Versatility of Omega 3 Benefits for Brain Health and Athletic Performance

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Sports Dietitian

My Background

16 years practicing as a Sports Dietitian

Current Work

Taylor Hooton Foundation

My Sports Dietitian (www.mysportsd.com and www.eat2win.online)

Assistant Professor, Exercise Science/Sports Nutrition – Concordia University

Sports Nutrition Private Practice

Consultant for various High School Teams, Sports Performance, Fitness, and Sports Medicine Facilities

Previous Work (Sports Dietitian)

New Orleans Saints (2006-2013)

New Orleans Hornets/Pelicans (2008-2013)

Tulane University Athletics (2002-2016)

Disclaimer: Scientific Advisory Board for Nordic Naturals (Fish Oil Company)

Scientific Advisory Board for Examine.com

What are Omega 3 Fatty Acids?

Omega 3 Fats

- *PUFAS*
- *Essential Fatty Acid we need to consume from the diet*
- ***Eicosapentaenoic Acid (EPA)***
  - Found in Oily Fish, Algae, and Krill
  - Need it in high quantities to receive benefits
- ***Docosahexaenoic Acid (DHA)***
  - Found in Oily Fish, Algae, and Krill
  - Body converts some DHA back to EPA to keep levels equal
- ***ALA***
  - Plant based found in leafy veggies, flaxseeds, chia, canola, walnut, soybean oils
  - Short chain omega 3 which body has to convert into EPA and DHA
  - Only 1% is converted so it's an inefficient way to get Omega 3

Food Sources of Omega 3

Food Type	Omega 3s (mg)
Mackeral (3.5 oz)	5134
Fish Oil (1 tsp)	3000
Cod Liver Oil (1 tbsp.)	2664
Salmon (3.5 oz)	2260
Anchovies	2113
Herring (3.5 oz)	1729
Sardines	1480
Caviar (1 tbsp.)	1086
Flaxseeds (1 tbsp.)	2338 (seeds) 7196 (oil)
Chia Seeds (1 oz)	4915
Walnuts (1 oz)	2542
Soybeans (1/2 cup)	1241

Benefits of Omega-3s

Cardiovascular Protection

Cognitive Function

Body Fat/Lean Tissue

Lean Muscle Preservation

Muscle Growth/Recovery

Inflammation & Pain Management

Concussion/TBI Protection

Mood Support

What are Omega 6 Fatty Acids?

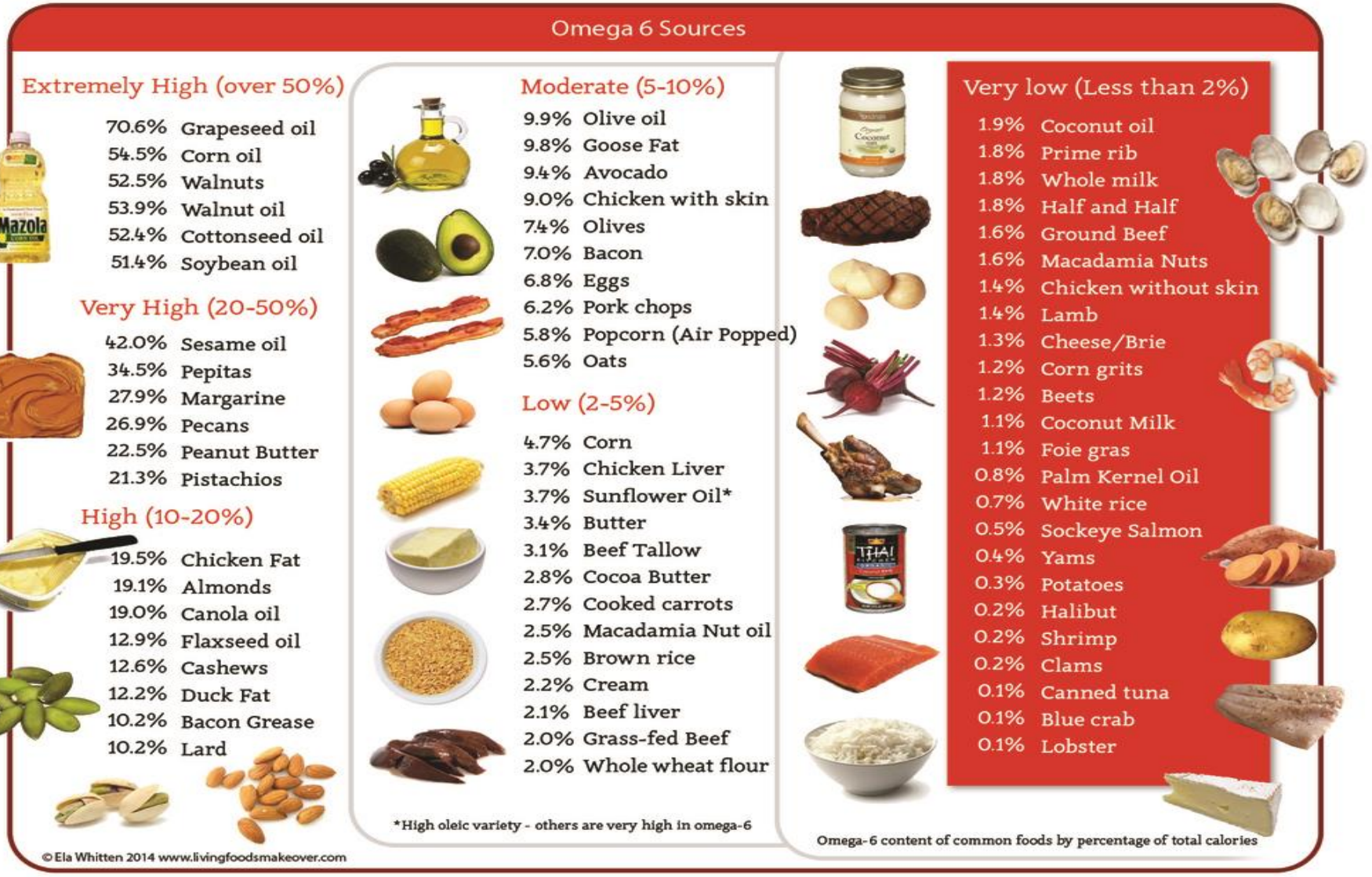
Omega 6 Fats

- *PUFAS*
- *Essential Fatty Acid we need to consume from the diet*
- ***Linoleic Acid***
  - Converts to GLA and breaks down into Arachidonic Acid
  - Soybean, Corn Oil, Safflower, Sunflower, Peanut Oil, Cottonseed
- ***Arachidonic Acid***
  - Peanut Oil, Meat, Eggs, Dairy Products
- ***Gamma Linoleic Acid (GLA)***
  - Hemp seeds, Spirulina, Eevening Primrose Oil, Borage, Black Currant Seed

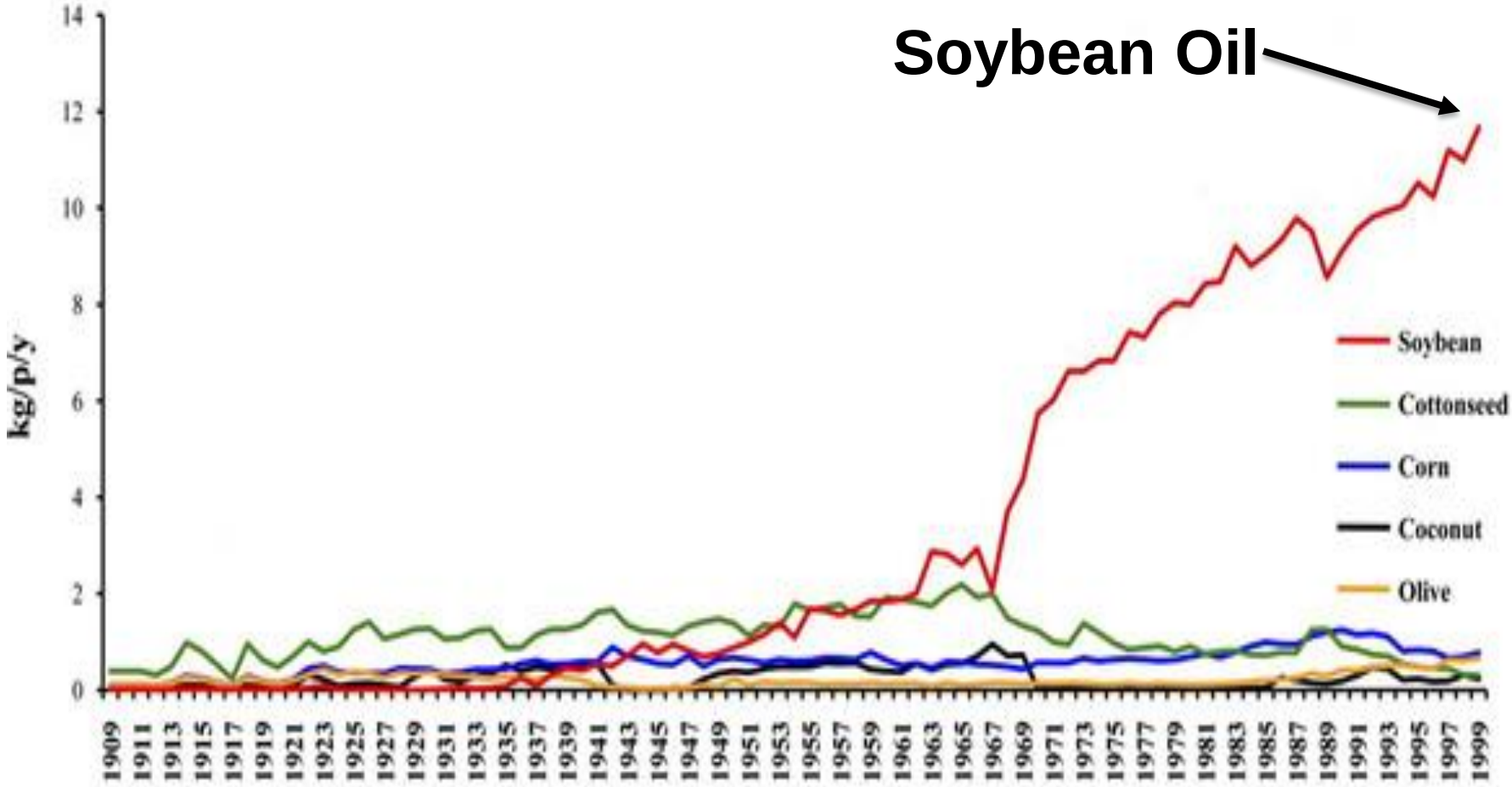
Are there benefits to Omega 6?

- **When consumed in the right balance:**
  - **Reduces nerve pain**
  - **Fights Inflammation**
  - **Improves Arthritis**
  - **Improves ADHD Symptoms**
  - **Reduces High Blood Pressure**
  - **May reduce risk for Heart Disease**
  - **Improves Bone Health**

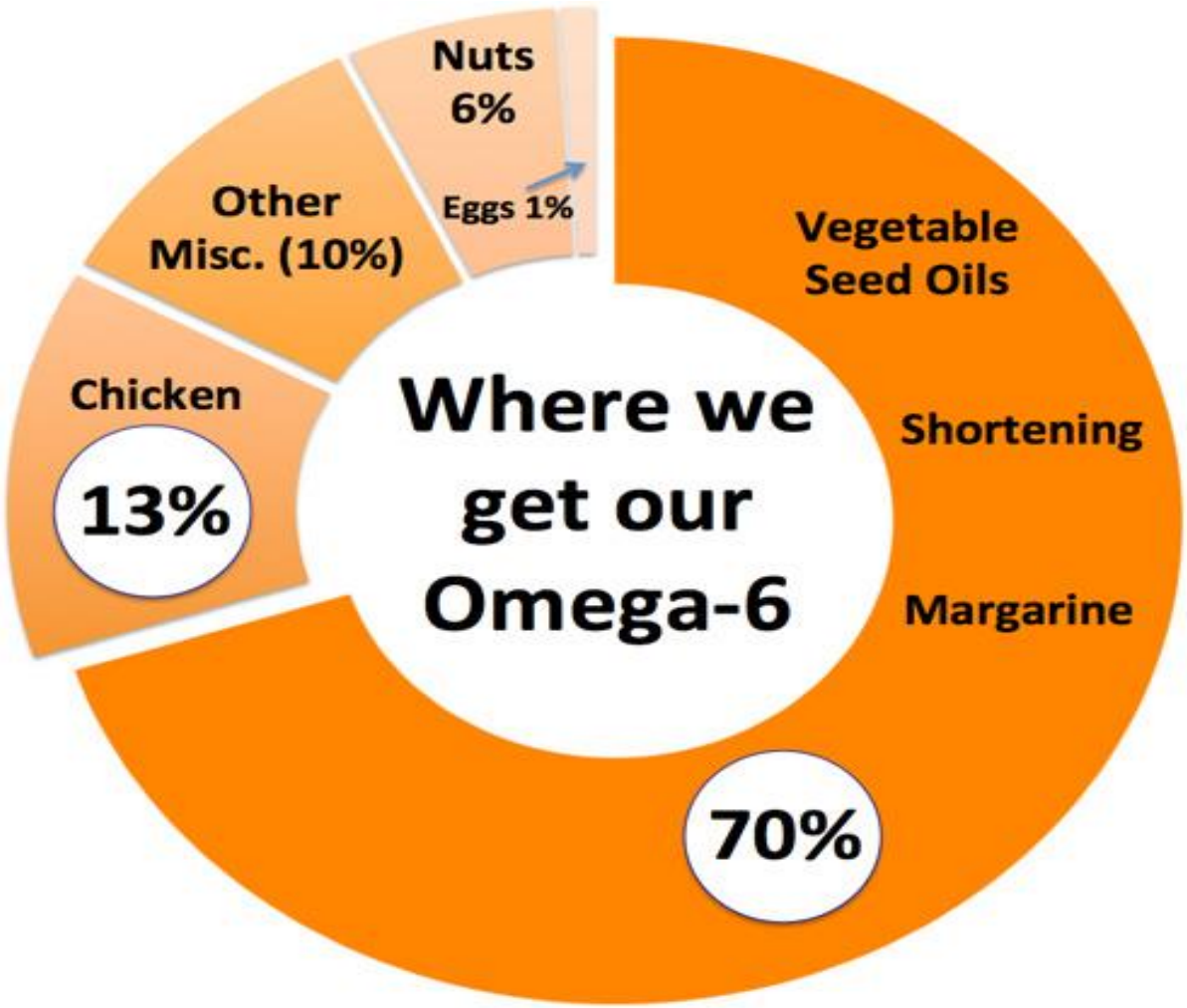
Omega 6 Sources



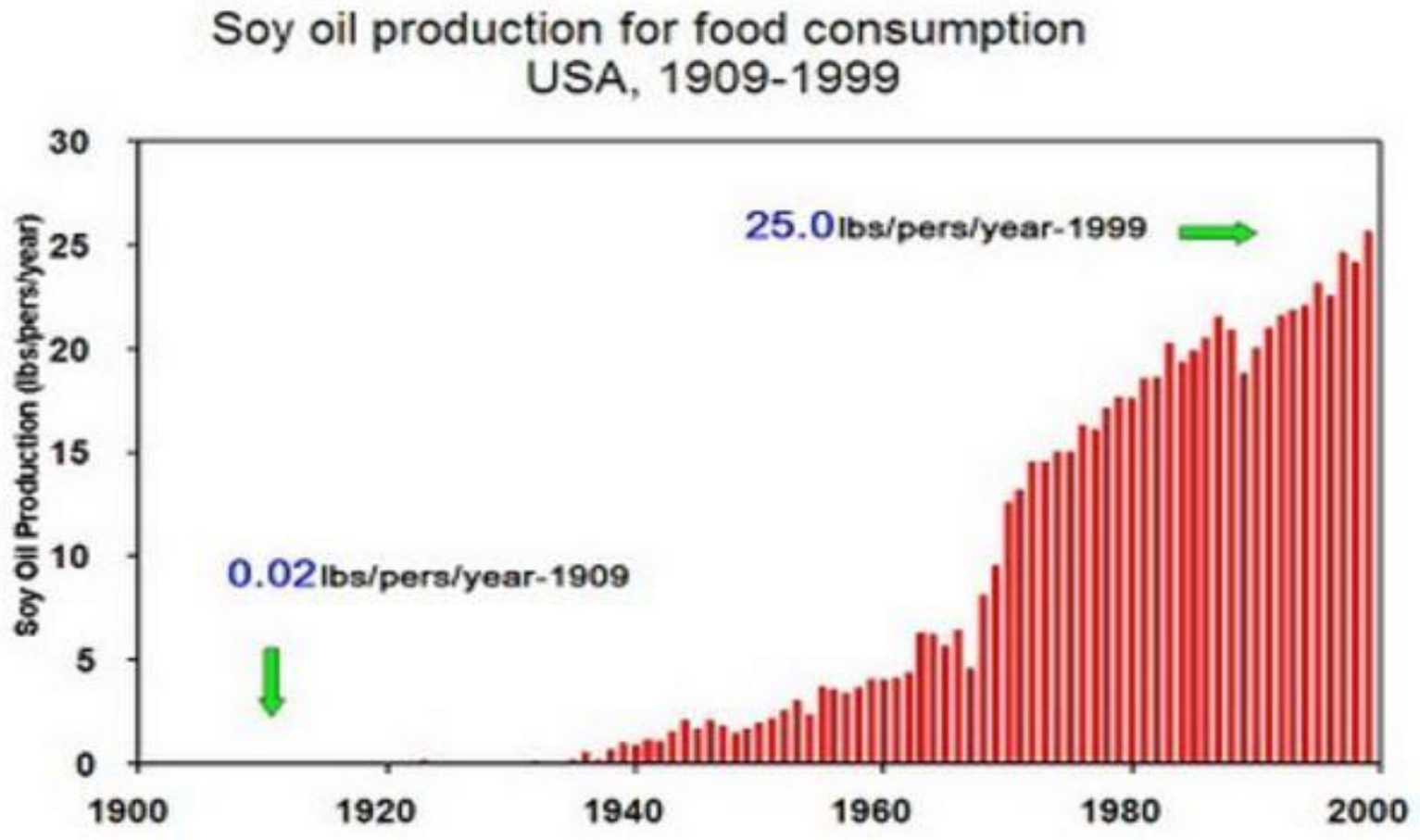
The Omega-6 Problem



Omega 6 Fats


Nuts
6%
Eggs 1%
Other
Misc. (10%)
Chicken
13%
Where we
get our
Omega-6
Vegetable
Seed Oils
Shortening
Margarine
70%

The Omega-6 Problem



Omega-3 vs. Omega-6

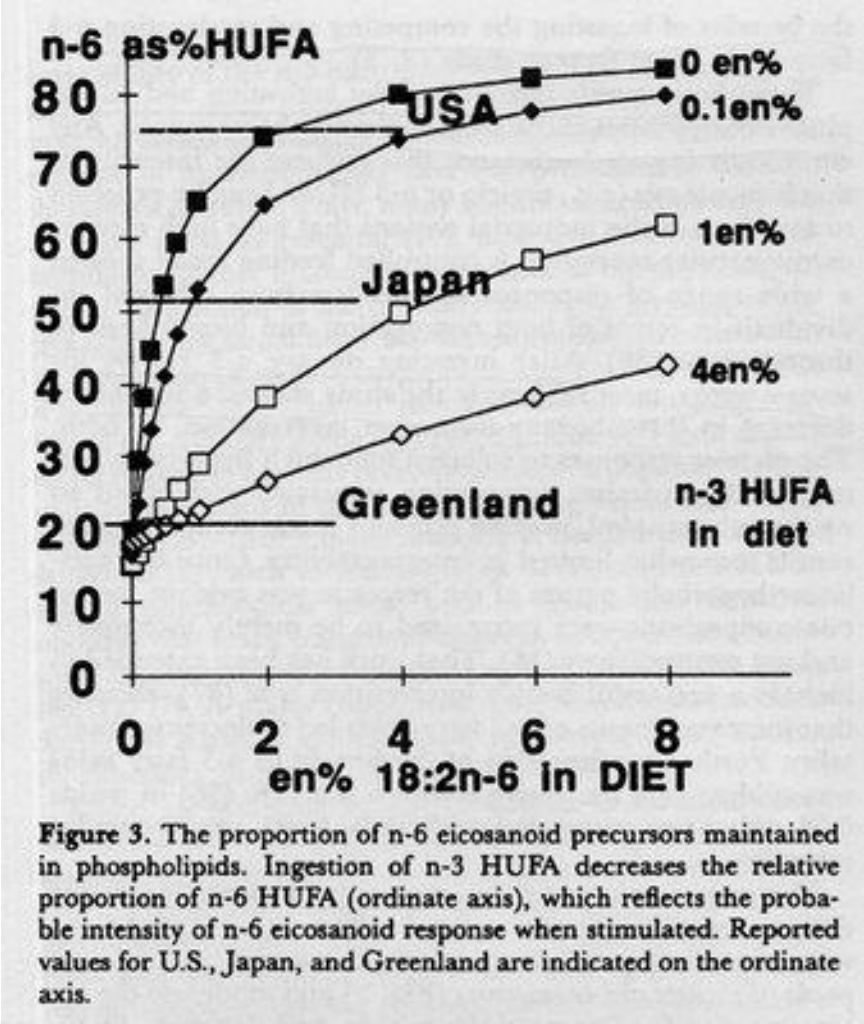
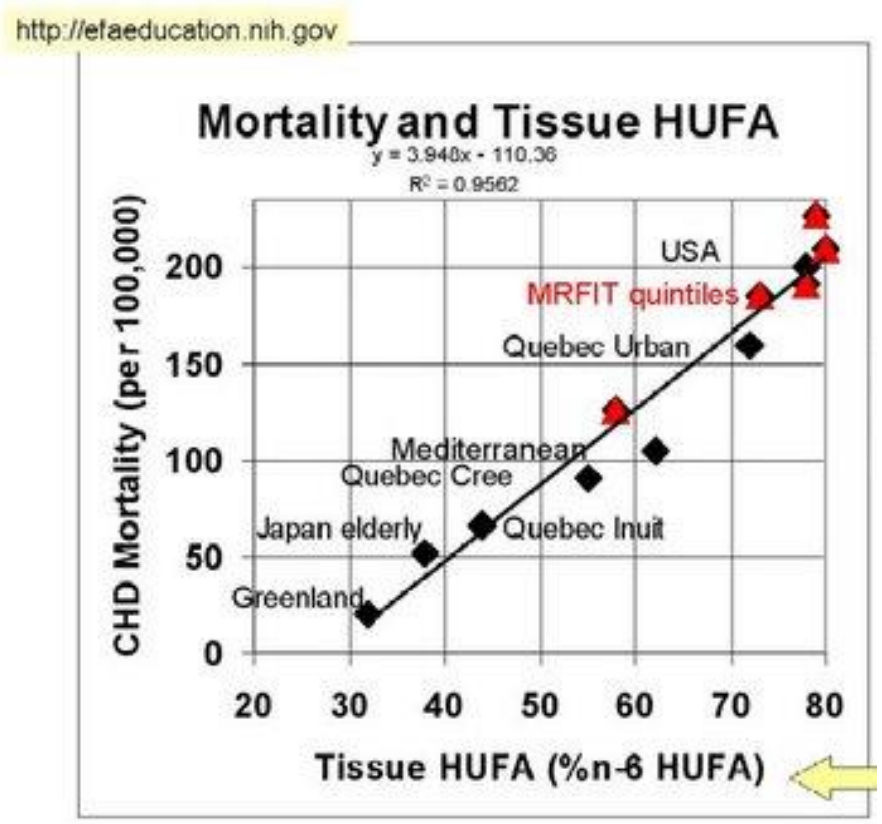
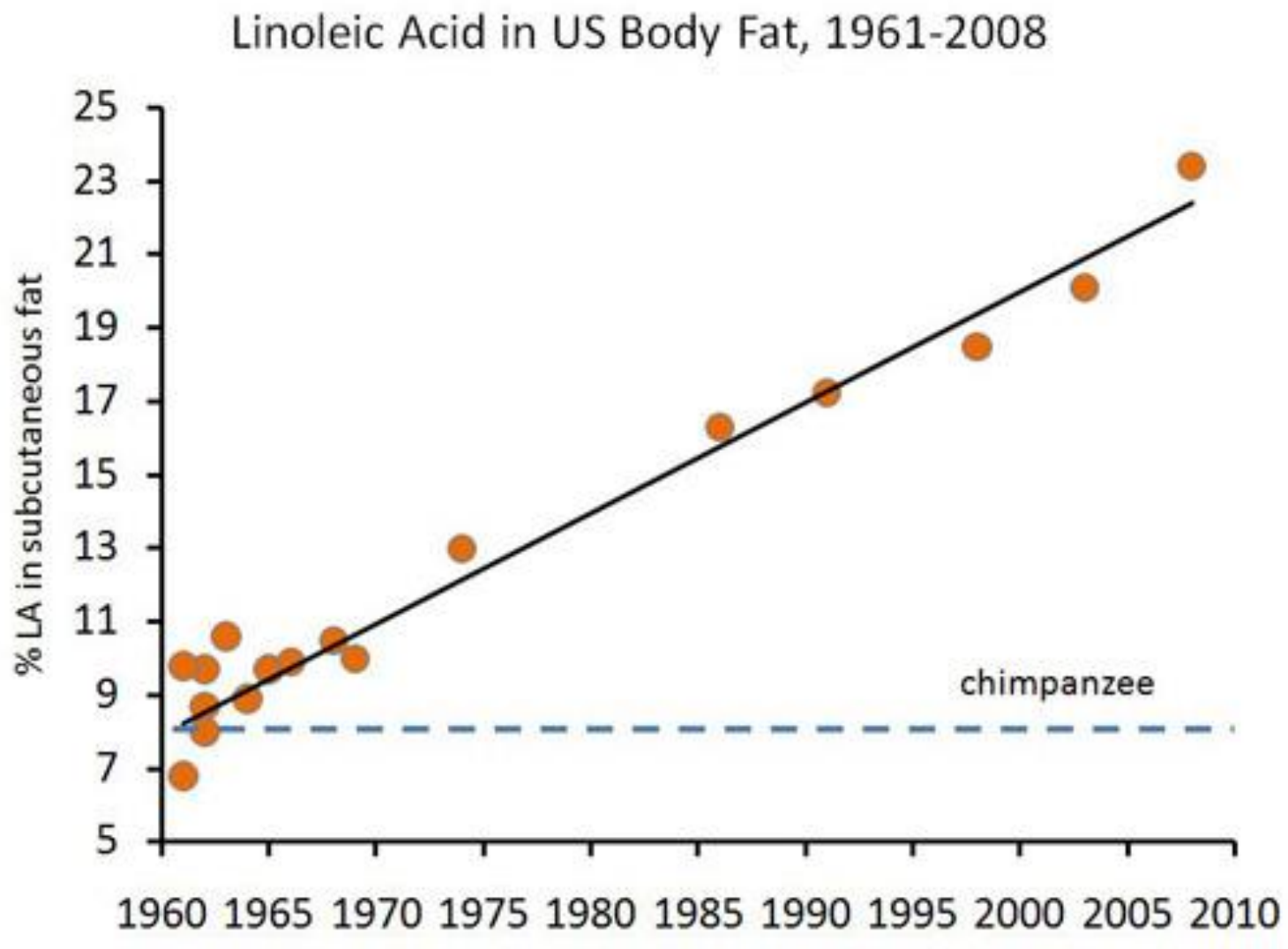


Figure 3. The proportion of n-6 eicosanoid precursors maintained in phospholipids. Ingestion of n-3 HUFA decreases the relative proportion of n-6 HUFA (ordinate axis), which reflects the probable intensity of n-6 eicosanoid response when stimulated. Reported values for U.S., Japan, and Greenland are indicated on the ordinate axis.



What Mortality Rate is Optimal?

Omega-6 and Tissue Fat



Omega 6 Rich Foods

- *Western diet has an abundance of Omega 6 rich foods*
- *Pro-Inflammatory as diet is around 20:1 Omega 6:Omega 3*
- *Biggest Culprits are Vegetable Oils (Safflower) & Soybean Oil*
  - Fried foods
  - Regular Mayo
  - Potato Chips
  - Salad Dressings
  - Baked goods
  - Processed Foods
  - Fast Food

The Omega 6 Problem

KEEP REFRIGERATED Firm out of refrigeration, softens quickly. Okay to freeze.

Nutrition Facts

Serv Size 1 Tbsp (13g)
Servings: About 32
Calories 80
Fat Cal. 80

Amount/Serving	% DV*	Amount/Serving	% DV*
Total Fat 9g	**14%**	**Cholesterol** 0mg	**0%**
Sat Fat 2.5g	**13%**	**Sodium** 80mg	**3%**
Trans Fat 0g		**Total Carb** 0g	**0%**
Polyunsat Fat 2g		**Protein** 0g	
Monounsat Fat 4.5g			
Vitamin A 10%		Vitamin D 20%	

*Percent Daily Values (DV) are based on a 2,000 calorie diet.

Not a significant source of dietary fiber, vitamin C, calcium and iron

INGREDIENTS: OIL BLEND (CANOLA, PALM, FISH, FLAX, OLIVE, AND SOYBEAN OILS), WATER, LESS THAN 2 PERCENT OF SALT, PEA PROTEIN, NATURAL AND ARTIFICIAL FLAVORS, SUNFLOWER LECITHIN, LACTIC ACID, VITAMIN A PALMITATE, BETA-CAROTENE COLOR, VITAMIN D, MONOGLYCERIDES OF VEGETABLE FATTY ACIDS (EMULSIFIER), POTASSIUM SORBATE, TBHQ, CALCIUM DISODIUM EDTA (TO PRESERVE FRESHNESS).

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The Omega 6 Problem

Nutrition

Serving Size 1 Tbsp (13g)

AMOUNT PER SERVING	
Calories	**90 CAL**
Calories From Fat	90 CAL
	% Daily Value
Total Fat	**10 G**
Saturated Fat	1.5 G
Cholesterol	**1**
Sodium	**70 MG**
Total Carbohydrates	**0**
Dietary Fiber	0 G
Sugars	0 G

Allergens
Egg

Ingredients
INGREDIENTS: SOYBEAN OIL, WATER, EGGS, VINEGAR, CONTAINS LESS THAN 2% OF SUGAR, SALT, EGG YOLKS, NATURAL FLAVOR (CONTAINS MUSTARD), LEMON JUICE CONCENTRATE, CALCIUM DISODIUM EDTA (TO PROTECT FLAVOR), DRIED GARLIC, DRIED ONIONS, PAPRIKA

Servings
120, 1 Tbsp (13g)

INGREDIENTS: WATER, OLIVE OIL, CANOLA OIL, VINEGAR, SOYBEAN OIL, MODIFIED FOOD STARCH*, EGGS, SUGAR, CONTAINS LESS THAN 2% OF EGG YOLKS, SALT, BLACK PEPPER, MUSTARD FLOUR, NATURAL FLAVOR, PHOSPHORIC ACID*, DRIED ONIONS, OLEORESIN PAPRIKA* (COLOR), BETA-CAROTENE*(COLOR) POTASSIUM SORBATE* AND CALCIUM DISODIUM EDTA (TO PROTECT FLAVOR)
*INGREDIENT NOT NORMALLY FOUND IN MAYONNAISE

CONTAINS: EGG.

Reversing the Omega 6 Problem

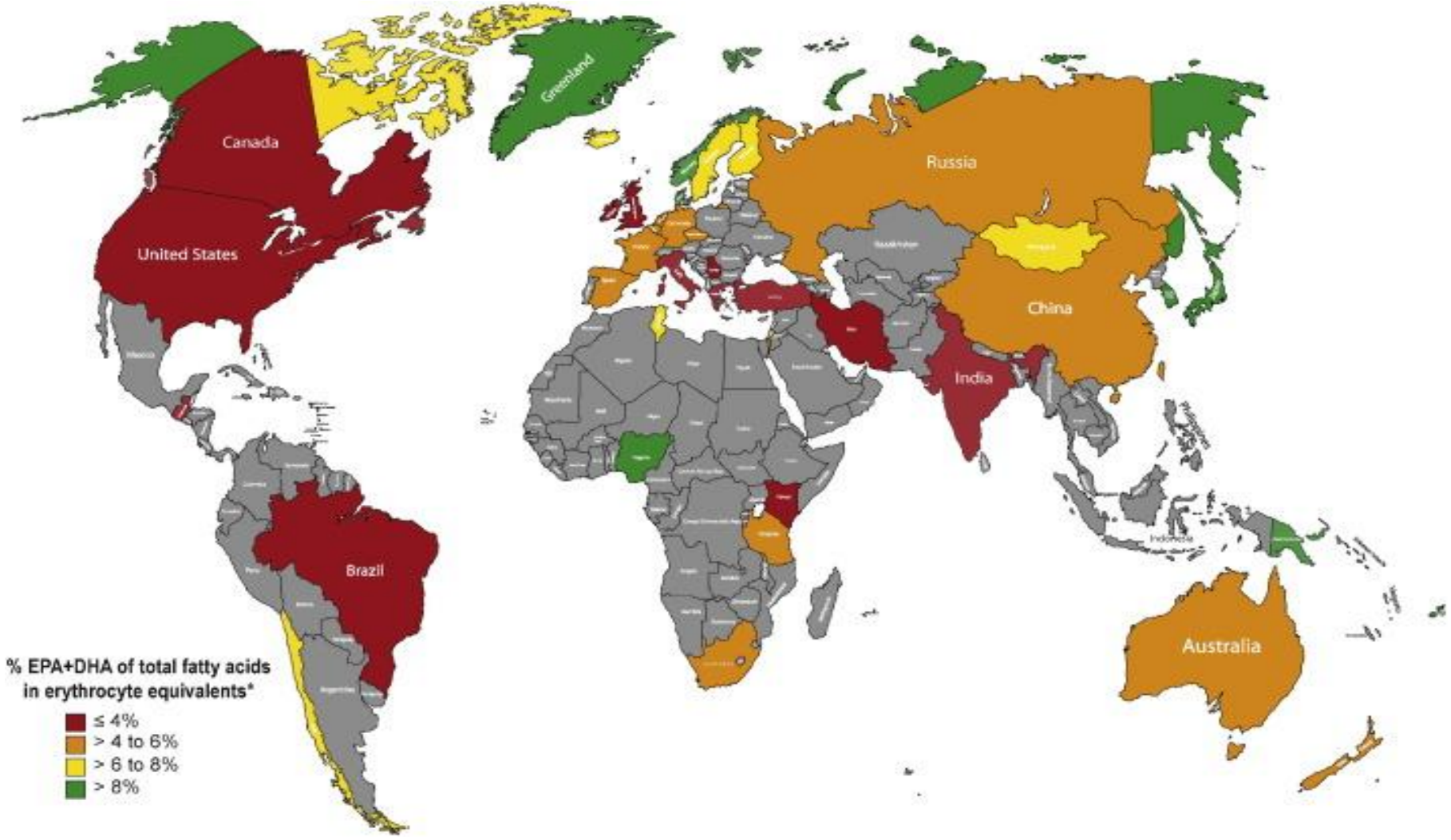
- ***What happens when ratio is 1:1 Omega 3:Omega 6?***
  - Healthier Blood Vessels
  - Lower lipid count (improvement in HDL and LDL)
  - Reduced risk for plaque buildup
  - Reduced risk for Diabetes
  - Reduced risk for several forms of cancer (i.e. breast)
  - Reduction in blood Triglycerides (those with high levels)

Testing Omega 3

Omega 3 Index Test

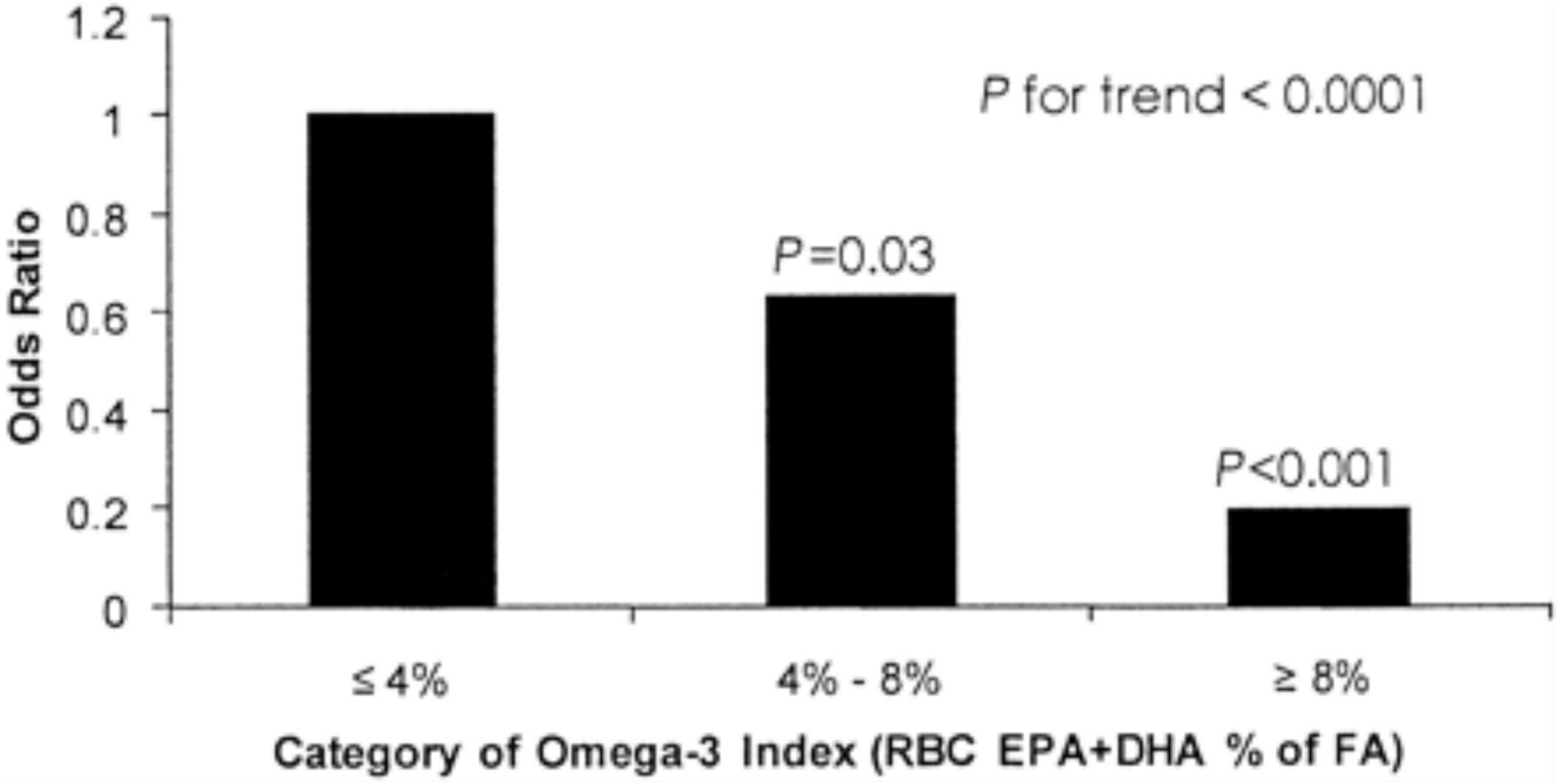
- Simple blood marker to assess Omega 3 in blood
- Sum of EPA + DHA in the erythrocyte membranes
- Rarely tested by physicians to assess CVD risk
- Good predictor of CVD/CHD risk
- **Levels of Risk based on Score**
  - **High risk:** <4%
  - **Intermediate Risk:** 4-8%
  - **Low Risk:** > 8%

Global view of Omega 3 Index



Stark et al. Global survey of the Omega 3 Fatty Acids, docosahexaenoic acid and eicosapentaenoic acid in the blood stream of healthy adults. (2016). *Progress in Lipid Research; (63), 132-152.*

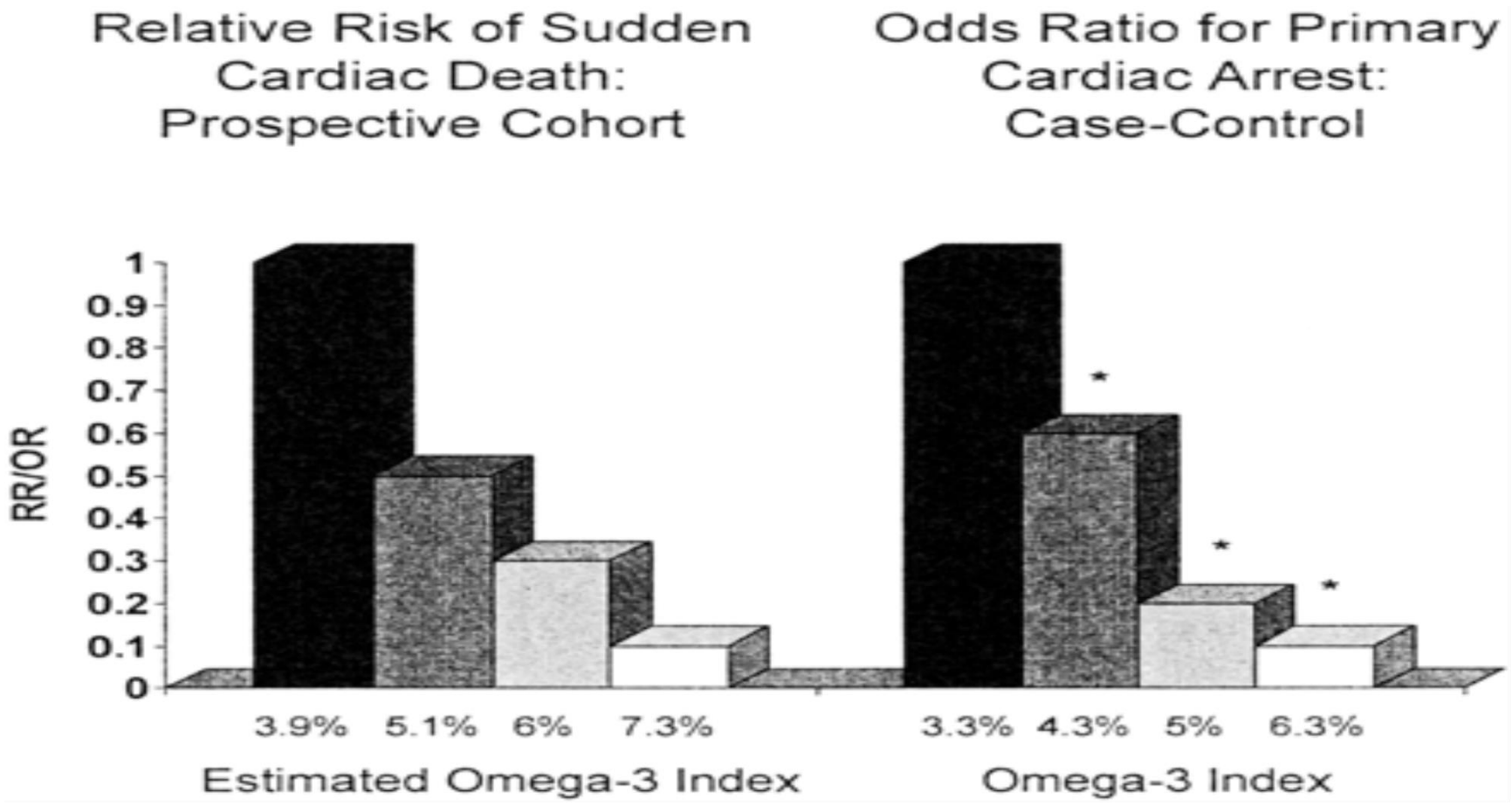
Omega 3 Index and CHD Risk



From: The omega-3 index as a risk factor for coronary heart disease

Am J Clin Nutr. 2008;87(6):1997S-2002S. doi:10.1093/ajcn/87.6.1997S

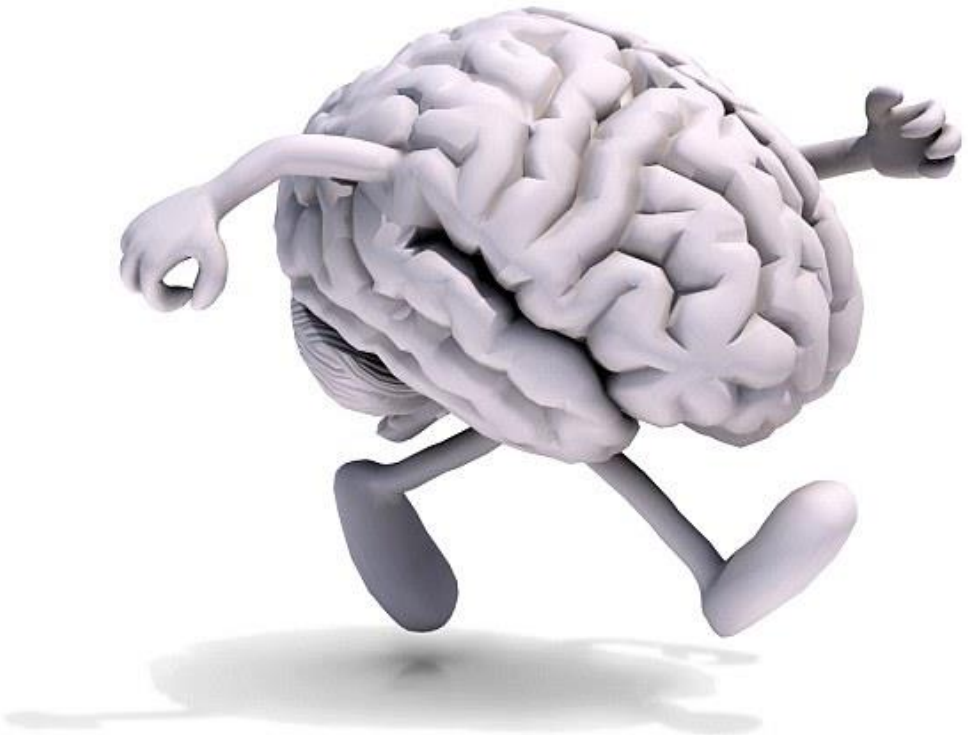
Omega 3 Index and CHD Risk



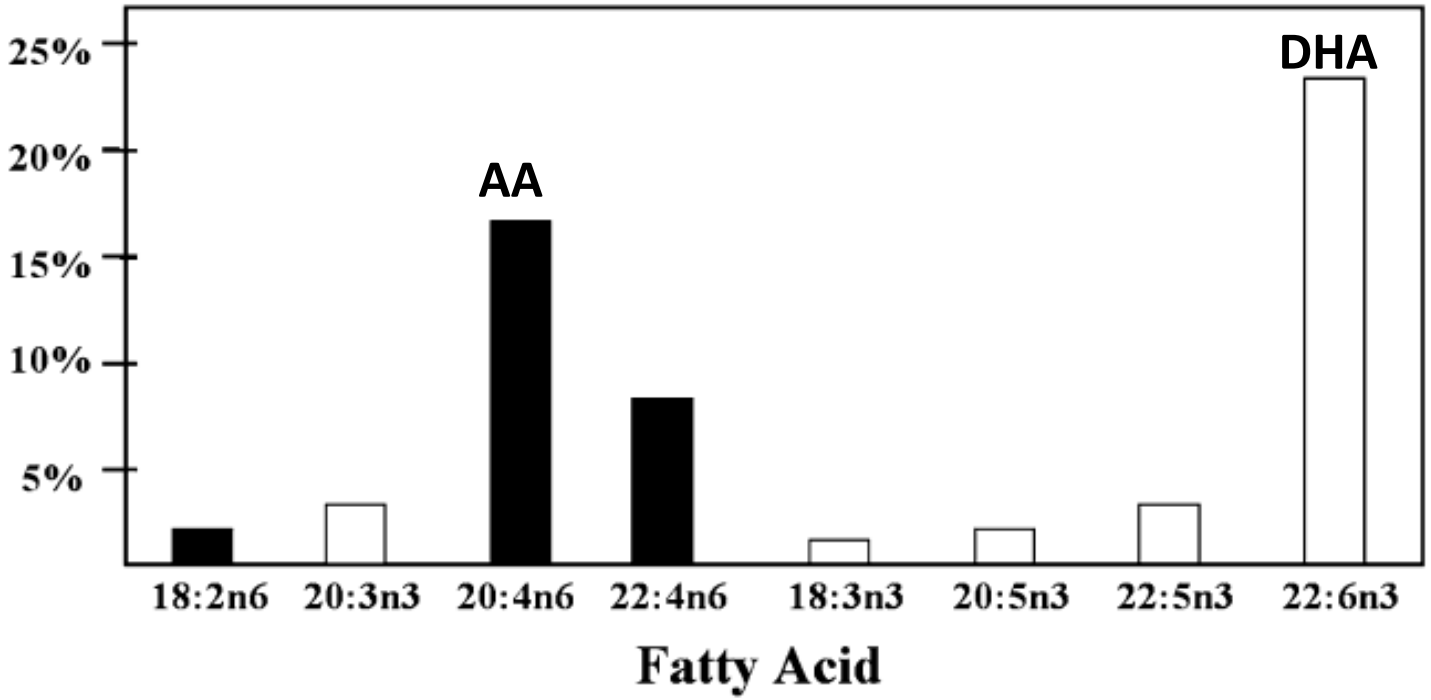
From: The omega-3 index as a risk factor for coronary heart disease

Am J Clin Nutr. 2008;87(6):1997S-2002S. doi:10.1093/ajcn/87.6.1997S

Omega 3 and Brain Health



Fatty Acid Composition of the Brain



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1. Ruff CB, Trinkhaus E, Holliday TW. Body mass and encephalisation in Pleistocene Homo. *Nature* 1997; 387: 173–176.

2. Leonard WR, Robertson ML. Evolutionary perspective on human nutrition: the influence of brain and body size on diet and metabolism. *Am J Hum Biol* 1994; 6: 77–88.

3. Aiello LC, Wheeler P. The expensive tissue hypothesis. *Curr Anthropol* 1995; 36: 199–222.

4. Crawford MA. The role of dietary fatty acids in biology: their place in the evolution of the human brain. *Nutr Rev* 1992; 50:3–11.

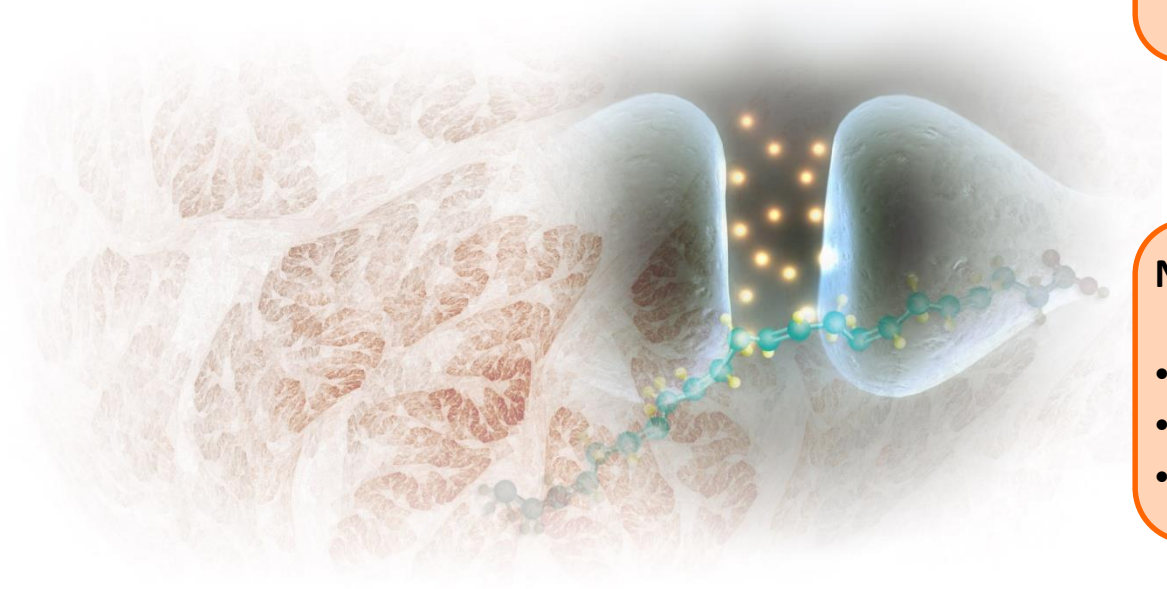
5. Cordain L, Watkins BA, Mann NJ. Fatty acid composition and energy density of foods available to Africanhominids. *World Rev Nutr Diet* 2001; 90:144–161.

Neuroprotective Effects of DHA

Release of DHA From Cell Membrane by Phospholipase A2

DHA

Resolvins
Lipoxins
15-Lipoxygenase (15-LOX) activation



Neuroprotectin-D1
(10,17S-docosatriene)
- Neuroprotective
- Anti-apoptotic
- Anti-inflammatory

Role of Omega-3s in Brain Development

Women with low omega-3 stores pass on this sub-optimal status to their newborns

Increasing omega-3 intake during pregnancy can enhance maternal DHA status

Otto, S.J., Houwelingen, A.C., Antal, M., Manninen, A., Godfrey, K. & Lopez, J.P. (1997) Maternal and neonatal essential fatty acid status in phospholipids: an international comparative study. *Eur. J. Clin. Nutr.* **51**, 232–242

Omega-3 in Early Child Development

Mothers who ate fish four times a week during pregnancy had babies with higher developmental scores at 18 months compared with those who ate no fish

Children whose mothers received 1.18 g DHA and 0.8 g EPA per day at 4 years of age showed significantly higher IQ tests

Daniels,et al, Fish Intake During Pregnancy and Early Cognitive Development of Offspring. *Epidemiology* 2004;15: 394–402)

Helland, I.B., Smith, L., Saarem, K., Saugstad, O.D. & Drevon, C.A. (2003) Maternal supplementation with very-long-chain n-3 fatty acids during pregnancy and lactation augments children's IQ at 4 years of age. *Pediatrics* 111, 39–44.

Omega-3 and Autism

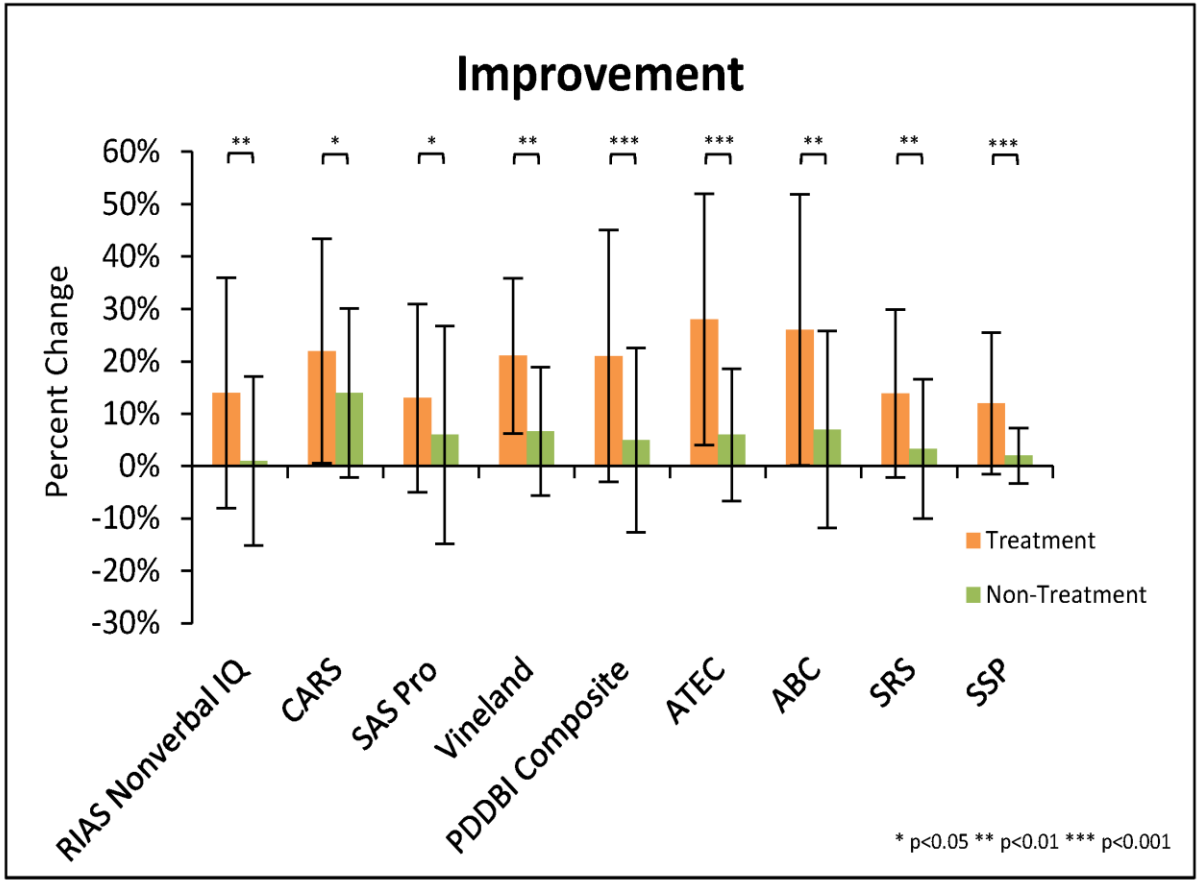
- *12 Month Randomized Controlled Trial with Children and Adults with Autism Spectrum Disorder (ASD) who received a multi-nutrient supplement + EPA and DHA starting at day 60.*
- ***Treat Dose dependent on size***
  - 30-50 lbs: 2 caps/d (850 mg EPA/220 mg DHA)
  - 51-100 lbs: 3 caps/d (1275 mg EPA/330 mg DHA)
  - 100+ lbs: 4 caps/d (1700 mg EPA/440 mg DHA)

Adams,et al, Comprehensive Nutritional and Dietary Intervention for Autism Spectrum Disorder – A Randomized Controlled 12 Month Trial. *Nutrients* 2018;10(3): 394–402)

Omega-3 and Autism

Measurements of:

- Performance
- Autism Symptoms
- Functionality
- Behavior
- Social Response



Adams,et al, Comprehensive Nutritional and Dietary Intervention for Autism Spectrum Disorder – A Randomized Controlled 12 Month Trial. *Nutrients* 2018;10(3): 394–402)

Omega-3 and ADD/ADHD

- *Systematic review of 16 RCT which included 1,514 children and young people (up to 18 years) with ADHD*
- *Subjects had ADHD at baseline*
- *Had to be taking Omega 3 supplement with EPA, DHA, and GLA*
- *4 studies used a ratio of 9:3:1 (EPA:DHA:GLA)*
- ***Results***
  - 13/16 studies demonstrated favorable benefits on ADHD symptoms
  - Omega 3 lowered to dose of traditional medicine and proved to be an effective adjunct therapy

Derbyshire E. Do Omega-3/6 Fatty Acids Have a Therapeutic Role in Children and Young People with ADHD? *J Lipids 2017;6285218.*

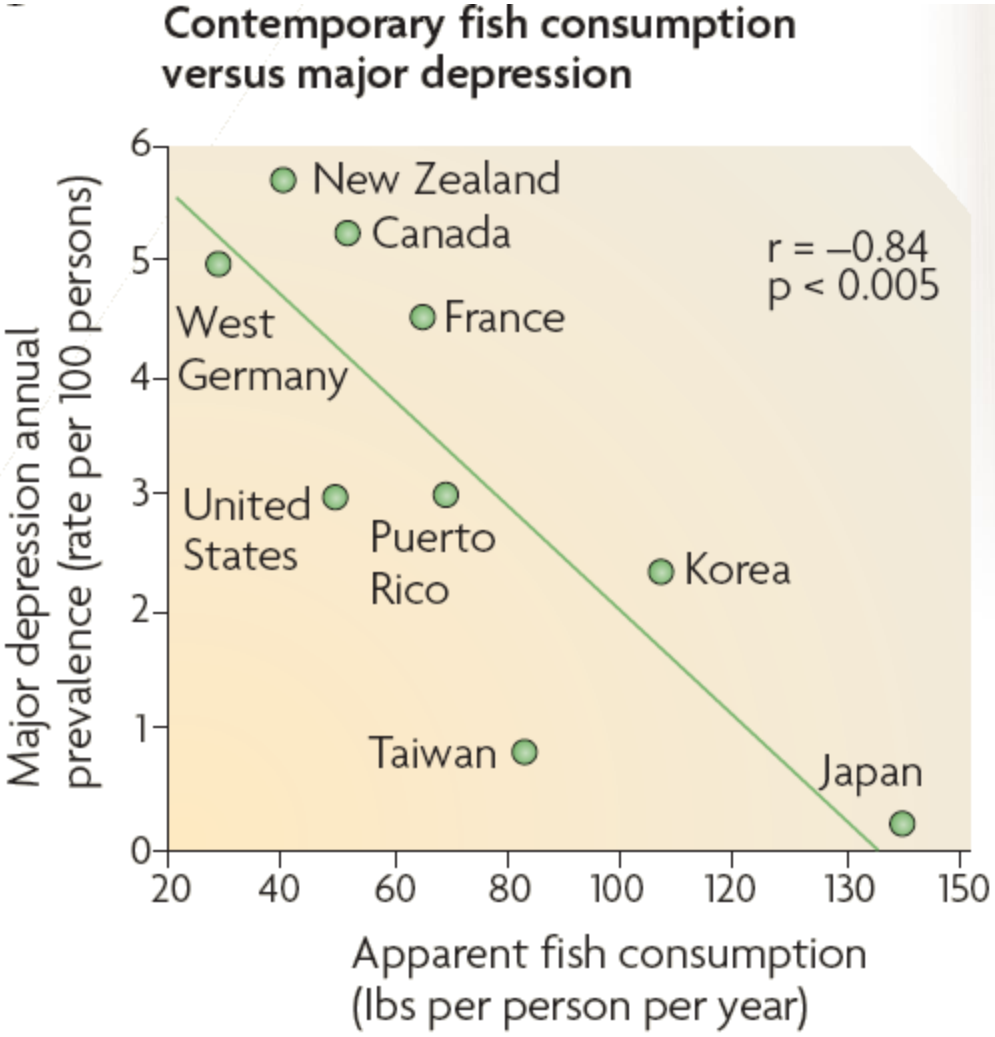
Omega-3 and ADD/ADHD

Omega 3 supplementation demonstrated improvements in:

- Hyperactivity
- Impulsivity
- Attention
- Visual learning
- Word reading
- Working/Short-term memory

Derbyshire E. Do Omega-3/6 Fatty Acids Have a Therapeutic Role in Children and Young People with ADHD? *J Lipids 2017;6285218.*

Depression and Omega-3



Hibbeln JR. Fish consumption and major depression. *Lancet 1998;351:1213.*

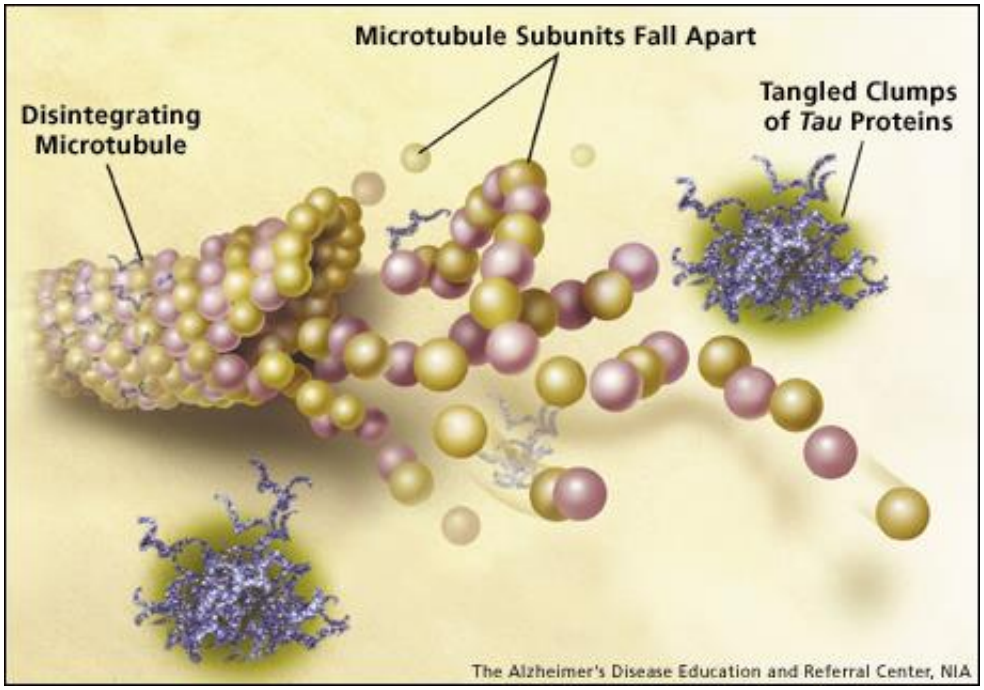
Alzheimer's Disease

As many as 5.2 million people in the United States are living with Alzheimer's.

10 million baby boomers will develop Alzheimer's in their lifetime.

Every 71 seconds, someone develops Alzheimer's.

Alzheimer's is the sixth-leading cause of death.



The direct and indirect costs of Alzheimer's and other dementias to Medicare, Medicaid and businesses amount to more than $148 billion each year.

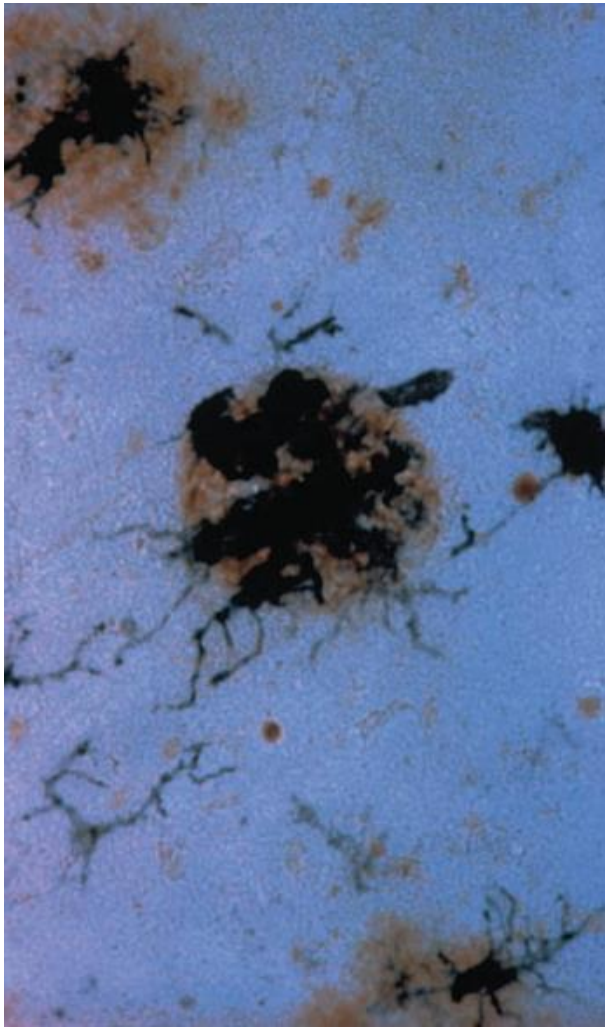
Alzheimer's Disease is an Inflammatory Disease

There is evidence within the brain of:

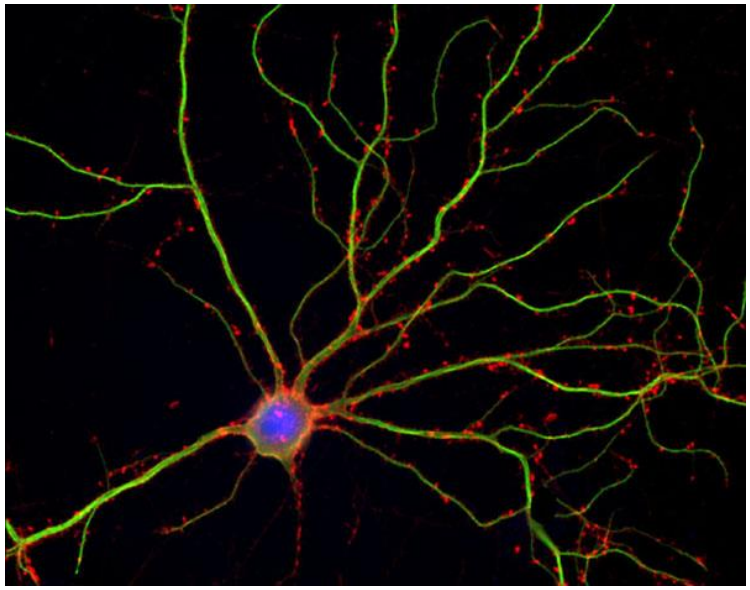
Pro-inflammatory cytokines

Reactive microglia (phagocytes producing oxygen radicals)

Effect of anti-inflammatory drugs



DHA as a Possible Treatment for Existing Beta Amyloid Plaques



DHA increases the production of LR11, a protein that is found at reduced levels in Alzheimer's patients.

LR11 is known to destroy the beta amyloid protein plaques associated with AD

Ma *et al.* Omega-3 DHA Increases AD Protective Factor LR11 J. *Neurosci.,* December 26, 2007. 27(52):14299 –14307

Dietary Fats and the Risk of Incident Alzheimer's Disease

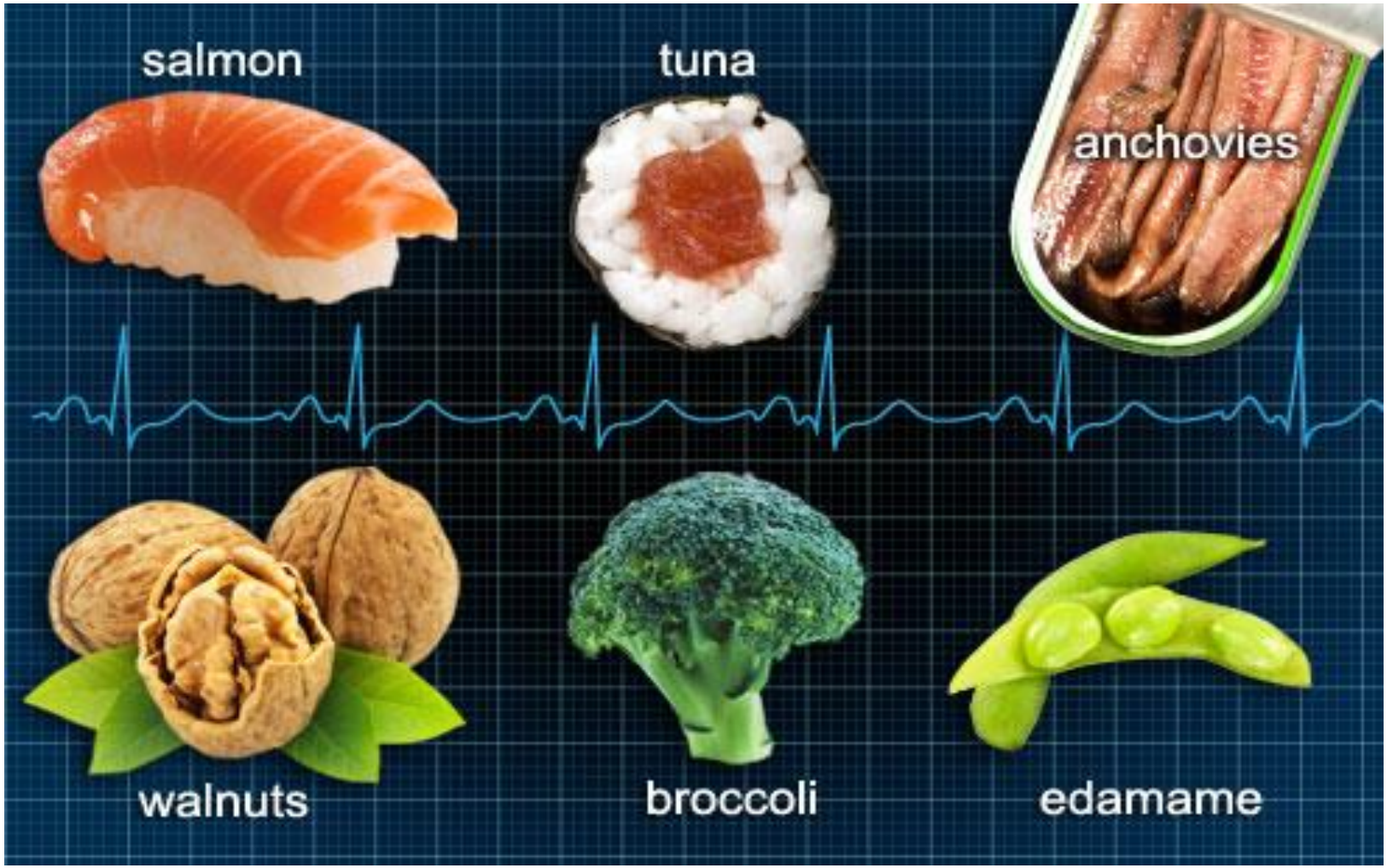
High intake of hydrogenated fats increased risk of Alzheimer's by 360%

High intake of un-hydrogenated fats reduced risk of Alzheimer's by 20%

The age-adjusted risk of Alzheimer disease for persons in the top fifth of saturated fat intake was 70% higher than for persons in the lowest fifth

Morris, M.C., *et al.*, Arch Neurol 60: 194-200; February, 2003

What's the role of omega-3s for athletes?



Concussion in Youth Sports

3.8 million concussions in 2012

47% from football, followed by hockey and soccer

33% happen at practice

Considered an "invisible" wound

- Symptoms not reported

54/100,000 athletic exposures

- Boy's hockey

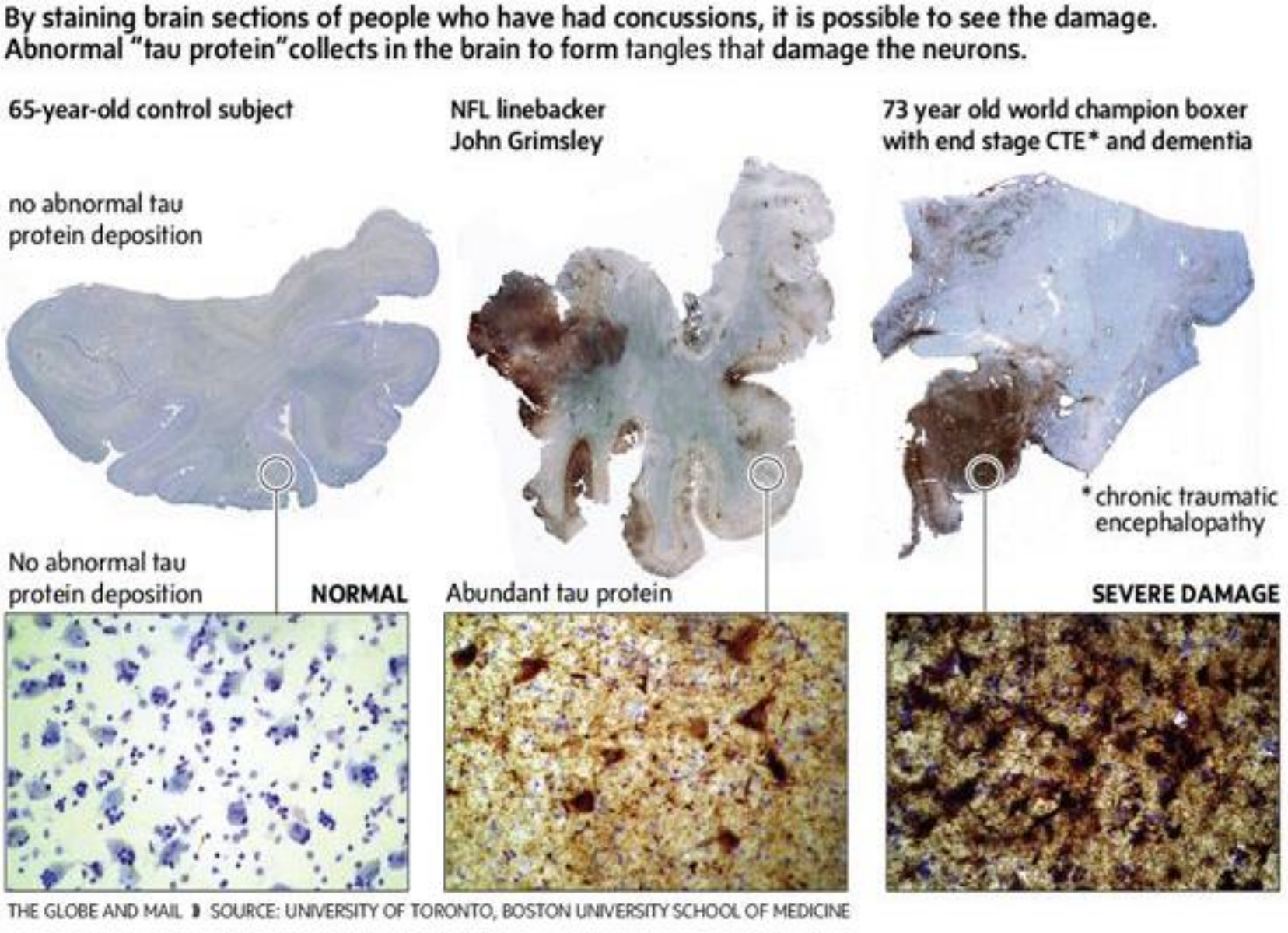
Comparison of Concussions

	NFL*	NHL*	High School*
# of Participants	1,696	690	1,050,000
Ave Concussions per year	144	71	63,750
Annual % per year	8.5	10.3	5.75

Ref: Pellman, EJ, Concussion in Football, Neurosurg Focus:21 (4) E12, 2006, Wennberg, RA, Concussion Incidence and Time Lost from Play in the NHL during the Past 10 years, Can J Neurol Sci, (35) 2008, Collins, M, Examining Concussion Rates and RTP in HS Football Players Wearing Newer Helmet Technology: A 3-yr Study, Neurosurgery, (58) No 2 Feb 2006

*** Approximation** **90 reported concussions NHL in 2013**

The Injured Brain



Current Treatment for TBI/Concussion

Remove from play immediately!

Physical and cognitive rest until asymptomatic

Progressive return to play

Medications (symptom control)

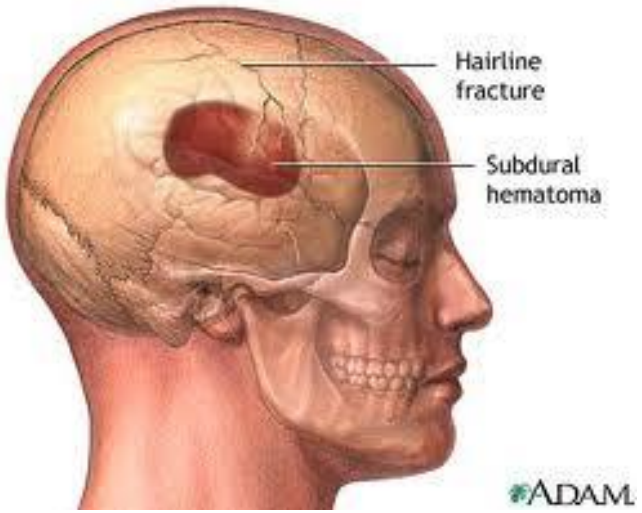
- One symptom → One Drug

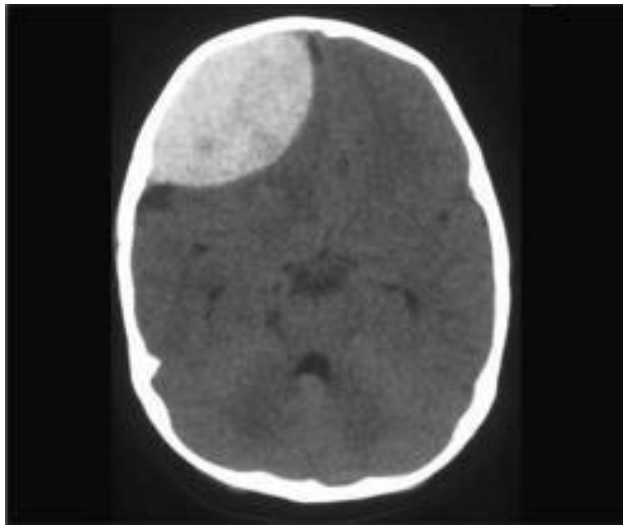
Nothing addresses the BRAIN itself!

*Nothing for **neuroprotection**, **neuroinflammation** and **regeneration** following TBI*

Dr. Michael Lewis, AND Conference (2014)

Severe TBI





American Journal of Emergency Medicine (2013) 31, 273.e5–273.e8

ELSEVIER

The American Journal of Emergency Medicine

www.elsevier.com/locate/ajem

Teenager with severe TBI in auto accident

Case Report

Therapeutic use of omega-3 fatty acids in severe head trauma☆

Abstract

Traumatic brain injury (TBI) has long been recognized as the leading cause of traumatic death and disability. Tremendous advances in surgical and intensive care unit management of the primary injury, including maintaining adequate oxygenation, controlling intracranial pressure, and ensuring proper cerebral perfusion pressure, have resulted in reduced mortality. However, the secondary injury phase of TBI is a prolonged pathogenic process characterized by neuroinflammation, excitatory amino acids, free radicals, and ion imbalance. There are no approved therapies to directly address these underlying processes. Here, we present a case that was intentionally treated with substantial amounts of omega-3 fatty acids (n-3FA) to provide the nutritional foundation for the brain to begin the healing process following severe TBI. Recent animal research supports the use of n-3FA, and clinical experience suggests that benefits may be possible from substantially and aggressively adding n-3FA to optimize the nutritional foundation of severe TBI patients and must be in place if the brain is to be given the opportunity to repair itself to the best possible extent. Administration early in the course of treatment, in the emergency department or sooner, has the potential to improve outcomes from this potentially devastating public health problem.

Traumatic brain injury (TBI) has long been recognized as a leading cause of traumatic death and disability [1-3]. Tremendous advances in surgical and intensive care unit management of the primary injury, including maintaining adequate oxygenation, controlling intracranial pressure, and ensuring proper cerebral perfusion, have resulted in reduced mortality [3,4]. However, the secondary injury phase of TBI is a prolonged pathogenic process characterized by neuroinflammation, excitatory amino acids, free radicals, and ion imbalance [5]. There are no approved therapies to directly address these underlying processes. Here we present a case that was intentionally treated with substantial amounts of omega-3 fatty acids (n-3FA) to provide the nutritional foundation for the brain to begin the healing process following severe TBI.

In March 2010, a teenager sustained a severe TBI in a motor vehicle accident. After prolonged extrication, he was resuscitated at the scene and flown to a Level I Trauma Center. His Glasgow Coma Scale score was 3. Computerized tomography revealed panhemispheric right subdural and small temporal epidural hematomas and a 3-mm midline shift (Fig. 1). The patient underwent emergency craniotomy and intracranial pressure monitor placement. The patient was rated at Rancho Los Amigos Cognitive Scale Level I, and the attending neurosurgeon's impression was that the injury was likely lethal.

On hospital day 10, T2-weighted magnetic resonance imaging revealed right cerebral convexity subdural hemorrhage and abnormal fluid-attenuated inversion recovery signals consistent with diffuse axonal injury (Fig. 2). Believed to be in a permanent vegetative state, a tracheotomy and percutaneous endoscopic gastrostomy (PEG) tube were placed for custodial care; and enteral feedings were started (Promote; 80 mL/h; 1920 kcal/d). The following day, n-3FA were added to enteral feedings.

On day 10, it was recommended to the patient's father to procure Nordic Naturals (Watsonville, CA) brand Ultimate Omega from a local retail store. With the cooperation of the attending neurosurgeon and hospital pharmacy, the patient began receiving 15 mL twice a day (30 mL/d), providing 9756 mg eicosapentaenoic acid, 6756 mg docosahexaenoic acid (DHA), and 19212 mg total n-3FA daily via his PEG. On day 21, he was weaned off the ventilator and transported to a specialized rehabilitation institute 3 days later. His level of functioning was measured at Rancho Los Amigos Level III. The patient began therapy that gradually led to cognitive and physical improvements. Notably, the patient was given permission and attended his high school graduation 3 months after the injury to receive his diploma. He was discharged to home 4 months after the injury. Over the following year, Nordic Naturals generously donated a steady supply of Pro Omega-D (the professional version of Ultimate Omega) that also provided vitamin D3 (6000 IU). The patient remained on this level of n-3FA for more than 1 year and experienced no adverse effects. Two years later, the patient is at Rancho Los Amigos Level VIII, but

☆ Support: Therapeutic nutritional material as described in this manuscript was provided at no cost by Nordic Naturals, Inc, 111 Jennings Dr, Watsonville, CA 95076.

Omega-3s and TBI

Teenager sustained TBI in Motor Vehicle Accident

Glasgow Coma Scale score of 3 (deep unconsciousness)

Right subdural and small temporal hematoma

***Day 10**: believed to be in vegetative state, placed tracheotomy and PEG tube, started enteral feedings*

- Was not given the weekend to live

***Day 11**: 9.7 g EPA, 6.7 g DHA provided via PEG tube*

***Day 21**: weaned off ventilator and began rehabilitation 3 days later*

Omega-3s and TBI

Played by Alec Baldwin in Concussion

Surviving a Mine Explosion

Lawrence Roberts, MD, Julian Bailes, MD, Harakh Dedhia, MD, Anthony Zikos, MD, Anil Singh, MD, Darby McDowell, RD, LD, Conrad Failinger, MD, Russell Biundo, MD, James Petrick, PhD, Jeffrey Carpenter, MD

In January 2006, an explosion in the Sago mine in central West Virginia resulted in 14 trapped miners. Approximately 41 hours later, one lone survivor was found and brought to medical care. It became apparent that the survivor had not suffered blast injuries, but rather hypoxia and exposure to toxic gases, dehydration, and rhabdomyolysis. During rapid prehospital care, followed by acute resuscitation and hospitalization, this patient demonstrated many classic features of carbon monoxide toxicity, including neurologic, cardiac, and renal dysfunction. In addition, the patient suffered from respiratory failure. Rapid resuscitation with end-organ perfusion and hyperbaric oxygen therapy treatment resulted in a dramatic improvement in all areas. After inpatient rehabilitation, the patient has returned to his wife, children, and family and is conversant and ambulating. This article explores the causes of these unique injuries, and a medical explanation for the extent of recovery in the sole survivor. To our knowledge, this is the first case of a survivor of prolonged exposure in a mining accident.

Case presentation

A 26-year-old man, a roof bolter on a coal mining team, was trapped with 13 other miners in the Sago Mine in north-central West Virginia on January 2, 2006. At the time of this writing, the leading theory is that an adjacent abandoned mine had an apparent accumulation of methane gas, and a resulting explosion from a presumed lightning bolt blasted out the wall between old and new mines. Immediate smoke and debris forced the 13 miners to a mine shaft that was farthest from the mine entry. The miners attempted to construct a barricade to preserve clean air, and used sledge hammers on ceiling bolts to attract attention. The miners used emergency air supplies. Smoke and toxic air was soon overwhelming and, based on best data including autopsy reports, the miners died of asphyxiation one by one. Several who died had high (>70%) carboxyhemoglobin levels. This case involves the only survivor, who was ultimately found in the mine adjacent to his perished fellow miners approximately 41 hours after the explosion. Delay in rescue was related to high levels of toxins and dense smoke in the mine preventing rescuers from entering. Carbon monoxide (CO) measurements in the air adjacent to where the miners were found measured 1,300 parts per million, and >2,000 parts per million at the surface mine exhaust fan opening.

The first rescuers to find the sole survivor found him sitting up but slumped, in respiratory distress with shallow breathing, and "gasping for breath." His jaw was clenched. Because of his shallow breathing, supplemental air supplied by the emergency breathing "rescuer" devices was only of limited benefit. The two rescuers carried the survivor on a stretcher 1/2 mile to a man-car on which he was transported the additional 2 1/2 miles out of the mine shaft. Evacuation to the surface once the survivor was found took >1 hour.

Emergency medical services responders initially expected multiple survivors. Supplemental oxygen by facemask was provided. An IV was started and crystalloid hydration begun. The patient was emergently transported to the nearest hospital. The initial neurologic examination showed that the patient was comatose and unresponsive to verbal stimuli. The Emergency Department physician promptly intubated the patient and began high-flow oxygen therapy. Carboxy-hemoglobin (HbCO) was measured at <20% using a 30% sodium hydroxide HbCO screening test.[1] A Foley catheter was placed, which yielded minimal urine. The patient was transported by ground to the Jon Michael Moore Trauma Center of West Virginia University in Morgantown, WV. Air evacuation was not possible because of weather and fog. Evaluation in the trauma bay confirmed proper endotracheal tube placement, and chest x-ray demonstrated opacification of the left hemithorax, suggestive of lung collapse (atelectasis.) The patient re-

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doi:10.1016/j.jamcollsurg.2008.02.015

- One lone survivor out of 14
- Suffered from respiratory distress due to elevated CO levels
- Lung collapse
- Unresponsive and comatose
- **Given high dosage of Fish Oil through PEG tube**
- **Had full recovery**

DOI: 10.3171/2010.5.JNS08914

J Neurosurg / July 16, 2010

Omega-3 fatty acid supplementation and reduction of traumatic axonal injury in a rodent head injury model

Laboratory investigation

James D. Mills, M.D.,[1] Julian E. Bailes, M.D.,[1] Cara L. Sedney, M.D.,[1] Heather Hutchins, M.S., R.D.,[2] and Barry Sears, Ph.D.[2]

[1]*Department of Neurosurgery, West Virginia University School of Medicine, Morgantown, West Virginia; and* [2]*Inflammation Research Foundation, Marblehead, Massachusetts*

Object. Traumatic brain injury remains the most common cause of death in persons under 45 years of age in the Western world. Recent evidence from animal studies suggests that supplementation with omega-3 fatty acid (O3FA) (particularly eicosapentaenoic acid [EPA] and docosahexaenoic acid [DHA]) improves functional outcomes following focal neural injury. The purpose of this study is to determine the benefits of O3FA supplementation following diffuse axonal injury in rats.

Methods. Forty adult male Sprague-Dawley rats were used. Three groups of 10 rats were subjected to an impact acceleration injury and the remaining group underwent a sham-injury procedure (surgery, but no impact injury). Two of the groups subjected to the injury were supplemented with 10 or 40 mg/kg/day of O3FA; the third injured group served as an unsupplemented control group. The sham-injured rats likewise received no O3FA supplementation. Serum fatty acid levels were determined from the isolated plasma phospholipids prior to the injury and at the end of the 30 days of supplementation. After the animals had been killed, immunohistochemical analysis of brainstem white matter tracts was performed to assess the presence of β-amyloid precursor protein (APP), a marker of axonal injury. Immunohistochemical analyses of axonal injury mechanisms—including analysis for caspase-3, a marker of apoptosis; RMO-14, a marker of neurofilament compaction; and cytochrome c, a marker of mitochondrial injury—were performed.

Results. Dietary supplementation with a fish oil concentrate rich in EPA and DHA for 30 days resulted in significant increases in O3FA serum levels: 11.6% ± 4.9% over initial levels in the 10 mg/kg/day group and 30.7% ± 3.6% in the 40 mg/kg/day group. Immunohistochemical analysis revealed significantly ($p < 0.05$) decreased numbers of APP-positive axons in animals receiving O3FA supplementation: 7.7 ± 14.4 axons per mm^2 in the 10 mg/kg/day group and 6.2 ± 11.4 axons per mm^2 in the 40 mg/kg/day group, versus 182.2 ± 44.6 axons per mm^2 in unsupplemented animals. Sham-injured animals had 4.1 ± 1.3 APP-positive axons per mm^2. Similarly, immunohistochemical analysis of caspase-3 expression demonstrated significant ($p < 0.05$) reduction in animals receiving O3FA supplementation, 18.5 ± 28.3 axons per mm^2 in the 10 mg/kg/day group and 13.8 ± 18.9 axons per mm^2 in the 40 mg/kg/day group, versus 129.3 ± 49.1 axons per mm^2 in unsupplemented animals.

Conclusions. Dietary supplementation with a fish oil concentrate rich in the O3FAs EPA and DHA increases serum levels of these same fatty acids in a dose-response effect. Omega-3 fatty acid supplementation significantly reduces the number of APP-positive axons at 30 days postinjury to levels similar to those in uninjured animals. Omega-3 fatty acids are safe, affordable, and readily available worldwide to potentially reduce the burden of traumatic brain injury. *(DOI: 10.3171/2010.5.JNS08914)*

Omega 3 and TBI

40 adult male Sprague Daley rats

3 groups of 10 rats received accelerated impact injury and the remaining surgery (sham injury)

2 groups supplemented with 10 or 40 mg/kg/day

No supplementation for 1 injured group and Sham injury group

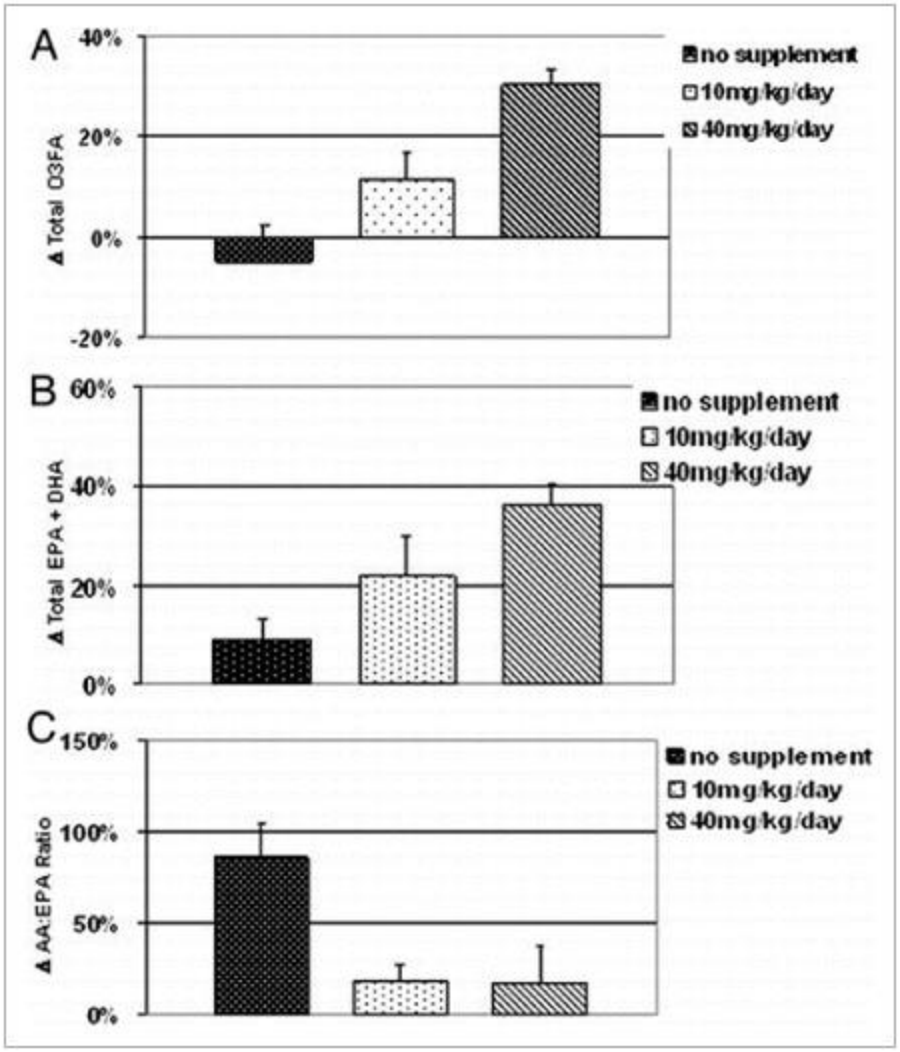


FIG. 1.

Graphs showing that oral supplementation with either 10 mg/kg/day or 40 mg/kg/day of concentrated fish oil for 30 days increased serum total O3FA levels **(A)** and combined EPA and DHA levels **(B)**. The AA/EPA ratio, a marker of systemic inflammation, was significantly lower in animals receiving fish oil supplementation than in unsupplemented animals **(C)**. The y axis values represent the percentage increase (or decrease) compared to preinjury values.

Omega 3 and TBI

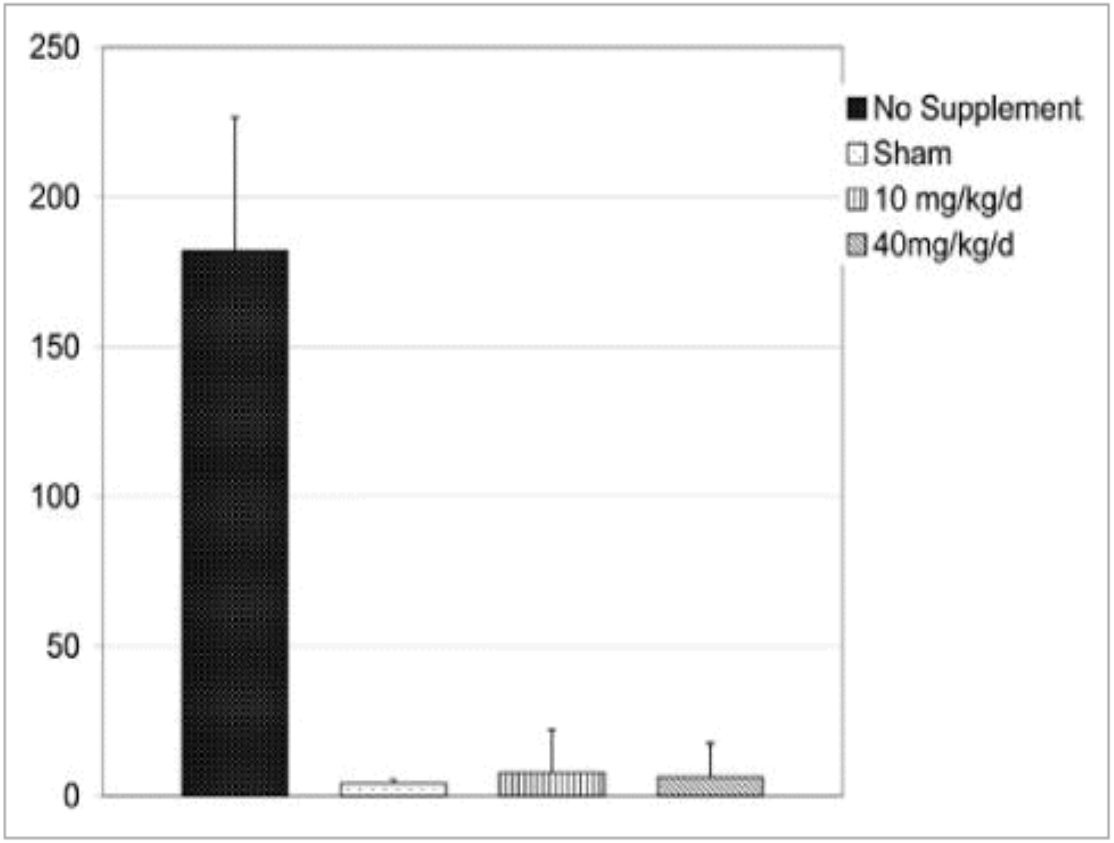


FIG. 3.

Graph demonstrating the density of APP-positive axons in corticospinal tracts and medial lemnisci in sham-injured, unsupplemented, and O3FA-supplemented rats. * $p < 0.05$, significantly different from the 3 other groups.

Omega 3 and TBI/Concussion

- *Boxing, Football, and Hockey have elevated risk of sustaining a Concussion/TBI*
- *Increase in head rotational acceleration and deceleration forces putting more force through the brain*
- *Results in acceleration/deceleration on neurons which lead to axonal injury (major characteristic of TBI)*
- *Single season of High School FB resulted in changes in MRI indicative of axonal injury in the absence of concussion diagnosis*

Davenport et al. (2014) J. Neurotrauma

Omega 3 and TBI/Concussion

- *Neurofilament Light (NFL) = key intermediate fibers in neurons and the axonal skeleton*
- *Unsure mechanism of release and appearance of NFL in biological fluids*
- *Do know significant changes in NFL as a result of axonal injury*
- *Elevations in cerebrospinal fluid (CSF) and NFL reported in boxers sustaining concussive or sub-concussive head impacts*
- *Also seen elevations in CSF and NFL in patients suffering from neurodegenerative and neuro-inflammation related diseases*

Siedler et al. (2014) Front Cell Neurosci
Neselius et al. (2012) Plos ONE

Omega 3 and TBI

Medicine & Science in Sports & Exercise, Publish Ahead of Print
DOI: 10.1249/MSS.0000000000000875

Effect of Docosahexaenoic Acid on a Biomarker of Head Trauma in American Football

Jonathan M. Oliver[1], Margaret T. Jones[2], K. Michele Kirk[1,3,4], David A. Gable[1,3], Justin T. Repshas[1], Torie A. Johnson[1], Ulf Andréasson[6], Niklas Norgren[5], Kaj Blennow[6], and Henrik Zetterberg[6,7]

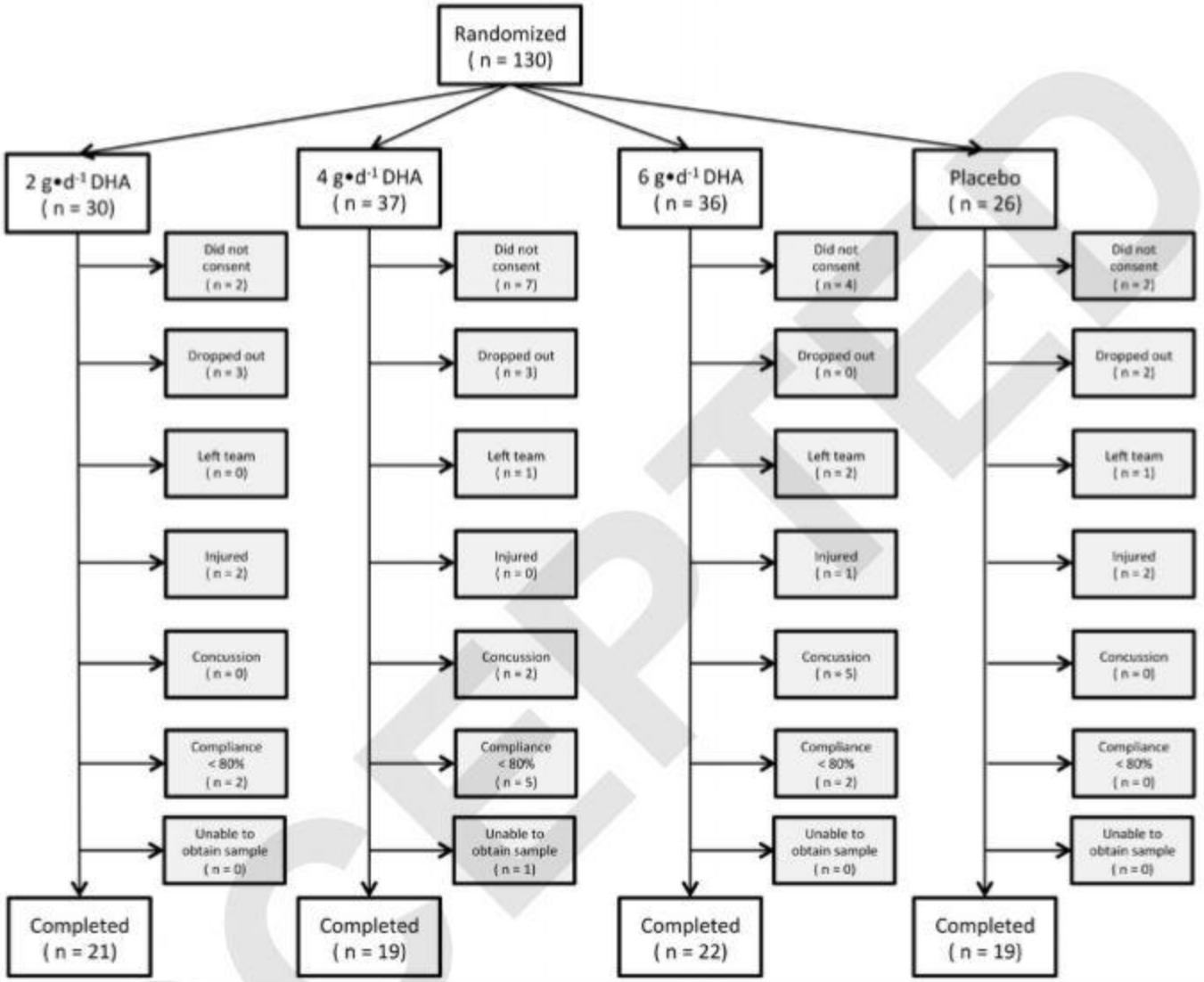
Omega 3 and TBI

Purpose: *To examine the effects of DHA supplementation on Neurofilament light (NFL) – marker of Axonal injury*

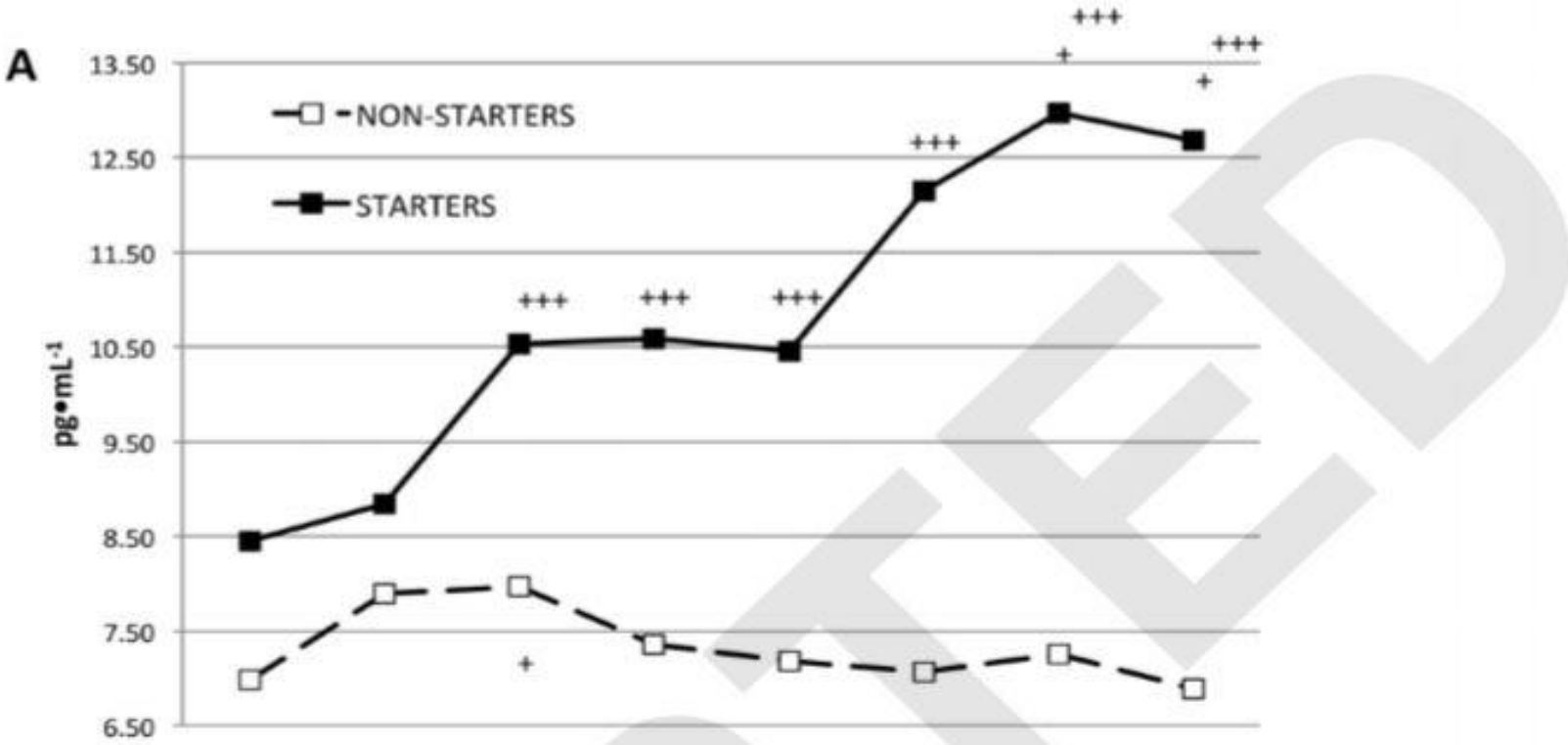
Methods: *RDBPC study with 81 NCAA Divison 1 football players to ingest 2g/d, 4g/d, 6g/d of DHA or placebo (corn oil)*

Design: *Examined 189 days (57 days summer conditioning, 23 days pre-season camp, and 109 days of season)*

Oliver et al. (2016) Med Sci Sports Exerc

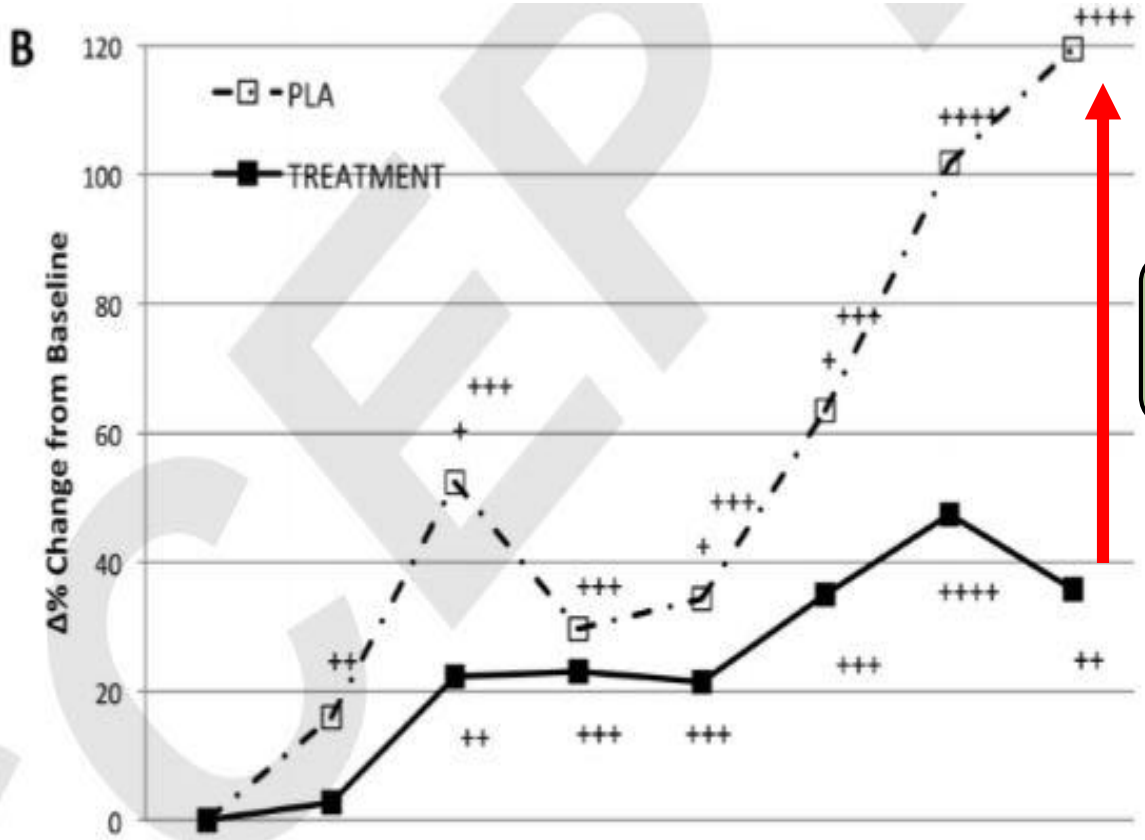

Randomized
(n = 130)
2 g•d-1 DHA
(n = 30)
4 g•d-1 DHA
(n = 37)
6 g•d-1 DHA
(n = 36)
Placebo
(n = 26)
Did not consent (n = 2)
Dropped out (n = 3)
Left team (n = 0)
Injured (n = 2)
Concussion (n = 0)
Compliance < 80% (n = 2)
Unable to obtain sample (n = 0)
Did not consent (n = 7)
Dropped out (n = 3)
Left team (n = 1)
Injured (n = 0)
Concussion (n = 2)
Compliance < 80% (n = 5)
Unable to obtain sample (n = 1)
Did not consent (n = 4)
Dropped out (n = 0)
Left team (n = 2)
Injured (n = 1)
Concussion (n = 5)
Compliance < 80% (n = 2)
Unable to obtain sample (n = 0)
Did not consent (n = 2)
Dropped out (n = 2)
Left team (n = 1)
Injured (n = 2)
Concussion (n = 0)
Compliance < 80% (n = 0)
Unable to obtain sample (n = 0)
Completed
(n = 21)
Completed
(n = 19)
Completed
(n = 22)
Completed
(n = 19)

Omega 3 and TBI/Concussion



Changes in serum neurofilament light (pg•mL-1) over the course of the study in starters and non-starters

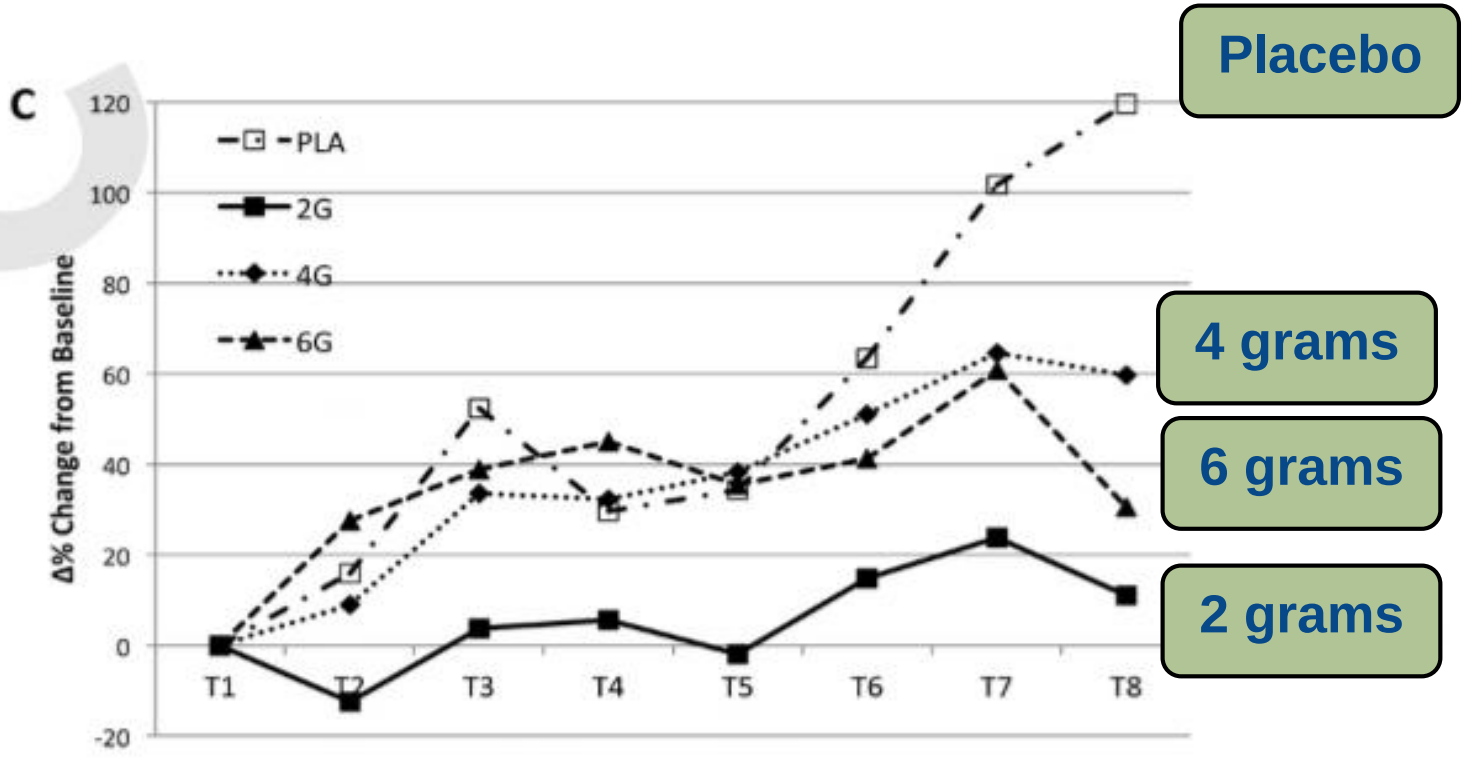
Omega 3 and TBI/Concussion



Significant difference

Effect of supplemental docosahexaenoic acid (DHA) on serum neurofilament light (% change from baseline) over the course of the study in starters;

Omega 3 and TBI



Effect of supplemental docosahexaenoic acid (DHA) on serum neurofilament light (% change from baseline) over the course of the study in starters across all doses and separated by dosage;

Why Higher Dosages of Omega-3s

Balance to the omega 6:3 ratio

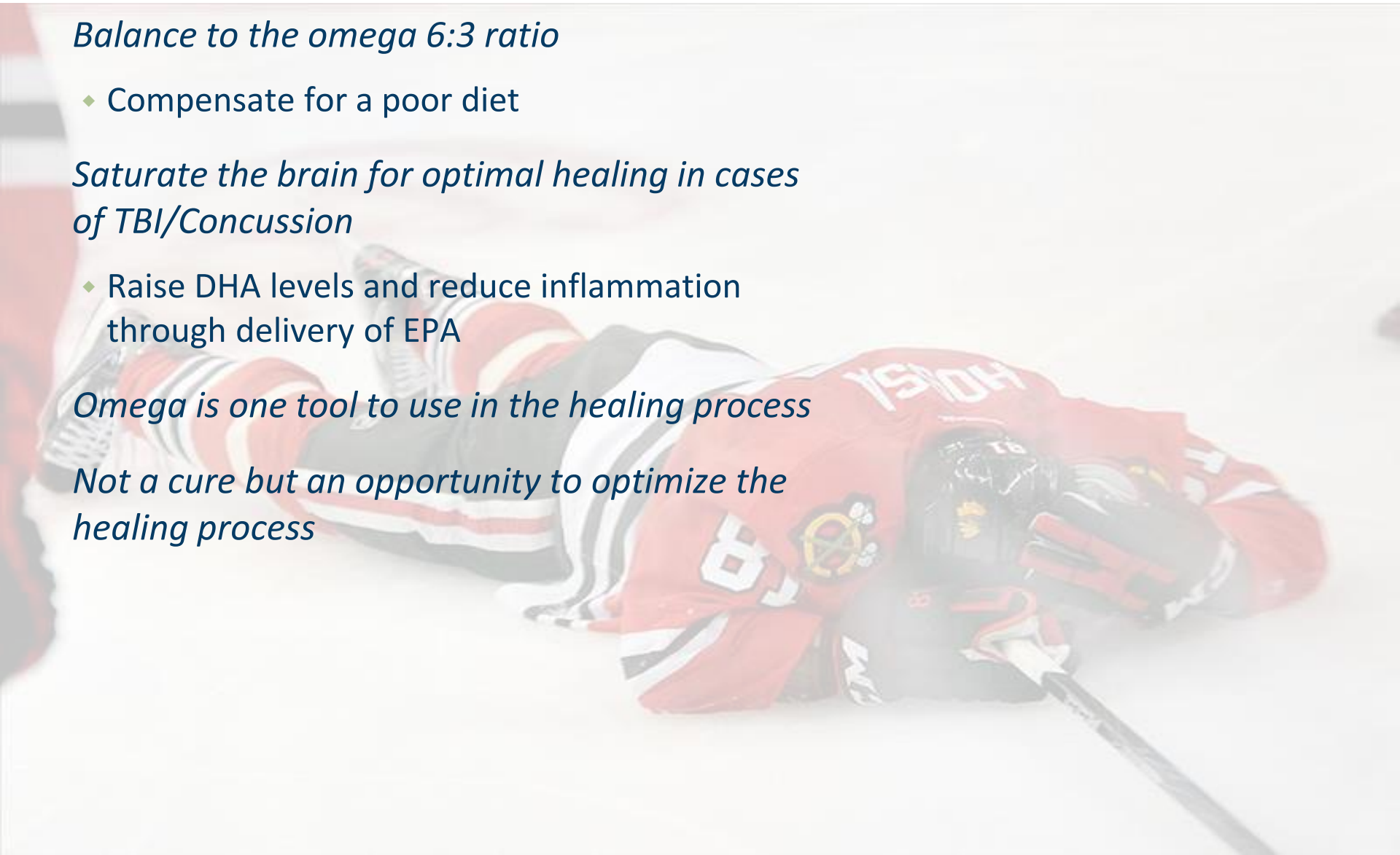
- Compensate for a poor diet

Saturate the brain for optimal healing in cases of TBI/Concussion

- Raise DHA levels and reduce inflammation through delivery of EPA

Omega is one tool to use in the healing process

Not a cure but an opportunity to optimize the healing process



Omega 3 and Athletic Performance

Omega-3s and Body Composition

Overweight subjects: BMI > 25 with high BP, cholesterol, and triglycerides

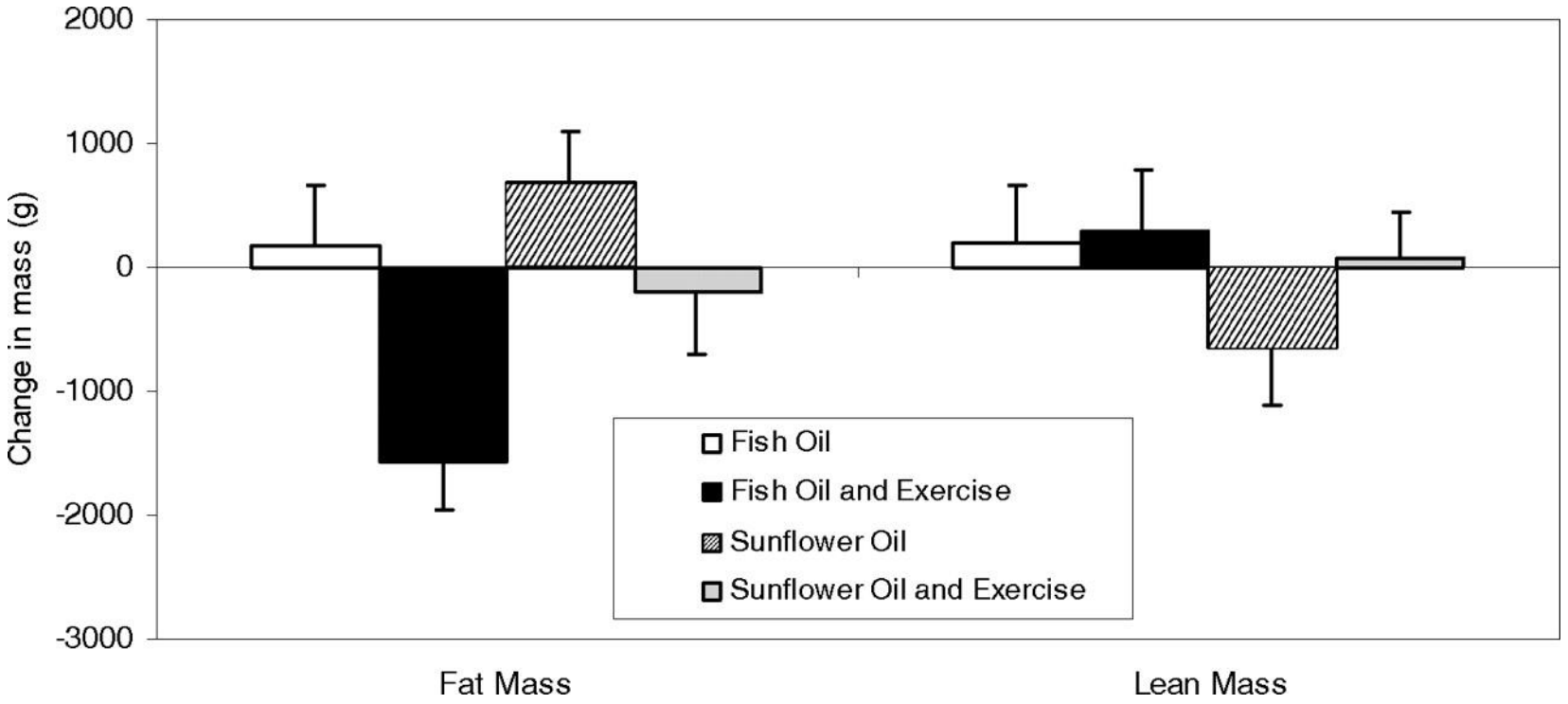
*Subjects received **6 g fish oil** or 6 g sunflower oil combined with exercise or alone*

Exercise protocol: walking 3 day/week for 45 min at 75% max HR

Measured MHR, lipids, BP, body comp (DEXA), and arterial function

Dual-energy X-ray absorptiometry assessed changes in fat and lean mass after supplementation with 6 g docosahexaenoic acid–rich fish oil/d (n = 17), 6 g sunflower oil/d (n = 18), fish oil and exercise (n = 16), or sunflower oil and exercise (n = 14) for 12 ...

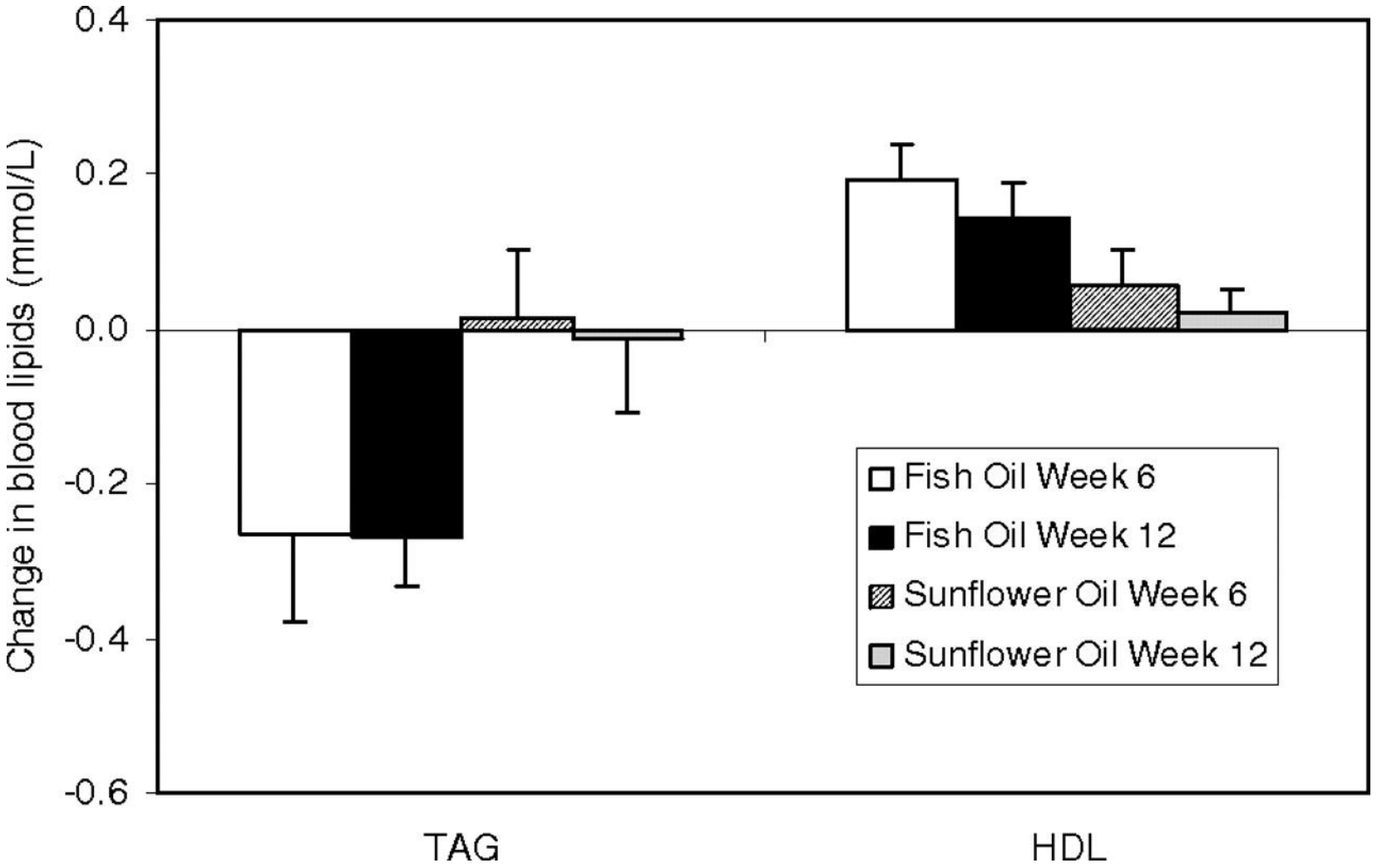
The American Journal of Clinical Nutrition



Alison M Hill et al. *Am J Clin Nutr* 2007;85:1267-1274

Mean (± SEM) changes in serum lipid concentrations by oil treatment after supplementation with 6 g docosahexaenoic acid–rich fish oil/d (n = 31) or 6 g sunflower oil/d (n = 31).

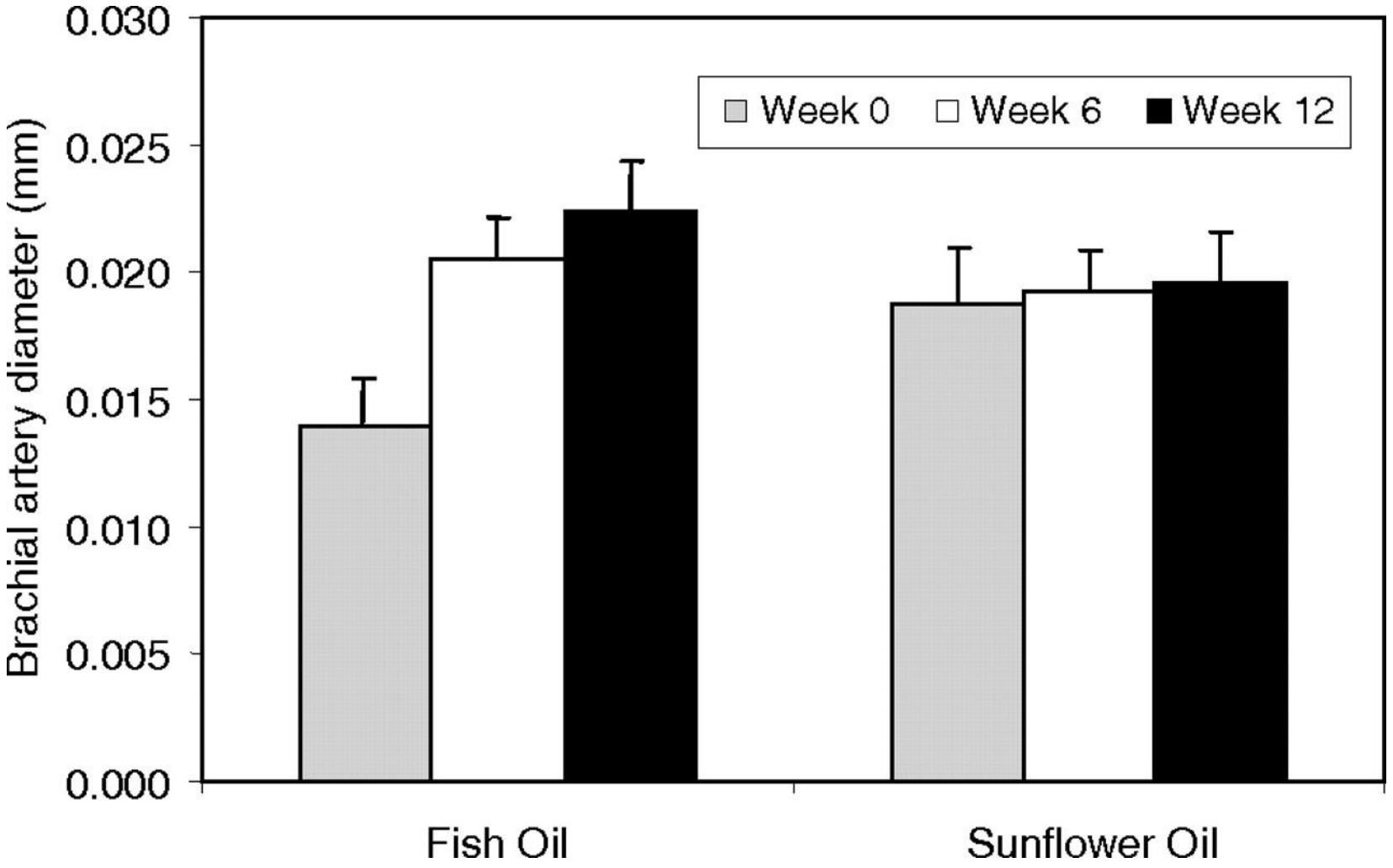
The American Journal of Clinical Nutrition



Alison M Hill et al. *Am J Clin Nutr* 2007;85:1267-1274

Mean (± SEM) change in endothelium-dependent dilatation of the brachial artery by oil treatment after supplementation with 6 g docosahexaenoic acid–rich fish oil/d (n = 33) or 6 g sunflower oil/d (n = 31).

The American Journal of Clinical Nutrition



Alison M Hill et al. *Am J Clin Nutr* 2007;85:1267-1274

Omega-3s and Body Composition

Noreen *et al. Journal of the International Society of Sports Nutrition* 2010, **7**:31
http://www.jissn.com/content/7/1/31

RESEARCH ARTICLE Open Access

Effects of supplemental fish oil on resting metabolic rate, body composition, and salivary cortisol in healthy adults

Eric E Noreen*, Michael J Sass, Megan L Crowe, Vanessa A Pabon, Josef Brandauer, Lindsay K Averill

Abstract

Background: To determine the effects of supplemental fish oil (FO) on resting metabolic rate (RMR), body composition, and cortisol production in healthy adults.

Methods: A total of 44 men and women (34 ± 13y, mean+SD) participated in the study. All testing was performed first thing in the morning following an overnight fast. Baseline measurements of RMR were measured using indirect calorimetry using a facemask, and body composition was measured using air displacement plethysmography. Saliva was collected via passive drool and analyzed for cortisol concentration using ELISA. Following baseline testing, subjects were randomly assigned in a double blind manner to one of two groups: 4 g/d of Safflower Oil (SO); or 4 g/d of FO supplying 1,600 mg/d eicosapentaenoic acid (EPA) and 800 mg/d docosahexaenoic acid (DHA). All tests were repeated following 6 wk of treatment. Pre to post differences were analyzed using a treatment X time repeated measures ANOVA, and correlations were analyzed using Pearson's r.

Results: Compared to the SO group, there was a significant increase in fat free mass following treatment with FO (FO = +0.5 ± 0.5 kg, SO = -0.1 ± 1.2 kg, p = 0.03), a significant reduction in fat mass (FO = -0.5 ± 1.3 kg, SO = +0.2 ± 1.2 kg, p = 0.04), and a tendency for a decrease in body fat percentage (FO = -0.4 ± 1.3% body fat, SO = +0. 3 ± 1.5% body fat, p = 0.08). No significant differences were observed for body mass (FO = 0.0 ± 0.9 kg, SO = +0.2 ± 0.8 kg), RMR (FO = +17 ± 260 kcal, SO = -62 ± 184 kcal) or respiratory exchange ratio (FO = -0.02 ± 0.09, SO = +0.02 ± 0.05). There was a tendency for salivary cortisol to decrease in the FO group (FO = -0.064 ± 0.142 μg/dL, SO = +0.016 ± 0.272 μg/dL, p = 0.11). There was a significant correlation in the FO group between change in cortisol and change in fat free mass (r = -0.504, p = 0.02) and fat mass (r = 0.661, p = 0.001).

Conclusion: 6 wk of supplementation with FO significantly increased lean mass and decreased fat mass. These changes were significantly correlated with a reduction in salivary cortisol following FO treatment.

Omega-3s and Body Composition

44 men and women (34 ±13 y)

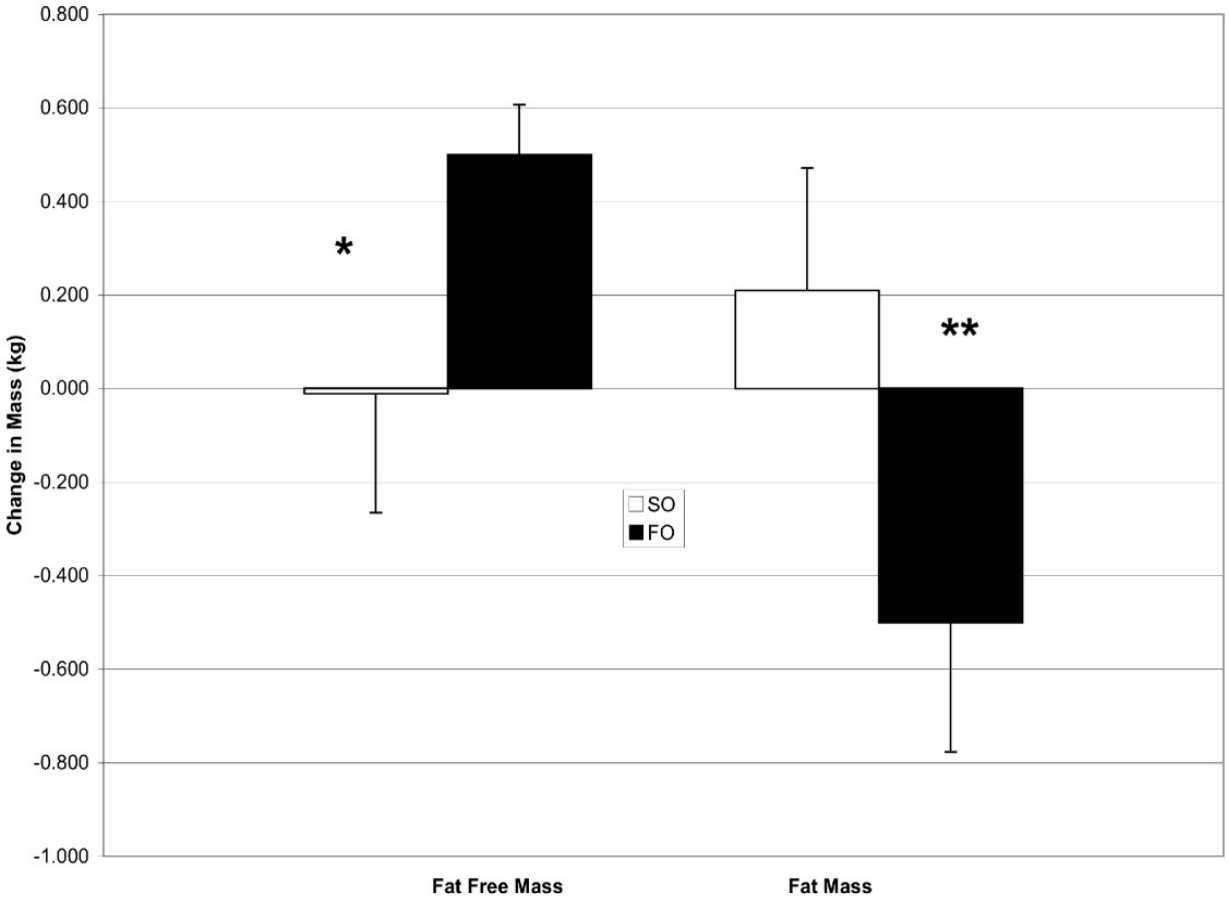
Healthy individuals but not engaged in consistent exercise training

4 g Fish oil or 4 g Safflower Oil/day

Excluded subjects who ate fatty fish 3 d/wk and those with metabolic or endocrine disorders

Measured RMR, BF (BodPod)

Omega-3s and Body Composition



Change in fat mass and fat free mass following 6 wk of treatment with either 4 g/d of safflower oil (SO), or 4 g/d of fish oil (FO). Data are means ± SEM. * significant treatment X time interaction, p = 0.04. ** significant treatment X time interaction, p = 0.03

Noreen *et al. Journal of the International Society of Sports Nutrition* 2010 **7**:31 doi:10.1186/1550-2783-7-31

Download authors' original image

Age (y)	35 ± 14y (29;41)			33 ± 13y (27;39)		
Weight (kg)	71.1 ± 15.2 (64.7;77.5)	71.3 ± 15.3 (65.1;77.6)	0.2 ± 0.8 (-0.2;0.6)	71.3 ± 14.4 (65.1;77.6)	71.3 ± 13.7 (65.1;77.6)	0.0 ± 0.9 (-0.4;0.4)
Body Fat (%)	27.7 ± 10.6 (23.0;32.4)	28.0 ± 10.8 (23.2;32.8)	0.3 ± 1.5† (-0.4;1.0)	30.5 ± 7.7 (26.7;32.5)	30.1 ± 7.6 (26.3;33.9)	-0.4 ± 1.3† (-1.2;0.2)
Fat Mass (kg)	19.7 ± 9.7 (15.4;24.0)	19.9 ± 9.9 (15.5;24.3)	0.2 ± 1.2* (-0.3;0.7)	22.3 ± 8.2 (18.3;25.7)	21.8 ± 7.6 (	-0.5 ± 1.3*
Fat Free Mass (kg)	50.5 ± 11.9 (45.2;55.5)	50.4 ± 12.3 (	-0.1 ± 1.2** (-0.6;0.4)	50.1 ± 11.7 (45.1;55.1)	50.6 ± 11.9 (45.5;55.6)	0.5 ± 0.5** (0.3;0.8)
Salivary Cortisol (µg/dL)	0.305 ± 0.240 (0.212;0.399)	0.321 ± 0.311 (0.217;0.425)	0.016 ± 0.272 (-0.108;0.140)	0.270 ± 0.179 (0.179;0.361)	0.206 ± 0.131 (0.104;0.308)	-0.064 ± 0.142 (-0.127;-0.002)
RMR (24 h Kcal); n = 26	1290 ± 295 (1103;1477)	1228 ± 277 (1053;1400)	-62 ± 184 (-179;55)	1335 ± 213 (1200;1470)	1352 ± 323 (1147;1557)	17 ± 260 (-148;152)
RER; n = 26	0.809 ± 0.052 (0.776;0.842)	0.832 ± 0.41 (0.806;0.858)	0.023 ± 0.54 (-0.011;0.057)	0.841 ± 0.59 (0.804;0878)	0.822 ± 0.48 (0.791;0.853)	-0.019 ± 0.85 (-0.073;0.035)

Marker of Stress Hormones

Data are expressed as means ± SD (95% confidence interval). Data were analyzed using a treatment X time repeated measures ANOVA

* significant treatment X time interaction, p = 0.04

** significant treatment X time interaction, p = 0.03

† treatment X time interaction, p = 0.08

Omega-3 Fat and Athletic Performance

- Omega-3 fats activate PPAR isoforms; this should enable a greater reliance on fat for fuel during exercise while sparing glycogen
  - ***PPAR – Peroxisome Proliferator Activated Receptors – nuclear receptors involved in Fat Metabolism, Cell Death, and Inflammation***
- Omega-3 fats may confer a positive effect on exercise by improving blood flow
- Omega-3 fats may attenuate muscle soreness by reducing inflammation

Mickleborough, Omega-3 Polyunsaturated Fatty Acids in Physical Performance Optimization, *International Journal of Sport Nutrition and Exercise Metabolism*, 2013, 23, 83-96

Omega-3 polyunsaturated fatty acids in physical performance optimization

Increased muscle oxidative stress and inflammatory responses among athletes have been reported consistently. In addition, it is well known that exhaustive or unaccustomed exercise can lead to muscle fatigue, delayed-onset muscle soreness, and a decrement in performance. Omega-3 polyunsaturated fatty acids (PUFAs) have been shown to decrease the production of inflammatory eicosanoids, cytokines, and

Conclusion: ...the ingestion of EPA and DHA of approximately 1-2 g/d, at a ratio of EPA to DHA of 2:1, may be beneficial in counteracting exercise-induced inflammation and for the overall athlete health.

supplementation. It should be noted that high omega-3 PUFA consumption may lead to immunosuppression and prolong bleeding time. Future studies investigating the efficacy of omega-3 PUFA supplementation in exercise-trained individuals should consider using an exercise protocol of sufficient duration and intensity to produce a more robust oxidative and inflammatory response.

- Tiryaki-Sonmez, Schoenfeld, Vatansever-Ozen, Omega-3 Polyunsaturated Fatty Acids in Physical Performance Optimization, *Biomedical Human Kinetics*, 2011, 3, 23-29

Cellular Signals: Athletic Performance

EPA & DHA support

- *Cellular health*
- *Joint comfort*
- *Tissue generation*
- *Joint mobility*
- *Healthy recovery*

Work synergistically

Omega-3s Support Athletic Performance

Tissue injury or Inflammation + ↑ **Omega-3s** + ↓ **Omega-6s** = Healing / Complete Resolution

Tissue injury or Inflammation + ↓ **Omega-3s** + ↑ **Omega-6s** = Chronic Inflammation / Lack of Healing

Omega-3s, Inflammation and Recovery

Lipids in Health and Disease

BioMed Central

Research

Open Access

Effect of eicosapentaenoic and docosahexaenoic acid on resting and exercise-induced inflammatory and oxidative stress biomarkers: a randomized, placebo controlled, cross-over study

Richard J Bloomer*, Douglas E Larson, Kelsey H Fisher-Wellman, Andrew J Galpin and Brian K Schilling

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Email: Richard J Bloomer* - rbloomer@memphis.edu; Douglas E Larson - mmaperformancecoach@gmail.com; Kelsey H Fisher-Wellman - khf0812@ecu.edu; Andrew J Galpin - ajgalpin@bsu.edu; Brian K Schilling - bschllng@memphis.edu

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This article is available from: http://www.lipidworld.com/content/8/1/36

Omega-3s, Inflammation and Recovery

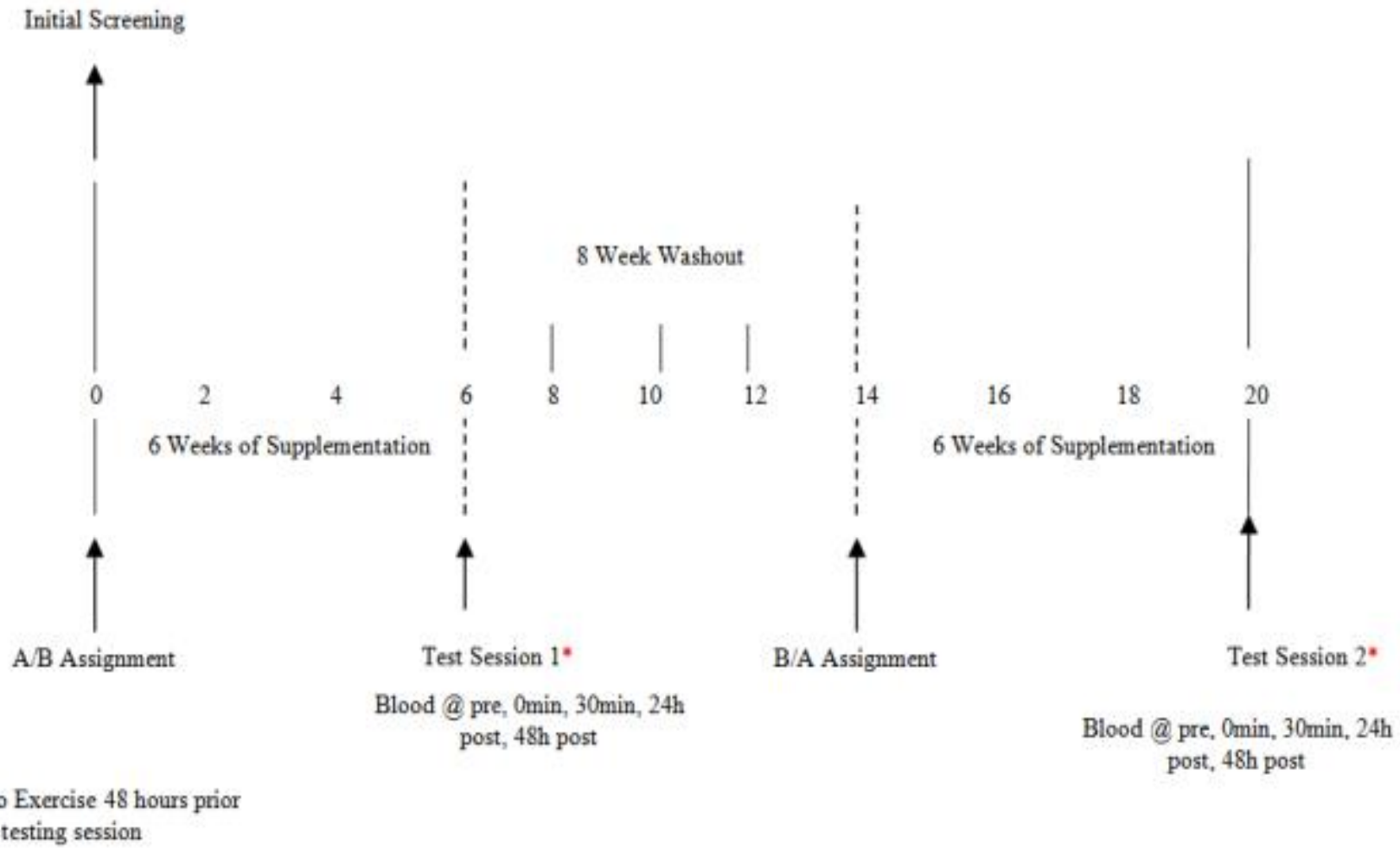
14 exercised trained males

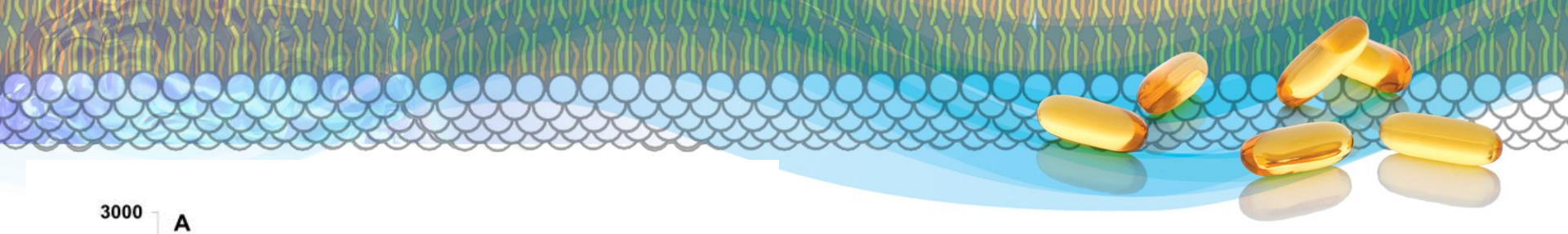
60 min treadmill climb with weighted backpack

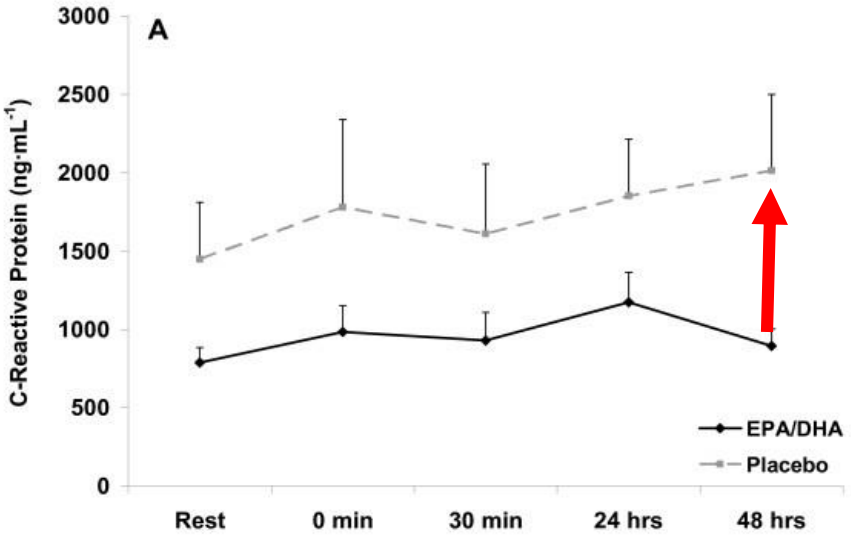
Provided with 4.4 grams of fish oil
(2.2 grams of EPA and 2.2 grams of DHA)

Pre/post markers for inflammation and oxidative stress

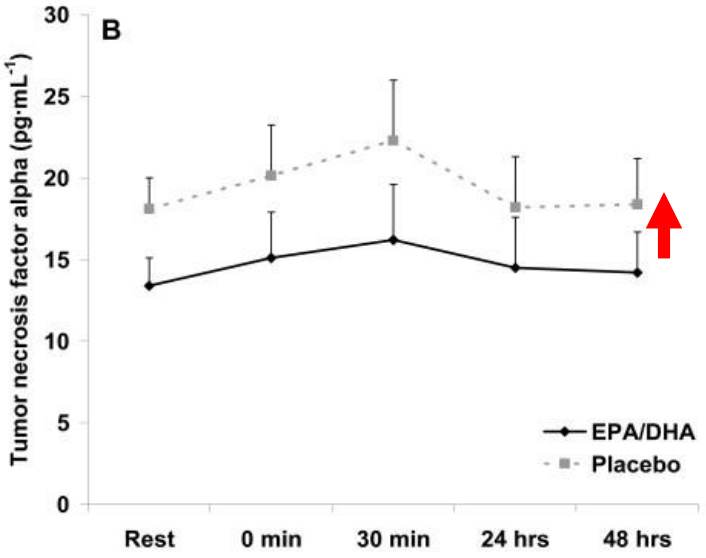
Omega-3s, Inflammation and Recovery

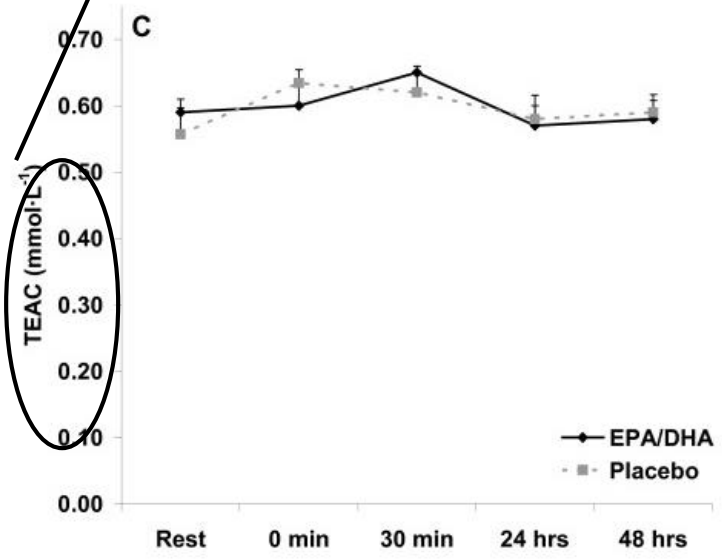






Trolox Equivalent Antioxidant Capacity





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Surgical Neurology 65 (2006) 326–331

SURGICAL NEUROLOGY

www.surgicalneurology-online.com

Pain

ω-3 Fatty acids (fish oil) as an anti-inflammatory: an alternative to nonsteroidal anti-inflammatory drugs for discogenic pain†

Joseph Charles Maroon, MD*,‡, Jeffrey W. Bost, PAC‡

Department of Neurological Surgery, University of Pittsburgh Medical Center, Pittsburgh, PA

Received 3 October 2005; accepted 13 October 2005

Abstract

Background: The use of NSAID medications is a well-established effective therapy for both acute and chronic nonspecific neck and back pain. Extreme complications, including gastric ulcers, bleeding, myocardial infarction, and even deaths, are associated with their use. An alternative treatment with fewer side effects that also reduces the inflammatory response and thereby reduces pain is believed to be ω-3 EFAs found in fish oil. We report our experience in a neurosurgical practice using fish oil supplements for pain relief.

Methods: From March to June 2004, 250 patients who had been seen by a neurosurgeon and were found to have nonsurgical neck or back pain were asked to take a total of 1200 mg per day of ω-3 EFAs (eicosapentaenoic acid and decosahexaenoic acid) found in fish oil supplements. A questionnaire was sent approximately 1 month after starting the supplement.

Omega 3 and Inflammation

©Journal of Sports Science and Medicine (2014) **13**, 151-156
http://www.jssm.org

Research article

Influence of Omega-3 (N3) Index on Performance and Wellbeing in Young Adults after Heavy Eccentric Exercise

Peter Lembke [1], Jillian Capodice [2]✉, Kathleen Hebert [2] and Thomas Swenson [3]
[1] Bioseutica, Rhinebeck, New York; [2] Nutraceutical Medical Research, New York, New York; [3] Ithica College, Ithica, New York, USA

Omega 3 and Inflammation

Purpose: *To assess tissue levels of Omega 3 (Omega 3 Index) on clinical and quality of life outcomes in healthy young adults after heavy eccentric exercise*

Methods: *Ensured Omega 3 index was at optimal levels by supplementing with 2.7 g for 30 days prior to exercise while remaining subjects received placebo*

Design: *Subjects performed a heavy eccentric exercise routine and blood markers of CRP, Creatine Kinase, and Blood Lactate measured at 0, 24, 48, 72, and 96 hours after exercise*

Lembke et al (2014) J Sports Sci Med

Omega 3 and Inflammation

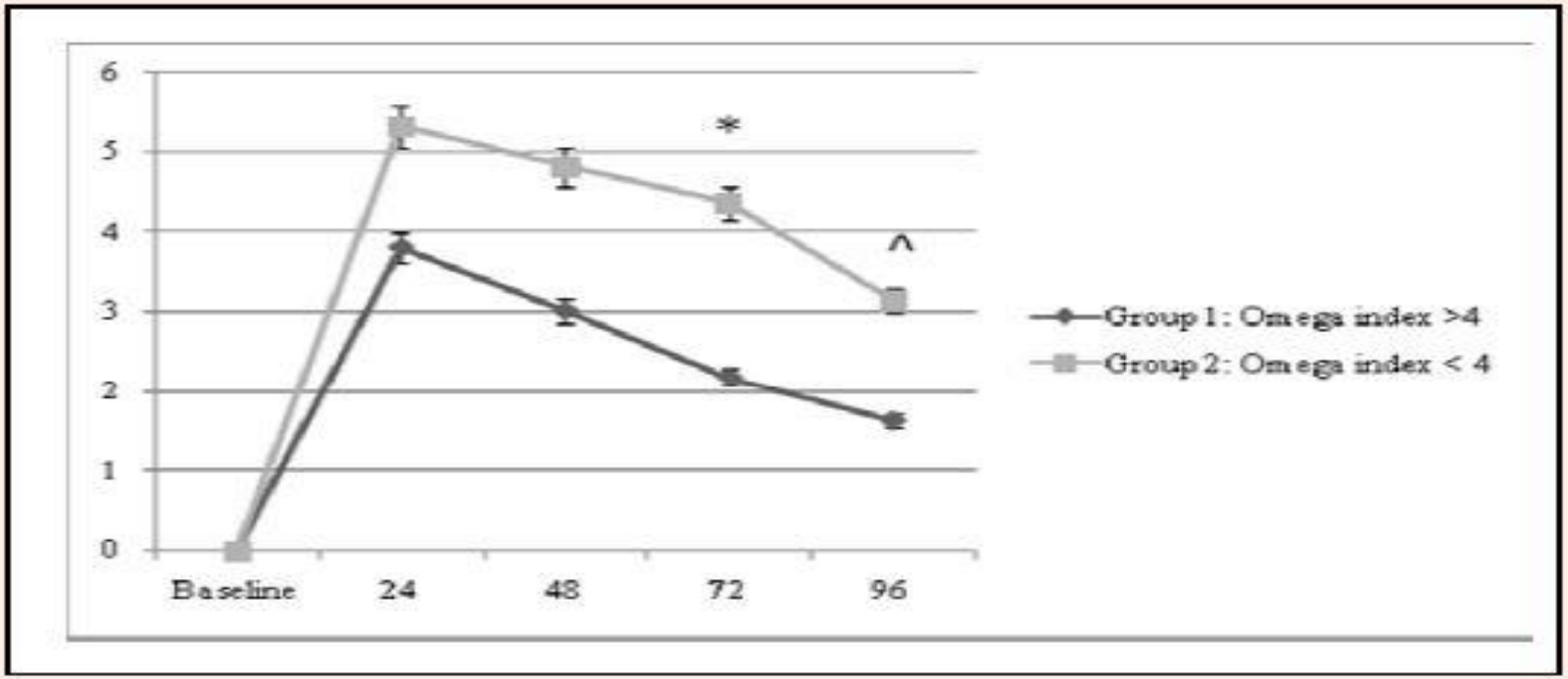

Figure 1. Comparison of DOMS at 24-96 Hours after Exercise between Group 1 and 2. *P* values are based on two-sample *t* tests comparing differences in between-group means. * p = 0.031, ^ p = 0.035.

Omega 3 and Inflammation

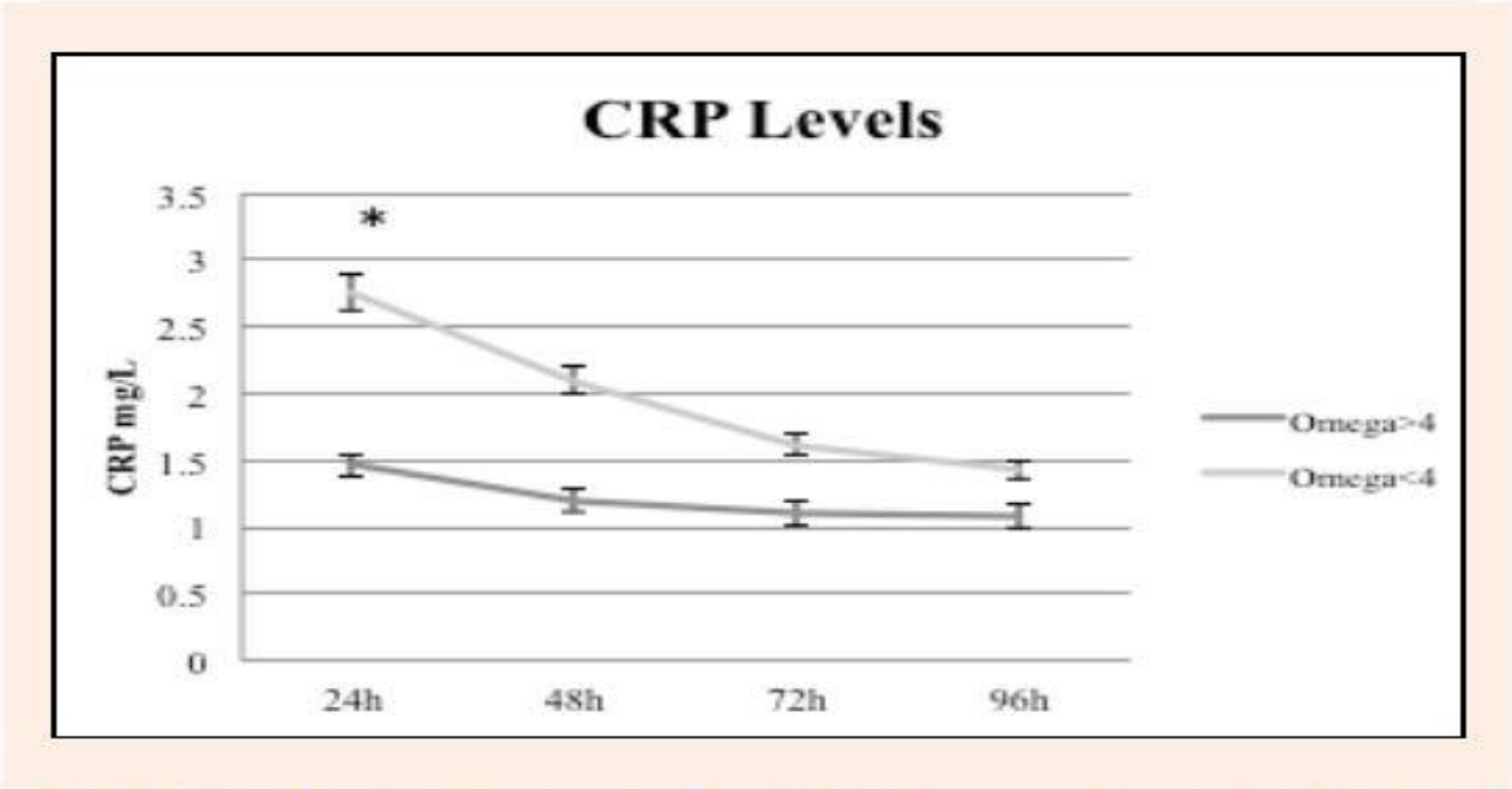

Figure 2. Decreased serum CRP level was shown in Group 1 (N3 Index >4) vs Group 2 (N3 Index <4) at 24 hours, * p = 0.001. There was a non-significant trend in reduced CRP in Group 1 vs 2 from 48-96 H.

Omega 3 and Inflammation

Table 1. Comparison of between-group mean scores on extension and torque. Data are means (±SD).

Outcome Measure and Time Point	Group 1 Omega index >4 (n=42)	Group 2 Omega index < 4 (n=22)
Extension (expressed as angle)		
24 hours	2.94 (5.7)	2.67 (8.50)
48 hours	1.6 (6.7)	1.91 (8.50)
72 hours	1.8 (6.8)	1.67 (7.30)
96 hours	1.12 (6.53)	1.08 (8.50)
Torque (expressed as Nm)		
24 hours	50.44 (23.94)	38.88 (19.74)
48 hours	48.25 (22.02)	40.00 (25.01)
72 hours	49.81 (24.32)	42.13 (26.81)
96 hours	52.38 (24.19)	42.00 (25.57)

Omega 3 and Muscle Growth and Recovery

Nutrients **2018**, *10*(3), 309; doi:10.3390/nu10030309

Open Access

Review

Potential Roles of n-3 PUFAs during Skeletal Muscle Growth and Regeneration

Bill Tachtsis, Donny Camera and Orly Lacham-Kaplan *

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Omega 3 and Muscle Growth and Recovery

- Omega 3's can modulate molecular signaling for muscle growth and hypertrophy
- Activates muscle stem cells which drive skeletal muscle repair to damage tissue from exercise
- Stimulates muscle protein synthesis (MPS)
- Maintains skeletal muscle mass
- May combat sarcopenia in older adults
- 2-5 gram dose range for optimal results

Fish Oil Supplementation

- **Should you take a Fish Oil Supplement?**
  - Are you eating Omega 3 rich fish at least 3 days per week?
  - Easy and convenient way to increase Omega 3 levels in your blood
  - Helps balance Omega 6: Omega 3 ratio

Protocol for Athletes

Usage	Treatment
General Health	3-6 grams per day
Body Composition	2-4 grams per day
Inflammation and Recovery	2-4 grams per day
Depression/Mood	2-4 grams per day
Exercise Performance	2-4 grams per day

Fish Oil Protocol for Concussion/TBI

Length of Usage	Treatment
Week 1	3 grams 3x/day (equal DHA/EPA)
*Week 2	3 grams 2x/day (equal DHA/EPA)
Week 3 (Maintenance Dose)	3 grams per day

*If symptoms are improving but not back to normal, continue taking higher dosage (i.e. Week 2) until athlete improves

Michael Lewis, MD Brain Health Education and Research Institute

Fish Oil Type

Laidlaw *et al. Lipids in Health and Disease* 2014, **13**:99
http://www.lipidworld.com/content/13/1/99

RESEARCH Open Access

A randomized clinical trial to determine the efficacy of manufacturers' recommended doses of omega-3 fatty acids from different sources in facilitating cardiovascular disease risk reduction

Maggie Laidlaw*, Carla A Cockerline and William J Rowe

Abstract

Background: Omega-3 fatty acids confer beneficial health effects, but North Americans are lacking in their dietary omega-3-rich intake. Supplementation is an alternative to consumption of fish; however, not all omega-3 products are created equal. The trial objective was to compare the increases in blood levels of omega-3 fatty acids after consumption of four different omega-3 supplements, and to assess potential changes in cardiovascular disease risk following supplementation.

Methods: This was an open-label, randomized, cross-over study involving thirty-five healthy subjects. Supplements and daily doses (as recommended on product labels) were:

Concentrated Triglyceride (rTG) fish oil: EPA of 650 mg, DHA of 450 mg
Ethyl Ester (EE) fish oil: EPA of 756 mg, DHA of 228 mg
Phospholipid (PL) krill oil: EPA of 150 mg, DHA of 90 mg
Triglyceride (TG) salmon oil: EPA of 180 mg, DHA of 220 mg.

Subjects were randomly assigned to consume one of four products, in random order, for a 28-day period, followed by a 4-week washout period. Subsequent testing of the remaining three products, followed by 4-week washout periods, continued until each subject had consumed each of the products. Blood samples before and after supplementation were quantified for fatty acid analysis using gas chromatography, and statistically analysed using ANOVA for repeated measures.

Results: At the prescribed dosage, the statistical ranking of the four products in terms of increase in whole blood omega-3 fatty acid levels was concentrated rTG fish oil > EE fish oil > triglyceride TG salmon oil > PL krill oil. Whole blood EPA percentage increase in subjects consuming concentrated rTG fish oil was more than four times that of krill and salmon oil. Risk reduction in several elements of cardiovascular disease was achieved to a greater extent by the concentrated rTG fish oil than by any other supplement. Krill oil and (unconcentrated) triglyceride oil were relatively unsuccessful in this aspect of the study.

Conclusion: For the general population, the form and dose of omega-3 supplements may be immaterial. However, given these results, the form and dose may be important for those interested in reducing their risk of cardiovascular disease.

Trial registration: ClinicalTrials.gov: NCT01960660.

Keywords: Omega-3 supplements, Cardiovascular disease, Risk biomarkers

Fish Oil Type

Phospholipid

Triglyceride

Ethyl Ester

Fish Oil Comparison

- *35 subjects*
- *28 days of fish oil supplementation, followed by 4-week washout for each product*

DOSE

Product	EPA+DHA per Capsule	Label Recommended Dose (caps / day)	Daily EPA+DHA Dosage
Nordic Naturals ProOmega	EPA: 325 mg DHA: 225 mg	2	EPA: 650 mg DHA: 450 mg
Ethyl Ester Fish Oil	EPA: 756 mg DHA: 228 mg	1	EPA: 756 mg DHA: 228 mg
Salmon Oil	EPA: 90 mg DHA: 110 mg	2	EPA: 180 mg DHA: 220 mg
Krill Oil	EPA: 75 mg DHA: 45 mg	2	EPA: 150 mg DHA: 90 mg

Bioavailability of Fish Oil

COMPARATIVE OMEGA-3 BLOOD LEVELS

FIGURE 1 Based on manufacturer's recommended dose

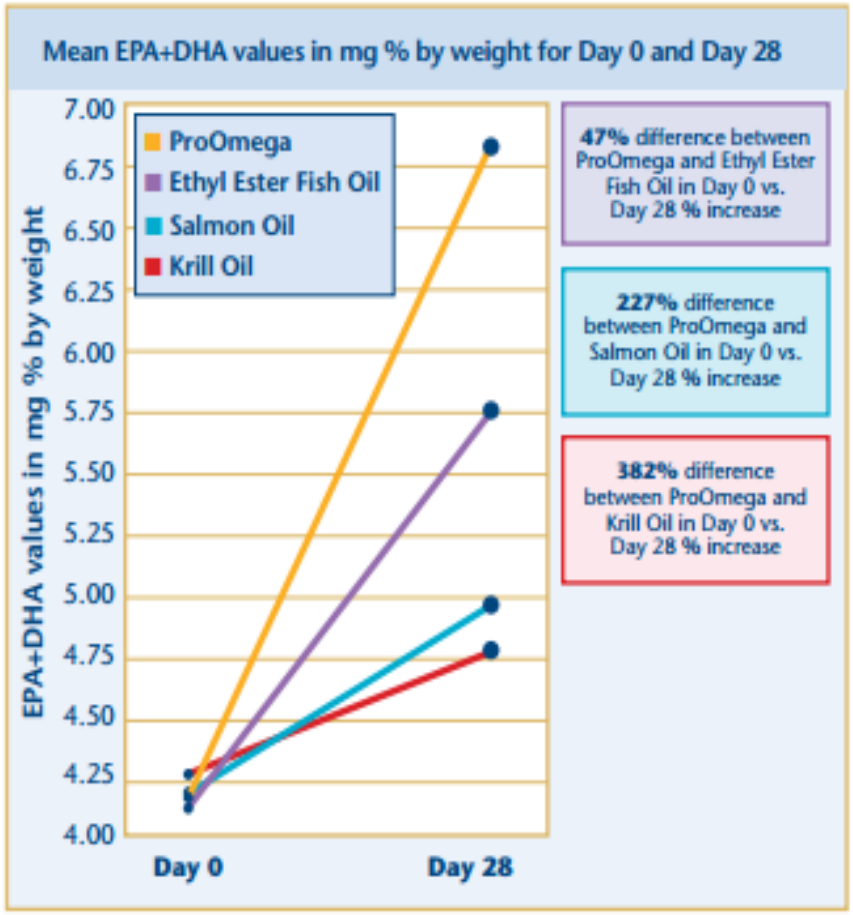
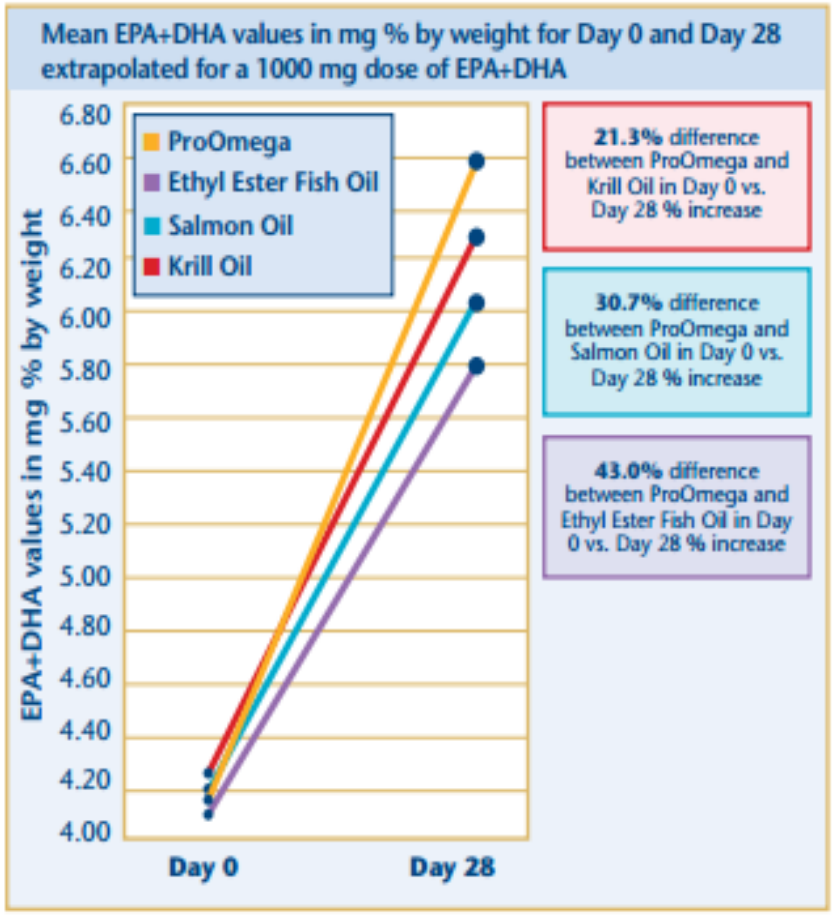


FIGURE 2 Extrapolated for a 1000 mg dose of EPA+DHA



Fish Oil Cost Comparison

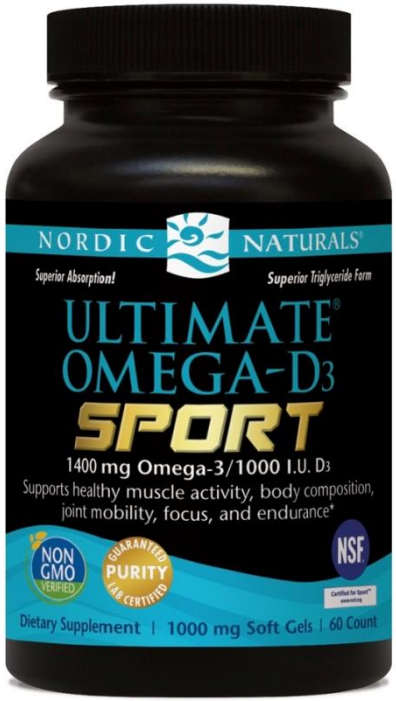
Product	Label Recommended Dose (caps/day)	Cost / Bottle	Cost / Cap	To Match EPA+DHA Levels Achieved by Taking ProOmega	
				# of Caps Needed	Total Cost
Nordic Naturals ProOmega	2	$27.95	$0.47	2	$0.94
Ethyl Ester Fish Oil	1	$31.31	$1.04	2	$2.08
Salmon Oil	2	$31.95	$0.53	7	$3.71
Krill Oil	2	$38.50	$0.64	10	$6.40

Based on iHerb.com product SRP pricing of 30 servings, as of July 2014

NSF Certified for Sport

Certified for Sport

Eliminates risk for contamination and banned substances



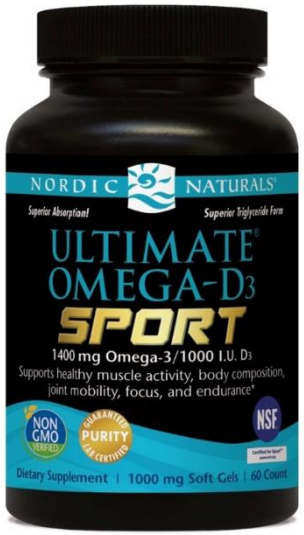
Application for Athletes

Breakfast or Lunch

- 2 capsules ***Ultimate Omega®-D3 Sport or Klean Athlete*** with breakfast

Post Workout

- 2 capsules ***Ultimate Omega®-D3 Sport*** with meal for recovery/inflammation



Application for Individuals or Athletes

Breakfast or Lunch

- ½ to 1 tsp ***Ultimate Omega®-D3 Sport*** with breakfast

Post Workout

- ½ to 1 tsp capsules ***Ultimate Omega®-D3 Sport*** with meal for recovery/inflammation

If not a fan of the taste, athlete can cut with:

- Honey
- Sports Drink
- OJ or Juice of Choice
- Add to Smoothie after blended

Supplement Facts

Serving Size: **1 Teaspoon (5 mL)**

Amount Per Serving		% Daily Value*
Calories	45	
Calories from fat	45	
Total Fat	5.0 g	8%
Saturated Fat	0.2 g	1%
Trans Fat	0 g	†
Vitamin D3 (cholecalciferol)	1000 I.U.	250%
Total Omega-3s	2900 mg	†
EPA (Eicosapentaenoic Acid)	1450 mg	†
DHA (Docosahexaenoic Acid)	1060 mg	†
Other Omega-3s	390 mg	†

* Percent Daily Values are based on a 2,000 calorie diet.
† Daily Value not established.
Less than 5 mg of Cholesterol per serving.

Ingredients: purified deep sea fish oil (from anchovies and sardines), natural lemon flavor, d-alpha tocopherol, rosemary extract (a natural preservative), vitamin D3 (cholecalciferol in olive oil).

No gluten, milk derivatives, or artificial colors or flavors. Non-GMO.

3 g/tsp

* These statements have not been evaluated by the Food and Drug Administration. This product is not intended to diagnose, treat, cure, or prevent any disease.

Summary

Omega-3 fish oil is a very versatile nutraceutical

Need to increase Omega 3 from food and supplementation to balance Omega 6:Omega 3 ratio.

Need more studies on athletes to measure various dosages on treatment strategies for concussions/TBI

Should be strongly considered as a treatment strategy for athletes with concussions

Should start with 2-3 grams per day as an appropriate dose

Triglyceride FO is best for bioavailability and absorption

Thank You!

Contact information

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tpattoly@mysportsd.com