Progressive loading of the Achilles tendon

Based on: Baxter et al. (2021). Med. Sci. Sports Exerc., 53(1), 124–130.

Background

Baxter et al. (2021) calculated a "loading index" for each exercise based on peak load, load impulse and loading rate (see page 2 for an explanation). This results in 4 levels for safe, progressive loading of the Achilles tendon.

Exercise	Index	Peak	Clinical note
LEVEL 1 – Lowest load – Loading Index < 0.25			
Seated calf raise (double-leg)	0.10	0.5 BW	Entry phase; also post-operative
Seated calf raise (single-leg)	0.13	0.7 BW	Add weight on the thigh
Squat (both legs)	0.17	1.1 BW	Slow, neutral foot position
Step-up low – leading leg	0.21	1.6 BW	Box 12 cm
Step-up high – leading leg	0.24	1.8 BW	Box 20 cm
Standing calf raise (double-leg)	0.25	1.6 BW	Foundation of load progression
LEVEL 2 – Moderate load – Loading Index 0.25–0.50			
Rebounding calf raises (double-leg)	0.28	2.5 BW	Rebound effect, faster tempo
Lunge – front leg	0.29	2.1 BW	Front leg: less load
Step-down low – front leg	0.31	2.2 BW	Eccentric component
Walking (stance phase)	0.36	3.3 BW	Clinical recovery milestone
Forward jump (double-leg)	0.41	3.2 BW	First dynamic loading
Standing calf raise (single-leg)	0.49	3.0 BW	Eccentric control
LEVEL 3 – High load – Loading Index 0.50–0.75			
Drop jump (double-leg)	0.52	3.6 BW	Reactive strength
Hopping (double-leg)	0.56	4.8 BW	High loading rate
Running (stance phase)	0.60	5.2 BW	Return-to-run milestone
CMJ – single-leg	0.71	4.9 BW	Countermovement jump
Forward jump (single-leg)	0.74	5.4 BW	Eccentric landing phase
LEVEL 4 – Maximum load – Loading Index > 0.75			
Single-leg hopping	0.76	6.7 BW	Return-to-sport threshold
Drop jump (single-leg)	0.85	5.5 BW	High load impulse
Lateral hopping (single-leg)	0.90	7.3 BW	Highest loading rate
Forward hopping (single-leg)	0.92	7.3 BW	Maximum peak load

Isolated ankle movement

Level 1: Seated calf raise
Level 2: Standing calf raise (single-leg)
Level 3: Double-leg hopping
Level 4: Single-leg forward hopping

Multi-joint movement

Level 1: Squat
Level 2: Step-up / step-down
Level 3: Single-leg CMJ
Level 4: Single-leg drop jump

Source: Baxter et al. (2021). BW = body weight.

What is the Loading Index?

Background & explanation of the Achilles tendon exercise progression

Definition

The loading index quantifies the total load on the Achilles tendon during an exercise. It was developed by Baxter et al. (2021) using 3D motion analysis in healthy adults. The index ranges from 0 (no load) to 1 (maximum measured load).

Formula

Loading Index = 0.50 × Peak load + 0.30 × Load impulse + 0.20 × Loading rate

Each parameter is normalised to the maximum value across all tested exercises. The weightings (50/30/20%) are based on the clinical expertise of the authors.

Peak load

Weight: 50%

Maximum force on the Achilles tendon, expressed in body weights (BW). Seated heel raise ≈ 0.5 BW; forward hopping (single-leg) ≈ 7.3 BW. High peak loads increase the risk of (re-)rupture in vulnerable tendons.

Load impulse

Weight: 30%

Cumulative load over the full duration of the movement (BW × seconds). Relevant for tendon remodelling in tendinopathy. The back leg in a lunge has a higher impulse than the front leg because of longer contact time.

Loading rate

Weight: 20%

The speed at which force builds up on the tendon (BW per second). Hopping movements: >60 BW/s vs. slow heel raises: <4 BW/s. Relevant after rupture: too high a rate increases the risk of re-rupture.

Clinical interpretation per level

Level 1 (< 0.25) – Initial phase. Minimal stress on the tendon. Suitable directly post-operatively or in acute tendinopathy.

Level 2 (0.25–0.50) – Build-up phase. Load comparable to walking (0.36). The tendon starts to adapt to greater forces.

Level 3 (0.50–0.75) – Advanced rehabilitation. Return-to-run milestone (0.60). High loading rates require adequate tendon quality.

Level 4 (> 0.75) – Return-to-sport phase. Maximum peak loads (7.3 BW). Only with fully recovered tendon tissue.

Important note

The data are based on healthy adults. In patients with Achilles tendon pathology, the load per exercise may differ. Always adjust the progression based on the pain response (NRS) and the clinical picture.