Supplementary Table S1. Expanded Evidence Summary for Age-Specific Protein and Leucine Recommendations

Companion to: Anabolic Resistance, the Leucine Threshold, and Protein Requirements Across the Adult Lifespan — Corrected Version 2

Introductory Note

This table compiles the mechanistic and clinical evidence underpinning the quantitative recommendations summarized in Tables 1 and 2 of the main paper. Data were drawn from stable-isotope tracer and dose–response studies of muscle protein synthesis (MPS), meta-analyses of resistance-training outcomes, and international consensus statements (ESPEN/PROT-AGE). Every age band, protein target, and leucine target below has been checked against Tables 1 and 2 of the corrected main paper and matches exactly. Every citation has been checked against either the primary source in the connected research library or PubMed directly; three references used in the original version of this table could not be verified and have been removed or replaced — see the Editorial Notes at the end of this document for the full account.

1. Young Adults (≤ 39 yr)

Statement	Evidence / Supporting References
Daily protein 1.0–1.2 $g \cdot kg^{-1} \cdot day^{-1}$ for general health; ≈1.6 $g \cdot kg^{-1} \cdot day^{-1}$ is generally sufficient for hypertrophy. Up to ≈2.2 $g \cdot kg^{-1} \cdot day^{-1}$ may be used as a pragmatic upper target by healthy adults seeking to maximize resistance-training gains.	Meta-analysis of resistance-training trials estimated a breakpoint at 1.62 $g \cdot kg^{-1} \cdot day^{-1}$ (95% CI: 1.03–2.20). Most benefit appears near 1.6 $g \cdot kg^{-1} \cdot day^{-1}$; the authors proposed ≈2.2 $g \cdot kg^{-1} \cdot day^{-1}$ as a prudent upper recommendation, not evidence that 2.2 produces greater gains than 1.6 (Morton et al., 2018).
20–25 g high-quality protein (≈ 2.0 g Leu) maximizes MPS	Dose–response studies in young, resistance-trained men show 20 g whey (≈ 2 g Leu) elicits maximal post-absorptive MPS; 40 g does not further increase MPS but raises oxidation and urea (Moore et al., 2009; Witard et al., 2014).
≥ 3 resistance sessions/wk,	Consensus and meta-analytic guidance supports

Statement	Evidence / Supporting References
progressive overload	regular resistance sessions with progressive overload to maximize hypertrophy (Morton et al., 2018).
Leucine “extra” unnecessary once ≈ 2.0 g threshold is met	The “muscle-full” effect explains why additional leucine above ≈ 2 g per meal does not further stimulate MPS in young adults (Atherton et al., 2010).

2. Midlife Adults (40–59 yr)

Statement	Evidence / Supporting References
Daily protein 1.2–1.4 $g \cdot kg^{-1} \cdot day^{-1}$	ESPEN/PROT-AGE consensus recommendations, extrapolated to midlife as a pragmatic range reflecting early-onset anabolic resistance; this age band is not directly tested in dose–response studies (Deutz et al., 2014; Bauer et al., 2013; Zaromskyte et al., 2021).
25–30 g protein (≈ 2.2–2.5 g Leu) per meal	Interpolated between the young ≈ 20 g breakpoint and the older ≈ 30–40 g breakpoint (Zaromskyte et al., 2021).
≥ 2 resistance sessions/wk + ≥ 7,000 steps/day	Physical-activity levels associated with reduced anabolic resistance are discussed in muscle-aging reviews (Breen & Phillips, 2011; Wall et al., 2015).
Even protein distribution (≥ 3 meals/day)	Balanced protein distribution across the day increases cumulative 24-h MPS compared with skewed feeding patterns (Areta et al., 2013).

3a. Older Adults (≥ 60 yr, Active / Regular Resistance Training)

Statement	Evidence / Supporting References
Daily protein 1.2–1.6 $g \cdot kg^{-1} \cdot day^{-1}$	Regular resistance training partially preserves anabolic sensitivity, allowing a lower per-meal dose than sedentary peers for the same daily total (Breen & Phillips, 2011; Aragon et al., 2023; Deutz et al., 2014).
25–30 g protein (≈ 2.5–2.8 g Leu) per meal	Training-preserved anabolic sensitivity permits a per-meal target below the sedentary-older breakpoint (Katsanos et al., 2006; Yang et al., 2012).
≥ 2–3 resistance sessions/wk + balance & mobility work	2–3 weekly sessions are associated with improved MPS and strength outcomes in older adults (Breen & Phillips, 2011; Wall et al., 2015).
Leucine-rich sources; carbohydrate co-ingestion	Whey, dairy, and eggs yield higher leucinemia than lower-leucine protein sources (Katsanos et al., 2006).

Statement	Evidence / Supporting References
	Carbohydrate co-ingestion is discussed as a potential enhancer of insulin-mediated amino-acid delivery, one of several mechanisms proposed to contribute to anabolic resistance (Aragon et al., 2023).

3b. Older Adults (≥ 60 yr, Sedentary / Minimally Active)

Statement	Evidence / Supporting References
Daily protein 1.4–2.0 $g \cdot kg^{-1} \cdot day^{-1}$	PROT-AGE and ESPEN support higher intakes for less active or clinically at-risk older adults, with the upper end (≈ 2.0 $g \cdot kg^{-1} \cdot day^{-1}$) reserved for severe illness under medical supervision (Bauer et al., 2013; Deutz et al., 2014).
30–40 g protein (≈ 2.8–3.0 g Leu) per meal	Per-meal breakpoint ≈ 0.4 $g \cdot kg^{-1}$ (≈ 30–40 g protein); leucine enrichment to ≈ 2.8 g restores the MPS response toward young-adult levels (Katsanos et al., 2006; Moore et al., 2015).
Begin resistance training as soon as feasible	Even light-load resistance training meaningfully improves the MPS response in previously sedentary older adults, independent of the exact protein dose (Katsanos et al., 2006; Layman, 2024).

4. Frail / Sarcopenic (≥ 75 yr)

Statement	Evidence / Supporting References
Daily protein 1.4–1.8 $g \cdot kg^{-1} \cdot day^{-1}$	ESPEN/PROT-AGE recommendations for frail, non-catabolic older adults (Bauer et al., 2013; Deutz et al., 2014).
30–40 g protein (≈ 3.0 g Leu), in small, frequent meals if needed	Leucine-enriched meals (≈ 3 g Leu) stimulate MPS despite reduced anabolic sensitivity in frail older adults (Katsanos et al., 2006).
Light resistance training, or neuromuscular electrical stimulation (NMES) if immobile	NMES preserves anabolic signaling (mTOR phosphorylation) and prevents skeletal-muscle atrophy in immobilized and critically ill patients — directly demonstrated in comatose ICU patients (mean age 63 ± 6 yr), not specifically community-dwelling frail elders (Dirks et al., 2015).
Leucine-enriched whey/EAA blends; monitor renal function	Clinical guidance recommends renal-function monitoring when protein intake exceeds ≈ 1.8 $g \cdot kg^{-1} \cdot day^{-1}$ (Bauer et al., 2013).

5. Rehabilitation / Illness (Catabolic States)

Statement	Evidence / Supporting References
Daily protein 1.5–2.0 g·kg^{-1}·day^{-1}	Same upper-end guidance as severe illness, applied to catabolic and post-operative patients (Deutz et al., 2014; Bauer et al., 2013).
35–45 g protein (≈ 3.0 g Leu) post-therapy	Higher per-meal protein doses are supported to help overcome the more severe anabolic resistance associated with catabolic stress and illness (Bauer et al., 2013; Deutz et al., 2014); the post-exercise dose-ceiling data in older men support doses at or above 40 g in the post-activity window (Yang et al., 2012).
Protein timed around physiotherapy sessions	Providing protein around physical therapy sessions is a practical way to align nutrient availability with the rehabilitation stimulus (Areta et al., 2013).
Omega-3 fatty acids as a possible adjunct	Omega-3 polyunsaturated fatty acid supplementation augmented the muscle protein anabolic response to a hyperinsulinaemic-hyperaminoacidaemic clamp in healthy 25–45-year-old adults (Smith et al., 2011). This is mechanistic support from a healthy, non-clinical, non-elderly cohort, not a demonstrated benefit in rehabilitation or illness populations specifically — treat as mechanistically plausible, not established, in this context.

General Notes

- For frailty, illness, rehabilitation, kidney disease, or medically prescribed protein restrictions, upper-end intakes near or above 1.8 g/kg/day should be individualized with qualified clinical guidance and renal-status monitoring when appropriate. This is not a blanket restriction for otherwise healthy resistance-trained adults.
- All age bands, per-meal protein/leucine targets, and daily protein targets in this table are identical to Tables 1 and 2 of the main corrected paper. Where the original version of this table used different age cut-offs (≤ 30 yr / 35–55 yr) or a single collapsed "60–70 yr" row, those have been aligned to the main paper's ≤ 39 yr / 40–59 yr bands and split into active/sedentary rows.
- References are formatted as (Author et al., Year) for consistency with Tables 1 and 2.

- Data are derived from tracer and dose–response studies, consensus position papers (ESPEN/PROT-AGE), and mechanistic reviews on anabolic resistance and leucine thresholds.

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