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Relevance of Isometric Strength Assessments in Sports

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ABSTRACT

Background: Isometric tests quantify force under controlled conditions, but reliable measurements do not necessarily lead to defensible coaching decisions. Objective: This critical narrative review examines how isometric peak force and time-dependent measures can inform athlete monitoring without being mistaken for direct measures of sport performance. Approach: Selected primary studies and methodological reviews are critically interpreted; no systematic search or meta-analysis is claimed. Contribution: A six-stage decision-accountability framework links a predefined coaching question to test choice, data-quality checks, uncertainty-aware interpretation, documented action and reassessment. Unlike existing testing guidance, the framework treats disagreement between isometric and dynamic outcomes, as well as the consequences of a decision, as reasons to review the original interpretation. Application: A hypothetical example illustrates why an observed increase in peak force may not justify an immediate programme change. Conclusion: The framework offers a transparent and testable way to organise judgement, but its effectiveness has not been empirically established.

Keywords: *isometric strength; force–time characteristics; peak force; rate of force development; athlete monitoring; strength assessment*

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Introduction

Strength assessment can inform resistance-training prescription, athlete monitoring and rehabilitation decisions, but maximal force capacity is only one determinant of sport performance. Movement skill, coordination, contraction velocity, task constraints and training history also shape outcomes. Isometric testing offers a practical way to assess force production under a controlled posture. Its appeal should not obscure a fundamental distinction: a measure can be repeatable without being responsive to training, and it can correlate with performance without accurately predicting an individual athlete's future results. This review therefore treats test selection and interpretation as connected decisions rather than assuming that any one force metric is universally superior.

Isometric tests include the isometric mid-thigh pull (IMTP), isometric squat (ISqT), bench press (IBPress) and bench pull (IBPull). Depending on the apparatus, outputs may include peak force, net force at prespecified time points, impulse and rate of force development (RFD). Each quantity requires an operational definition. For example, force at 150 ms is meaningful only when the contraction onset, baseline correction and filtering methods are specified. The central challenge is therefore not merely to record a high value, but to determine whether the value is repeatable, relevant to the target task, sensitive to training and sufficiently precise to support a coaching decision. This review evaluates those distinctions while archiving the historical study-summary tables separately.

Review scope and critical interpretive approach

This review starts with a practical question: when should an isometric strength result lead a coach to change the training plan? We use a critical narrative approach rather than a systematic review or meta-analysis. We selected studies for their relevance to four connected issues: relationships between isometric and dynamic performance (Bazyler et al., 2015; Lum et al., 2020; Tan & Lum, 2024); test setup and signal processing (Comfort et al., 2019; Guppy et al., 2022);

reliability and responsiveness (Drake et al., 2017; Grgic et al., 2022; Hopkins, 2000); and the interpretation of monitoring information in training decisions (Buchheit, 2014; Kiely, 2012). This selection helps explain the argument but is not comprehensive. We did not screen databases systematically, formally rate risk of bias or pool study results.

We read each source with three questions in mind. What, precisely, did the test measure? How closely do its participants, equipment and procedures resemble the setting in which a coach might use it? And does the result tell us about differences between athletes, repeatability, or change over time? These questions guide the discussion; they are not a validated appraisal tool.

Existing work answers related but different questions. Lum et al. (2020) synthesised associations between isometric force–time characteristics and dynamic performance; those associations cannot by themselves determine what a coach should do when an individual athlete's results change. Comfort et al. (2019), Grgic et al. (2022), and Hopkins (2000) clarify how protocols and measurement error affect interpretation, but reliable measurement is only one condition for an appropriate action. Buchheit (2014) and Kiely (2012) situate monitoring within adaptive training, without establishing a specific isometric-test decision sequence. Our contribution is therefore narrower and more testable than a new theory of coaching: we make the link between a measurement, a competing explanation, an action or deliberate non-action, and subsequent reassessment explicit. A dated record allows another practitioner to examine whether the evidence available at the time justified the decision, and whether new evidence prompted reconsideration. Auditability is not the same as accuracy or improved athlete outcomes; both remain empirical questions.

What is new: from test quality to accountable decisions

The proposed six-stage process has two distinctive applications (Table 1). When isometric and dynamic outcomes disagree, neither result is automatically treated as the truth. The coach checks measurement quality, task specificity, fatigue and the initial explanation before acting. The process also requires a prospective review condition: the record specifies what was done or deferred, why, and what new finding would justify changing course. These features make decisions easier to inspect and compare over time. They do not establish that the process is unique to this framework or superior to experienced practitioners' existing methods.

Rationale for isometric strength assessment

Isometric assessments are attractive because they can be completed without lifting a maximal external load through a full range of motion, and because calibrated devices can record detailed force–time data. Under appropriate supervision, they may reduce some technical demands and be convenient during periods of heavy training. These practical advantages do not establish that isometric tests are universally safer, less fatiguing or more responsive than dynamic testing. Maximal voluntary contractions still require preparation, appropriate positioning and consideration of symptoms or contraindications. The principal scientific advantage is the ability to standardise the mechanical task and examine specific force characteristics. Conversely, the fixed posture reduces ecological similarity to movements involving acceleration, stretch–shortening behaviour and coordination across changing joint angles.

Studies have reported links between isometric force and dynamic strength, jumping, sprinting and other athletic tasks (Bazyler et al., 2015; Lum et al., 2020). These findings can guide test choice, but their meaning depends on who was tested, how the test was performed and which performance task was examined. A test that separates stronger from weaker athletes may still be too variable to track a small change in one person. That distinction matters throughout this review.

Measurement constructs and interpretation

Peak force is the highest recorded force within a valid trial, but the meaning of that value depends on the equipment and signal processing. A force plate may record the resultant ground-reaction force, whereas a cable load cell records tension along a defined line of pull. Values obtained from different configurations are not interchangeable without calibration and appropriate mechanical interpretation. Reporting should specify whether system weight has been removed, whether force is unilateral or bilateral, and whether the value represents raw or net force. Relative force expressed per kilogram of body mass answers a different question from absolute force and should not automatically replace it.

Rate of force development (RFD) describes change in force divided by elapsed time over a stated interval. It is particularly sensitive to the method used to detect contraction onset, baseline noise, filtering, sampling frequency and pretension. Force at 100 or 200 milliseconds and impulse accumulated over an early window can be easier to interpret than a single peak RFD value, but neither is immune to processing choices. The investigator must report the exact time origin, window and calculation. Early force values can also be mathematically associated with peak force, so a larger early force does not by itself establish superior rapid-force capability relative to maximal strength.

Position specificity is central to validity. Joint angle, trunk orientation, bar height, grip, footwear and support surfaces alter the muscles and mechanical leverage contributing to the recorded force. The aim is not to find one universally correct posture, but to reproduce a position that corresponds to the monitoring question and has acceptable reliability in the target group. Comparisons with published norms should be cautious when protocols differ. Standardisation guidance for the isometric mid-thigh pull emphasises these procedural choices (Comfort et al., 2019).

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Upper-limb isometric assessments: construct and interpretation

The isometric bench press (IBPress; Figure 2) measures pushing force without movement at a selected joint position. Shoulder and elbow angles, bench support, bar fixation and instructions all affect the reading. It may add useful information to dynamic strength testing, but it does not replace a one-repetition-maximum bench press or measure power in a sporting movement. Its value depends on the specific question the coach is trying to answer.



Figure 2. Illustrative isometric bench-press position.

The isometric bench pull (IBPull; Figure 3) measures pulling rather than pushing force. Although the two tests can complement each other, their scores describe different tasks. Grip, body support, joint position and the direction of measured force must be considered before interpreting a result.



Figure 3. Illustrative isometric bench-pull position.

For repeated upper-limb assessments, document bench and padding configuration, grip width, joint position, warm-up, contraction instructions and sensor settings. These details matter more than comparing absolute scores from dissimilar apparatus.

Lower-limb isometric assessments: construct and interpretation

The isometric mid-thigh pull (IMTP; Figure 4) and isometric squat (ISqT; Figure 5) both assess lower-limb force, but they place the athlete in different mechanical conditions. The IMTP may suit a programme that needs a consistent measure of maximal pulling force. The ISqT may be more informative when squat posture or a particular joint angle is central to the question. Tan and Lum (2024) examined how squat-test position relates to dynamic squat strength, illustrating why joint angle cannot be treated as a minor detail. The better test is the one that fits the intended comparison and can be repeated reliably.



Figure 4. Illustrative isometric mid-thigh pull setup.

For sprinting, jumping and change-of-direction tasks, a static force test captures only part of the performance problem. Sprint acceleration, for example, also depends on direction of force application, coordination and technique. A coach should therefore pair the isometric measure with the dynamic task that matters, and interpret agreement or disagreement between outcomes rather than treating either as a substitute for the other (Lum et al., 2020).

For longitudinal monitoring, retain the same lower-limb test, joint configuration and apparatus unless there is a defensible reason to change. If a protocol changes, the new series should not be treated as directly continuous with the old one. Local familiarisation and repeatability checks are preferable to assuming that published norms apply to every athlete.

Interpreting associations with athletic performance

Studies reporting associations between isometric and dynamic performance describe relationships within their sampled populations, not guaranteed responses to training. Small samples, restricted performance ranges, body size and differences in processing can influence the result. A high correlation is not proof that improving the measured force will improve performance, and a modest correlation does not necessarily make a test useless for tracking an individual athlete. The decision depends on what the measure captures, how precisely it can be repeated and whether the outcome is actionable.

A negative correlation with sprint or change-of-direction time often means that greater force is associated with faster completion, because lower time is better. It does not mean that strength is detrimental. Equally, a strong positive correlation between peak force and an explosive outcome can partly reflect body size or general training status. Absolute and relative force should therefore be interpreted in light of anthropometry and the chosen performance criterion. Confidence intervals, measurement precision and the number of comparisons are more informative than a threshold label such as moderate or strong alone.

Consider two athletes. One produces more force on an isometric test after training, yet runs no faster. The strength gain may be real, but sprint technique, force direction or coordination may not have changed enough to affect performance. Another athlete runs faster without a meaningful increase in peak force, perhaps because movement efficiency has improved. Neither pattern means the assessment has failed. Each asks the coach to revisit what the test was expected to reveal.

Testing protocols and quality control

The practical value of an isometric test depends on standardisation, transparent data processing and consistent interpretation across sessions. The following procedures should be documented before testing begins.

Select the joint position on the basis of the construct and task of interest, then reproduce it at follow-up. There is no single joint angle that maximises validity for every athlete and dynamic movement. Report how knee and elbow angles were defined, as conventions differ between anatomical and internal-joint-angle notation.

For isometric bench press and bench pull, retain the same bench, padding, body position, elbow configuration and fixation apparatus at each session. Differences in contact surfaces or apparatus compliance can alter the recorded force and compromise longitudinal comparisons.

For the IMTP, document the bar height, grip and strap use, knee and hip configuration, trunk position, foot placement and instructions. Published standardisation guidance highlights how methodological differences can affect the measured force–time curve (Comfort et al., 2019). Familiarisation and a consistent warm-up should precede testing, particularly when early force is the intended outcome.

For early force or rate of force development, instruct athletes to produce force rapidly and maximally. Predefine the force-onset algorithm, sampling rate, filtering and analysis windows. An onset shift of only a few milliseconds can alter short-window estimates, so report these settings and retain the original traces.

For peak-force testing, athletes should exert maximal effort long enough for force to plateau without sacrificing technique or tolerability. Record contraction duration and rest interval,

and use the same rules at each session. A fixed number of seconds should not be presented as optimal for every protocol.

Inspect baseline force and trial traces for excessive pre-tension, countermovement, equipment movement and delayed effort. Predefine criteria for rejecting or repeating a trial; otherwise practitioners may inadvertently select favourable traces after observing the results.

Figure 6 illustrates why force–time traces should be inspected before an attempt is accepted. Pre-tension, movement artefacts and delayed maximal effort should trigger protocol-defined review rather than post hoc selection of a favourable trial.

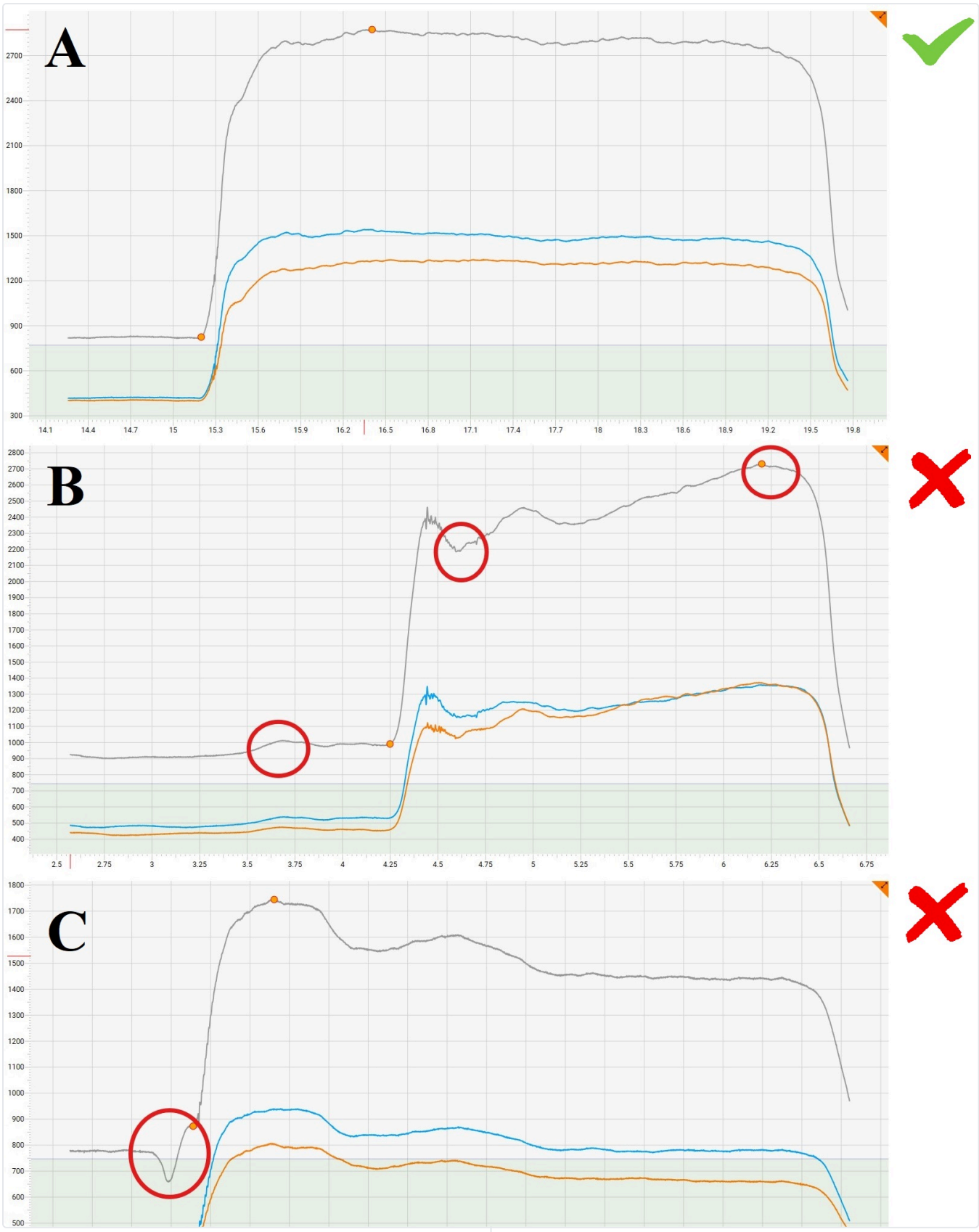


Figure 6. Illustrative force–time traces: stable trial (A) and trials requiring inspection (B, C).

Integrated discussion: measurement quality, change and coaching decisions

Table 1 sets out six linked decisions, not six new measurements. The sequence begins before the athlete touches the equipment: what question needs answering, and what result would change the plan? Only then does the coach select a test, check its quality, interpret change, decide what to do and return to that decision. Good equipment cannot

compensate for a vague question, and a change in force does not by itself dictate an intervention.

Before comparing scores, the coach checks whether the trials were performed in the same way. Familiarisation, posture, warm-up, instructions and signal processing need to be consistent. Rejected trials should be retained with a reason for exclusion. Otherwise, a difference in procedure can easily be mistaken for a change in the athlete.

Relative reliability, such as an intraclass correlation coefficient, describes how consistently individuals retain their ranking. Absolute reliability, such as typical error, is more useful when judging change within an athlete (Hopkins, 2000). The same test may rank athletes consistently while remaining too imprecise to interpret a small individual change. Reliability should therefore be estimated for the actual protocol and population rather than borrowed uncritically from a different setting.

Association, reliability and responsiveness are different forms of evidence. Isometric peak-force testing has substantial repeatability evidence, but the ability to detect training adaptation is a separate question (Drake et al., 2017; Grgic et al., 2022). Time-dependent measures also depend on contraction-onset and processing choices (Comfort et al., 2019; Guppy et al., 2022). Buchheit (2014) similarly argues that monitoring measures should be interpreted against error, meaningful change and training context. The present framework adds an explicit requirement to record what interpretation led to which action.

Worked example (hypothetical; not participant data). An athlete's isometric mid-thigh pull peak force rises from 2,500 N to 2,650 N, an observed gain of 150 N (6%). Assume, only to demonstrate the calculation, a single-session typical error of 100 N, independent errors and equal error variance at both sessions. The standard error of the difference is then $\sqrt{2} \times 100 \approx 141$ N. Multiplying this by 1.96 gives an illustrative measurement-error margin of approximately ±277 N. This margin is neither a confidence interval for the athlete's true adaptation nor a validated decision threshold. It omits uncertainty in the typical-error estimate, potential systematic bias and any departure from the stated assumptions. Because the observed gain is smaller than this illustrative margin, the coach would record the result as inconclusive rather than automatically increase the training load. The next steps would be to inspect force traces, check test positioning and fatigue, and repeat testing if the decision warrants the cost. A paired sprint or jump assessment could test whether the original performance explanation remains plausible. If force improves but dynamic performance does not, the coach would consider task-specific limitations rather than claim that the isometric test has failed. The record would identify the decision to act or wait, its rationale, and the evidence that would trigger reassessment.

A useful decision record is brief but specific. It states the question, metric, protocol, accepted trials, uncertainty estimate and any relevant dynamic result. It also notes competing explanations, what the coach decided to do or postpone, and what would prompt another decision. The record allows the reasoning to be examined later. It does not mean that every uncertain result must trigger another test; time, cost and the consequences of acting or waiting still matter (Buchheit, 2014; Kiely, 2012).

Limits of inference and practical implications

An isometric test tells us how much force an athlete produces in a constrained task. On its own, it cannot establish injury status, readiness to compete or whether a gain will transfer to sport. When force and performance results disagree, the coach should not rush to dismiss either measure. The mismatch may be a clue that the initial explanation was incomplete.

More monitoring is not always better. A small set of dependable measures may be more useful than many outputs that fluctuate from session to session. If a proposed programme change rests on a difference that could plausibly be measurement noise, the coach may be better served by checking context or repeating the assessment. The choice also depends on the costs of acting too soon and of waiting too long.

The proposed process has not been tested for usability, decision accuracy, or athlete benefit. Its principal output is an inspectable record of reasoning, not proof of better reasoning. Because the review deliberately selected relevant sources rather than conducting a systematic search, it may omit alternative frameworks or contrary evidence. We therefore make no claim that the six stages are exhaustive, unique or superior. Nor do we prescribe universal thresholds: error distributions, costs of testing, and consequences of acting prematurely differ across sports and athletes. The framework should be judged against usual practice in prospective studies, including whether it changes decisions appropriately when evidence conflicts.

Future validation of the proposed framework

The first validation study should test decisions rather than assume a performance benefit. In a preregistered assessor study, practitioners could be assigned to usual interpretation or a six-stage worksheet and asked to interpret standardised cases. Cases would vary force-trace validity, measurement uncertainty, and agreement between isometric and dynamic outcomes. Before data collection, investigators should define a decision-quality rubric and reference decisions, developed by an independent panel blinded to group allocation. Primary outcomes could include identification of invalid trials, appropriate recognition of uncertainty, consideration of competing explanations, and justified action or non-action. Secondary outcomes could include inter-rater agreement, decision changes after new information, documentation completeness and time burden. The study should report

disagreements with the reference panel and potential harms from overtesting; a longer record alone must not count as a better decision.

A second, prospective multisite study should examine whether any improvement in decision quality persists across coaching experience, sports and equipment, and whether the approach reduces unnecessary programme changes without delaying useful interventions. The design should prespecify meaningful outcomes, monitor adverse consequences and distinguish improved documentation from improved decisions. Research involving athlete participants requires appropriate ethics review. Until such work is completed, the framework is an unvalidated organisational aid, not an evidence-based performance intervention.

Conclusion

Isometric strength assessments offer useful information when the task, equipment and measurement uncertainty are understood. The remaining challenge is to decide what that information warrants. This critical narrative review proposes six linked steps that make a coach's question, test selection, quality checks, interpretation, action and reassessment visible. Its specific contribution is to preserve conflicting evidence and prospective review conditions within the decision record, so that reasoning can be examined rather than reconstructed after an outcome is known. These are proposed advantages, not demonstrated improvements. Future comparisons with usual practice should establish whether greater auditability leads to more appropriate decisions or meaningful athlete benefit.

Table 1. Proposed decision-accountability matrix for isometric strength assessment in sports

Stage	Decision Question	Required Evidence or Quality Check	Documented Action / Review Condition
1. Define	What coaching decision is at stake?	Specify performance hypothesis, target athlete and intended consequence.	Record question, anticipated action and decision horizon.
2. Select	Which test and metric address that question?	Choose IMTP, ISqT or another measure based on construct and athlete; identify a relevant dynamic comparator.	Record protocol, chosen outcome and reason for selection.
3. Standardise	Can the data be trusted across trials and dates?	Fix apparatus, joint angles, footwear, verbal instructions, sampling frequency and filtering.	Record full testing setup; reject trials with visible artefacts or unstable baselines.
4. Calibrate	What counts as a real change?	Calculate typical error, CV, SWC and measurement uncertainty for this metric, squad and testing context.	Record analytical threshold; require observed difference to exceed measurement noise.
5. Decide	Does the evidence support the proposed action?	Compare observed change with threshold, corroborate with training load, fatigue and dynamic performance.	Document decision, supporting indicators and any contradictory findings.
6. Review	Did the decision achieve its intended purpose?	Evaluate athletic response, re-test at planned horizon, and update threshold or protocol if necessary.	Record review outcome and note modifications to testing or training.

Declarations

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Table 1. Proposed decision-accountability matrix

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