Omega-3 Status in Elite Athletes: Barriers, Food-First Strategies, and Implications for Recovery

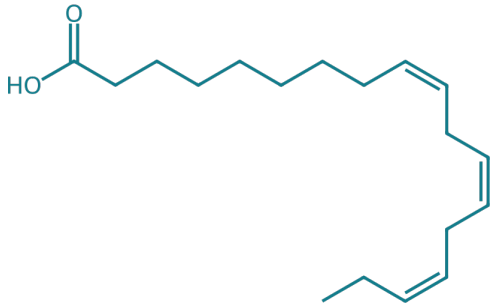
Matthew Hooks

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05/11/26

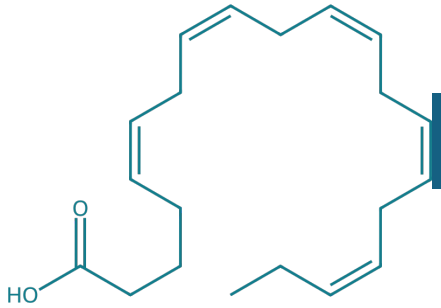
Omega-3 PUFAs Pathway

ALA — Alpha-linolenic acid



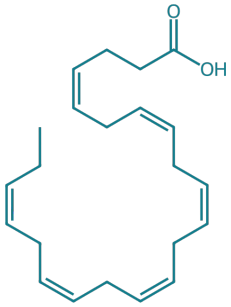
ALA to EPA: ~8% (men) to 21% (women)

EPA — Eicosapentaenoic acid



ALA to DHA: very low in men, ~9% in women

DHA — Docosahexaenoic acid



EFSA: AI = 250mg.day
UL = 5g.day*

Plant sources

Flaxseed, chia seeds, walnuts and rapeseed oil

Marine sources

Oily fish (e.g., salmon, mackerel, herring, sardines) and algal oil

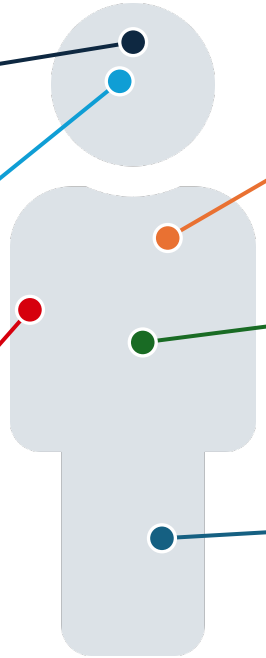
Takeaway: plant foods provide ALA but conversion to EPA and DHA is limited therefore EPA and DHA can be considered conditionally essential nutrients (Burdge and Wootton, 2002, Burdge et al., 2002).

Omega-3s in the Body

Brain
DHA is the main omega-3; >50% of the brain is lipid, with DHA 20–30%

Eyes (retina)
Highest DHA concentration in the body; needed by light-sensing cells

Blood
Direct impact to dampen inflammatory signalling



Heart
O3I tracks heart tissue EPA + DHA, which is why it began as a CVD risk marker

Fat stores
Stored as triglycerides; slowest to change, reflecting long-term intake

Skeletal muscle
EPA predominant in muscle membranes; plateaus after 6–8 weeks of high intake

How fast tissues change

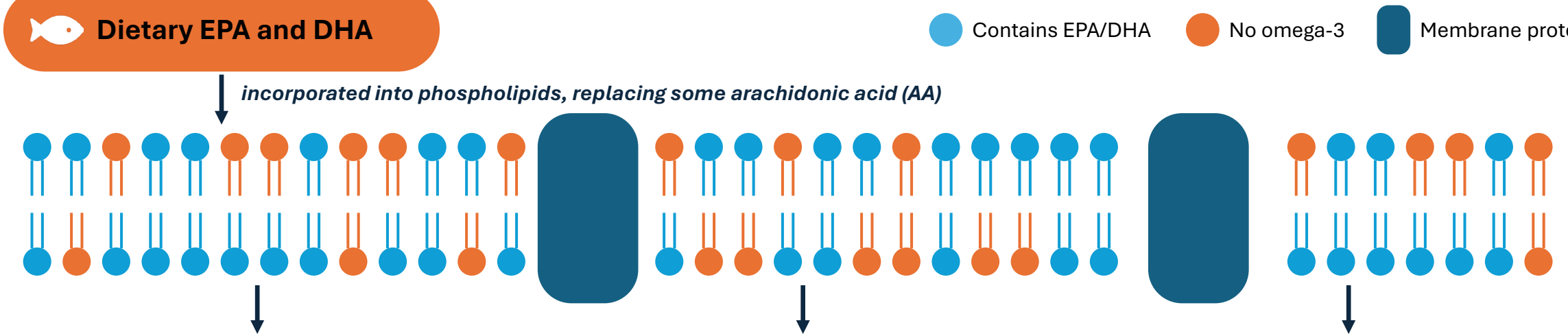
- **Plasma** — days
- **Skeletal muscle** — 6–8 weeks
- **Red blood cells (O3I)** — 3–4 months
- **Brain and fat stores** — months to years

Takeaway: EPA and DHA reach every cell membrane, but tissues fill at different speeds, so benefits need weeks to months of regular intake. The O3I reflects ~3–4 months and tracks heart tissue (Harris and von Schacky, 2004).

Omega-3 PUFAs Mechanism of Action

Dietary EPA and DHA

incorporated into phospholipids, replacing some arachidonic acid (AA)



Lipid mediators

Fewer pro-inflammatory AA-derived messengers (prostaglandins and leukotrienes) and more EPA/DHA-derived resolvins and protectins

Membrane function

Altered membrane fluidity impacts activity of receptors and other signalling proteins

Cell signalling

Reduced inflammatory signalling (e.g., NF-κB) and changes in gene expression

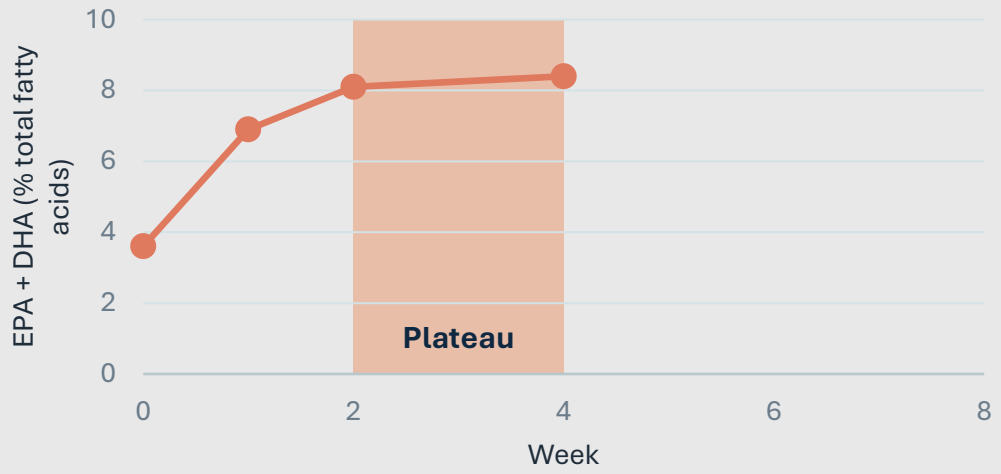
Net effect: less inflammation and better resolution, the proposed basis for benefits to recovery and brain health (Calder, 2017).

Incorporation Timeline for High Dose n-3 Supplementation

Blood

~2 weeks to plateau

10 young men | 5 g/day fish oil (3.5 g EPA, 0.9 g DHA) | 4 weeks

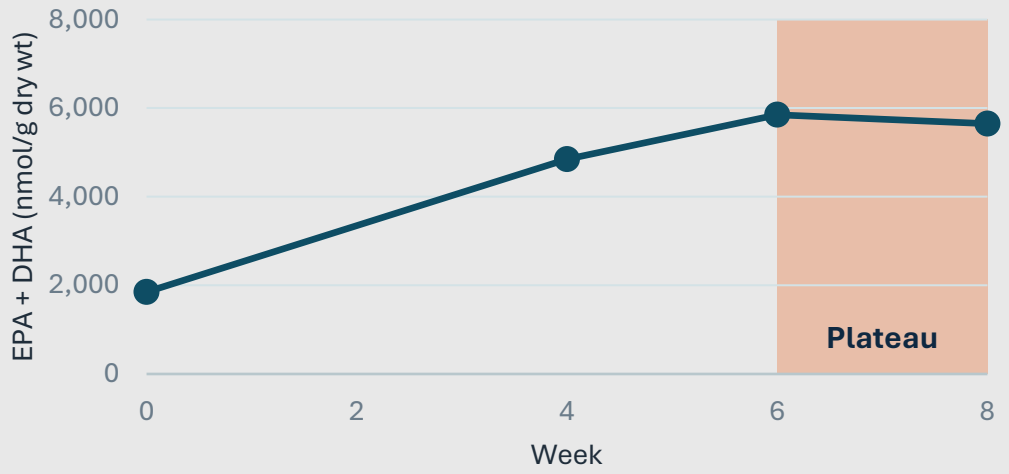


Study ended at week 4. Values read from the published figure.

Skeletal muscle

6 to 8 weeks to plateau

10 young women | 5 g/day n-3 (3.0 g EPA, 2.0 g DHA) | 8 weeks



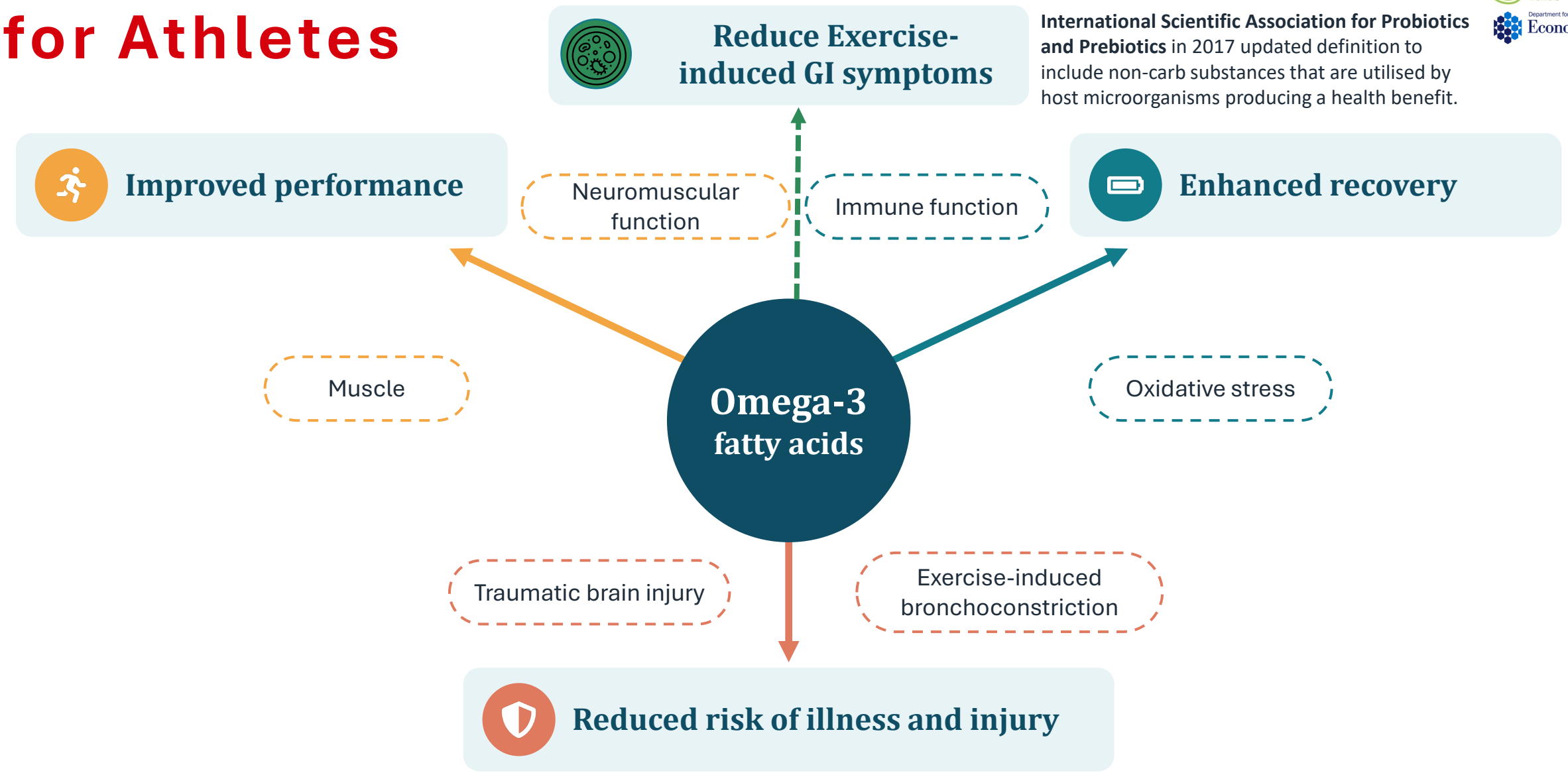
Weeks 4 to 6 included single-leg immobilisation, followed by 2 weeks of recovery.

Takeaway: blood EPA + DHA plateaued within 2 weeks, but muscle took 6 to 8 weeks, so short trials may miss changes in muscle.

McGlory et al. (2014) and McGlory et al. (2019).

Benefits of Omega-3 PUFAs for Athletes

International Scientific Association for Probiotics and Prebiotics in 2017 updated definition to include non-carb substances that are utilised by host microorganisms producing a health benefit.



Jäger., 2025 (ISSN Position Stand)
Thielecke & Blannin (2020)

Omega-3 PUFAs Study Considerations

1 Blood biomarker

Use erythrocyte EPA + DHA (O3I), which reflects tissue incorporation

Result: *can measure whether it worked*

2 Pre-screening

Exclude n-3 supplement users and athletes eating ≥1 fish meal per week

Result: *low baseline O3I (~4.7%)*

3 Remove outliers

Exclude athletes outside the 90th percentile for baseline O3I

Result: *similar baseline O3I (~4.5%)*

4 Dietary assessment

Assess the whole diet at baseline and after supplementation

Result: *rules out diet change*

5 Dose and duration

Choose EPA or DHA, dose and duration to achieve the required membrane change

Result: *outcomes linked to membrane n-3*

6 Group separation

Measure O3I to confirm compliance and separation between groups

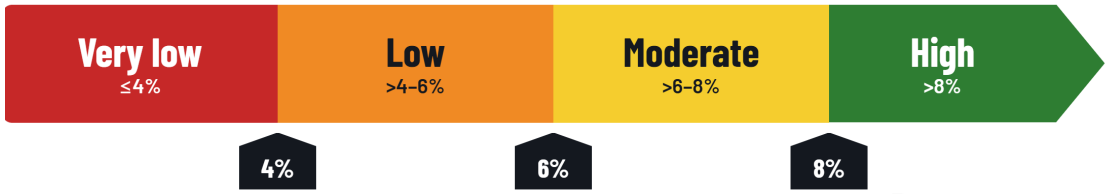
Result: *clear rise in treatment group only*

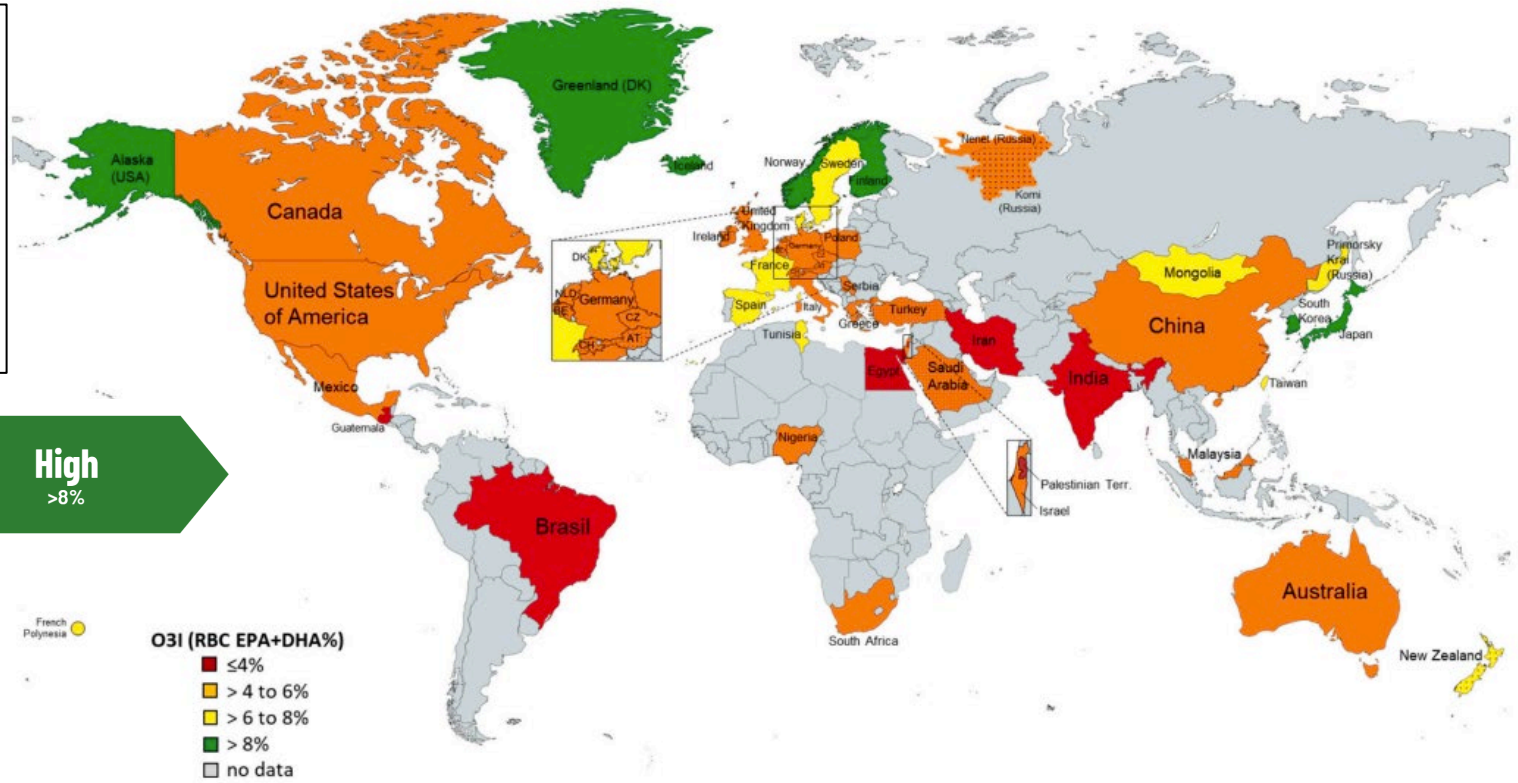
Adapted from Anthony et al. (2023).

Omega-3 Status of Healthy Adults

Omega-3 Index: Sum of EPA and DHA combined in red blood cells expressed as a percentage of total fatty acids.

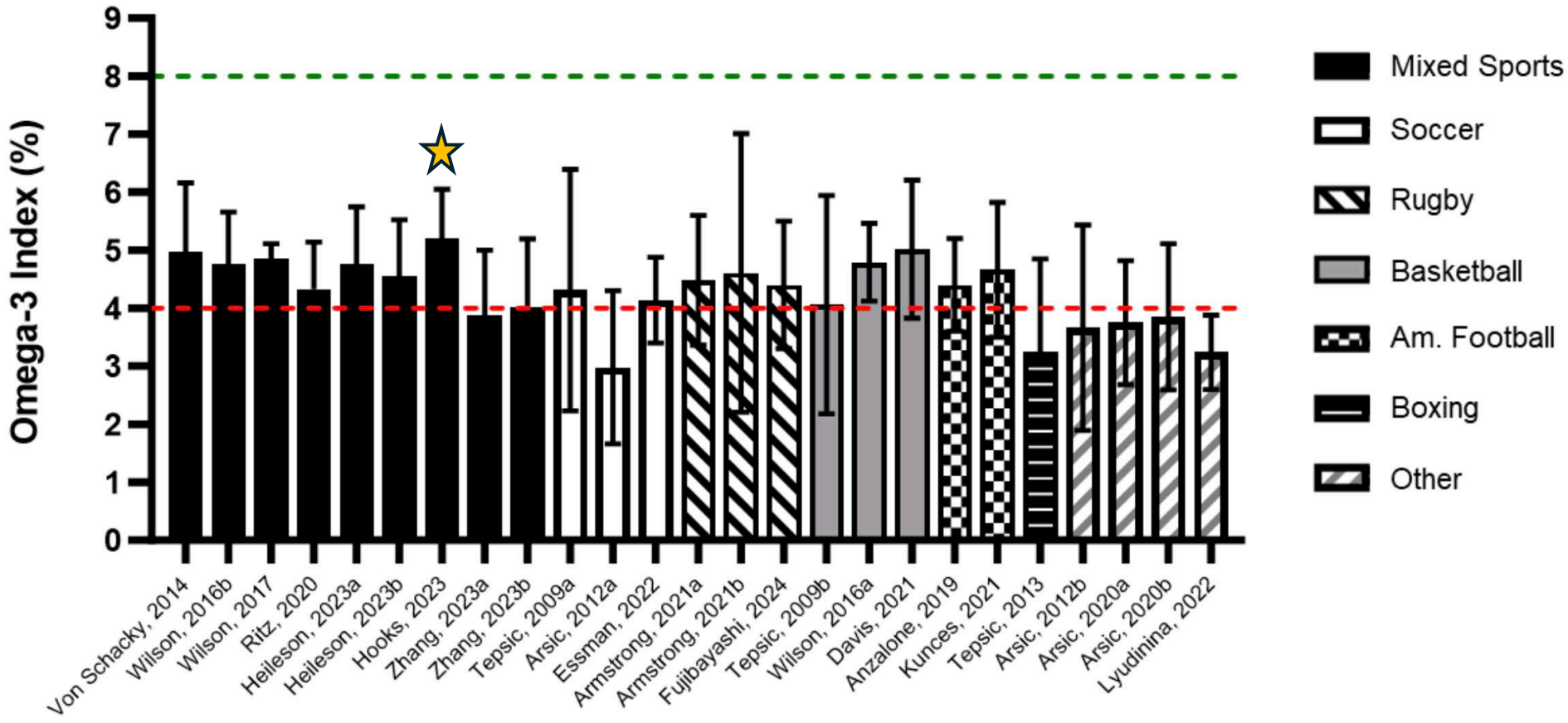
- Stems from risk of CV event (Harris et al., (2008); no current sports related thresholds.





Schuchardt., 2024

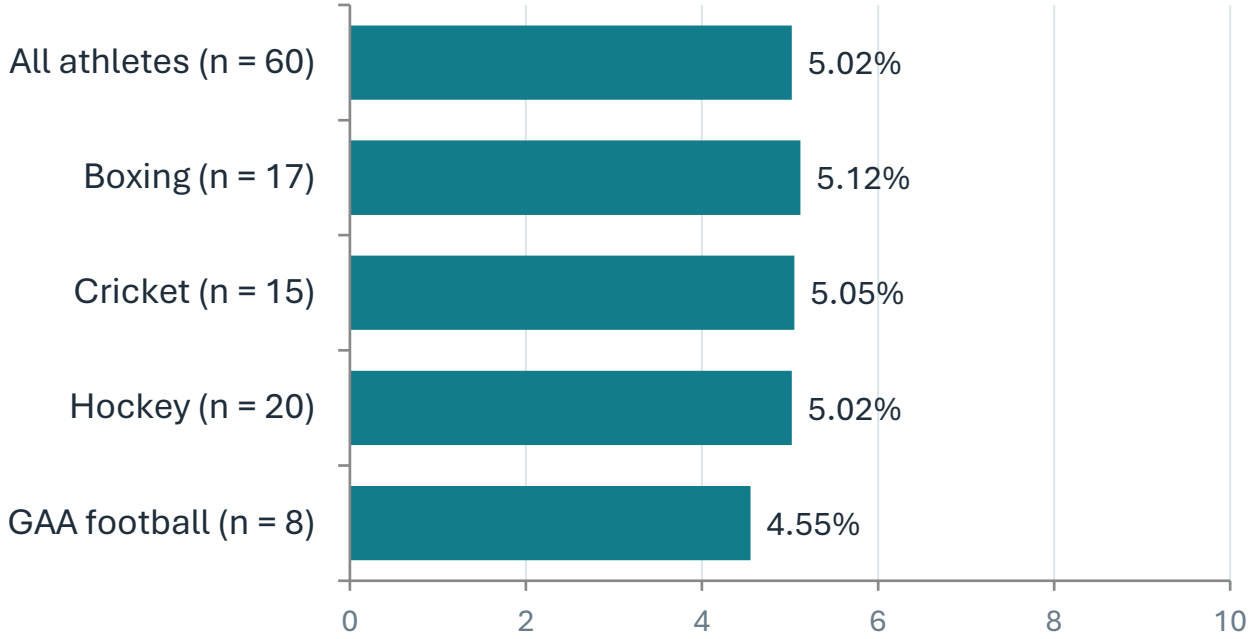
Omega-3 Status of Athletes



Heileson., 2025

Omega-3 Status of Athletes

Median omega-3 index of 60 elite Irish athletes across four sports

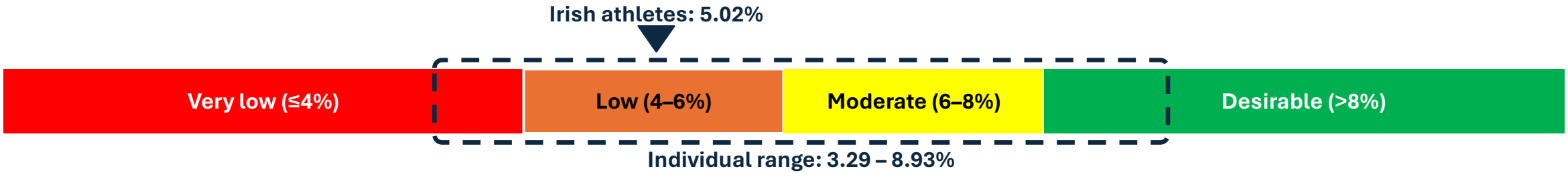


4.55–5.12%

median O3I by sport, all within the low range

1 of 60

athletes reached the desirable range (>8%)



O3I ranges are based on cardiovascular risk research (Harris and von Schacky, 2004); athlete-specific targets have not yet been established.

Factors Influencing Omega-3 Status

Diet

Diet is the main driver of O3I

Sex

Oestrogen increases ALA to DHA conversion, so women tend to have higher DHA

Body composition

Body weight and BMI affect status and the response to a given dose

Training load

High weekly training volume may lower O3I – weekly running distance negatively associated with O3I

Smoking

Linked to lower omega-3 status

Alcohol

Another lifestyle factor adding to variation between individuals

Based on Arterburn et al. (2006), Lohner et al. (2013), de Groot et al. (2019) and Davinelli et al. (2019).

Reported Barriers to Omega-3 Dietary Intake

42%
Sensory

Taste and smell of fish



11 of 26 athletes

→ PRACTICAL RESPONSE
Offer alternatives to fish: n-3 enriched foods and supplements

38%
Cooking skills

Not confident preparing fish



10 of 26 athletes

→ PRACTICAL RESPONSE
Cooking workshops to build practical skills, starting with younger athletes

27%
Knowledge

Of n-3 health and performance benefits



7 of 26 athletes

→ PRACTICAL RESPONSE
Educate athletes on n-3 benefits and which fish are rich in EPA + DHA

OTHER FACTORS LIMITING N-3 STATUS (N = 35)

26%

ate 2 or more fish servings per week (9 of 35)

Cod and salmon

most-eaten fish (80% and 74%); none reported herring or mackerel

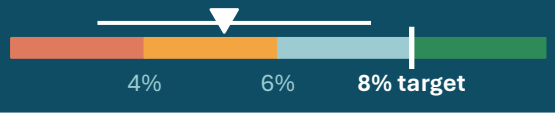
11%

used an n-3 supplement (4 of 35); reasons for non-use not assessed

OMEGA-3 INDEX

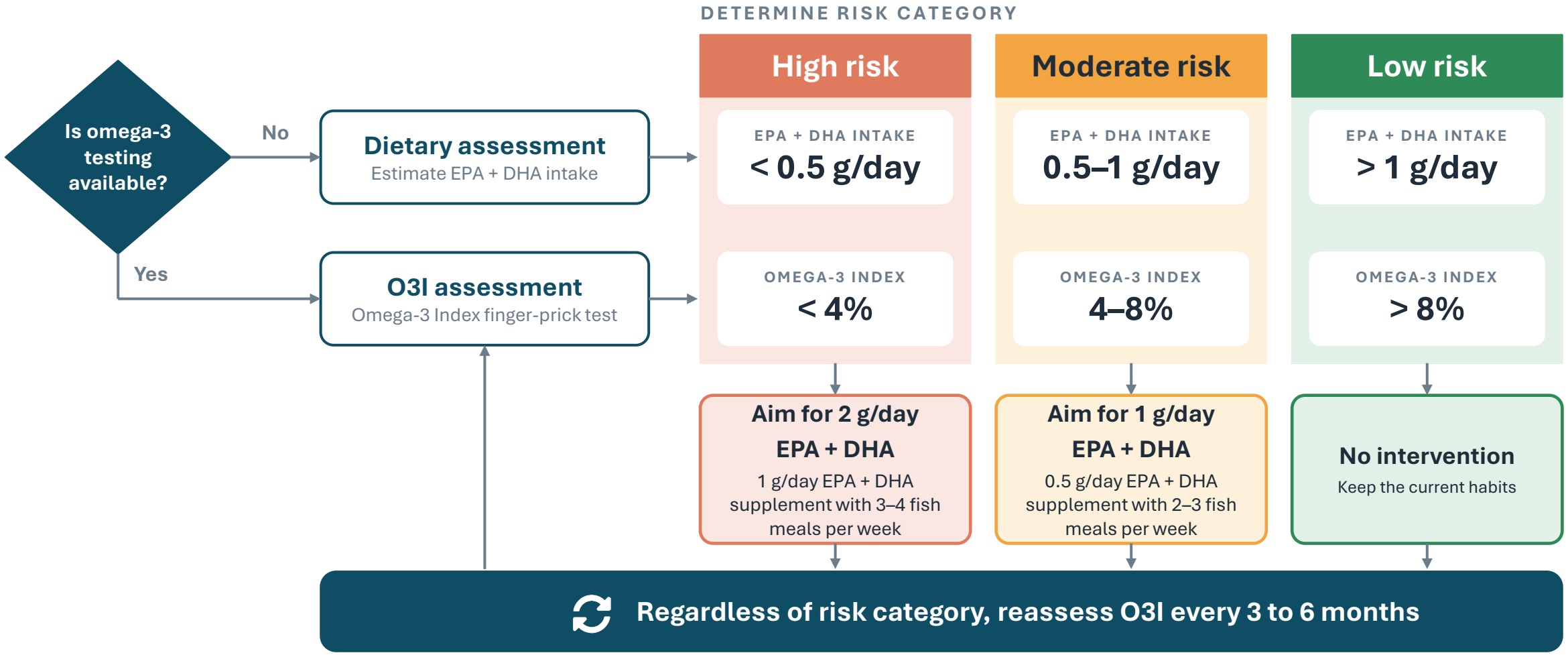
0 of 35 reached the ≥8% target

Mean 5.2% | range 3.3–7.4%



Hooks et al. (2023)

Omega-3 Decision Tree



Heileson., 2025

Omega-3 Supplements

About this product

Description

Tesco Health omega 3 fish oil food supplement.
A daily supplement containing the essential fatty acid omega 3. †This product contains 1000mg of fish oil a source of eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) which support the normal function of the heart. The beneficial effect is obtained from a daily intake of 250mg of EPA and DHA.
Heart care†. 1000mg. Supports normal heart function†. 1 a day. Fish Body Oil, 1000mg, , providing, EPA and DHA, 250mg, . NRV = Nutrient Reference Value. = No NRV established.





Serving Size - 1 Softgel
Servings Per Container - 90 (90 Softgels), 250 (250 Softgels)
Typical Nutritional Values

	Per Serving
Total Omega 3	760 mg
EPA (Eicosapentaenoic Acid)	530 mg
DHA (Docosahexaenoic Acid)	90 mg
Other Omega 3 Fatty Acids	140 mg

Omega-3 Supplements

- ✓ Dosage on labels closely reflects actual concentrations: Rucklidge and Shaw (2020)
- ✓ Read the actual EPA and DHA dosage
- ✓ Look for n-3 supplement in natural triglyceride form rather than EE (more bioavailable)
- ✓ To achieve general benefits pick a supplement that provides EPA/DHA in relatively equal quantities.
- ✓ Informed sport for tested athletes.

Omega-3 EPAX®

90 softgels (= 3 months)

A supplement containing omega-3 fatty acids, designed as a daily supplement for athletes, especially for those with a low intake of fatty fish. Each premium softgel contains a potent EPAX® fish oil, highly concentrated in omega-3 fatty acids and with exceptionally low oxidation levels. The Friend of the Sea label guarantees that the fish oil is sustainably sourced.

- **Fish oil softgels:** highly concentrated omega-3 fatty acids (EPA & DHA)
- **Premium-grade Epax® 5025 TGN:** a registered trademark of Epax Norway AS.
- **Top-tier quality & purity:** best absorbable triglyceride form and exceptionally low oxidation levels.
- **Easy & precise dosing:** just 1 capsule per day.
- **Pocket-sized blisters:** easy to carry and tamper-proof
- **Banned substance tested:** guaranteeing the highest level of safety

€49.50

In stock

1 Add to Cart

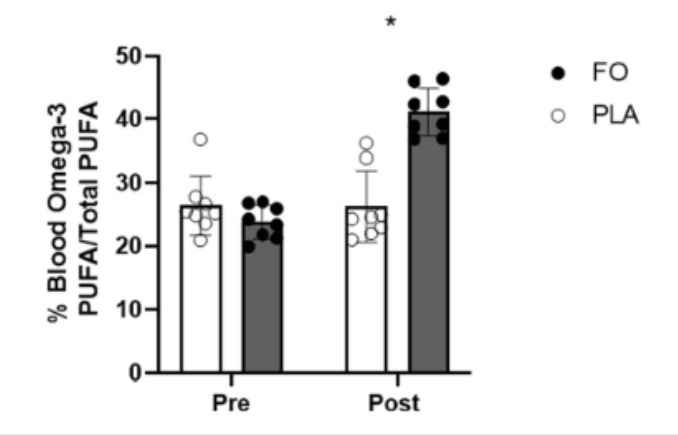


Omega-3 PUFAs for Muscle Damage and Recovery

Fish oil alone

Mackay et al. (2023)

16 trained males
2.4 g EPA + DHA/day | 4 weeks

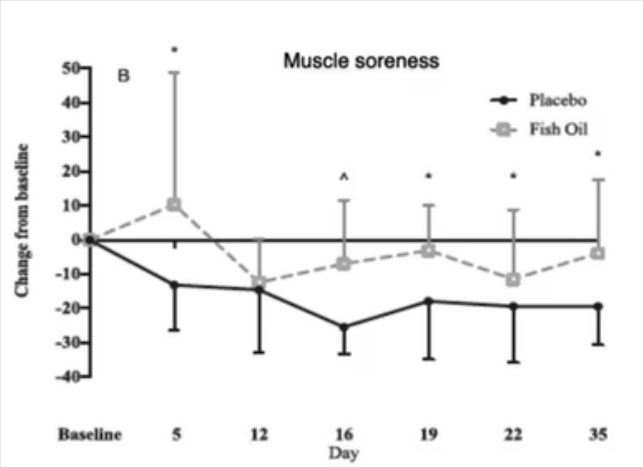


No clear benefit: blood n-3 rose ~70%, but no sig. differences between FO & PLA in CK, VAS scores and peak force.

Fish oil + protein

Black et al. (2018)

20 professional rugby union players
2.2 g EPA + DHA/day | 5-week pre-season

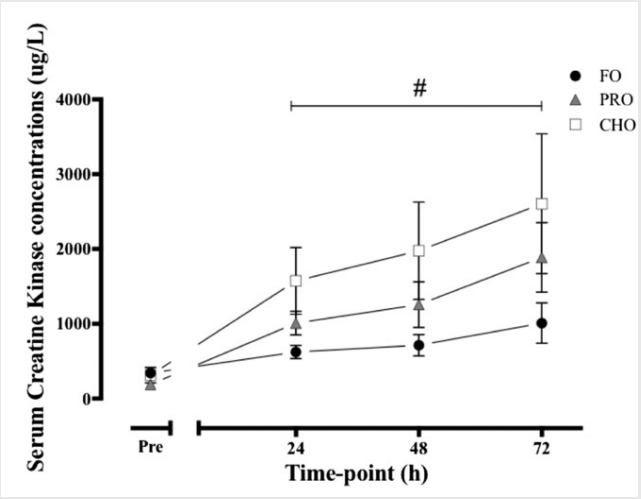


Power maintained: CMJ +4.6% vs −3.4%, with less soreness and fatigue.

Fish oil + protein + carbs

Philpott et al. (2018)

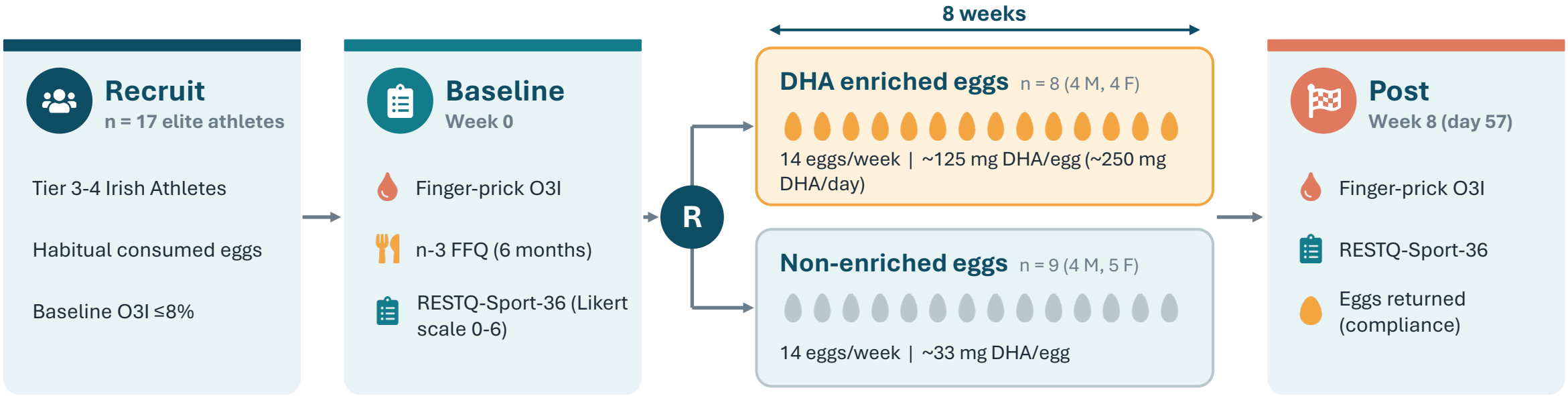
30 competitive soccer players
1.1 g EPA + DHA/day | 6 weeks



58% less soreness than protein + carbs alone, with a smaller CK rise. There was a likely beneficial effect on performance

Mackay et al. (2023) Eur J Sport Sci; Black et al. (2018) Eur J Sport Sci 18:1357–67; Philpott et al. (2018) Int J Sport Nutr Exerc Metab 28:26–36.

Food-First Strategy



Eligibility

Excluded: smokers, hypertension, statins, O3I <8%. Withdrawn if injured >1 week

Eggs

Algae-fed hens (enriched); delivered weekly with 2 spare; replaced usual egg intake (10±3 eggs. Week)

Outcomes

Primary: O3I. Secondary: recovery-stress. Wilcoxon and Mann-Whitney tests

Unpublished

ISSN Position Stand on Dietary Antioxidants & Exercise Performance

Omega-3 (EPA + DHA)

Dose	1,000 to 6,000 mg/day EPA + DHA
Duration	6 to 12 weeks
Mechanism	Reduces reactive oxygen species via mitochondrial and Nrf2 pathways
Benefits	Less inflammation and oxidative stress; supports recovery
Adaptation	Does not appear to blunt training adaptations

How it compares (top-ranked nutrients)

	Performance	Antioxidant
Creatine	High	Weak to moderate
Omega-3	Moderate	Moderate to high
Tart cherry	Moderate to high	Moderate

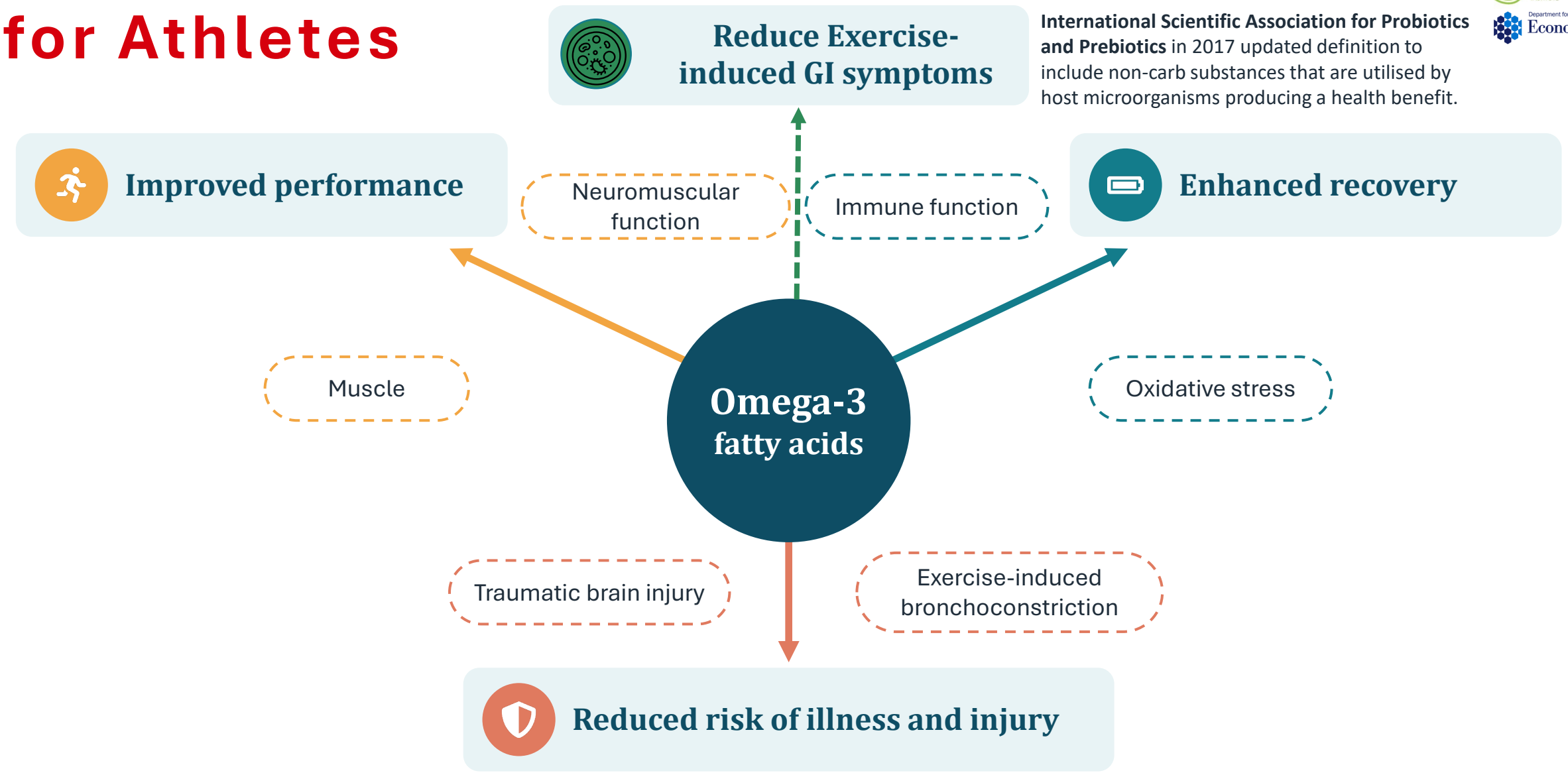
Astaxanthin was also ranked in the top group. Food first: supplements are best for low intake or periods of high training stress.

The ~250 mg DHA/day from enriched eggs sits well below the 1,000 mg/day lower end of this range.

Gonzalez et al. (2026)

Benefits of Omega-3 PUFAs for Athletes

International Scientific Association for Probiotics and Prebiotics in 2017 updated definition to include non-carb substances that are utilised by host microorganisms producing a health benefit.



Jäger., 2025 (ISSN Position Stand)
Thielecke & Blannin (2020)

Omega-3 and Neuroprotection

A DHA-rich brain

>50%

of the brain is lipid, with DHA accounting for 20–30%

DHA supports membrane stability, nerve transmission, cell communication and neuroplasticity, while EPA is more anti-inflammatory

Repeated head impacts

>15

head hits linked to higher Nf-L in amateur boxers

Sub-concussive impacts are often symptom-free, so go unnoticed, yet may have long-term effects on brain health

Limited evidence

3

studies of n-3 and Nf-L, all in American football

Two found lower Nf-L with n-3 and one found no effect; none were in boxing or used field-based sampling

Aim: describe the omega-3 status of elite boxers and explore whether O3I is associated with Nf-L, using finger-prick samples taken around competition.

Sources: Arterburn et al. (2006); Bailes et al. (2013); Dyall (2015); Shahim et al. (2017); Mallick et al. (2019); Heileson et al. (2024b); Li et al. (2025).

A Systematic Review and Meta-Analysis on n-3 and Nf-L

Study	Daily dose (g)	Duration and sampling points	Nf-L outcome	Score
Oliver et al. (2016) n = 81 | 62 n-3, 19 placebo	2 g DHA 4 g DHA 6 g DHA	27 wk T1 T2 T3 T4 T5 T6 T7 T8	**Lower Nf-L late season** n-3 groups combined were lower at T7 and T8; clearest with 2 g/day DHA	4
Heileson et al. (2021) n = 66 | 31 n-3, 35 placebo	0.6 + 2.0 g	~20 wk T1 T2 T3 T4 T5 T6	**Lower Nf-L than placebo** Lower at T2 to T4; Nf-L only rose in the placebo team. Not randomised	3
Mullins et al. (2022) n = 29 | 12 n-3, 17 placebo	1.0 + 2.4 g	33 wk T1 T2 T3	**No effect on Nf-L** Nf-L rose similarly in both groups; underpowered, with 37% dropout on n-3	3

EPA DHA Nf-L lower with n-3 No difference Design score: 4 to 5 high 2 to 3 moderate

Gap: all in American football; none studied boxing, recorded head impacts or used finger-prick sampling.

Adapted from Heileson et al. (2024b); design score adapted from Anthony et al. (2023)..

Summary

- Elite level athletes have **inadequate n-3 dietary** intake which was reflected as **suboptimal O3I (<8)**
- The **sensory barriers** towards fish alongside limited **cooking skills** and are **not aware of the benefits** of consuming foods rich in n-3.
- **n-3 enriched eggs are a feasible strategy to improve the O3I** whilst also acting as a vehicle for both n-3 and other essential nutrients but are **insufficient as a standalone strategy.**
- Remote method Nf-L results do not provide strong evidence that O3I had an influence on the Nf-L response but does **warrant further investigation with larger sample sizes.**

Impact Beyond the Thesis

Challenges of Applied Research



Recruitment

Elite Irish athletes are a very small population, so sample sizes were small and recruitment targets were not always met.



Logistics

Travel, training camps and competitions dictated when samples could be collected, e.g., the 5 to 9 day post-competition Nf-L window.



Planned vs reality

Plans had to adapt to schedules and suppliers, e.g., the enriched chicken product was discontinued before the egg study.



Practitioner vs researcher

Balancing day-to-day support for athletes with research rigour, as performance always comes first.

Lesson: low-burden, field-based methods such as finger-prick testing and flexible plans made research possible within elite sport.

Participant Education





Resource Development and Informed Practice

Omega-3 Index Feedback

Name	Date	Omega-3 Index

Background

Omega-3's are a type of fatty acid that must be provided by the diet (e.g., salmon, mackerel, herring and tuna) or supplementation. Eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA) are the most important omega-3's and when consumed in adequate amounts may offer benefits for health and performance.



The Omega-3 Index reflects the omega-3 status of your body over the last 4 months, see ranges below:



Omega-3 Intervention

Omega-3 Index	Guidance *(*double supplement amount if no fish consumed)*
<5%	3x omega-3 rich meals per week & 1g.day EPA + DHA supplement*
5-8%	3x omega-3 rich meals per week & 0.75g.day EPA + DHA supplement*
8-12%	3x omega-3 rich meals per week or 1g.day EPA + DHA supplement

Evidence based approach developed from Heileson et al. 2025; The omega-3 index in Athletes.

Re-testing omega-3 index in 3-6 months will confirm intervention success. Once the omega-3 status is optimised (O3I >8%), missing or skipping several days of intake will have minimal impact as cell content is maintained for 2 weeks, even when omega-3 intake is withdrawn.

Supplement Considerations

- All supplements carry a doping risk. Athletes should only use batch-tested supplements, see discount codes for reputable brands below.
- Consuming the fish oil capsules in conjunction with a normal meal to maximise absorption.
- Very high doses have been reported to cause gut discomfort (rare).
- EFSA state Intakes up to 5g of EPA + DHA per day are considered safe.
- Store in a consistently cool environment (e.g., cool dark cupboard or refrigerator) to help prevent oxidation and minimise reflux/aftertaste.

Healthspan Elite = **SII-HEDT** // NutritionX = **SPORTIRELAND** // Kinetica = **SPORT**

omegaquant



Professional Development

- In-person/online workshops
- 1:1 support
- Major competition support
- Resource development



Dr Anne Nugent
Prof. Sharon Madigan
Prof. Jayne Woodside

Sport Ireland Institute Team

And all the participants & co-authors

Thank You