Time for key GPS variables, with match MIPs of 1-5 min) (Buchheit, Lopez Sagarra et al., 2026).

Metabolic - field.

- **Minimum Effective Set Up:** HR is used to verify intensity-exposure time on this second assessment day, which is typically one of the two highest cardiovascular load days of the week (Buchheit, Parak et al., 2026). Practically ∼15-20 min >85-90% HRmax (Buchheit, Parak et al., 2026) depending on load distribution, contributing toward the weekly target of ≥30 min >85-90% HRmax (Buchheit, Akubat et al., 2025). HR is also used to track personalised exposure for individual top-up.
- **Complementary Set Up:** VE monitoring, where available, can be tracked in parallel on this high-running-volume day for the same purpose of verifying metabolic load, with the same caveats as on D+3 regarding the absence of established dose thresholds.

Overall. Global RPE (7-9) & sRPE (600-700), same reasons as D+3.

D-2

D-2 is a tapering session (Table 1): volume reduced, intensity depending on staff approach (low to moderate overall).

Player response and readiness

Neuromuscular. After two high-load days, the intensity of D-2 and D-1 depends on the staff's periodisation strategy, typically progressing from moderate to low load or from low to moderate load (Buchheit et al., 2021). Monitoring limited to passive measures, with no maximal-intent testing. If the session load is low, player-response monitoring is not required.

- **Minimum Effective Set Up:** ROM measures are likely best scheduled on D-2 to assess the impact of the high training loads accumulated over the previous days.
- **Minimum Effective Set Up:** Soreness (Likert), expected within the 2-3/5 range, is the read of the day.
- **Complementary Set Up:** LFF is a promising passive add-on, useful to assess tolerance to the cumulative high-load days, particularly when D-2 is planned as a moderate-load session with some sprint exposure (Tito et al., 2026; Buchheit, Barba Balda et al., 2026). Similarly, thermography and CK sit on the same passive footing and can be used to monitor local inflammatory or muscle damage status.

Active markers (CMJ, bar velocity) are deliberately omitted: their maximal-effort cost is incompatible with the day's protective intent.

Metabolic. No monitoring: tactical tapering day, generally unsuitable for testing. Submaximal runs may be feasible only if the planned load is low.

Overall. Subjective wellness may complement the other neuromuscular reads to improve confidence in decisions.

Player load

Neuromuscular - field. Load monitoring on D-2 depends on the staff's periodization approach, and two distinct strategies coexist in practice (Buchheit et al., 2021).

- When D-2 is programmed as a low-intensity recovery session, no GPS, HR or RPE monitoring is warranted.
- When D-2 includes a moderate-intensity session with finishing exercises requiring near-maximal sprint exposure (25% of practitioners surveyed; Buchheit et al., 2021), GPS becomes relevant: it verifies that peak velocity exposure is achieved (95% MSS) while confirming that weekly sprint accumulation remains within the proposed optimal range (e.g., > ∼1 match load; Buchheit et al., 2023) and that match-like peak intensity periods are avoided. The monitoring tool follows the session intent, not the other way around.

Metabolic & overall. No metabolic or overall monitoring: session intensity too low for meaningful data, with little to no time above 85-90% HRmax and low RPE (e.g., 1-3). Depending on staff periodisation, RPE is either collected (moderate load) or estimated (i.e., when the planned load is low, RPE may still be registered to support chronic load tracking, using a staff-derived rather than player-reported rating to minimize player burden).

D-1

D-1 emphasizes tactical rehearsal, set pieces, and short position-specific drills, with quickness and agility (neuromuscular priming; load low to moderate depending on staff periodisation; Buchheit et al., 2021; Table 1).

Player response and readiness

Neuromuscular. Agility and quickness tasks will provide an opportunity to monitor neuromuscular response through maximal efforts in the gym before and to induce post-activation potentiation for the pitch session.

- Subjective wellness is most likely unreliable on D-1, as players may consciously or unconsciously bias their responses given the priority of being selected to play.
- Measuring neuromuscular response here assesses freshness and gives feedback on the microcycle's neuromuscular loading. This is not intended to influence match selection but to support learning from the week and inform load adjustments for upcoming microcycles.
- Gym-based bursts of high-intensity efforts allow CMJ on force plates (and/or bar velocity) to track the return to neuromuscular readiness and identify potential positive adaptation.

Metabolic. No testing: tactical taper, unsuitable for testing; submaximal runs incompatible with the quickness/agility demands, and testing would interfere with match preparation.

Overall. Of little use: players are unlikely to report fatigue the day before a match.

Player load

Neuromuscular - field. GPS verifies that locomotor activity is kept deliberately low, avoiding match-related MIPs.

- GPS helps confirm the chosen load sequencing follows the consistent practitioner pattern on D-2 & D-1: moderate → low or low → moderate (Buchheit et al., 2021).

Metabolic & overall. No metabolic or overall monitoring: intensity too low for meaningful data, with little to no time above 85-90% HRmax and low RPE (e.g., 1-3). RPE may still be collected for global chronic-load tracking, using a staff-rated RPE rather than player-perceived RPE.

Match Day (MD)

On match day. both systems are maximally stressed (Table 1), and the priority is the result, particularly given evidence that professional players do not necessarily need to be fully recovered to perform (Carling et al., 2018).

Player response and readiness

Neuromuscular. Optional pre-match priming and associated CMJ, not common practice nor actively recommended here. A short morning priming session (15-20 min of mobility, activation, resistance, and agility work) may enhance physical readiness (Modric et al., 2023), and some practitioners use the CMJs performed as part of this session as a readiness read. We note this for completeness, not as a recommendation: a low pre-match score cannot and should not stop a player playing (Carling et al., 2018), which sits in tension with our own mid-week logic.

Metabolic. No testing. Not relevant and would interfere with match preparation.

Player load

Neuromuscular - field. GPS used to determine match external load and acute and chronic load.

- A note on what GPS match data should and should not be used for: running volume is not a performance indicator and should not be treated as a KPI. Match running activity is primarily a consequence of tactical decisions, game context, and opposition behaviour rather than a driver of success. The highest probability of winning was observed when players combined high cardiovascular fitness and high freshness with lower, not higher, running activity (Mandorino et al., 2025). GPS match data is collected here to quantify external load for recovery planning and substitute compensation, not to evaluate performance or infer physical capacity (Little & Buchheit, 2025).
- External match load is quantified as the reference for volumes and most intense periods (e.g., MIP for GPS 3.0, HSR for 2.0, Buchheit, Lopez Sagarra et al., 2026). Training-to-match ratios help plan locomotor exposure across the microcycle, generally slightly above match demands, to mitigate muscle-injury risk.
- Tracking data is also used to assess match external load (e.g., intensity exposure time (IET) for key GPS 3.0 variables, with match MIPs of 1 min) in relation to players' usual demands, which, when elevated, may drive greater neuromuscular fatigue over the following 2-3 days and could in turn justify enhanced recovery interventions.
- Finally, GPS is useful to track potential post-match compensation, helping adjust locomotor load for substitutes on MD and D+1.
- A post-match CMJ is taken by a small number of practitioners to quantify the neuromuscular cost of the match from the pre-to-post change, functioning as an objective measure of match load rather than response/readiness (Buchheit & Clarup, 2026). It belongs under load for that reason. We note it as a practised approach with a defensible rationale, not a recommendation.

Metabolic - field. HR is of limited value during the match itself, strongly influenced by stress, caffeine, cardiac drift and contextual demands, which can make it misleading as an estimate of aerobic load for match monitoring (Buchheit, Akubat et al., 2025; Buchheit, Parak et al., 2026). It can still be tracked, particularly in preseason, to contribute to HRmax assessment. For substitutes, HR monitoring helps assess the cardiovascular stimulus provided by the post-match compensatory running session.

Overall. RPE is of limited value, heavily influenced by match result and psychological/situational factors (Fanchini et al., 2016; Abbott et al., 2018). A staff-estimated RPE may still be recorded for global chronic-load tracking, based on the observed session demands rather than player self-report.

Putting the week together

Table 2 consolidates the day-by-day rationale into a single week-level view. It follows the convention introduced above: tools written **plainly** are part of the minimum setup every club should run, and tools shown **in brackets** are optimal complementary measures that add resolution when staffing, budget and player buy-in allow. Reading down a column gives the full monitoring plan for a day; reading across a row shows how a given purpose is served across the week.

Table 2. Suggested monitoring tools and strategies as a function of the day within the microcycle (structure from Table 1). Plain text = minimum setup; (brackets) = optimal complementary add-ons. Empty cells indicate no monitoring is recommended for that purpose on that day.

	D+1	D+2	D+3/D-4	D-3	D-2	D-1	MD
Neuro response/ readiness	Soreness (LFF) (CK) (Thermo)		Soreness, ROM, Squeeze, CMJ, Bar velocity† (LFF) (CK) (Thermo)	Soreness (LFF) (Thermo)	Soreness, ROM (LFF) (CK) (Thermo)	CMJ, Bar velocity†	
Metabolic response				HR (VE, La) responses to Submax run			
Overall response	Subjective Training Effects		Subjective Training Effects	Subjective Training Effects	Subjective Training Effects		
Neuro load	RPE-Neuro†, Bar velocity†, GPS*		RPE-Neuro†, Bar velocity†, GPS	RPE-Neuro†, Bar velocity†, GPS	GPS (if moderate load with sprint exposure)	GPS (if moderate load)	GPS
Metabolic load	HR (VE)*		HR (VE)	HR (VE)			HR (VE)*
Overall load	RPE*		RPE	RPE	"RPE"	"RPE"	"RPE"

Note: * Substitutes only: GPS to confirm compensatory locomotor and mechanical load; HR to verify time above 85-90% HRmax toward the weekly target; RPE to check overall session intensity. † Gym session only: RPE-Neuro and bar velocity apply exclusively when a gym session is scheduled that day. "RPE" refers to staff-rated rather than player-perceived RPE. D-2 load monitoring depends entirely on staff periodization. When D-2 is programmed as a low-intensity recovery session, no load monitoring is needed (no GPS, HR, or RPE). When D-2 includes a moderate-intensity session with finishing exercises and near-maximal sprint exposure, GPS becomes relevant to verify peak velocity exposure and confirm the weekly sprint stimulus remains within the proposed optimal range (Buchheit et al., 2023). CMJ: countermovement jump, CK: creatine phosphokinase, GPS: global positioning system, HR: heart rate, La: lactate, LFF: low-frequency fatigue, ROM: range of motion, RPE: rating of perceived exertion, RPE-Neuro: rating of perceived neuromuscular exertion, Thermo: thermography VE: minute ventilation.

Reliability and thresholds for meaningful change

Table 3 provides the full rationale for the thresholds referenced throughout the day-by-day text. Deciding whether a change in a monitoring variable is meaningful requires a framework for within-player variation, and three approaches are used depending on the variable.

For some measures the smallest worthwhile change (SWC) is clearly defined, anchored either to a physiological adaptation (e.g., a ∼4% change in submaximal HR relating to ∼+0.5 km/h in maximal aerobic speed (Buchheit, Shushan et al., 2025)) or to a performance outcome (e.g., a 1% improvement in 20-m sprint time, equivalent to the 20-50 cm gap needed to win a ball ahead of an opponent (Haugen & Buchheit, 2016). Here a change is substantial when it exceeds SWC combined with the typical error (SWC + TE) (Buchheit, 2018; Hopkins, 2004)

What changes with a day off on D+1?

The structure above assumes the day off falls on D+2. When the day off is instead scheduled on D+1, the less optimal albeit most common arrangement in elite football (Buchheit et al., 2021), the monitoring logic is unchanged but its timing shifts. Rather than repeat the full template, we highlight only what differs and Table 4 summarises this week-level monitoring framework.

With D+1 off, D+2 becomes the first collective training exposure, ∼48 h post-match, when starters still present substantial neuromuscular fatigue and muscle-damage responses. D+2 therefore becomes the key day to evaluate tolerance to the previous match and guide training progression.

D+2 (now the first training day)

Player response and readiness (primary objective): ***Neuromuscular:*** Avoid active neuromuscular testing (CMJ, bar velocity, MVIC) due to residual fatigue, additional neuromuscular cost, and potential discomfort.

- **Minimum Effective Set Up:** Response relies on ROM and dynamic mobility monitoring, soreness, perceived fatigue, sleep quality and stress.
- **Complementary Set Up:** an objective and passive measure of neuromuscular response is especially valuable in this context. If a club could invest in only one monitoring tool during a season characterized by frequent D+1 days off, this would arguably be the most impactful option. At the team level, it informs the design of the starters' session and its targeted neuromuscular load. At the individual level, it helps identify delayed recovery and supports individualized training-load / recovery decisions. LFF can inform on the restoration of lower-limb neuromuscular function from the immediate post-match period through D+2 (Tito et al., 2025; Buchheit & Laursen 2026; Buchheit, Barba Balda et al., 2026), while thermography, and CK can provide complementing information flagging local inflammatory status (Gómez-Carmona et al., 2020; Majano et al., 2023) and overall muscle-damage, respectively.

Metabolic. No testing. Residual match fatigue is still too high for a meaningful submaximal test.

Table 3. Athlete-monitoring metrics: measurement reliability and threshold for meaningful change. TE: typical error; SWC: smallest worthwhile change. Threshold values are working defaults to be calibrated to each context and dataset.

Quadrant	Tool	Metric	TE %	SWC	Threshold for meaningful change
Neuro load	GPS	Total distance	~2%[1]	~2%[2–3]	SWC + TE > ~4%
		High speed running	~2%[4]	~6%[2]	SWC + TE > ~8%
		Sprinting	~1%[5]	~9-10%[2–3]	SWC + TE > ~11%
		High acceleration	~4.5%[6]	~7.5%[7]	SWC + TE > ~12%
		High deceleration	~6%[6]	~5%[7]	SWC + TE > ~11%
		MW/multidirection metrics	~7%[8] ‡	2-3%[8]	SWC + TE > ~10%
	Subjective measure	RPE-Neuro			Z-score > 1.2
	Bar velocity (0.8-1 m/s) - Deadlift	Change in mean velocity (m/s)	~2.7%[9]	~2%[9]	SWC + TE > ~5%
	Inclinometer	Angle (°)	~2-9%[10]		2×TE > ~4-18%
Metabolic load	HR	%HRmax / time in zones	~3%[11]	~1%[12]	SWC + TE > ~4%
	VE	%VEmax / time in zones	Unknown	Unknown	Unknown
Overall load	Subjective measure	RPE			Z-score > 1.2
Neuro response	Force plate-CMJ	FT/CT	~5-6%[13]	~2%[13]	SWC + TE > ~7-8%
		RSI mod	~5.5%[14]	~3.5%[14]	SWC + TE > ~9%
		Concentric impulse (Ns)	~2.7%[15]	~9%[15]	SWC + TE > ~12%
		Peak power (W)	~3.5%[13]	~3.5%[13]	SWC + TE > ~7%
	Subjective measure	Soreness			Z-score > 1.2
	Adductors squeeze	Peak force (N)	~6.5%[16]	~5%[16]	SWC + TE > ~11%
	Hamstring MVIC	Peak force (N)	~6.5%[17]	~3.5%[17]	SWC + TE > ~10%
		Force at 50 ms (N)	~10%[17]	~5%[17]	SWC + TE > ~15%
	LFF	Myocene Powerdex (AU)	~4%[18]		2×TE > ~8%
	CK	CK concentration	~26%[13]	~9%[13]	SWC + TE > ~35%
	Thermography	Skin temperature	~1%[19]		2×TE > ~2%
Metabolic resp	HR response to submax run	%HRmax (%)	~1.5%[20]	~4-5%[20]	SWC + TE > ~6-7%
	VE response to submax run	%VEmax (%)	Unknown	Unknown	Unknown
	Lactate response to submax run	Blood Lactate (mmol/L)	~15-25%[21]	3.5-6.0%[21]	SWC + TE > ~20-30%
Overall resp	Subjective measures	Fatigue			Z-score > 1.2
		Sleep			Z-score > 1.2
		Stress			Z-score > 1.2

Note on GPS metrics thresholds and technology: HSR: high speed running, speed above 19.8 km/h; Sprinting: speed above 24 km/h in the cited studies; TE values reported here are based on 10 Hz GPS devices and should be treated as illustrative examples of the approach rather than universal benchmarks. Different brands and sampling rates will produce different error magnitudes, and practitioners should derive device-specific TE values from their own repeated-measures data where possible. **Note on SWC for GPS-related metrics (e.g., TD, HSR):** Defining a meaningful SWC for distance-based metrics remains an open problem. Unlike sprint performance, where a 1% change maps onto a meaningful competitive outcome (Haugen & Buchheit, 2016), running volume has no demonstrated relationship with match performance (Mandorino et al., 2025) and its association with injury risk at the muscle-tendon level is weak, making an anchor-based SWC difficult to justify. Using 0.2×SD as a between-player standardization is a pragmatic starting point rather than a validated threshold, and should be interpreted with appropriate caution. This limitation has not been resolved since it was first flagged (Buchheit, 2018). **TE & SWC references:** 1. Rampinini et al., 2015; 2. Lago-Peñas et al., 2020; 3. Altmann et al., 2023; 4. Huggins et al., 2020; 5. Waldron et al., 2011; 6. Varley et al., 2012; 7. Coutinho et al., 2024; 8. Buchheit et al., 2026; 9. Nieto-Acevedo et al., 2026; 10. Cejudo et al., 2015; 11. Buchheit 2014; 12. Lacome et al., 2018; 13. Roe et al., 2016; 14. Vieira et al., 2021; 15. Heishman et al., 2020; 16. Ryan et al., 2019; 17. Sundh et al., 2026; 18. Maia et al., 2025; 19. James et al., 2014; 20. Shushan et al., 2023. 21. Altmann et al., 2021. The TE and SWC values presented here are derived from the specific experimental conditions of the cited studies. They should therefore be interpreted as contextual reference values rather than universal thresholds. In practice, both TE and SWC may vary across populations, testing protocols, equipment, and environments, and should ideally be established in-house to best reflect each club's own context. ‡: The typical error for mechanical work is derived from between-unit error only (Ref. 8), as no repeated-measurement data exist for this metric. However, between-unit (8) and repeated-measurement (6) errors for high acceleration and high deceleration are of similar magnitude (both 4-6%), suggesting that between-unit and repeated-measurement errors are interchangeable for these metrics. By extension, the between-unit error reported for mechanical work (~7%) is likely a valid estimate of its repeated-measurement error as well. CMJ: countermovement jump, CK: creatine phosphokinase, FT/CT: flight time on contact time ratio, GPS: global positioning system, HR: heart rate, La: lactate, LFF: low-frequency fatigue, MVIC: maximal voluntary isometric contraction, ROM: range of motion, RPE: rating of perceived exertion, RPE-Neuro: rating of perceived neuromuscular exertion, RSI mod: reactive strength index modified, VE: minute ventilation.

Player load

Neuromuscular - gym: RPE-Neuro is of limited value on this day, as lower-limb eccentric preventive work is unlikely to be performed given the two upcoming high-load days.

Neuromuscular - field: for starters, GPS helps check progression from recovery toward reloading and quantify neuromuscular stress during the modified session. For non-starters, monitor cumulative running load after match-day compensation, preventing excessive accumulation across D+2 to D-2.

Metabolic - field. HR monitoring (mainly non-starters) tracks aerobic-stimulus distribution, helping to check if sufficient weekly exposure is reached ≥30 min >85-90% HRmax (Buchheit, Akubat et al., 2025; Buchheit, Parak et al., 2026)

D+3/D-4 onward

Similar rationale for response and load monitoring. As D+2 was a collective training day, D-2 would likely be low load.

Match Day (greater compensation role)

Because D+1 is a complete rest day, match day becomes the most important compensation opportunity for non-starters.

Player load

Neuromuscular - field:

- For non-starters: match-day compensation should provide a substantial share of the weekly locomotor stimulus, since later opportunities are reduced. GPS confirms sufficient locomotor and mechanical stimulus; the objective is to reduce the exposure gap between starters and non-starters before the first collective session on D+2.

Metabolic - field:

- Non-starters: match-day compensation becomes the first major opportunity for high-intensity aerobic exposure. HR is used to verify time above 85-90% HRmax toward the weekly target of ≥30 min (Buchheit, Akubat et al., 2025). Analyses of nearly 1000 microcycles show that most substitute compensation sessions fail to restore time in high heart rate zones, leaving non-starters chronically underloaded at the cardiovascular level relative to starters - even when GPS volume metrics appear adequately compensated. This reinforces the point that chasing distance targets is not sufficient to replace the aerobic stimulus players miss when they do not play (Buchheit, Parak et al., 2026).

In short, moving the day off from D+2 to D+1 makes D+2 the key day for monitoring neuromuscular response, raising the importance of passive measures such as ROM and dynamic mobility monitoring, perceived responses, and ideally LFF, CK or thermography, and gives Match Day a greater compensatory role for non-starters, since the next collective session is 48 h away.

Table 4. Suggested monitoring tools and strategies as a function of the day within the microcycle with days off on D+1. Plain text = minimum setup; (brackets) = optimal complementary add-ons. Empty cells indicate no monitoring is recommended for that purpose on that day.

	D+1	D+2	D+3/D-4	D-3	D-2	D-1	MD
Neuro response/ readiness		Soreness (LFF) (CK) (Thermo)	Soreness, ROM, Squeeze, CMJ, Bar velocity† (LFF) (CK) (Thermo)	Soreness (LFF) (Thermo)	Soreness, ROM (LFF) (CK) (Thermo)	CMJ, Bar velocity†	
Metabolic response				HR (VE, La) responses to Submax run			
Overall response		Subjective Training Effects	Subjective Training Effects	Subjective Training Effects	Subjective Training Effects		
Neuro load		RPE-Neuro†, Bar velocity†, GPS	RPE-Neuro†, Bar velocity†, GPS	RPE-Neuro†, Bar velocity†, GPS	GPS (if moderate load with sprint exposure)	GPS (if moderate load)	GPS
Metabolic load		HR (VE)	HR (VE)	HR (VE)			HR (VE)*
Overall load		RPE	RPE	RPE	"RPE"	"RPE"	"RPE"

Note: * Substitutes only: HR to verify time above 85-90% HRmax toward the weekly target. † Gym session only: RPE-Neuro and bar velocity apply exclusively when a gym session is scheduled that day. "RPE" refers to staff-rated rather than player-perceived RPE. CMJ: countermovement jump, CK: creatine phosphokinase, GPS: global positioning system, HR: heart rate, La: lactate, LFF: low-frequency fatigue, ROM: range of motion, RPE: rating of perceived exertion, RPE-Neuro: rating of perceived neuromuscular exertion, Thermo: thermography, VE: minute ventilation.

Reading the matrix twice: why dual-system monitoring matters

Figure 2 ties the framework together by showing how the data collected each day should be read and acted upon, extending the original quadrant logic (Buchheit & Hader, 2025) from categorisation into decision-making. The single most important point is this: the matrix should be applied twice, once for the neuromuscular system and once for the metabolic system, every time monitoring data is reviewed. Adaptations are biologically system-specific, and a player can sit in completely different quadrants on each side. Treating a player as a single state ("fresh" or "fatigued", "good" or "bad") loses the information that makes the framework useful.

A second clarification concerns what "typical" means on each axis, because it has two layers. The first is chronic: this week's load or response compared with the player's usual week-to-week pattern. When reading this chronic layer, the absolute values matter as much as the relative deviation. Knowing a player's acute-to-chronic ratio is 1.2, or that their load is 20% above their rolling mean, tells you the same thing in different units - but neither tells you whether they actually reached the sprint speeds or HSR volumes that drive the physiological adaptations and risks we care about. A player can sit at a comfortable ratio while having barely sprinted all week. Beyond this, in elite football the ratio cannot even be reliably calculated in practice: training and matches are tracked with different systems, international duty breaks monitoring continuity, and off-season data are structurally absent, all of which make the chronic load figure untrustworthy as a denominator (Buchheit, 2017). These are not implementation details - they are fundamental barriers that apply to most elite clubs most of the time. This is one further reason ratio-based approaches have proven misleading alongside the deeper mathematical problems they carry (Impellizzeri et al., 2020). Tracking deviation from individual baselines is useful, but always read alongside the actual absolute numbers.

The second layer is short-term, anchored to the latest relevant event. On D+3, for instance, the load read can ask whether the match just played fell within the player's usual match range or was unusually demanding; on D-4 it can ask how the player responded to the previous day's session. Both layers feed the same matrix, and the layer to use depends on where you are in the week and what has just happened. The chronic layer drives slow, multi-week decisions; the short-term layer sharpens the read of a specific session or match. This is distinct from the time horizon of the action discussed below (how fast we respond), which is a separate question from which baseline we compare against.

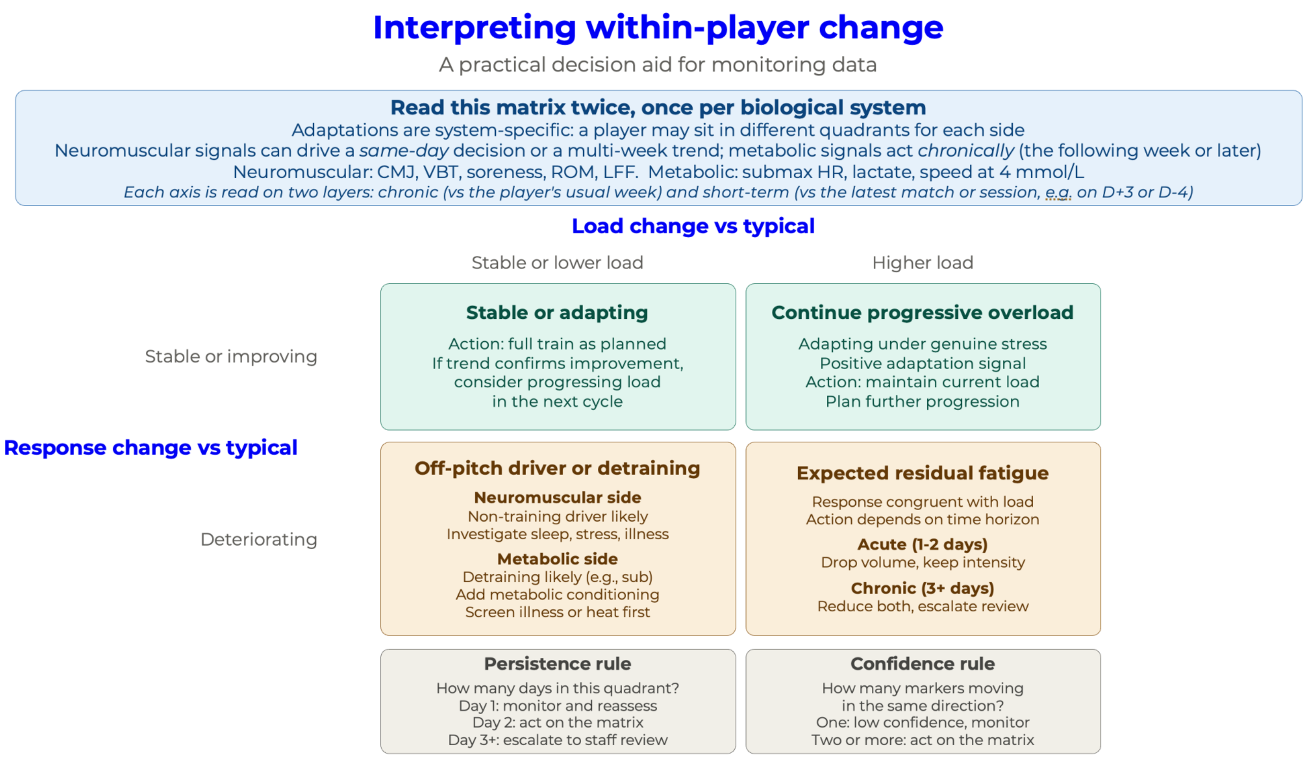

Fig. 2. Practical 2×2 matrix for interpreting within-player change in load and response across the microcycle. The matrix is applied twice: once for the neuromuscular system (markers such as CMJ, bar velocity, soreness, range of motion, low-frequency fatigue) and once for the metabolic system (markers such as submaximal HR, lactate at fixed intensity, speed at 4 mmol/L). Each axis is within-player change relative to what is typical for that player, read on two layers: a chronic layer (this week versus the player's usual week-to-week pattern) and a short-term layer (the latest relevant event, for example whether the match just played fell within the player's usual match range when read on D+3, or how the player responded to the previous day's session when read on D-4). The horizontal axis captures load change (stable/lower vs higher) and the vertical axis response change (stable/improving vs deteriorating); the same quadrant logic applies whichever layer is being read.

The persistence rule and the confidence rule protect decisions from noise by asking how many consecutive days the player has been in the same quadrant and how many markers move together. Action magnitudes are heuristic defaults to be calibrated to context. Thresholds for meaningful change on each variable are in Table 3.

The day-by-day section (Table 2) followed a consistent design rule worth restating. On recovery and protect days (D+1 for starters, D+2, and the protect side of D-3/D-2), monitoring relies on passive measures (soreness, ROM and dynamic mobility monitoring, and where available CK, thermography or LFF), because active testing is incompatible with recovery. On high-intensity training days, active maximal-intent measures take over: the neuromuscular battery (CMJ, bar velocity) on D+3/D-4, and the formal submaximal HR test on D-3. The tool follows the day, not the other way around.

A second principle is equally important and shapes how the two sides of the matrix are read: the neuromuscular and metabolic signals do not operate on the same time horizons. The neuromuscular signal works on two: collected on D+3/D-4 it informs an immediate, same-day decision about whether the player can be pushed maximally or whether the neuromuscular content of the session should be adjusted; read across several microcycles it also functions as a trend. A metabolic signal collected on D-3, in contrast, will never change what we do the same day: whatever the submaximal HR value, the player keeps training that session. Same-microcycle action is structurally not feasible either, because D-2 is a tapering day and D-1 a priming day, leaving no room to add meaningful metabolic conditioning before the match.

Both signals therefore earn value over weeks. If submaximal HR trends upward over two or three successive microcycles without an obvious confound, the player has likely lost cardiovascular fitness (Buchheit, Shushan et al., 2025) and needs a top-up. A note on broader metabolic monitoring approaches: beyond the submaximal HR (and potentially VE or lactate) test on a fixed day, the relationship between external and internal load across any session can itself serve as a rolling metabolic fitness indicator. When a player produces the same locomotor (GPS) output at a progressively lower HR over weeks, cardiovascular adaptation is occurring; the reverse signals deconditioning. This external-to-internal ratio approach, described recently in both Buchheit, Shushan et al. 2025 and Çiçek 2026, is not tied to a specific test day and can be applied opportunistically whenever matched GPS and metabolic-related data are available across the microcycle. It is an adjunct to, not a replacement for, the formal submaximal test.

The neuromuscular side carries an equivalent chronic arm: a player may pass several microcycles with no same-day flag, yet a consistent decline in explosiveness or strength over a couple of weeks, a pattern especially worth watching in substitutes and in young, still-developing players, is itself a signal to add targeted neuromuscular work, in exactly the same logic as the metabolic top-up. When any such top-up can be prescribed depends on the neuromuscular readiness reading: only once the neuromuscular markers confirm the player is recovered can extra conditioning be added without compromising freshness. The two systems therefore interact across time, with the same-day neuromuscular reading gating when either chronic prescription can be executed.

Three case studies make this concrete.

Case 1. Acute neuromuscular signal (starter coming off a high-minute match). A starter has played 90 minutes of a high-intensity match. On D+1, passive measures flag the neuromuscular side: soreness is elevated above baseline and CK is increased compared with previous MD+1 data. These fall within the matrix's predicted residual-fatigue zone (Figure 2) but can serve as an early indicator of an abnormally high match cost. They do not yet trigger a decision, because the session that day is off-feet recovery. On D+3/D-4 the neuromuscular battery is collected. ROM and CMJ are down by more than 2×TE, soreness is still above the player's typical Z-score band, and where the squad has objective markers, CK is elevated or LFF impaired. Two or more markers moving together cross the confidence rule. The player sits in the residual-fatigue quadrant on the neuromuscular side. The same-day action follows: the player is dropped partially from the neuromuscular content of the session (SSG participation reduced, contact actions limited), while the likely missed metabolic load is shifted to the next day via a generic post-session bike workout. By D-3 the player is reassessed on updated markers.

Case 2. Pure chronic metabolic signal (player losing fitness across weeks). A player trains with the squad but accumulates limited match minutes. Neuromuscular markers on D+3/D-4 stay within range week after week. On D-3 of week 1, submaximal HR sits slightly above the player's historical typical, but the change does not exceed SWC + TE; the reading is filed and the session continues. On D-3 of week 2, submaximal HR is clearly above SWC + TE and the two-week trend is consistent. The signal is confirmed chronic; the player sits in the off-pitch-driver / detraining quadrant on the metabolic side. The action is scheduled for the following week. That week the neuromuscular reading is checked on D+3/D-4 and is clean, which authorises the top-up. Post-session metabolic conditioning is added on a suitable day (D+3/D-4 and/or D-3), with a mix of generic runs and technical work calibrated to the player's profile (Buchheit 2019a, 2019b). The actual time in HR zones during this extra and any MD+1 compensation is also checked to confirm the work is sufficient (Buchheit, Akubat et al., 2025; Buchheit, Parak et al., 2026). Submaximal HR is then tracked over the following weeks to confirm the top-up is restoring fitness.

Case 3. Gated top-up with a low-fatigue alternative (substitute with chronic metabolic signal and concurrent illness or fatigue). A substitute carries the same confirmed chronic metabolic signal as in Case 2: submaximal HR elevated across a few successive weeks, clearly above threshold. More aggressive post-match compensation and a post-session top-up are justified by the metabolic data. Separately, the player has been flagging on the subjective and neuromuscular side, unusual for a substitute, whose limited match exposure should keep them fresh. The likely drivers are non-training: minor illness, several poor nights of sleep, or general fatigue. CMJ may not be clearly impaired, but soreness, fatigue rating and sleep have been outside the typical band for several consecutive days. The neuromuscular reading therefore does not authorise a standard high-load top-up. Two options remain. First, delay the top-up by one week: the chronic metabolic trend has built over weeks and one more will not change its status, so wait for the markers to clear, then prescribe the normal top-up. During this waiting period, the player is referred to the medical staff to rule out or treat illness, nutrition support is reviewed, and a scheduled nap opportunity is built into the day where possible to accelerate recovery. Second, prescribe a low-fatigue version that still delivers metabolic stimulus while minimising neuromuscular cost: off-field modalities such as cycling remove the decelerative and impact load of running, and adding heat exposure increases cardiovascular strain at lower intensities. The same medical, nutritional, and sleep support applies here in parallel. The player gets the conditioning stimulus without adding to existing fatigue. This option is most useful when the chronic signal is severe enough that waiting is undesirable, or when training continuity is wanted.

Across the three cases the same principle keeps appearing. A single global judgement collapses the diagnostic information and pushes everyone toward the same generic action, usually "reduce load." Reading by system instead forces two questions: which system is affected, and on what time horizon does the corresponding decision need to be made? Once answered, the action follows naturally: a same-day adjustment for the neuromuscular side, and chronic planning for the metabolic side, with the neuromuscular reading gating the timing of any metabolic top-up. But the principle goes further than just separating two systems. Each system has its own tools, its own time course, and its own specific actions. A depressed CMJ on D+3 calls for a reduction in neuromuscular session content that day - not a global load cut, not a rest day, and not a metabolic intervention. An elevated submaximal HR trend over three weeks calls for a targeted aerobic top-up in the following week - not an immediate session change, and not a neuromuscular adjustment. A player flagging on wellness with no clear objective impairment calls for a medical and recovery conversation - not a training decision made in isolation. The monitoring framework only delivers value when the signal is matched to the correct system, the correct time horizon, and the correct action. Collapsing these into a single number or a single response discards precisely the information the framework was built to preserve.

Two further rules are built into Figure 2 to protect decisions from noise. The persistence rule asks how many consecutive days the player has been in the same quadrant, because a single isolated reading is rarely worth acting on. The confidence rule asks how many markers move in the same direction, because two or three pointing the same way is a much stronger signal than one. Both connect back to Table 3: a marker only counts as moving when its change exceeds the threshold defined for that variable (SWC + TE, 2×TE, or 1.2 Z-score).

The combination of Table 3 and Figure 2 is the operational core of this paper. Table 3 tells the practitioner when a number is real. Figure 2 tells them what to do once a real change has been detected. Together they replace implicit, intuition-driven decisions with a structure that is transparent, repeatable, and explicit about why each action is taken. Importantly, in all three cases, training participation remains the default. Monitoring exists to protect and optimise that participation, not to restrict it.

Conclusions

In this paper, we set out to translate the quadrant-based monitoring framework (Buchheit & Hader 2025) from theoretical clarity into operational practice. Table 1 sets the structural backdrop of the microcycle. The day-by-day section justifies each tool and each day on the basis of load, system, and practical constraints. Table 2 consolidates those choices into a single week-level plan, separating the minimum setup from the optimal complementary add-ons. Table 3 defines when a change is meaningful and real. Figure 2 closes the loop by showing how to act once meaningful change has been detected, reading each signal both against the player's chronic norm and against the latest match or session, and acting on different time horizons for the two systems. The organising principle throughout is specificity: the right tool for the right system, read at the right time, triggering the right action.

We do not claim this is the final word on microcycle monitoring. The matrix in Figure 2 simplifies a more complex underlying decision logic that will be developed in future work. But as a practical first step from data collection to interpretation to action, this framework gives staff a defensible structure to work with on a MD+1 morning and a starting point to build on.

Used well, this framework should result in more training, not less: earlier detection of fatigue trends allows proactive load adjustments that prevent the accumulation that forces players out. The measure of a good monitoring system is not how often it flags players for rest, but how rarely it needs to.

Key applications

- Match the tool to the day. Exclusively passive measures (wellness, soreness, ROM) on recovery days; Addition of active maximal-intent measures (CMJ or bar velocity on D+3/D-4) on high-density days. The tool follows the day, not the other way around.
- Build cheap-to-complex within each system. Start with low-friction minimum-setup measures and add technology and cost only as the day's intent justifies.
- Minimum is not comprehensive. The minimum setup is a floor, not a ceiling: further layers can always be added for more precision, but each one moves the decision into a cost and burden versus benefit trade-off.
- Read the matrix twice. Apply Figure 2 once for the neuromuscular system and once for the metabolic system. A player can sit in different quadrants on each side, and the correct action depends on which system is affected.
- Match the time horizon to the system. A neuromuscular signal works on two horizons: a same-day decision about potentially modifying the session, and a multi-week trend that, like the metabolic signal, can justify adding targeted work (e.g., a substitute losing explosiveness over weeks). A metabolic signal is trend-only: it drives a chronic decision about adding conditioning in the following week or weeks, never a same-day one.
- Read change on two layers. Compare each signal both against the player's usual week-to-week norm (the chronic layer) and against the latest relevant event (the short-term layer): on D+3, whether the match response fell within the player's usual range; on D-4, how the player responded to the previous session. The chronic layer drives multi-week decisions; the short-term layer sharpens the read of a single session or match. This is the comparison baseline, a separate question from how fast the resulting action is taken.
- Use Table 3 to confirm the change is real. Apply SWC + TE for anchored variables, 2×TE for mechanistic markers, and 1.2 Z-score for psychometric variables before acting on any single value.
- Apply the persistence and confidence rules. A signal becomes actionable when multiple markers move together (confidence) and the pattern persists across days or weeks (persistence).
- Gate every top-up on the neuromuscular reading. The top-up prescription is system-specific: metabolic underload calls for aerobic conditioning, neuromuscular underload calls for explosive and strength work. Neither substitutes for the other. A chronic trend can call for extra metabolic conditioning, but it can equally call for extra neuromuscular work, most often in substitutes and in young, still-developing players who need more exposure than the match and microcycle provide. Whatever the type, the gate is the same: prescribe the top-up only when the neuromuscular markers confirm the player can absorb the load. Otherwise delay it, or shift it to a low-fatigue modality such as off-field conditioning with heat for the metabolic case, or low-fatigue technical and speed work for the neuromuscular case.
- 7-day microcycles with D+1 off. Passive and objective monitoring of players' neuromuscular response is arguably of particular importance. The first collective training session (D+2) takes place while starters are still recovering from substantial residual neuromuscular fatigue, making a passive, objective assessment of neuromuscular readiness especially valuable.
- Keep players training. The goal of this framework is not to exclude players from sessions on the basis of monitoring data alone. Reduced participation should be driven by pain, clinical concern, or a pattern of confirmed signals across multiple markers over multiple days - never by a single test on a single day. Monitoring should make training smarter and more individualised, not more cautious and more restrictive.

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