

Energy per Kilogram in Performance and Elite Sport

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Narrative evidence synthesis and proposed research. Not peer reviewed.

Abstract

This working paper evaluates intake per body mass as a practical descriptive variable in sport. It proposes that energy accounting must include workload and body composition, and that performance research should test the ratio against established alternatives. It does not propose a universal intake for elite athletes.

Evidence and definitions

Sports energy availability is (energy intake minus exercise energy expenditure) divided by fat-free mass. The IOC cautions against assuming one universal low-energy-availability threshold. [1]

A Tour de France Femmes case study measured mean daily expenditure of 7,572 kcal using doubly labelled water and intake of 5,246 kcal using food photography. [2] A single competition case illustrates demand; it cannot define all athletes' needs.

Using the reported baseline mass of 71.2 kg gives approximately 106.3 kcal/kg/day expended and 73.7 consumed. These calculations use starting mass rather than mean race mass; the intake estimate covers days 1–7. [2]

EPK describes intake/body mass. Energy balance compares intake with total expenditure. Energy availability subtracts exercise expenditure and uses FFM. Carbohydrate grams/kg and cycling watts/kg quantify different properties again.

Scope and search

This narrative paper uses the 2023 IOC consensus and a 2024 elite cycling case report, checked on 11 September 2026. It is a conceptual protocol supported by selected sources, not a systematic review or a completed trial.

Worked example

Consider a hypothetical 70 kg athlete with 55 kg FFM, intake of 3,000 kcal/day and exercise expenditure of 1,200 kcal/day. EPK is 42.9 kcal/kg body mass/day. Sports energy availability is 32.7 kcal/kg FFM/day. If exercise increases to 1,800 kcal/day with intake unchanged, EPK stays 42.9 while availability falls to 21.8. This demonstrates a limitation of intake/body mass when workload changes.

Study question

Does repeated intake/body mass predict subsequent performance or recovery beyond workload, carbohydrate availability, body composition and prior performance? The alternative is that workload-aware measures explain the relationship and the simpler ratio adds little.

Repeated-measures design

Follow athletes within a defined sport across rest days, ordinary training and a competition block. Collect daily food records with a feasible verification method, body mass under standard conditions and exercise expenditure with stated uncertainty. Record FFM using the same method throughout; repeat resting calorimetry at planned time points.

Choose one reproducible sport-specific primary outcome before enrolment. Record training volume, intensity, illness, sleep, menstrual status where relevant, and carbohydrate intake. Distinguish purposeful tapering from fatigue-related reduction in training. Include both women and men where recruitment permits, and report population limits.

Analysis and falsification

Use athlete-level repeated-measures models to separate between-athlete differences from changes within an athlete. Lag energy exposures ahead of the performance outcome to reduce same-day ambiguity. Compare intake/body mass, intake-to-RMR ratio, and sports energy availability using held-out athletes where sample size allows.

Report error ranges for food intake and exercise expenditure. Sensitivity analyses should examine whether measurement error changes athlete rankings or inferred thresholds. Avoid interpreting group averages as individual safety boundaries. A negative or null incremental result would limit the rationale for EPK as a performance predictor.

Connection to EPK research

EPK–004 concerns functional capacity and is the principal connection. EPK–005 provides the relative-deficiency hypothesis; EPK–003 motivates separate assessment of substrate availability. This paper does not infer mitochondrial failure from a low intake/body-mass ratio or equate greater fat oxidation with superior performance.

Practical boundary

The proposed study observes normal sporting practice; it does not assign athletes to prolonged underfeeding. Any future intervention should be designed with sports nutrition expertise and independently reviewed. Repeated adequate fuelling is a research exposure to measure, not an outcome to presume.

References and publication record

[1] Mountjoy et al. (2023). IOC consensus statement on Relative Energy Deficiency in Sport.

[Open source](#)

[2] Energetics of a World-Tour Female Road Cyclist During a Multistage Race (Tour de France Femmes). (2024).

[Open source](#)

Publication and reuse

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