The Proco Performance Research Brief

What ten performance interventions actually do, ranked by measured effect size

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What this is. This brief describes what published research has measured about ten widely-studied performance interventions. It ranks them by the size of effects observed in clinical trials and meta-analyses, and notes where the evidence is strong, where it's mixed, and where popular claims outrun the science.

What this isn't. This is not training prescription. It does not tell you which interventions to do, in what order, or at what doses. Personal application depends on your training history, age, health status, goals, and context — variables we cannot address in a general document.

Before significantly changing your training, consult a qualified clinician or sports medicine professional, particularly if you are over 60, have a cardiovascular condition, are pregnant, are previously sedentary, or have any chronic health issue.

How to read this brief

We've ranked ten interventions by the consistency and magnitude of effects reported in the published literature, not by their popularity in fitness media. Some interventions you may have heard a lot about have small or inconsistent measured effects. Some interventions you may have heard less about have very large measured effects.

For each intervention, we describe:

- **What the research measured** — the actual endpoints studied
- **Magnitude** — qualitative size of effect ("large", "moderate", "small", "mixed")
- **Population studied** — who the research was done in
- **Caveats** — limits, contradictions, and where popular framing overruns the data
- **Key citations** — anchor references for further reading

The effect-size ranking that follows is our editorial judgment based on the available literature. Other thoughtful readers of the same evidence may rank these differently. The point is to give you a calibrated sense of where the strongest signals are.

The effect-size ranking

Rank	Intervention	Measured effect size	Evidence strength
1	Resistance training (2-4×/week)	**Large**	Very strong
2	Adequate sleep (7-9h)	**Large**	Very strong
3	Zone 2 endurance training (sustained low intensity)	**Large** for endurance adaptations	Very strong
4	Adequate protein intake (1.6-2.2 g/kg/day for trained populations)	**Moderate-to-large** for muscle protein synthesis	Strong
5	Polarised training distribution (~80/20 low/high)	**Moderate-to-large** for endurance performance	Strong (elite literature)
6	HIIT (2-3×/week, structured)	**Moderate** for VO2 max gains	Strong
7	Sauna / heat exposure (regular use)	**Moderate** for cardiovascular adaptations	Moderate
8	Planned recovery / deload weeks	**Moderate** for sustaining adaptations	Moderate
9	HRV monitoring for recovery guidance	**Small-to-moderate** when implemented well	Mixed
10	Cold water immersion (post-exercise)	**Mixed** — depends on goal	Mixed

The interventions ranked 1-5 are the foundation of essentially every successful training program in the published literature for almost every performance goal. Interventions 6-8 are highly useful additions when applied in context. Interventions 9-10 are tools that work for some goals and may actively work against others — context matters.

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1. Resistance training (2-4 sessions per week)

What the research measured. The effects of structured resistance training on strength, hypertrophy, body composition, bone mineral density, metabolic health, functional capacity, and all-cause mortality have been measured across hundreds of trials spanning recreational adults, athletes, and clinical populations.

Magnitude. Large. Resistance training has among the largest effect sizes of any intervention in the entire human-performance literature. A 2017 meta-analysis of 38 studies in untrained adults found average strength increases of 35-50% after 8-26 weeks of supervised resistance training [Schoenfeld et al. 2017]. Mortality reductions associated with resistance training appear in the range of 15-30% over follow-up periods of 5-15 years in observational cohorts [Saeidifard et al. 2019].

Population studied. Extensively studied across age groups (children to centenarians), sexes, and clinical contexts. Effects appear in essentially every population studied, though magnitude varies.

Caveats. "Resistance training" includes a wide range of programs. Frequency, volume, intensity, and exercise selection all matter, but the *dose-response curve* shows most of the benefit from getting started and continuing consistently. Two sessions per week of compound movements produces 80%+ of the effect of more elaborate programs in most populations [Schoenfeld et al. 2016].

Key citations.

- Schoenfeld BJ et al. *Sports Medicine* 2017
- Saeidifard F et al. *European Journal of Preventive Cardiology* 2019
- Westcott WL. *Current Sports Medicine Reports* 2012 (resistance training is medicine)

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2. Adequate sleep (7-9 hours per night)

What the research measured. The effects of sleep duration and quality on athletic performance, cognitive performance, recovery markers, hormonal profiles, injury risk, and training adaptations have been measured in athletes, military populations, and the general public.

Magnitude. Large. Sleep restriction studies in athletes have repeatedly demonstrated that 4-6 hours of sleep per night for as little as one week produces measurable decrements in reaction time, sprint performance, accuracy in skill tasks, and self-reported fatigue [Reilly & Edwards 2007; Mah et al. 2011]. Sleep *extension* studies in athletes have shown measurable performance improvements when habitual sleep is increased toward 9-10 hours.

Population studied. Athletes (collegiate, professional, Olympic), military populations, and recreational adults.

Caveats. The effect of sleep on performance is sometimes described in popular content as "the single most important factor" — that framing overruns the evidence somewhat. Resistance training and Zone 2 cardio have comparable effect sizes for their specific endpoints. Sleep is foundational because deficits *prevent* the other interventions from working, not because it produces unique adaptations on its own. We covered sleep architecture in detail at <u>/sleep/sleep-stages-explained</u>.

Key citations.

- Reilly T, Edwards B. *Physiology & Behavior* 2007
- Mah CD et al. *Sleep* 2011
- Walker MP. *Why We Sleep* 2017 (popular synthesis; treat with the nuance any synthesis requires)

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3. Zone 2 endurance training

What the research measured. The effects of sustained low-intensity aerobic training on mitochondrial biogenesis, fat oxidation capacity, capillary density, lactate threshold, and endurance performance have been measured across endurance athletes and recreational populations.

Magnitude. Large for endurance-specific adaptations. The mitochondrial density of trained endurance athletes is 2-3× that of untrained controls [Holloszy 1967 and decades of follow-up]. Lactate threshold improvements of 10-30% are routinely reported in 12-week training studies.

Population studied. Elite endurance athletes (cycling, running, cross-country skiing, rowing) and recreational adults.

Caveats. "Zone 2" has become a fashionable framing in consumer fitness, sometimes carrying claims (especially around longevity) that the evidence doesn't directly support. The endurance-physiology benefits are very real. The "Zone 2 is the secret to longevity" framing is weaker — general aerobic fitness, however acquired, is what associates with longevity outcomes. We covered this in detail at /performance/zone-2-training.

Key citations.

- Holloszy JO. *Journal of Biological Chemistry* 1967
- San-Millán I, Brooks GA. *Sports Medicine* 2018
- Seiler S. *International Journal of Sports Physiology and Performance* 2010

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4. Adequate protein intake (for trained populations)

What the research measured. The effects of total daily protein intake on muscle protein synthesis, hypertrophy, strength gains, body composition, and recovery have been measured extensively in resistance-trained and endurance-trained populations.

Magnitude. Moderate-to-large for muscle protein synthesis in trained populations consuming below the optimal range. A 2018 meta-analysis of 49 studies found that protein supplementation above habitual intake produced measurable improvements in strength (~9%) and muscle mass (~0.3 kg over 12 weeks) when total daily intake reached 1.6-2.2 g/kg/day in resistance-trained individuals [Morton et al. 2018].

Population studied. Primarily resistance-trained men aged 18-50; less data in older adults, women, and endurance populations (though emerging research is filling these gaps).

Caveats. The marketing around protein is far more confident than the evidence supports. For sedentary adults, the recommended dietary allowance of 0.8 g/kg/day appears adequate for most outcomes. The 1.6-2.2 g/kg/day range applies to people doing meaningful resistance training and trying to maximize hypertrophy or strength. Protein *quality* (essential amino acid content, leucine in particular) matters, but "complete protein" obsession in food choice is largely unwarranted in mixed-diet eaters.

Key citations.

- Morton RW et al. *British Journal of Sports Medicine* 2018
- Phillips SM. *Nutrition Reviews* 2016
- Helms ER et al. *Journal of the International Society of Sports Nutrition* 2014

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5. Polarised training distribution (~80/20)

What the research measured. The effects of training intensity *distribution* — what proportion of total training time is spent at low, moderate, and high intensities — on endurance performance outcomes have been measured across elite endurance athletes.

Magnitude. Moderate-to-large for endurance performance. Studies comparing "polarised" (~80% low intensity, ~20% high intensity, minimal moderate) against "threshold" (more moderate-intensity work) training have consistently favoured the polarised model for elite endurance outcomes [Stöggl & Sperlich 2014; Esteve-Lanao et al. 2007].

Population studied. Elite endurance athletes — cyclists, runners, cross-country skiers, rowers. Recreational athletes less well studied.

Caveats. The polarised model is most strongly supported for *elite* endurance athletes training 10+ hours per week. For recreational athletes with limited weekly training time, the optimal intensity distribution may differ. The 80/20 ratio is a useful framing but not a magic number; coaches typically adjust based on the athlete's phase of training, race calendar, and recovery capacity.

Key citations.

- Stöggl T, Sperlich B. *Frontiers in Physiology* 2014
- Esteve-Lanao J et al. *Journal of Strength and Conditioning Research* 2007
- Seiler S. *International Journal of Sports Physiology and Performance* 2010

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6. HIIT (High-Intensity Interval Training)

What the research measured. The effects of structured high-intensity interval training (typically 30 seconds to 4 minutes at near-maximal effort, with recovery intervals) on VO2 max, lactate threshold, insulin sensitivity, body composition, and time-efficient fitness gains have been measured across hundreds of studies in athletic, recreational, and clinical populations.

Magnitude. Moderate for VO2 max gains, often comparable to longer steady-state training despite requiring less total time. Meta-analyses report VO2 max improvements of 6-15% over 6-12 weeks of structured HIIT in previously untrained adults [Bacon et al. 2013; Milanovi■ et al. 2015].

Population studied. Recreational adults, athletes, and clinical populations including type 2 diabetes, cardiovascular disease patients, and obese individuals.

Caveats. HIIT vs. steady-state cardio is frequently framed as a "which is better" question. The honest answer is "both work; what matters is consistency." HIIT has particular value for time-constrained recreational populations and as a complement to Zone 2 work in trained athletes. It is not categorically superior to sustained low-intensity training for endurance performance, and very high-intensity work has injury and overtraining risks if applied without adequate base. We covered the comparison in detail at /performance/hiit-vs-steady-state.

Key citations.

- Bacon AP et al. *PLoS One* 2013
- Milanovi■ Z et al. *Sports Medicine* 2015
- MacInnis MJ, Gibala MJ. *Journal of Physiology* 2017

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7. Sauna / heat exposure (regular use)

What the research measured. The effects of regular sauna use (typically Finnish-style dry sauna at 80-100°C, 15-30 minute sessions, multiple times per week) on cardiovascular adaptations, all-cause mortality, blood pressure, and endurance performance markers have been measured across cohort studies and smaller intervention trials.

Magnitude. Moderate for cardiovascular outcomes. The most-cited evidence comes from the Kuopio Ischemic Heart Disease cohort in Finland, where men using sauna 4-7 times per week had 40% lower all-cause mortality and 50% lower cardiovascular mortality compared with once-per-week users, over 20 years of follow-up [Laukkanen et al. 2015].

Population studied. Primarily Finnish adults (where regular sauna use is culturally standard), with some intervention studies in athletes.

Caveats. The mortality associations are striking but observational — Finnish sauna users may differ from non-users in many other ways. Causal claims should be tempered. Sauna use in athletes has shown modest benefits for endurance performance via heat acclimatization (plasma volume expansion), but these are smaller effects than the cardiovascular cohort data might suggest. Sauna use is generally safe for healthy adults but carries risks for people with significant cardiovascular disease, pregnancy, or who are dehydrated.

Key citations.

- Laukkanen T et al. *JAMA Internal Medicine* 2015
- Patrick RP, Johnson TL. *Experimental Gerontology* 2021 (review)
- Scoon GS et al. *Journal of Science and Medicine in Sport* 2007 (athletes)

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8. Planned recovery / deload weeks

What the research measured. The effects of structured recovery periods — reduced training volume or intensity for 5-14 days — on subsequent training adaptations, injury rates, overtraining markers, and performance peaks have been measured primarily in trained athletes.

Magnitude. Moderate for sustaining long-term adaptations. The classical periodisation literature consistently shows that athletes who include planned recovery periods accumulate more training volume over the course of a year, suffer fewer overuse injuries, and produce higher peak performances [Issurin 2010].

Population studied. Endurance athletes, strength athletes, and team-sport athletes; less studied in recreational populations.

Caveats. Deload weeks are a tool for *trained* populations operating near their recovery capacity. For recreational athletes training 2-4 hours per week, structured deload weeks may matter less; consistency over time matters more. The popular framing that "everyone needs deload weeks" is mostly drawn from elite training literature and doesn't necessarily apply to most recreational adults.

Key citations.

- Issurin VB. *Sports Medicine* 2010
- Bompa T, Haff G. *Periodization: Theory and Methodology of Training* 2009
- Pyne DB et al. *International Journal of Sports Physiology and Performance* 2009

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9. HRV (Heart Rate Variability) monitoring for recovery guidance

What the research measured. The effects of using daily HRV monitoring (typically via chest strap or photoplethysmography) to guide training intensity decisions have been measured in trained populations across endurance and team-sport contexts.

Magnitude. Small-to-moderate when implemented well. Intervention studies of HRV-guided training have shown modest improvements in performance (~5-10% in some endurance metrics) compared with traditional pre-planned periodisation [Vesterinen et al. 2016; Javaloyes et al. 2019]. The signal is real but smaller than popular framing suggests.

Population studied. Endurance-trained adults; some research in team-sport athletes.

Caveats. HRV is a real physiological signal, not a wellness placebo. But it is also noisy, sensitive to short-term factors (sleep, alcohol, hydration), and most useful when interpreted as a 7-day trend rather than a daily readout. Consumer wearables produce HRV estimates that vary substantially in accuracy. The framing in popular health content that "HRV tells you whether to train today" overruns the evidence — HRV is one input among many, not a daily verdict. We covered this in detail at <u>/performance/what-is-hrv</u>.

Key citations.

- Vesterinen V et al. *Scandinavian Journal of Medicine & Science in Sports* 2016
- Javaloyes A et al. *International Journal of Sports Physiology and Performance* 2019
- Buchheit M. *Frontiers in Physiology* 2014

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10. Cold water immersion (post-exercise)

What the research measured. The effects of post-exercise cold water immersion (typically 10-15 minutes at 10-15°C) on perceived recovery, muscle soreness, inflammatory markers, and subsequent training adaptations have been measured in trained populations.

Magnitude. Mixed — and direction-dependent. For *acute recovery* between competitions or hard sessions in a tournament context, cold water immersion produces modest reductions in soreness and perceived fatigue. For *long-term resistance training adaptations*, multiple studies have now shown that regular post-exercise cold water immersion *blunts* hypertrophy and strength gains by interfering with the inflammatory signalling required for muscle growth [Roberts et al. 2015; Fyfe et al. 2019].

Population studied. Athletes across multiple sports, recreationally trained adults.

Caveats. This is the clearest case where popular framing has outrun the evidence. "Ice baths are good for recovery" is *partially* true for acute recovery during competition. The same intervention applied regularly after strength-training sessions appears to actively reduce the gains being trained for. The honest summary: cold exposure has a role in some contexts (acute recovery, possible mental-health benefits, possible heat-adaptation reversal) but should not be applied indiscriminately after every session.

Key citations.

- Roberts LA et al. *Journal of Physiology* 2015
- Fyfe JJ et al. *Sports Medicine* 2019
- Bleakley CM et al. *Cochrane Database of Systematic Reviews* 2012

What the rankings tell you

Several patterns emerge from looking at these ten interventions together:

The largest effects are produced by the things people already know about. Resistance training, sleep, and Zone 2 cardio are not novel insights. They are also the interventions with the largest measured effects and the strongest evidence bases. Most performance-related anxiety and supplement-shopping happens in the domain of the *small effects*, while the *large effects* sit in plain view.

Consistency dominates optimisation. For all ten interventions, the dose-response curve is steepest in the early stages. Showing up consistently for 80% of the value matters more than fine-tuning for the last 20%. Most recreational athletes would benefit more from training twice a week, every week, for two years than from a perfectly periodised program they abandon after three months.

Popular framing often overstates novel interventions. Sauna, HRV-guided training, and cold exposure all have real evidence behind them, but the popular framing typically extrapolates well beyond what the trials actually showed. A useful exercise: when you encounter a confident claim about any performance intervention, ask "what was the actual measured effect size, and in whom was it measured?"

Some interventions work *against* each other. The cold-immersion-blunts-hypertrophy finding is a clean example: two interventions that both "sound healthy" interact in ways the marketing doesn't surface. Personal application requires sequencing decisions that depend on your actual goals.

What this brief deliberately doesn't cover

We've kept this brief to ten well-studied interventions where the evidence base is substantial. Several popular topics aren't included, and we want to be transparent about why:

- **Specific supplements** (creatine, beta-alanine, citrulline, etc.) — supplements are Scanner's domain. We treat them with their own rigour in our editorial coverage rather than ranking them next to fundamental training variables.
- **Specific diets for performance** (keto, carnivore, intermittent fasting) — these warrant their own brief. The nutrition hub at procohq.com/nutrition covers the underlying research.
- **Mental skills training** (visualisation, meditation, etc.) — substantial literature, but a different topic.
- **Specific protocols by sport** — running training, cycling training, lifting programs each have their own substantial bodies of literature.

Where to go next

If you want to read more on the research behind these interventions, our editorial coverage at procohq.com is research-voice and citation-dense:

- **Sleep:** How much sleep do you actually need · Sleep stages explained
- **Zone 2:** Zone 2 training research
- **HIIT:** HIIT vs steady-state cardio
- **VO2 max:** VO2 max — lab tests vs watch estimates
- **HRV:** What is HRV — heart rate variability explained
- **Recovery:** What "recovery" means in performance research

For supplements specifically, the **Proco Scanner** app (coming to iOS) reads any supplement label and surfaces what the published research describes for each ingredient. Join the waitlist at procohq.com.

Compliance note

This brief is educational. It describes what published research has measured about ten performance interventions. It is not training prescription, medical advice, or a substitute for individualised professional guidance.

Before significantly changing your training regimen — particularly if you are over 60, have a cardiovascular condition, are pregnant, have been previously sedentary, or have any chronic health issue — consult a qualified clinician or sports medicine professional.

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— The Proco editorial team Dublin, Ireland June 2026