

OMEGA-6 : OMEGA-3

THE BALANCE THAT DEFINES YOUR CLIENTS' RESULTS

Recovery • Joints • Hypertrophy • Body Composition • Performance

Presentation for Personal Trainers and Gym Managers
Based on Scientific Evidence

WHAT IS THE OMEGA-6 : OMEGA-3 RATIO?

OMEGA-6 (Linoleic Acid)

Arachidonic Acid (AA)

- Prostaglandins series 2 (PGE₂)
- Leukotrienes series 4 (LTB₄)
- Thromboxanes (TXA₂)

Functions:

Pro-inflammatory, vasoconstriction, platelet aggregation, pain amplification

Sources:

Vegetable oils (sunflower, soy, corn), processed foods, fast food

OMEGA-3 (EPA + DHA)

EPA and DHA

- Resolvins (RvD1, RvE1)
- Protectins (PD1)
- Maresins

Functions:

Anti-inflammatory, vasodilation, active resolution of inflammation, neuroprotection

Sources:

Fatty fish (salmon, sardines), fish oil, quality supplementation

They compete for the same enzymes (COX and LOX) — the ratio between them determines the body's inflammatory profile.

EVOLUTION OF THE OMEGA-6:3 RATIO IN THE HUMAN DIET

Paleolithic

1:1

Balanced diet
Fish, game, fruits

Early 20th C.

4:1

Start of food
industrialization

1960s-1980s

10:1

Mass refined
vegetable oils

Today

15-20:1

Fast food, processed
Western diet

WHAT CHANGED?

The food industrial revolution replaced ancestral balance with massive excess of omega-6 (sunflower, soy, corn oils) and omega-3 scarcity. The result: a chronically inflamed body — with direct impact on muscle recovery, joint health and body composition for those who train.

THE EXERCISE INFLAMMATION PARADOX

Training generates inflammation. That's necessary. But the client's biochemical environment defines whether that inflammation BUILDS or DESTROYS.

CONTROLLED INFLAMMATION

- ✓ Signaling for muscle repair
- ✓ Satellite cell activation
- ✓ Collagen synthesis in tendons
- ✓ Rapid resolution → adaptation
- ✓ Hypertrophy and strength gains

CHRONIC INFLAMMATION

- ✗ Continuous degradation (elevated MMPs)
- ✗ Prolonged and excessive DOMS
- ✗ Articular collagen destruction
- ✗ mTOR pathway blocked → catabolism
- ✗ Overtraining and repetitive injuries

The omega-6:3 ratio is the switch between these two scenarios.

HIGH RATIO ($\geq 15:1$) — IMPACT ON JOINTS

Cartilage Degradation

Excess omega-6 elevates MMP-13 and IL-1 β in chondrocytes — enzymes that degrade articular cartilage. Studies show linoleic acid is the only fatty acid producing pro-inflammatory response in chondrocytes (PGE₂ via TNF- α).

Synovitis and Joint Pain

High omega-6 levels are associated with knee synovitis (MOST study). People with higher n-6:n-3 blood ratio show more pain, worse joint function and greater psychological distress (Sibille et al. 2018).

22:1

Western diet vs. 1.5:1

In an animal model, the Western diet (22:1) accelerated osteoarthritis progression, while an omega-3-rich diet (1.5:1) significantly reduced disease progression ($p=0.048$), achieving histological profiles similar to OA-resistant animals.

HIGH RATIO ($\geq 15:1$) — POST-TRAINING RECOVERY

Intense Training
(eccentric, HIIT, weight training)

Muscle Damage (EIMD)
Membrane rupture, CK and Myoglobin release

With ratio $\geq 15:1$ → AA excess → PGE₂ and LTB₄
NF- κ B hyperactivated → TNF- α , IL-6, IL-1 β in excess

Prolonged DOMS (72-96h+) • Persistent elevated CK

Result: The client takes longer to recover, trains in pain, performs worse in the next session and accumulates fatigue — entering a cycle of overtraining and dropout.

HIGH RATIO ($\geq 15:1$) — IMPACT ON HYPERTROPHY

Molecular Mechanisms

Chronic inflammation → Anabolic resistance:

1. Activated NF- κ B suppresses mTORC1-p70S6K — the main regulator of muscle protein synthesis (MPS)
2. Elevated TNF- α activates catabolic pathways (FoxO3, MAFbx/MuRF1) → protein degradation
3. Excess ROS damage muscle membranes and mitochondria
4. Reduced sensitivity to anabolic stimuli (amino acids + insulin) post-meal

Practical Consequences

For the client who wants to gain mass:

- Lower response to training stimulus
- Muscle protein loss between sessions
- Even with perfect diet and training, results fall below potential
- Unexplainable gains plateau
- Frustration → program abandonment

HIGH RATIO ($\geq 15:1$) — BODY COMPOSITION

How a High Ratio Harms Body Composition

Chronic inflammation → Insulin resistance: Muscle cells become less sensitive to insulin, impairing glucose and amino acid uptake. GLUT-4 is less expressed, and fat is preferentially stored instead of oxidized.

Adipokine dysregulation: Inflammation in adipose tissue alters leptin and adiponectin — increasing appetite, reducing satiety and favouring visceral fat storage. Associated with metabolic syndrome (5x more OA risk).

↓ Fat
Oxidation

↑ Visceral
Fat

↓ Insulin
Sensitivity

↓ Lean
Mass

HIGH RATIO ($\geq 15:1$) — TENDONS AND INJURY RISK

The Elevated Ratio and Tendons

Pathological mechanism in tendons:

When large amounts of omega-6 are consumed at the expense of omega-3, the inflammatory response in tendons becomes much more potent and painful (Belch & Wood, 2000). Excess arachidonic acid stimulates pro-inflammatory eicosanoid production via COX/LOX, perpetuating the tendinopathy cycle.

Pre-clinical data:

In an Achilles tendinopathy model (collagenase type-1), the combination of omega-3 + aerobic exercise produced: significantly better cell and collagen arrangement, more uniform fibre alignment, increased type I collagen expression, reduction of MMP-3, MMP-9, TNF- α and IL-1 β , and better biomechanical tensile resistance.

Clinical trial in recreational athletes:

Essential fatty acid (n-3) supplementation combined with physiotherapy significantly improved chronic tendinopathy condition vs. placebo + physiotherapy (Jensen et al. Phys Ther Sport 2004).

WHAT IF WE REDUCE THE RATIO?

FROM $\geq 15:1$ TO $\leq 3:1$

Scientific data shows impact in 5 critical areas for those who train:

**Muscle
Recovery**

**Joint
Health**

**Protein
Synthesis**

**Body
Composition**

**Cardiovascular
Performance**

RATIO $\leq 3:1$ — ACCELERATED MUSCLE RECOVERY

2024 Meta-analysis

Omega-3 supplementation significantly reduced IL-6, TNF- α and CRP after exercise-induced muscle damage. Conclusion: omega-3 is a priority recovery agent.

Rahimi et al. ScienceDirect 2024

Reduced DOMS

4 weeks of 3g/day of n-3 significantly reduced DOMS at 24h post-exercise ($p=0.034$, $r=0.56$) and prevented IL-6 elevation in the supplemented group vs. placebo.

JISSN 2021 (Springer)

HIIT + Omega-3

After 4 weeks, omega-3 index rose 52.5%. Supplemented group: CK normalized at 48h (vs. elevated in control), less calf pain and faster strength recovery.

PubMed 38841630 (2024)

Optimal Dose

6g/day of fish oil (4200mg EPA+DHA) was the most effective dose for attenuating perceived pain and muscle damage markers in trained athletes, assessed up to 72h post-exercise.

ATH Sports Science 2023

RATIO $\leq 3:1$ — JOINT PROTECTION AND CHONDROPROTECTION

In Vitro and Animal Evidence

Human chondrocytes cultured at low n-6:n-3 ratio (1:1 to 2:1):

- Reduction of MMP-13 (collagen degradation enzyme)
- Reduction of IL-1 (key pro-inflammatory cytokine)
- Protection against cartilage damage

DHA protects against cartilage degradation after ligament injury (ACL) and may delay OA progression.

DHA inhibited RANKL (osteoclast formation mediator) — protecting bone and joint.

Clinical Evidence

Rheumatoid Arthritis:

Analysis of 70 studies: fish oil significantly reduced disease activity, pain and morning stiffness. Doses $>2.6\text{g/day}$ lowered inflammatory biomarkers (CRP, ESR). Remission achieved earlier.

Osteoarthritis:

2g/day of omega-3 for 24 weeks reduced joint space narrowing vs. placebo. Meta-analysis (6 RCTs, 454 patients): omega-3 is effective and safe for synovial OA pain relief.

Ideal ratio: $\leq 4:1$ for articular anti-inflammatory effect (Simopoulos 2008).

RATIO $\leq 3:1$ — PROTEIN SYNTHESIS AND mTOR PATHWAY

+30-
60%

Increase in Muscle Protein Synthesis (MPS) in response to anabolic stimuli
Smith et al. (2011): 8 weeks of 4g/day of omega-3 increased MPS stimulated by amino acids + insulin by 30-60% — with increased phosphorylation of mTORSer2448 and p70S6K1Thr389 ($p < 0.01$).

Membrane Incorporation

EPA/DHA incorporate into the muscle phospholipid membrane, modifying fluidity and activating anabolic signaling cascades.

Anti-Catabolism

Restoration of the Akt/mTOR/FoxO3 pathway — reduces muscle proteolysis and attenuates mass loss during immobilization (-6% in placebo vs. no change in n-3 group).

mTORC1 Activation

Omega-3 activates mTOR-p70S6K-4E-BP1, the main regulator of protein translation and muscle cell growth.

Anabolic Sensitization

Potentiates MPS response to ingested protein — whey protein works better in an omega-3-rich environment.

RATIO $\leq 3:1$ — CARDIOVASCULAR PERFORMANCE AND ENDURANCE

↑ **VO₂max**

Significant improvement in maximal oxygen consumption in trained cyclists after 3 weeks of supplementation (2.6g/day)

↓ **HR**

Reduction of submaximal heart rate — the heart works more efficiently during exercise. Lower O₂ consumption for the same load.

↑ **NO**

Increase in basal nitric oxide (+44%) — better vasodilation, muscular blood flow and nutrient/oxygen delivery.

↑ **FMD**

5.25% improvement in flow-mediated dilation — optimized endothelial function. Positive correlation with Δ VO₂max (r=0.68).

RATIO $\leq 3:1$ — OPTIMIZED BODY COMPOSITION

Abdominal Fat

Supplementation with 1020mg/day of omega-3 for 12 weeks, combined with a weight-loss diet, significantly reduced abdominal fat mass and percentage vs. control ($p \leq 0.05$). The effect is on fat redistribution, not just the scale.

Lean Mass Preservation

Krill oil supplementation during weight loss: supplemented group did not lose lean mass (-0.2kg) nor grip strength. Placebo group lost -1.2kg lean mass and -0.9kg strength ($p < 0.05$). Omega-3 preserves muscle while losing fat.

Mechanisms

- PPAR α activation: increases lipid β -oxidation (fat burning in mitochondria)
- AMPK activation: promotes lipid oxidation and insulin sensitivity
- Adipokine modulation: normalizes leptin and adiponectin → better appetite regulation
- Reduced inflammation in adipose tissue → lower insulin resistance → better nutrient partitioning

DIRECT COMPARISON: HIGH RATIO vs. LOW RATIO

| AREA | RATIO ≥15:1 | RATIO ≤3:1 |
|------------------|--|---|
| Recovery (DOMS) | Prolonged DOMS 72-96h+ Persistently elevated CK | Reduced DOMS 24-48h CK normalizes faster |
| Joints | Cartilage degradation (MMP-13↑) Synovitis, joint pain | Chondroprotection (MMP-13↓) Less pain, better function |
| Hypertrophy | Reduced MPS, mTOR blocked Anabolic resistance | MPS +30-60%, mTOR activated Anabolic sensitization |
| Body Composition | Insulin resistance Visceral accumulation | Better nutrient partitioning Lean mass preservation |
| Performance | Systemic inflammation Slow recovery | VO ₂ max↑, submaxHR↓ NO↑, endothelial function↑ |
| Tendons | Chronic tendinopathy Repetitive injuries | Type I collagen↑ Accelerated healing |

OFFICIAL POSITION: ISSN 2024

International Society of Sports Nutrition — Position Stand on Long-Chain Omega-3 PUFAs

Athletes may have elevated risk of omega-3 insufficiency.

Omega-3-rich diets, including supplements, are effective strategies to increase levels.

EPA and DHA supplementation has been shown to improve endurance capacity and cardiovascular function during aerobic exercise.

Consistent effects were reported on reaction time, mood, cardiovascular dynamics, skeletal muscle recovery, TNF- α and post-exercise NO responses.

An Omega-3 Index $\geq 8\%$ is recommended for athletes — most are far below (average 4.33% in university athletes).

Doses of 1.5-3g/day of EPA+DHA are suggested, being safe up to 5g/day.

SCIENTIFIC REFERENCES

1. Simopoulos AP. *Nutrients* 2016;8(3):128
2. Simopoulos AP. *Biomed Pharmacother* 2002;56(8):365-379
3. Simopoulos AP. *Exp Biol Med* 2008;233(6):674-88
4. Smith GI et al. *Am J Clin Nutr* 2011 (PMC3021432)
5. McGlory C et al. *Front Nutr* 2019
6. Rahimi MH et al. *ScienceDirect* 2024
7. *JISSN* 2021 (Springer)
8. *PubMed* 38841630 (2024)
9. *PMC9413343 Nutrients* 2022
10. Sibille KT et al. *Clin J Pain* 2018;34(2):182-189
11. *PMC11174396 Nutrients* 2024
12. Zebrowska et al. *Eur J Sport Sci* 2015
13. *PMC7760705 Nutrients* 2020
14. *ISSN Position Stand* 2024
15. Gundogdu et al. *Connect Tissue Res* 2022
16. Irani M et al. *Am J Sports Med* 2025
17. Jensen et al. *Phys Ther Sport* 2004
18. *PMC7561009 Nutrients* 2020
19. *OCL J* 2024
20. *Arthritis Foundation* 2022

REGULATING THE OMEGA-6:3 RATIO IS AN OPTIMIZATION TOOL THAT NO PERSONAL TRAINER CAN IGNORE

It's not supplementation — it's correcting an imbalance that affects ALL training adaptation processes

Your clients are already inflamed before entering the gym (ratio 15-20:1)

Regulating the ratio to $\leq 3:1$ improves recovery, joints, hypertrophy and body composition

It's a competitive differentiator: the gym that educates retains more clients and generates better

THE FIRST STEP: MEASURE THE CLIENT'S RATIO WITH A DRIED BLOOD TEST

Once you know the number, the action plan becomes personalized and measurable.