

Can Omega-3's Benefit Your Child's Behavior or School Performance?

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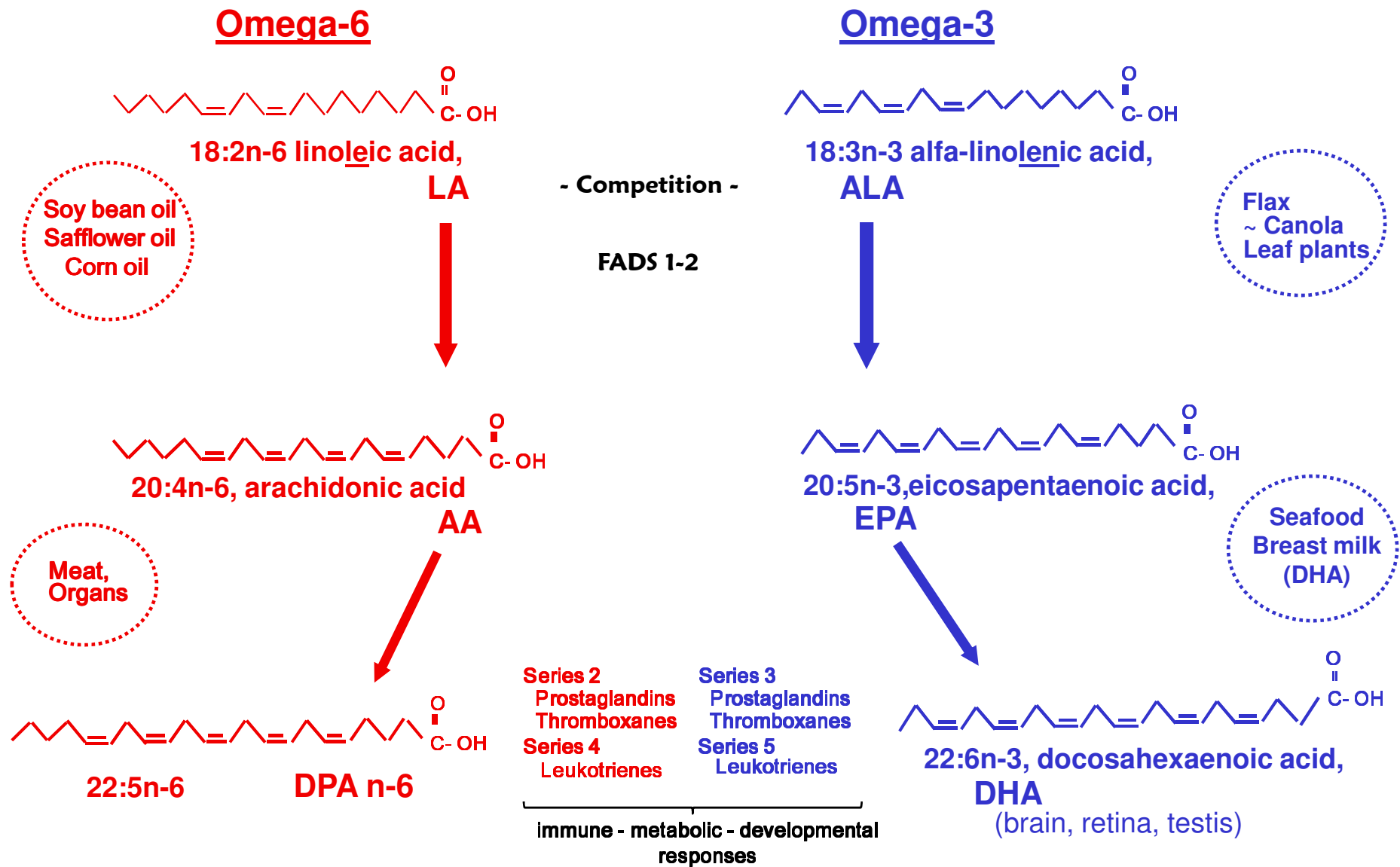
Woodlin Elementary, Silver Spring, MD

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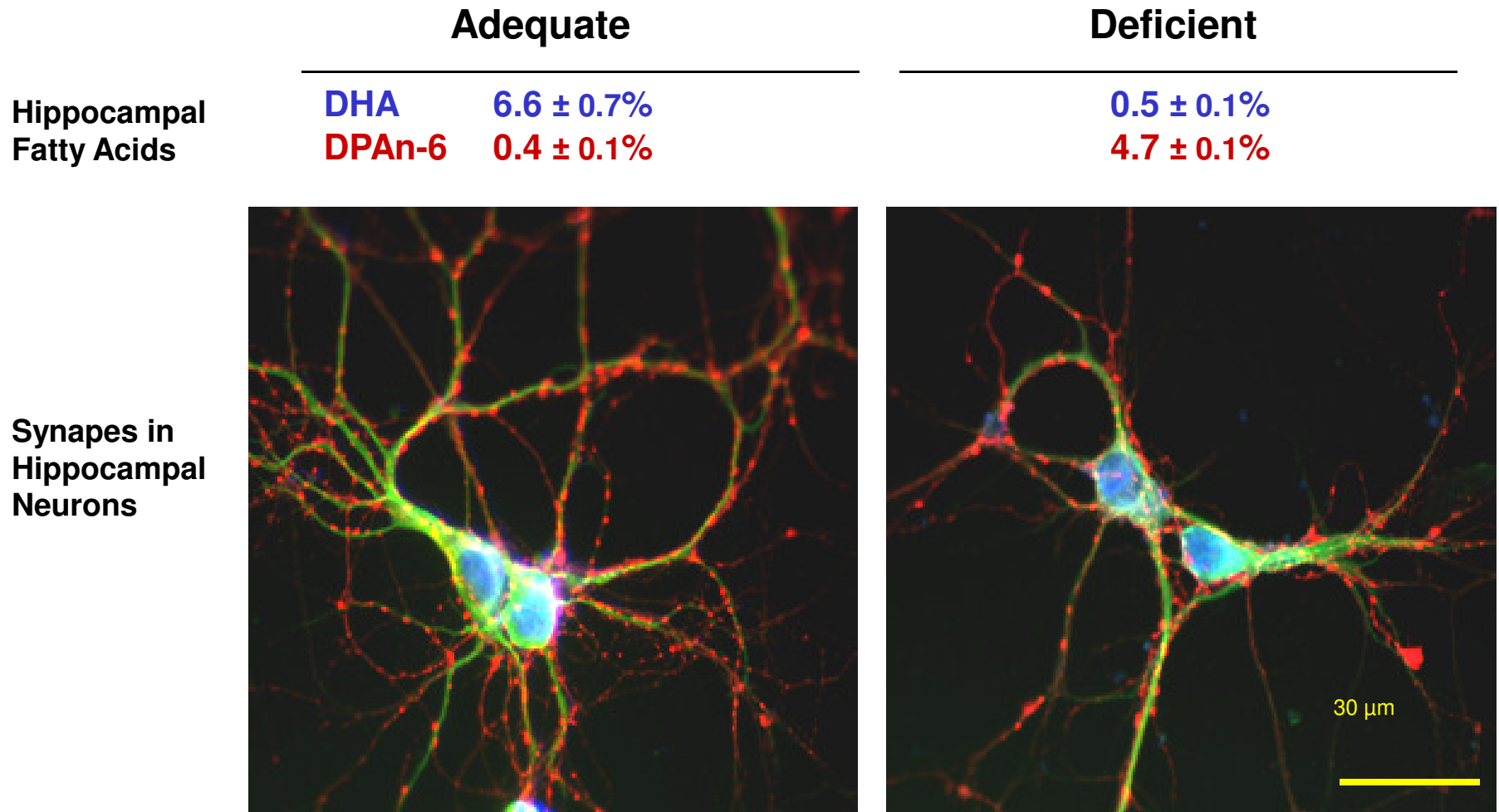
Outline

- Seafood as a source of omega-3 fatty acids-
- Essential Brain Nutrients-
- Deficiency in pregnancy and later risks to kids
- Risk of harm from deficiency vs. methyl mercury
- Academic Performance
 - Attention, Reading, Spelling
- Disruptive Aggressive Behaviors
- **Eat fish in your family 2-3 times per week.**

Essential Fats: Metabolism and Dietary Sources

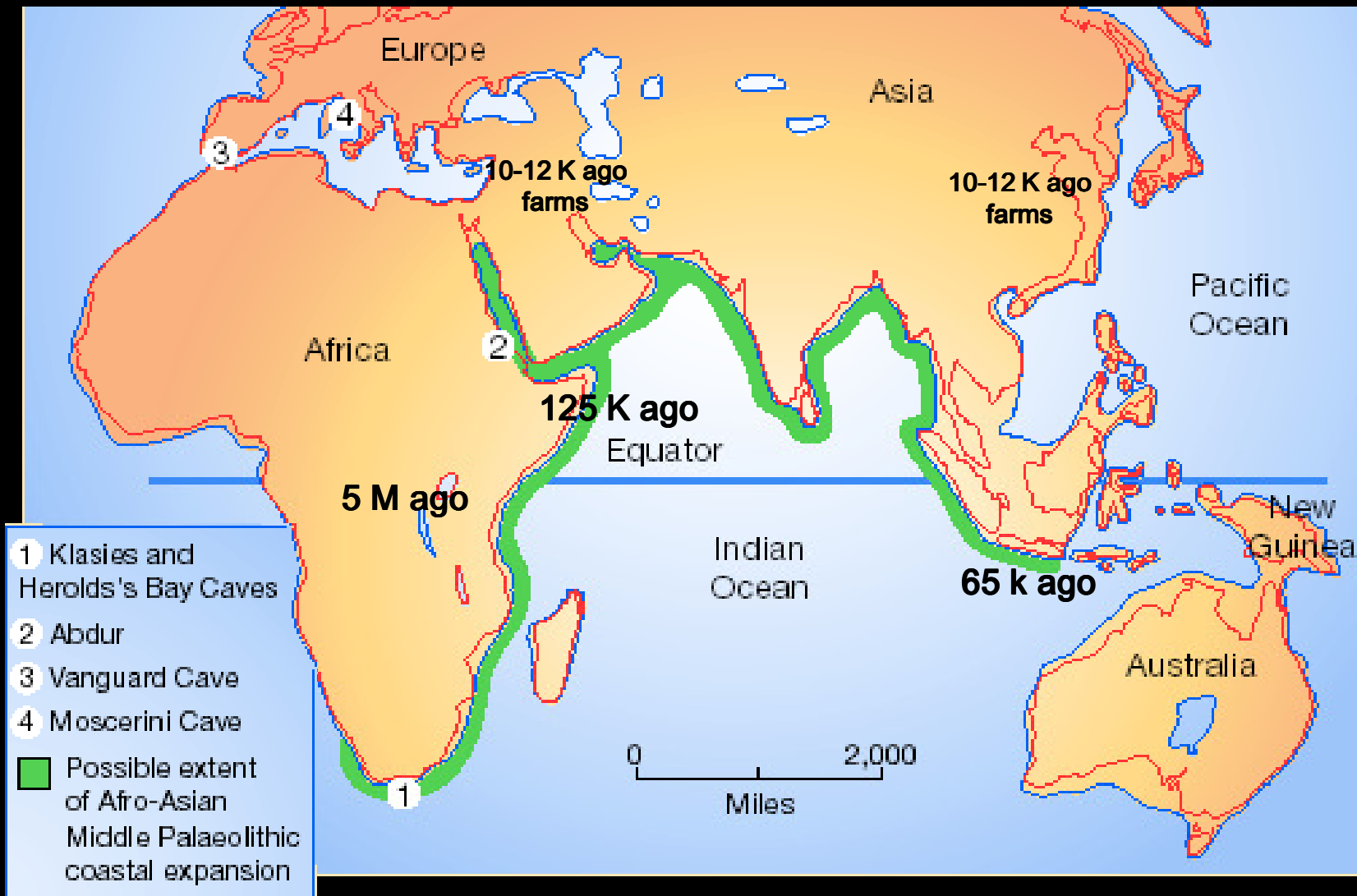


DHA dietary deficiency impairs synapse development



Mother mice fed adequate or deficient diets, embryo neurons harvested day 18

Route of humans out of Africa about 65,000 y ago



Stringer, C. Nature 2000; 405: 24-26



U.S. Department of Health and Human Services
and
U.S. Environmental Protection Agency



What You Need to Know About Mercury in Fish and Shellfish

**2004 EPA and FDA Advice For:
Women Who Might Become Pregnant, Women Who are Pregnant
Nursing Mothers and Young Children**

Advice

**Limit consumption to no more than 340 gm/w
of commercial species.**

~ Avoid 4 species completely ~

Fish and shellfish are an important part of a healthy diet.

...So, women and young children should include fish or shellfish in their diets due to the many **nutritional benefits**.

However, nearly all fish and shellfish contain traces of mercury.

...The **risks from mercury** in fish and shellfish depend on the amount of fish and shellfish eaten and the levels of mercury in the fish and shellfish.

March 2004 EPA-823-R-04-005

They're being poisoned.



Your kids are being poisoned by
deadly mercury from power plants.

**President Bush: Protect America's Children,
Not Power Company Profits!**

Any benefits for children
when mothers eat more seafood?

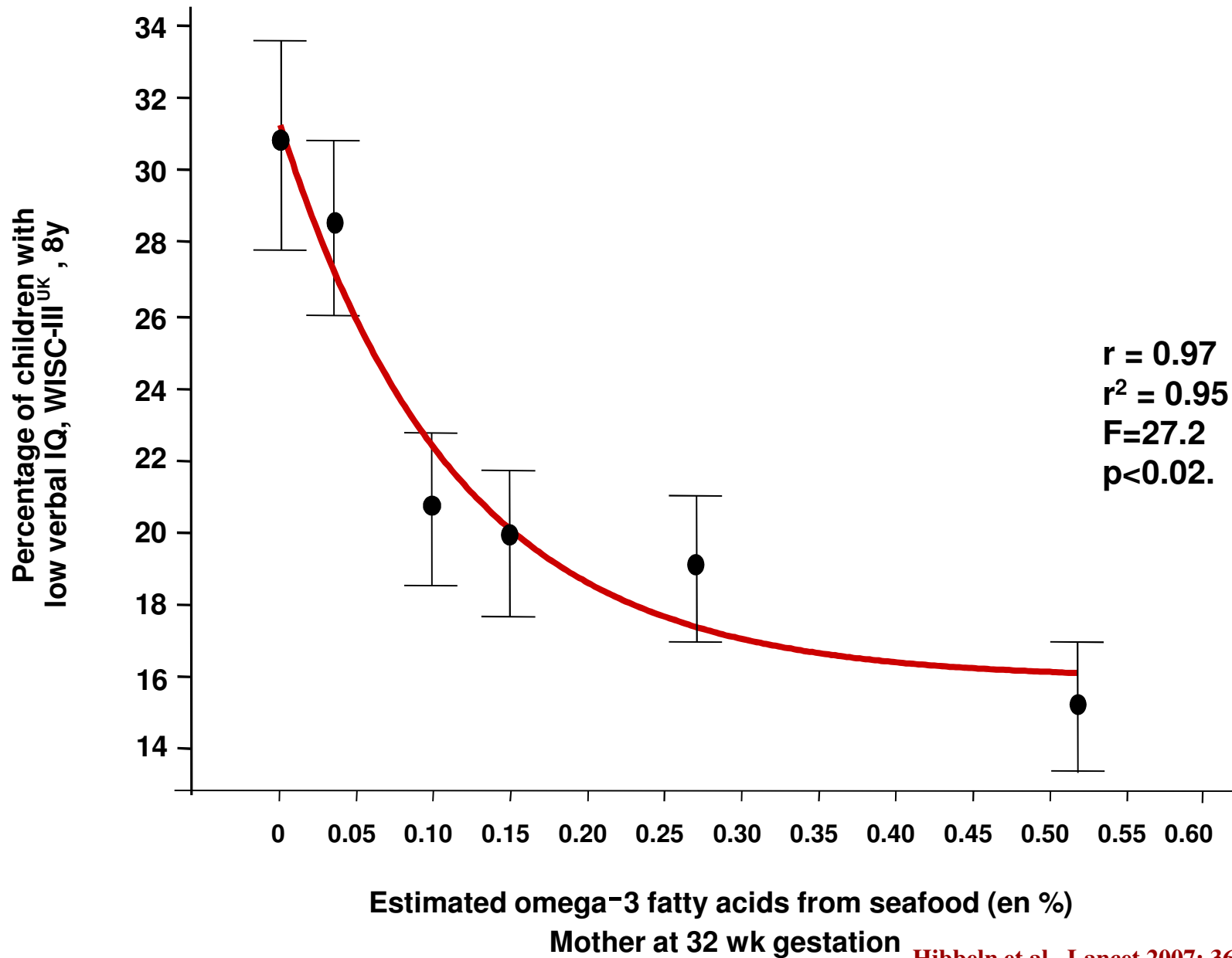


Avon Longitudinal Study of Parents and Children (ALSPAC)

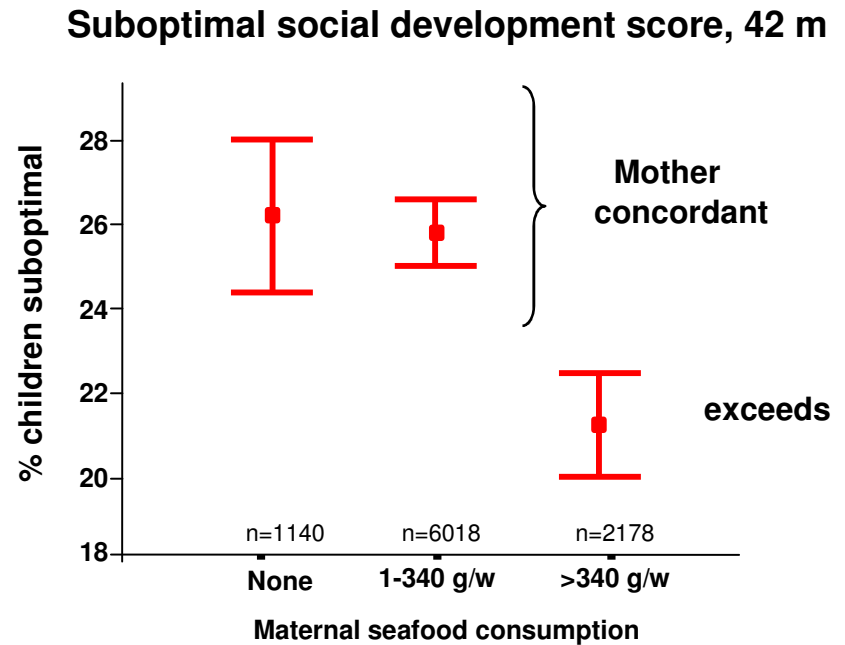
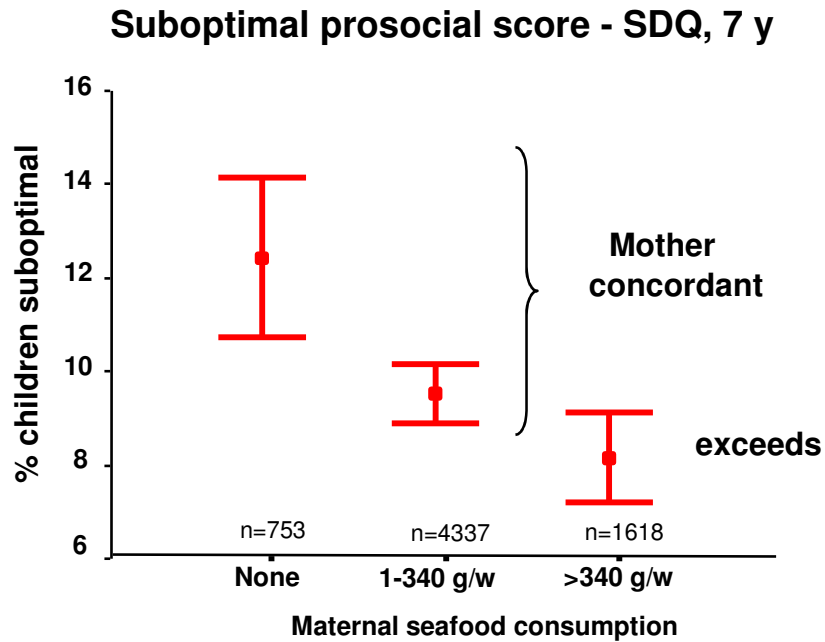
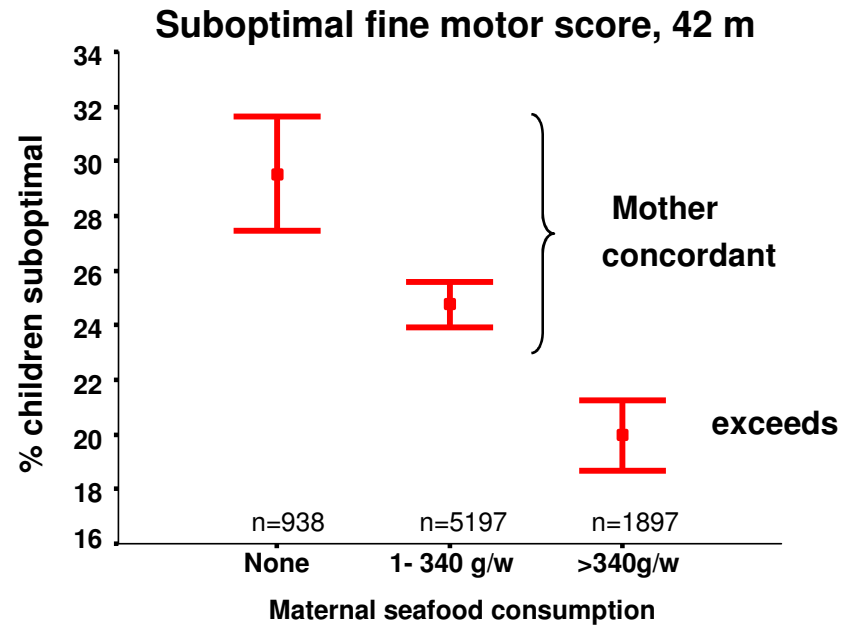
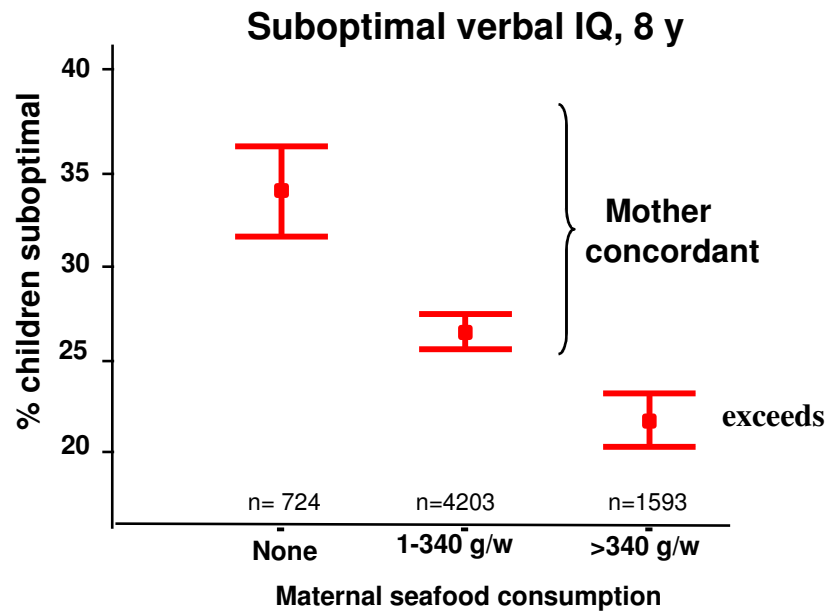
- Recruited 14,541 pregnant mothers.
- The largest and most complete longitudinal study in the world.
- Enrollment included every pregnancy between April 1st 1991 and December 31st 1992 in Avon (Southwest of London, UK)
- Children are now between 16.5 and 19 years of age
- Prof. Jean Golding, Ph.D.
- ALSPAC study group



Low maternal omega-3 consumption from seafood and suboptimal verbal IQ among their children



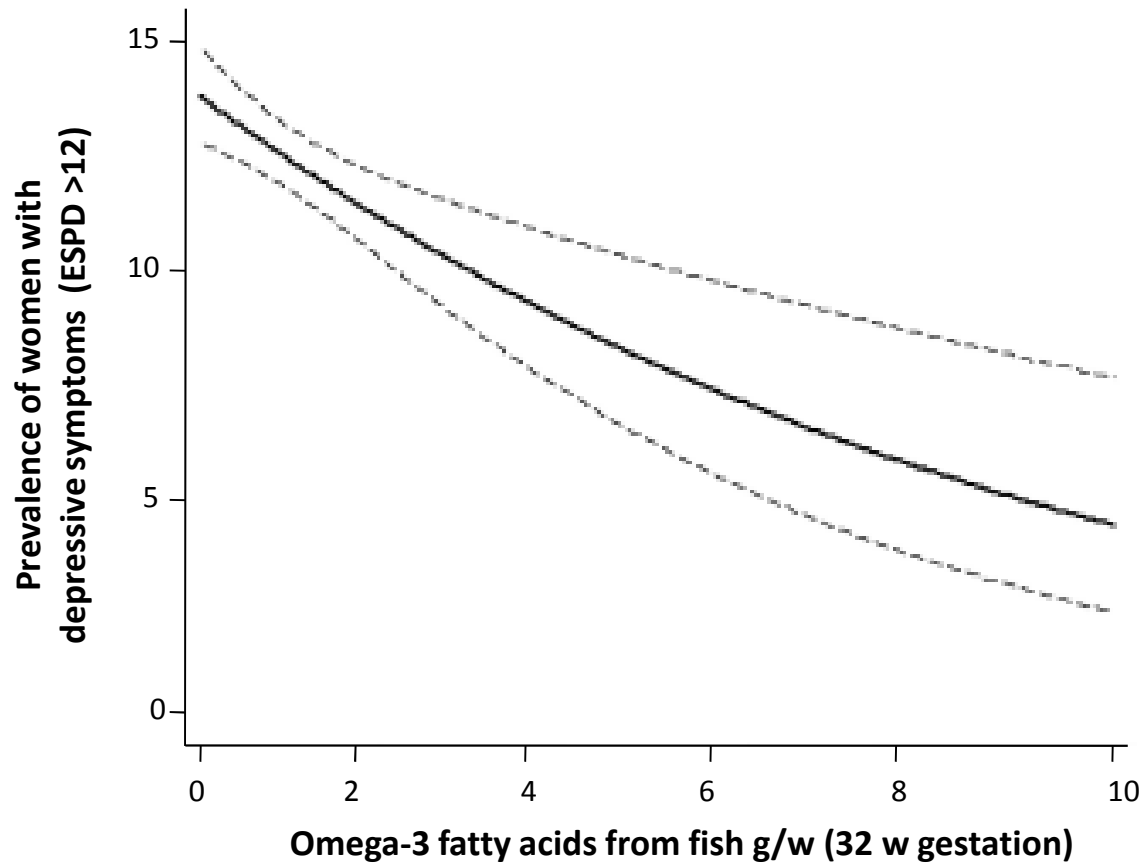
Hibbeln et al, Lancet 2007; 369: 578-585



ALSPAC Summary

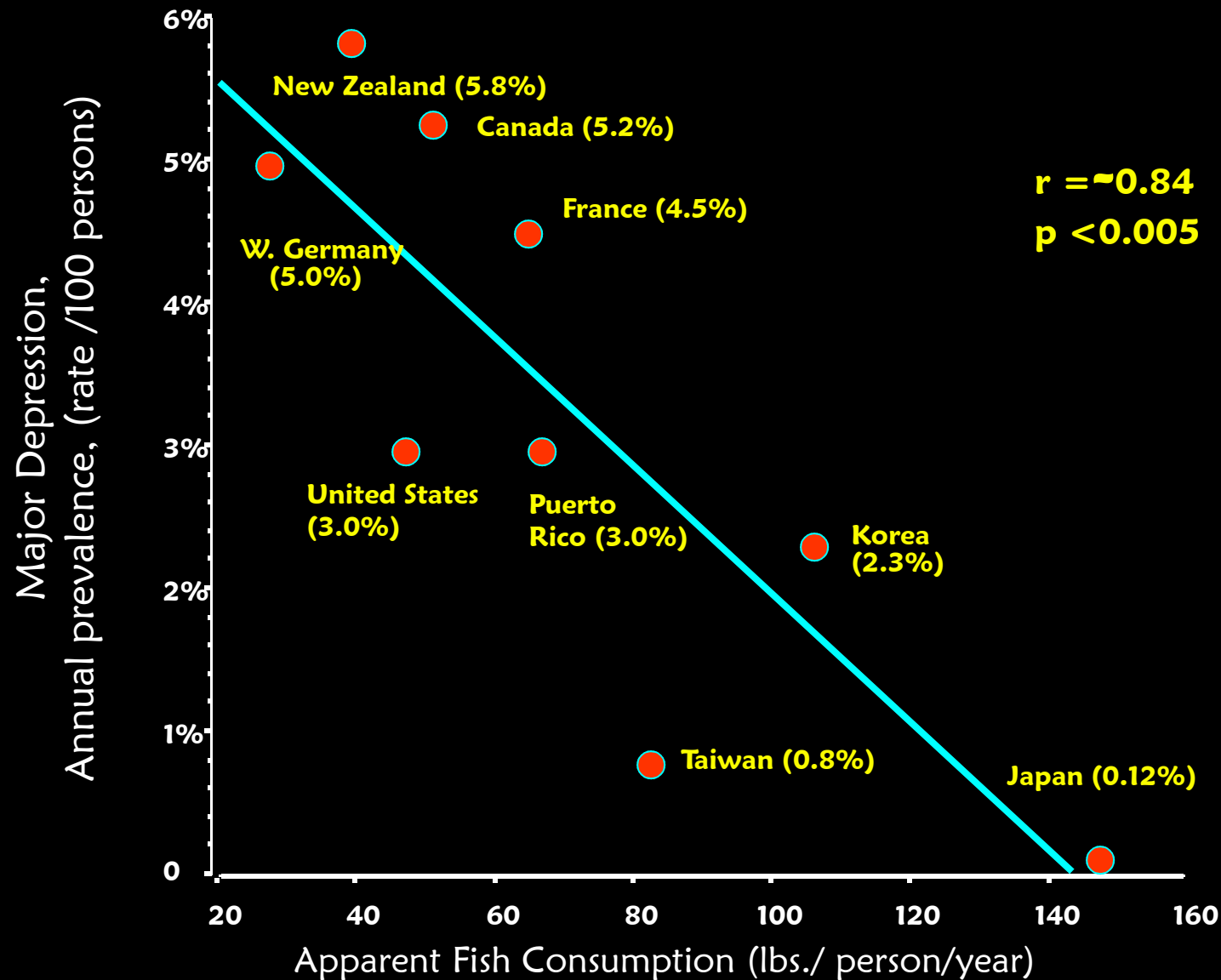
1. Maternal limitation of seafood consumption to $<340\text{g/w}$ during pregnancy did not protect children from adverse outcomes.
2. In contrast, this observational study showed beneficial effects on child development when maternal seafood intakes exceeded 340 g/w , with no upper limit of benefit.
3. These findings were robust after adjustment for multiple potential confounders.
4. These data indicate that advice for mothers to limit seafood intake during pregnancy is detrimental.

Depressive symptoms during pregnancy and omega-3 intake from seafood.



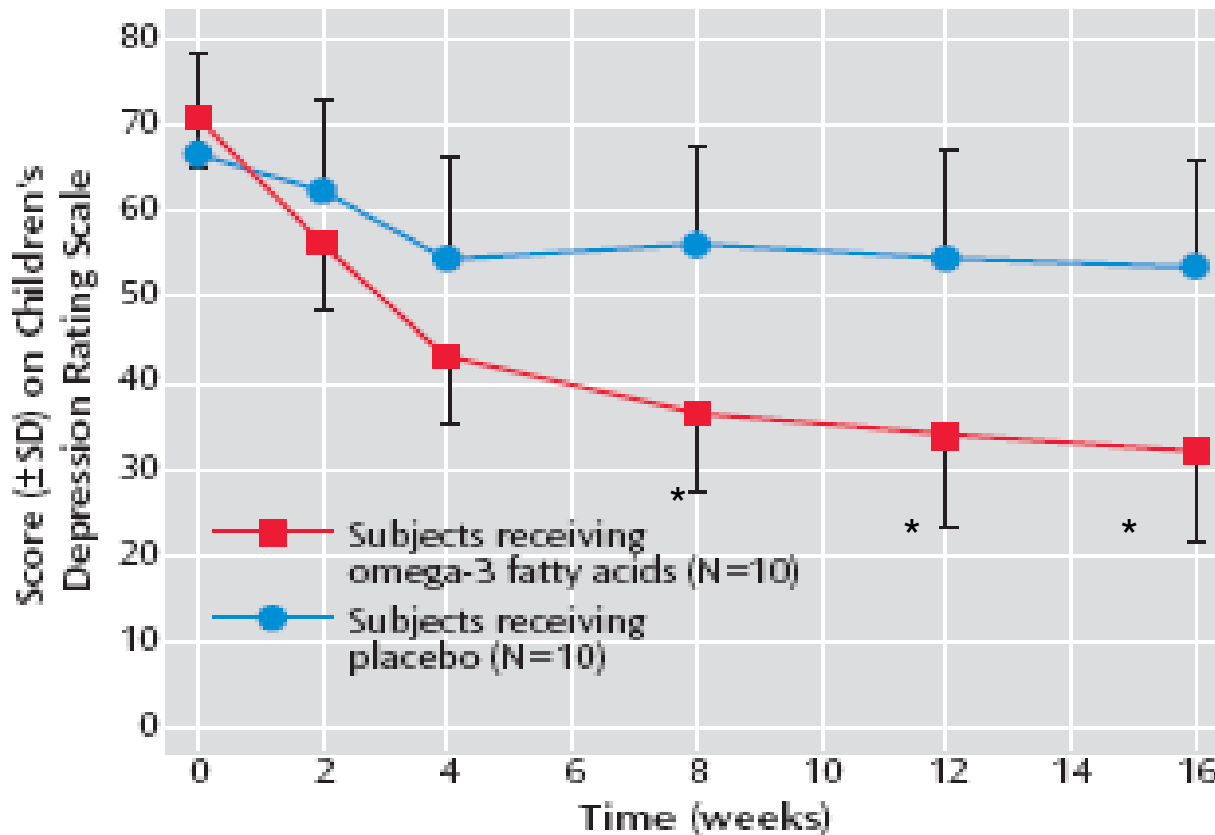
Omega-3 Intake (g/wk)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	
None	1.97 (1.63–2.38)	1.54 (1.25–1.89)	
0.1–0.4	1.64 (1.37–1.96)	1.37 (1.13–1.66)	
0.4–1.5	1.31 (1.13–1.52)	1.20 (1.03–1.41)	
>1.5	1.00	1.00	
<i>P for trend</i>	<i>0.0001</i>	<i>0.0001</i>	<i>n = 9,960</i>

Fish Consumption and Major Depression Annual Prevalence by Country



Omega-3 treatment of childhood depression: a controlled, double-blind pilot study.

FIGURE 1. CDRS During 16 Weeks of Omega-3 or Placebo Treatment^a



Age range= 8-12.5
Monotherapy

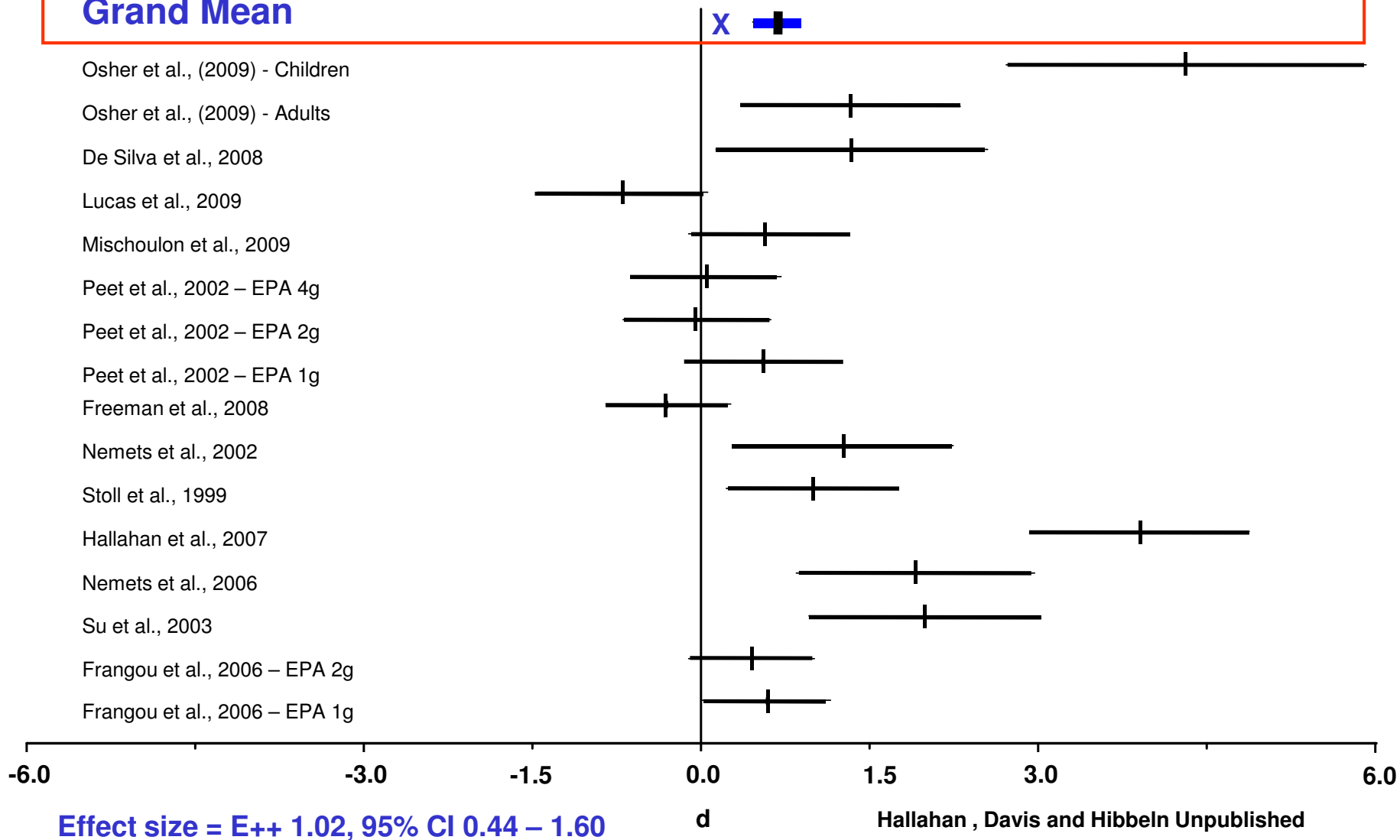
400 mg/d EPA
+ 200 mg/d DHA
vs. Safflower placebo

*p<0.05

EPA all RCT studies

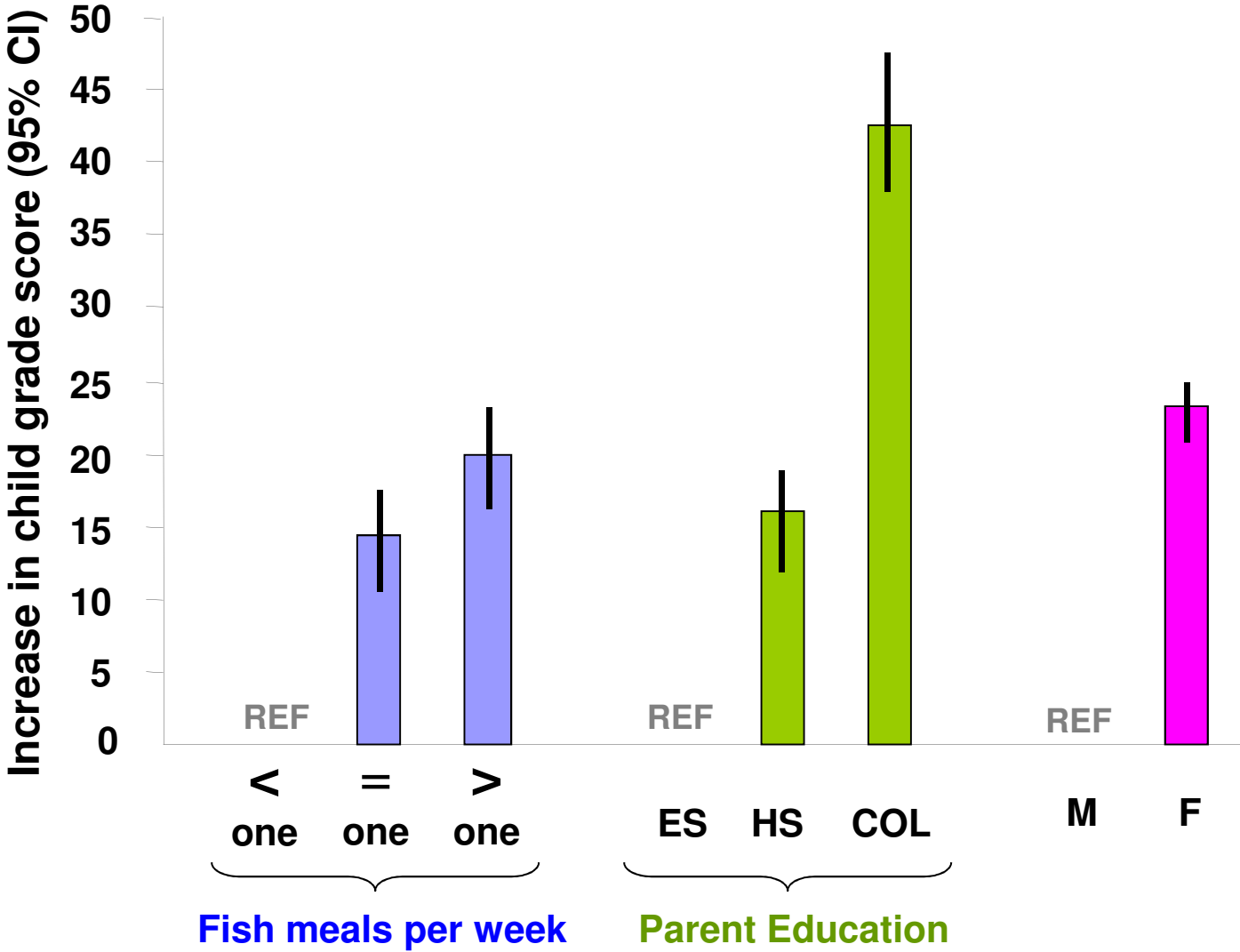


Grand Mean

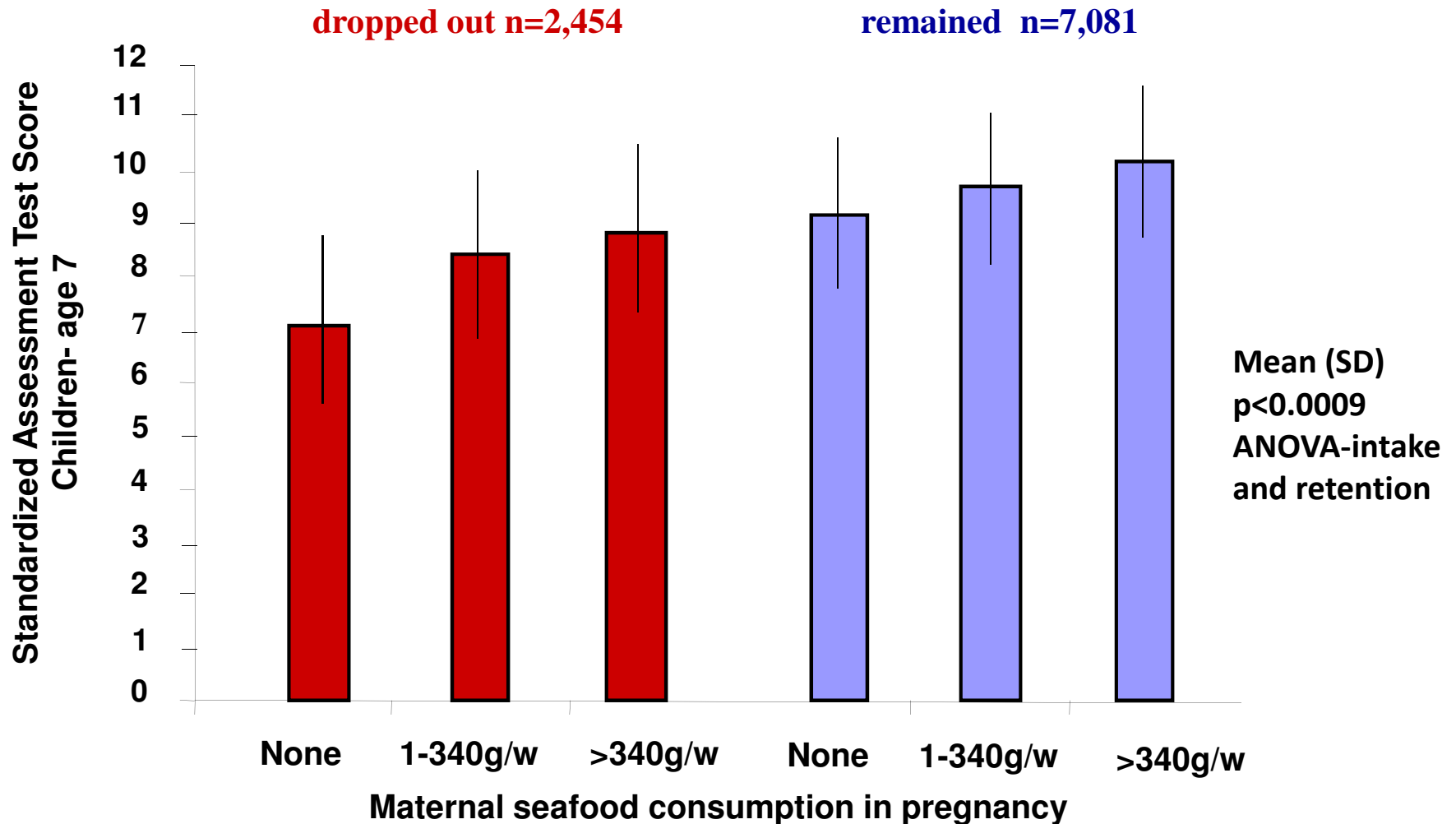


Back to school

More fish meals in Swedish 15 year olds and better school grades (n = 9,448)



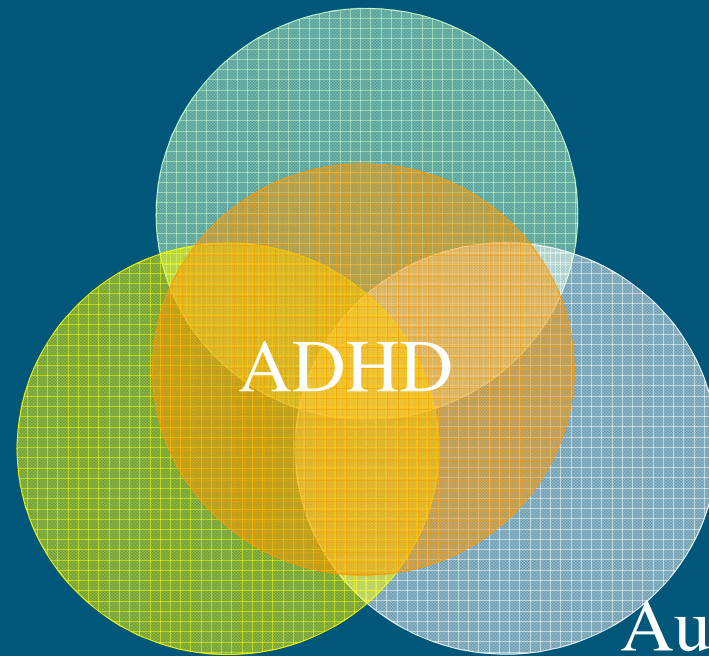
Better Standard Test Score in Children When Moms ate Fish in Pregnancy



When kids eat omega-3 fats
do they have better
academic performance
or behavior ?

Childhood Neurodevelopmental Disorders – the Overlap

Dyspraxia/DCD



Dyslexia

Autistic Spectrum

THE OXFORD-DURHAM STUDY: Developmental Coordination Disorder/ADHD

- **A randomised controlled trial of fatty acids supplementation**
- **Study population: 117 UK school children aged 6-11 years**
- **All met DSM-IV criteria for Developmental Coordination Disorder**
- **40% also had specific learning difficulties**
 - **2 years behind expected achievement levels in reading and spelling**
- **30% also had ADHD scores in the clinical range**

Richardson, A.J. and Montgomery, P. *Pediatrics*, 2005, 115:1360-6

Reading and Spelling

Active treatment

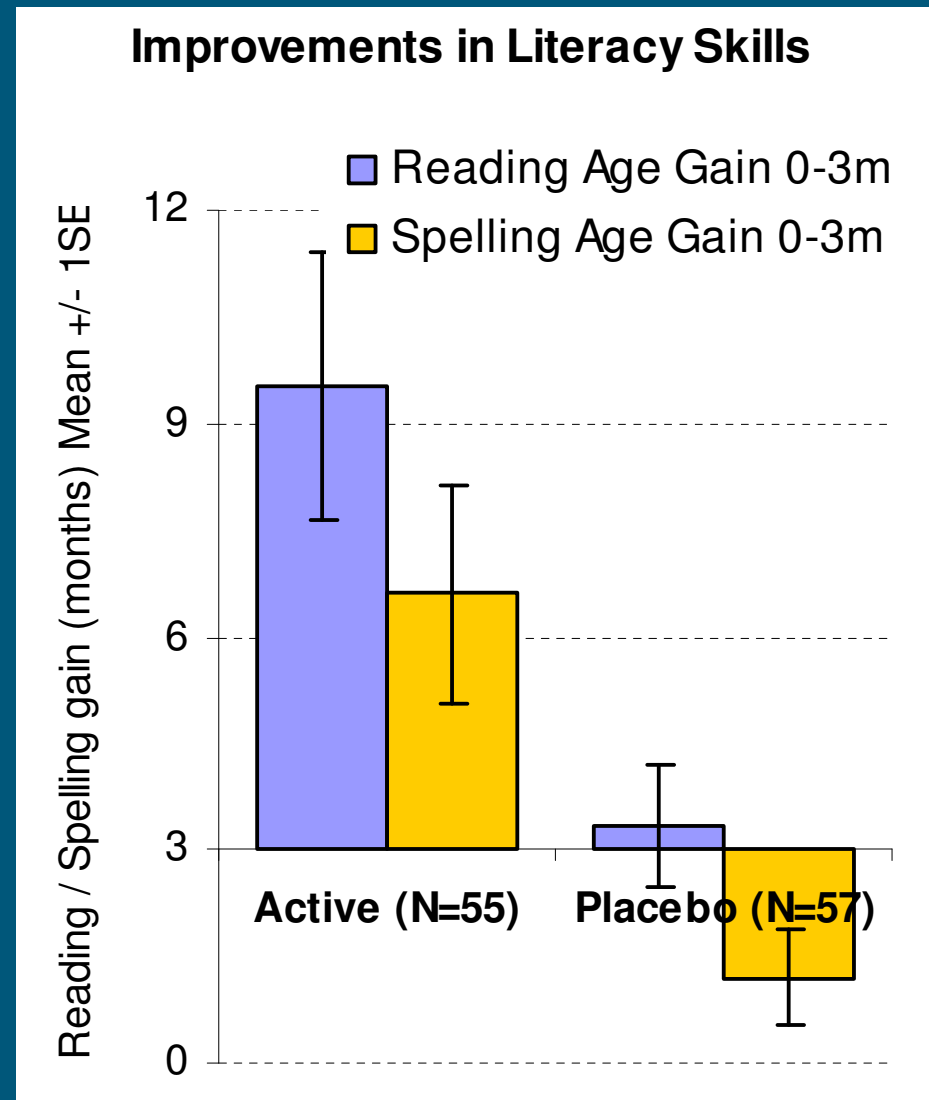
- Compared with expected rate of progress for normal children, gains were
> 3 x for reading,
> 2 x for spelling

Placebo

- Gains were
1 x normal rate for reading,
< 0.5 x for spelling

Group Differences

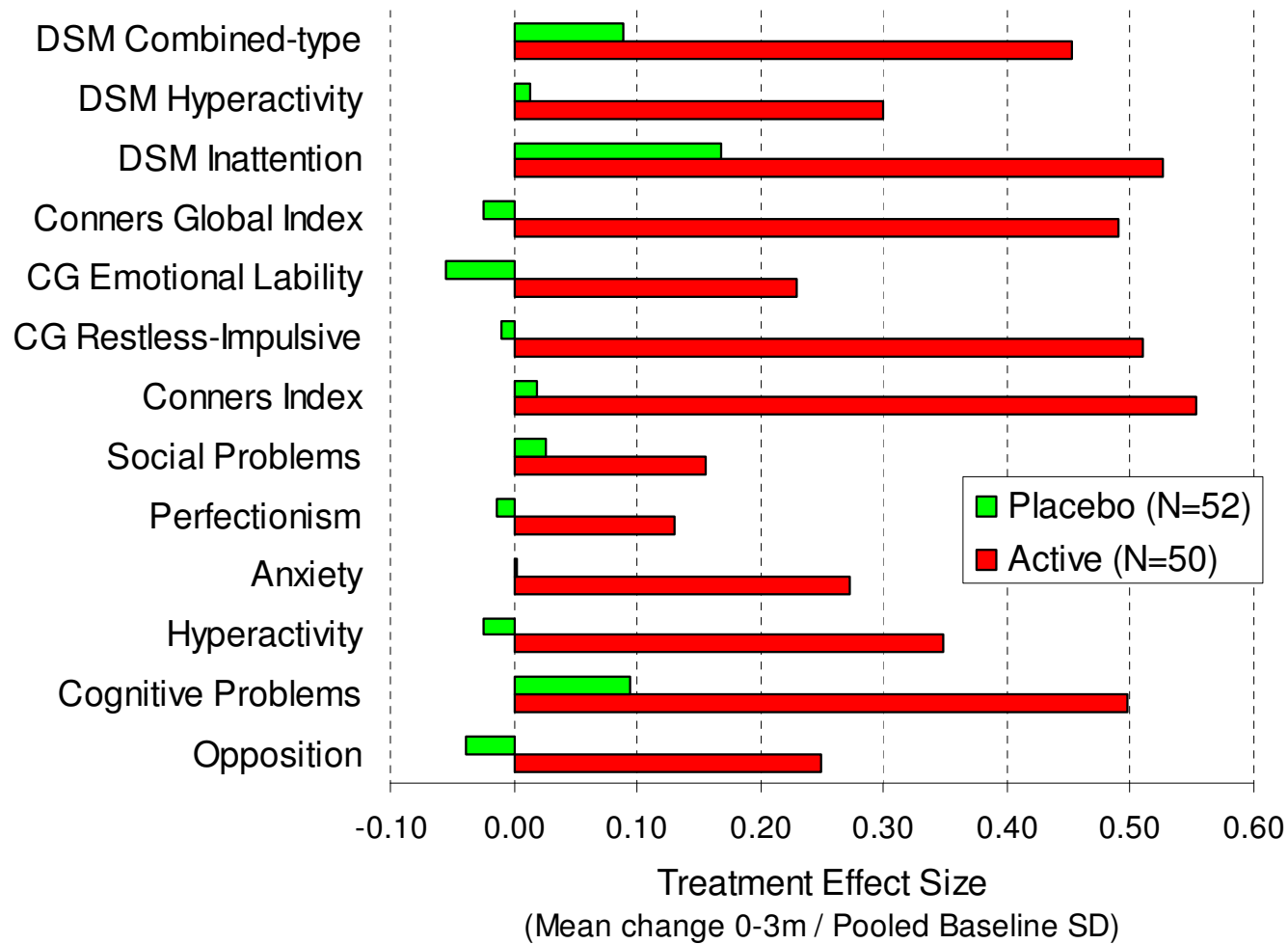
- Reading $p < 0.004$
- Spelling $p < 0.001$



Richardson and Montgomery, 2005

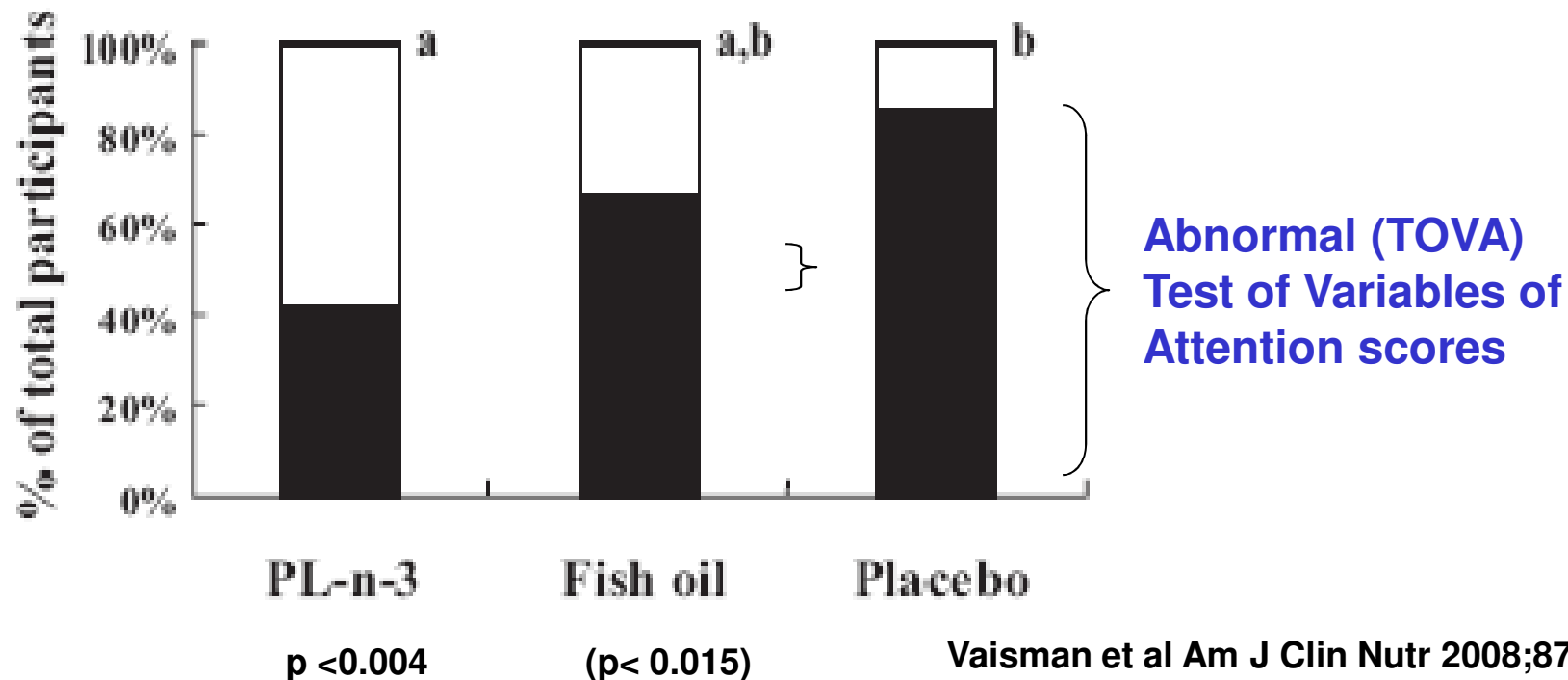
Teacher-rated ADHD symptoms

Reduction in ADHD-related Symptoms

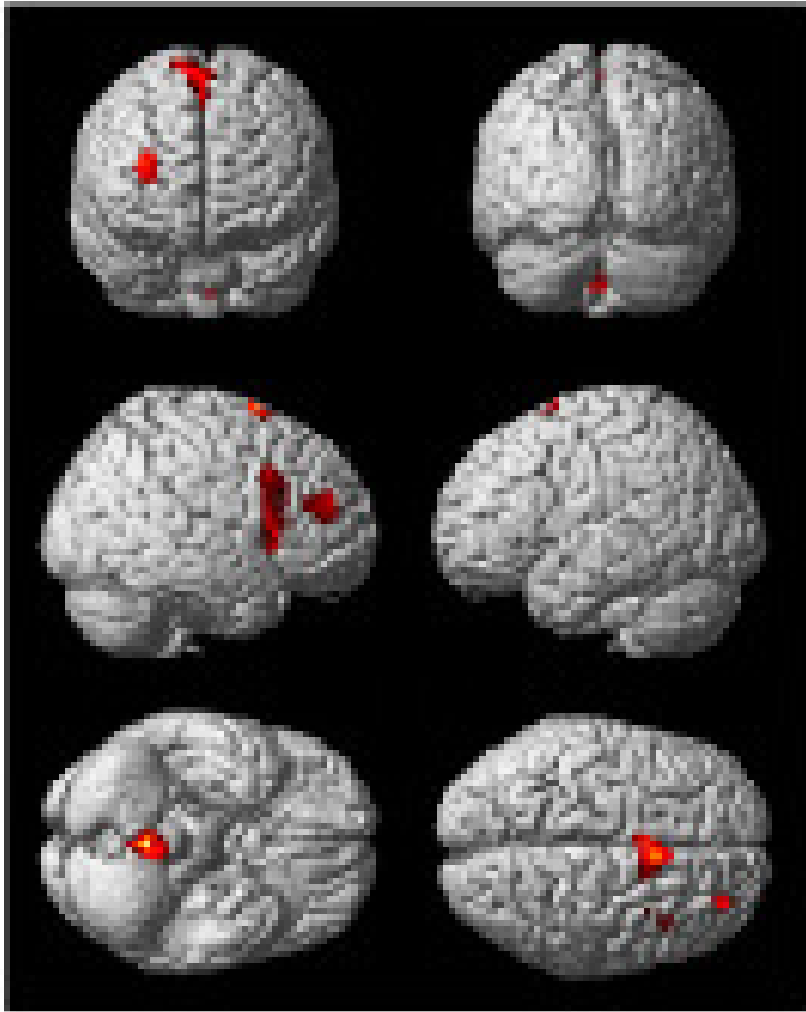


Improved Attention in Swedish ADHD Children

- 60 children
- 8–13 y old
- 3 months
- Chocolate flavored spreads 250 mg/d
- Previous diagnosis of ADHD by a professional.
- No significant sensory or neurological psychiatric or developmental disorders



DHA supplementation activates brain regions associated with attention, USA



- Healthy boys age 8-10
- n = 33
- 8 weeks
- Placebo or 400 mg/d and 1,200 mg/d, DHA

RESULTS

- Activation (fMRI) of the dorsolateral prefrontal cortex

(attention, executive function)

- Reduced activation of cerebellar cortex.

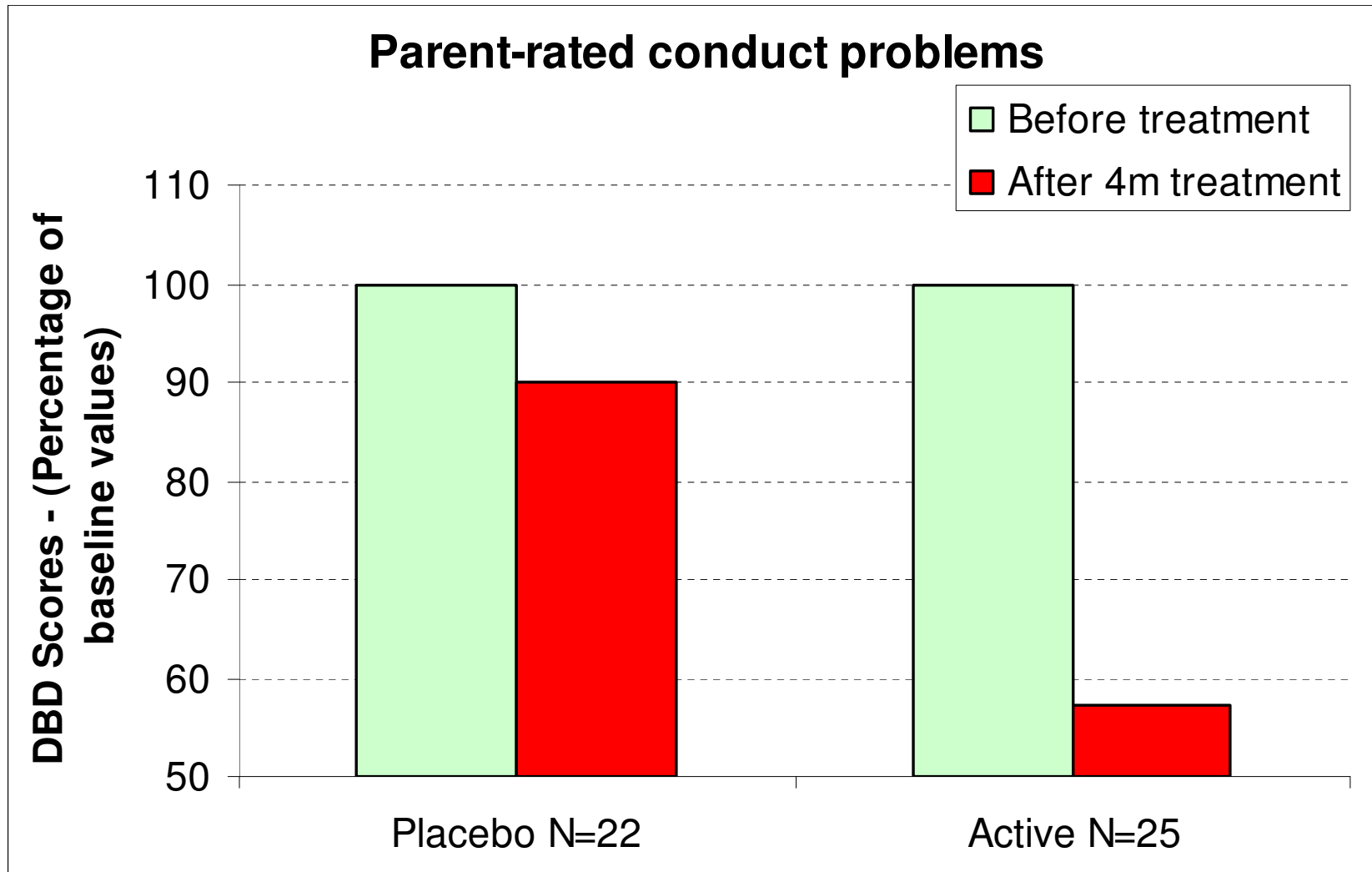
(over-active in ADHD)

↑ blood DHA and ↑ brain activity

Mcnamara et al, Am J Clin Nutr, 2010

EFA supplementation improves inattention and disruptive behaviors

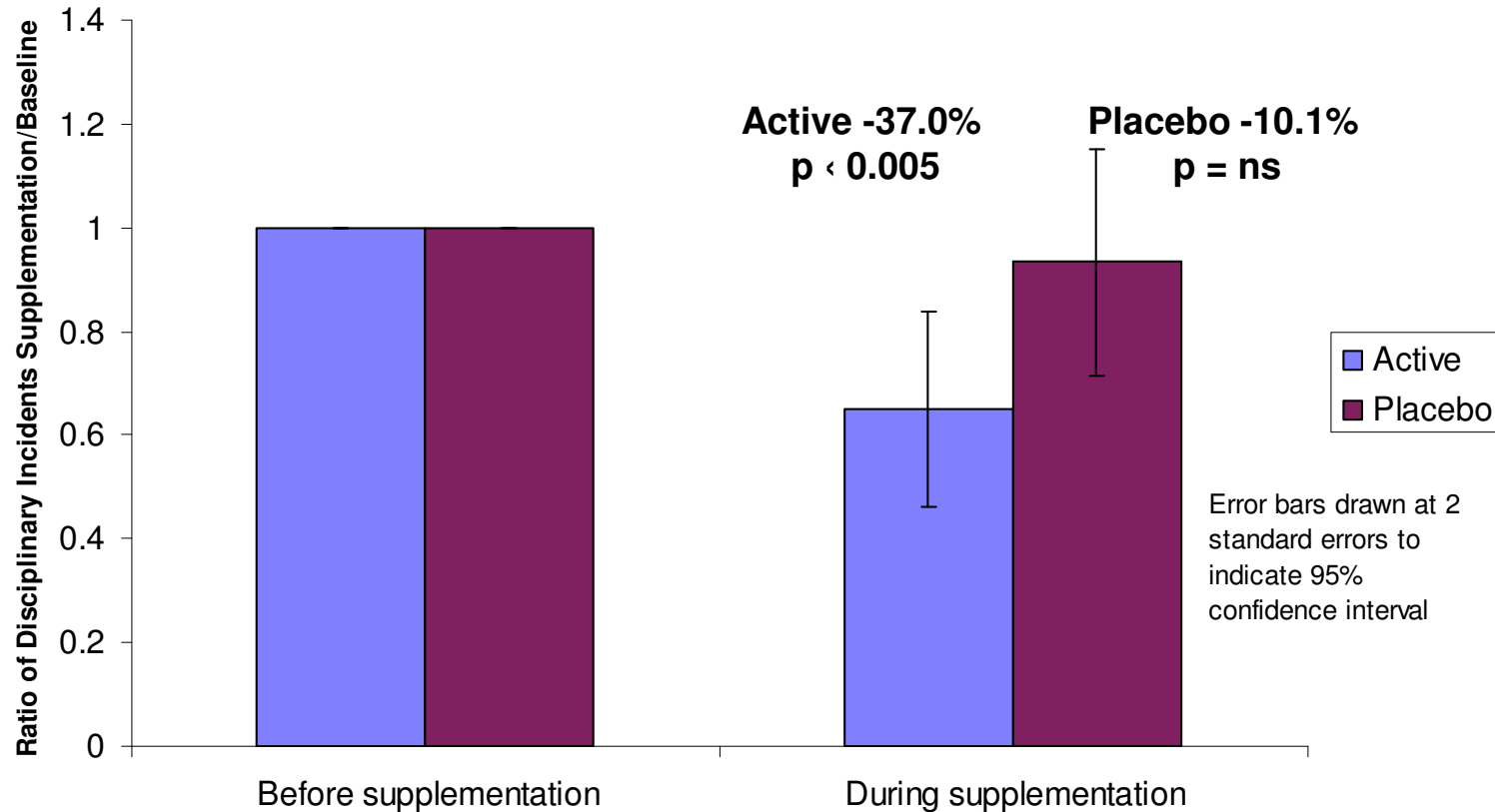
- RCT involving 50 children aged 6-13
- All were under treatment for ADHD-type difficulties
- All had inattention, hyperactivity and other disruptive behaviours
- Placebo or 480 mg DHA, 80 mg EPA, 40 mg AA, 96 mg GLA, and 24 mg alpha-tocopheryl acetate,
- 4 months



Group difference (ITT) $p < 0.05$

Stevens et al (2003) *Lipids*, 38(10) 1007-21

Reduced Felony Violent Offences Among Prisoners with recommended daily amounts of vitamins, minerals and essential fatty acids



UK maximum security prison - 338 offences among 172 prisoners over 9 months treatment in a compared to 9 months baseline.

Gesch et al. Br J Psychiatry 2002, 181:22-28

Not every child responds
30-50% with problems
improve substantially
(can't predict who)

Mood- Rude- Attention
Verbal Development

Hyperactivity not a strong response

Essential Fats: Metabolism and Dietary Sources

Omega-6



18:2n-6 linoleic acid, LA

Soy bean oil
Safflower oil
Corn oil



20:4n-6, arachidonic acid AA

Meat,
Organs



22:5n-6

DPA n-6

Series 2
Prostaglandins
Thromboxanes
Series 4
Leukotrienes

Series 3
Prostaglandins
Thromboxanes
Series 5
Leukotrienes

immune - metabolic - developmental responses

Omega-3



18:3n-3 alfa-linolenic acid, LNA

Flax
~ Canola
Leaf plants



20:5n-3, eicosapentaenoic acid, EPA

Seafood
Breast milk
(DHA)



22:6n-3, docosahexaenoic acid, DHA

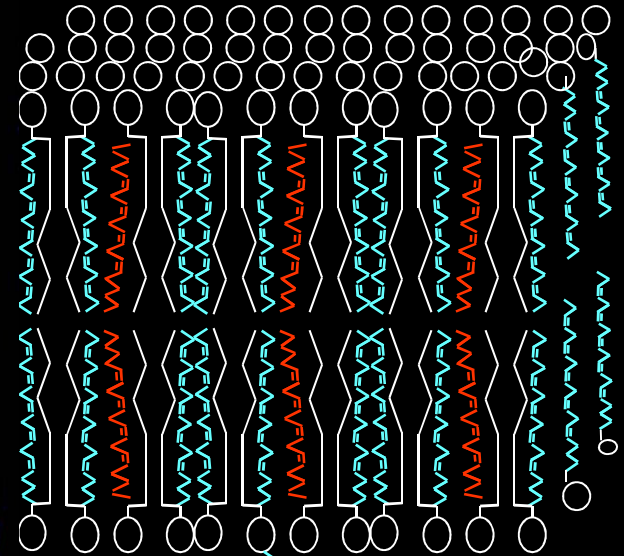
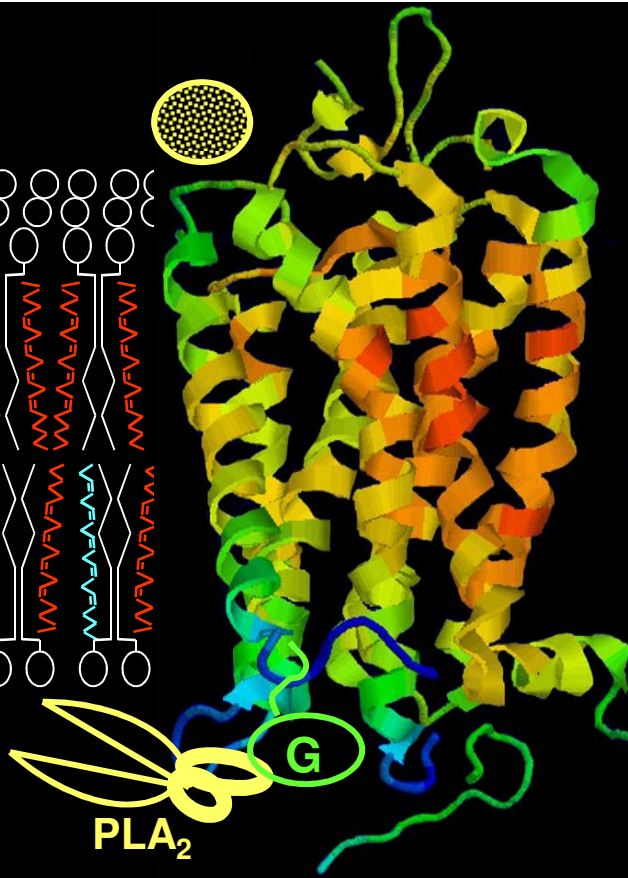
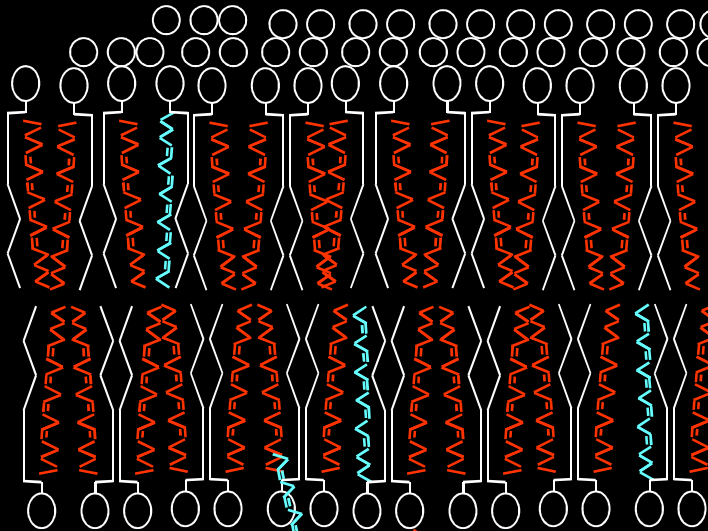
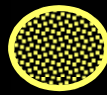
(brain, retina, testis)

- Competition -

FADS 1-2

U.S. Diet

Japanese Diet



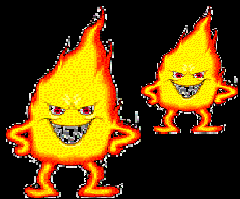
PLA₂

Aspirin
Other drugs
> \$ 10 Billion

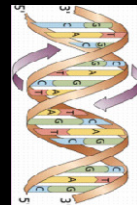
~~COX 1-2~~

PGE₂

TXA₂



Thrombosis

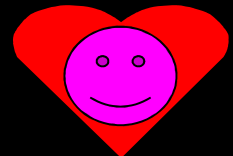


Gene Expression

COX 1-2

PGE₃

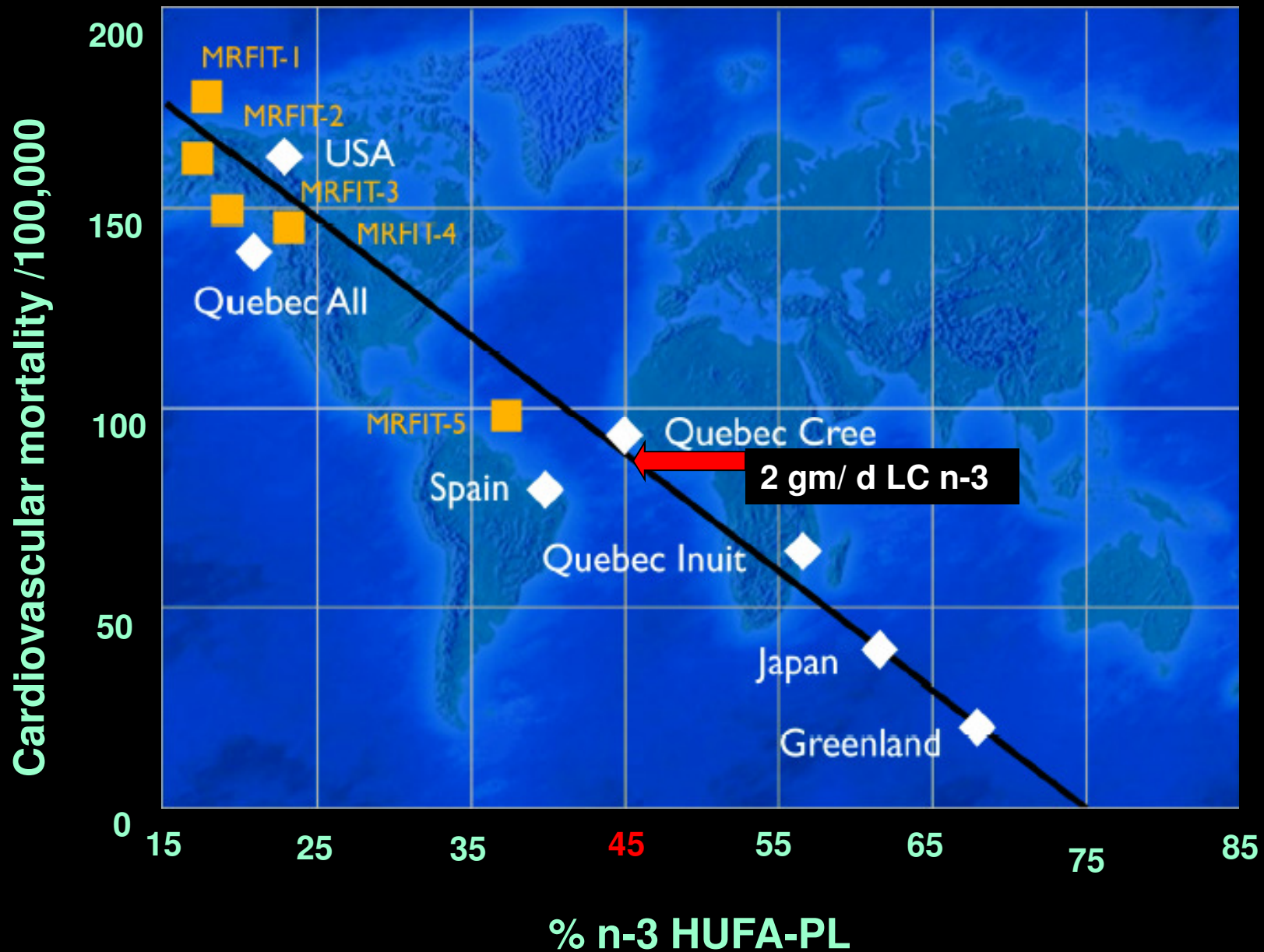
TXA₃



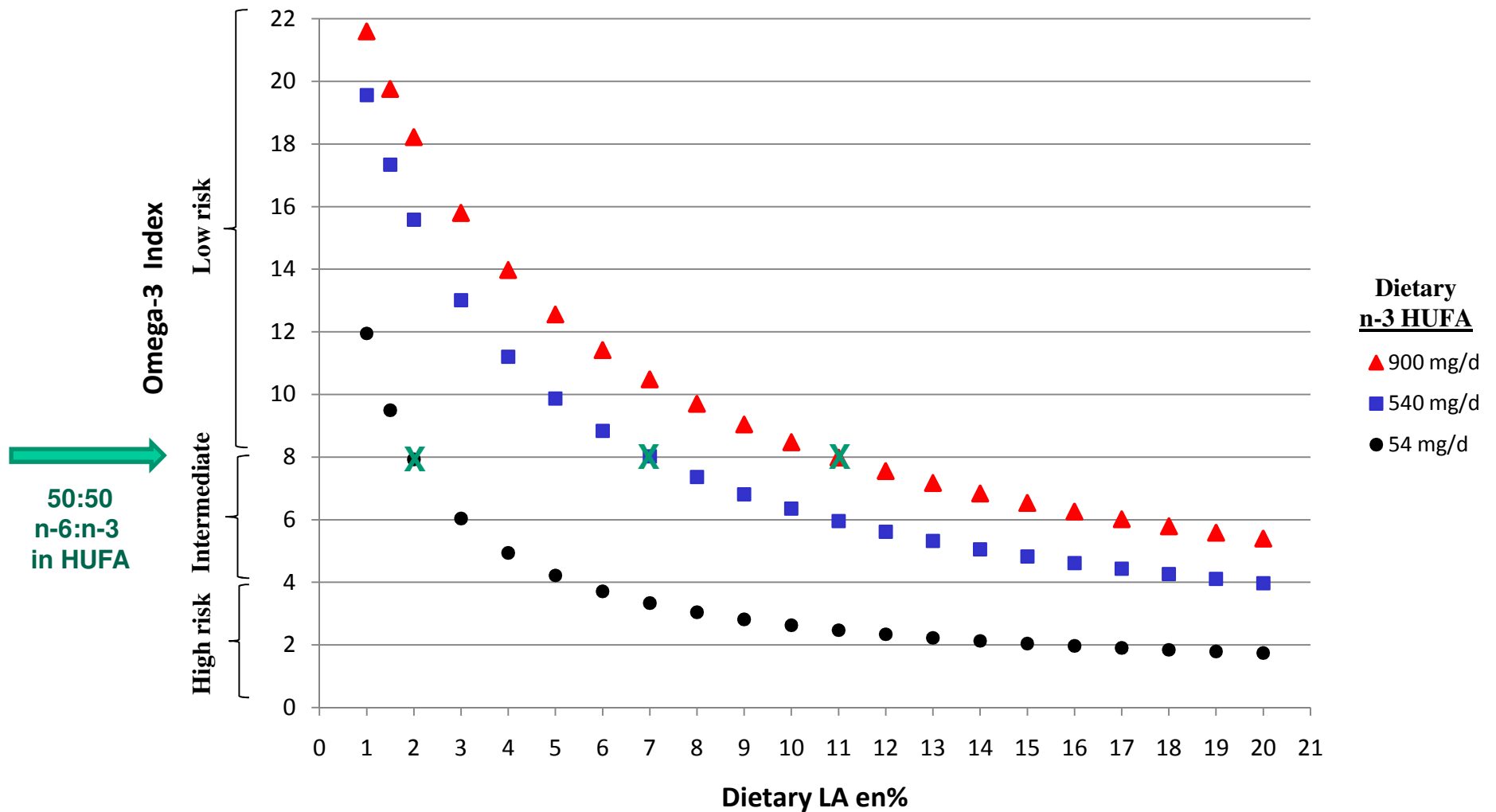
↓ SREP1

↓ Triglycerides

Cardiovascular mortality risk and LC n-3 in tissues



Predicting Omega-3 tissue compositions: Dietary n-3 HUFA and n-6 LA interactions



Based on equation of Lands et al Biochim Biophys Acta. 1992 Dec 10;1180(2):147-62.

How to count capsules to get 1 gm/d of EPA+DHA (kids)

Total oils in capsule	EPA	DHA	EPA+DHA/ capsule	# of capsules needed
1,000 mg Unconcentrated \$ (cod liver oil)	120 mg	180 mg	300 mg	= 900 mg 3-4 caps
1,000 mg molecularly distilled \$\$	200 mg	300 mg	500 mg	=1,000 mg 2 caps
1,100 mg highly purified \$\$\$	600 mg	400 mg	1,000 mg	=1,000 mg 1 cap

Parent, Public and Scholarly information

KIM-2 Program

**Enter your diet and
See the omega-3 content of your body
efaeducation.nih.gov**

**Food and Behavior Research U.K.
FABresearch.org**

**DHA EPA institute
dhaomega3.org**

**PUFA newsletter
www.fatsoflife.com**

Books to consider

They are What You Feed Them: How Food Can Improve Your Child's Behaviour, Mood and Learning

~ Alex Richardson

The Ultimate Omega-3 Diet: Maximize the Power of Omega-3s to Supercharge Your Health, Battle Inflammation, and Keep Your Mind Sharp

~ Evelyn Tribole

The Omega Diet: The Lifesaving Nutritional Program Based on the Diet of the Island of Crete

~ Artemis P. Simopoulos

Omega Rx Zone: The Miracle of the New High-Dose Fish Oil

~ Barry Sears

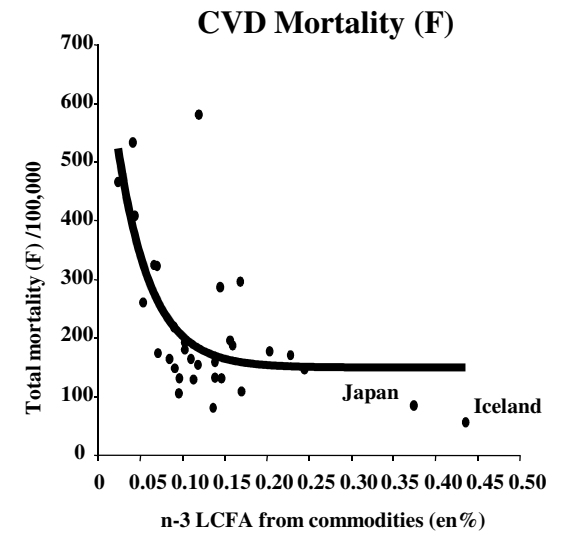
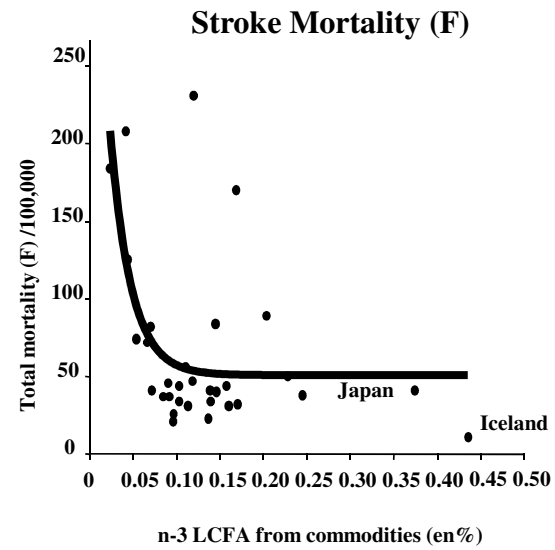
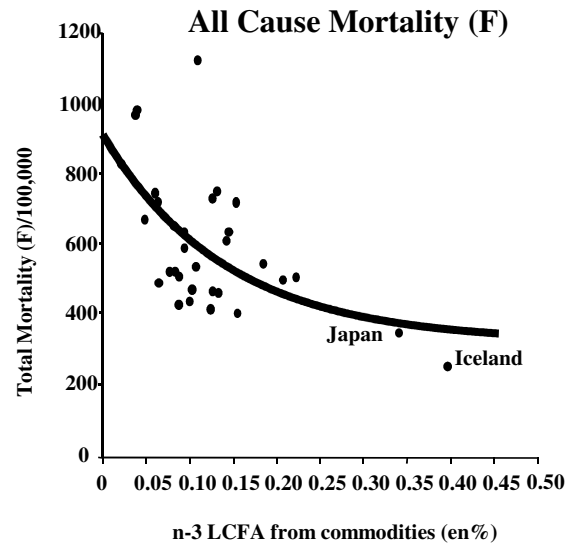
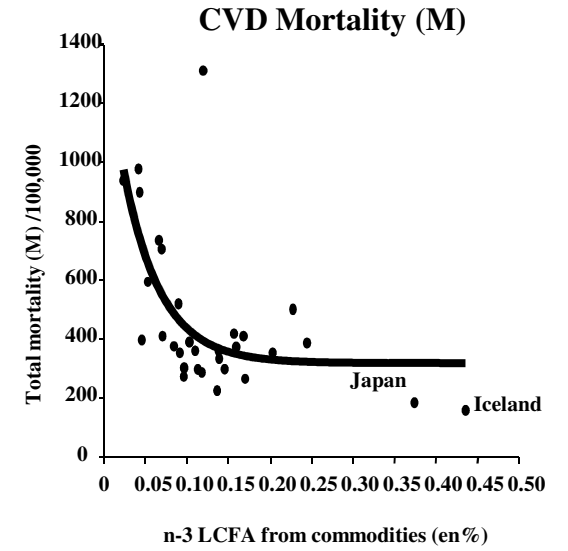
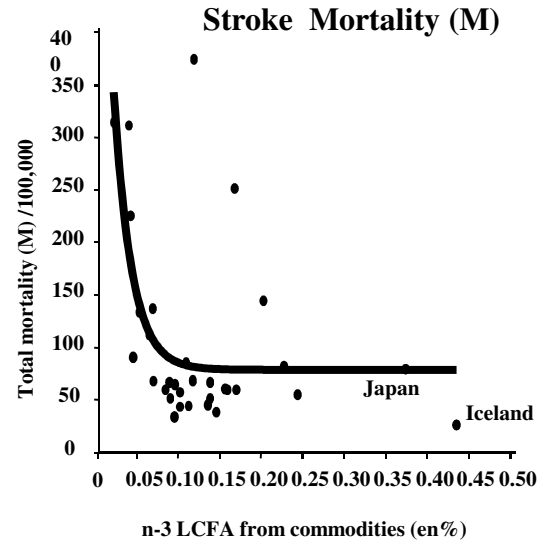
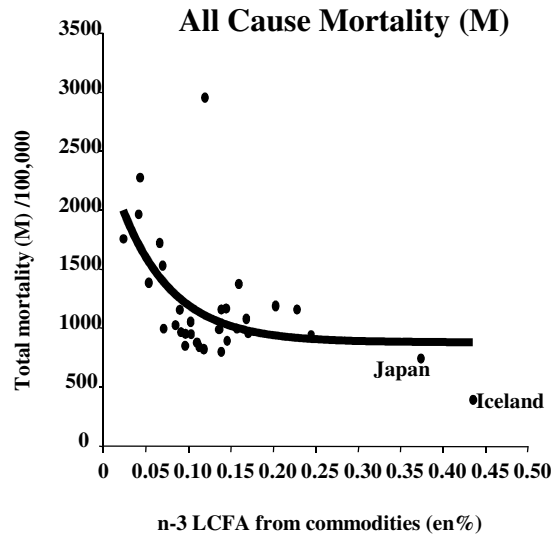
Thank you

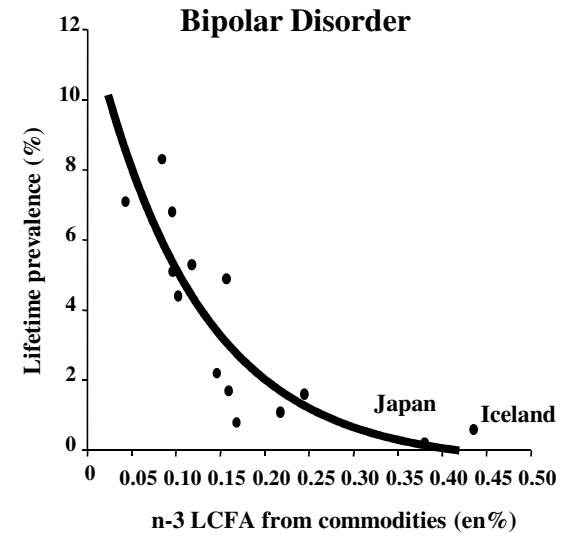
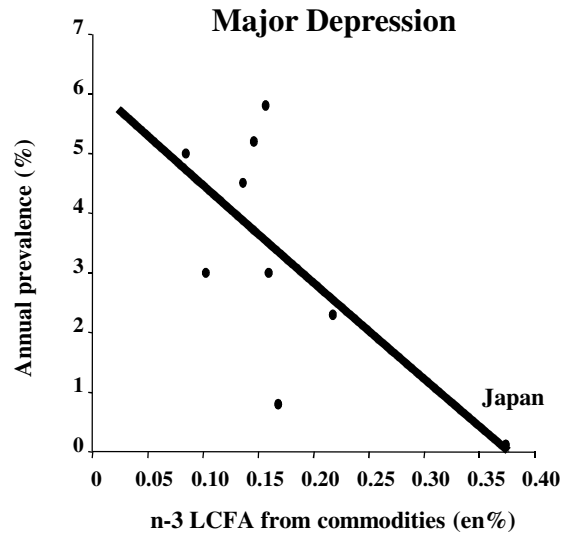
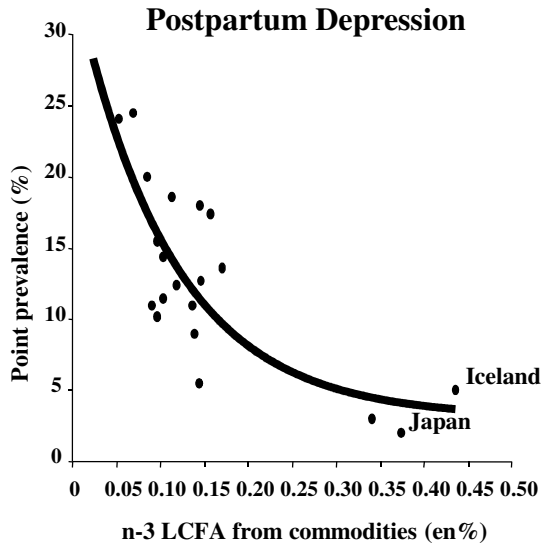
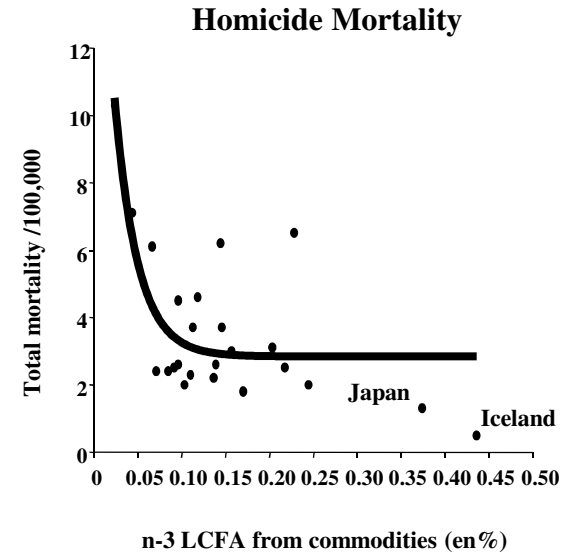
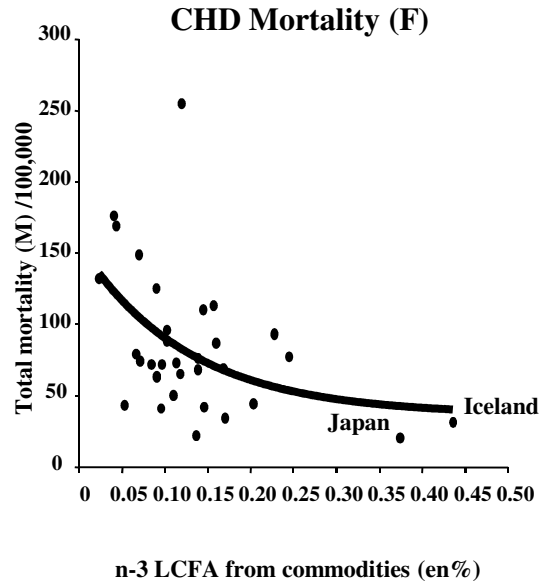
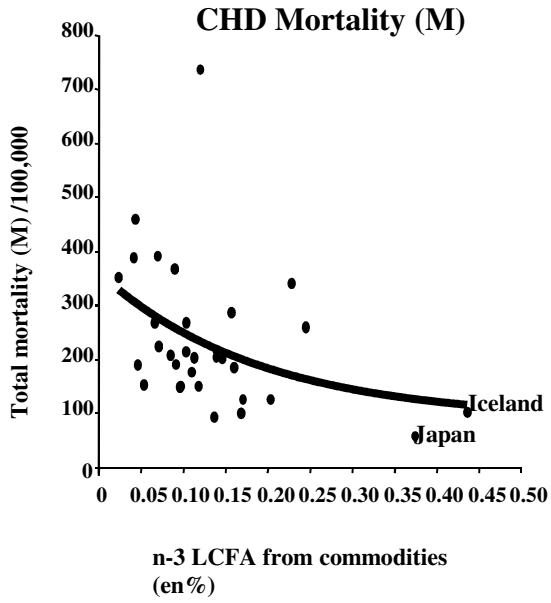
Putative EAR's and RDA's for n-3 LCFA intake during pregnancy

900 mg/d/2,000 Cal (0.40 en%) protects > 97.5% of the population

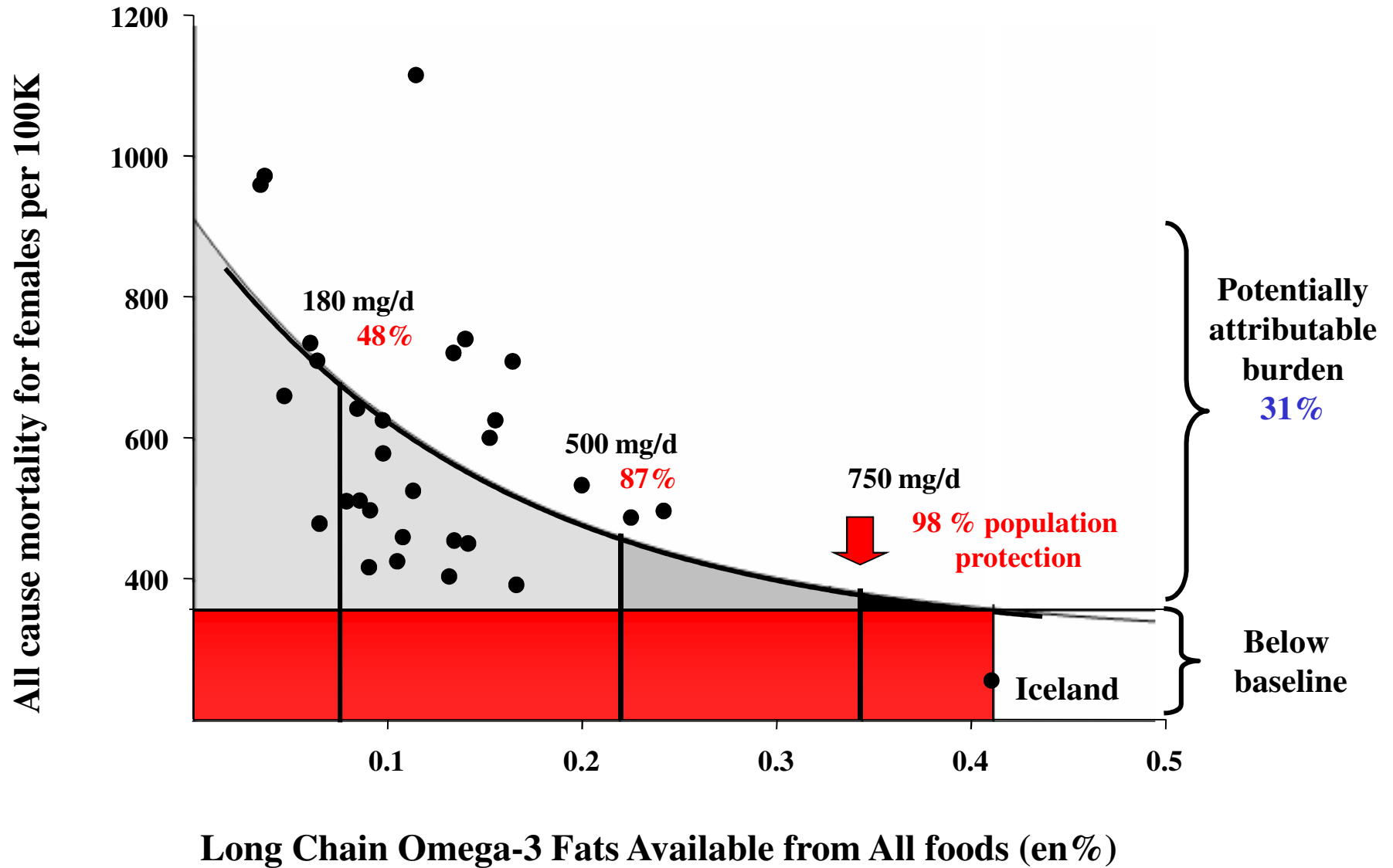
Inadequacy model	Putative- EAR		Putative- RDA	
	en%	mg/d 2,000 Cal	en%	mg/d 2,000 Cal
Suboptimal Fine Motor skills Child age 42 m	0.050- 0.06	111- 139	0.20- 0.26	456- 570
Low Verbal IQ Child age 8 y	0.065- 0.08	114- 181	0.22- 0.28	590- 611
Maternal Depression 18 wks gestation	0.15- 0.19	333- 417	0.30- 0.38	777- 850
Maternal Depression 32 wks gestation	0.18- 0.22	389- 486	0.33- 0.41	830- 917

Range indicates calculated EAR or RDA + 25% underestimation error.
Hibbeln and Davis under review AJCN, 2008





All cause mortality for females



Disease/Disorder Model	Disease burden potentially modifiable by n-3 HUFAs	Percent vulnerable population protected from illness (%)		
		Model Advice for n-3 HUFA Intake		
		0.08 en% (180 mg/d)	0.22 en% (500 mg/d)	0.34 en% (750 mg/d)
CHD mortality M	41.2%	45.2	85.4	97.9
CHD mortality F	42.5%	52.4	89.7	98.6
Stroke mortality M	32.9%	97.7	99.9	>99.9
Stroke mortality F	31.1%	96.4	99.9	>99.9
CVD mortality M	26.1%	83.4	99.3	>99.9
CVD mortality F	29.1%	86.9	99.6	>99.9
All Cause mortality M	20.8%	73.6	97.7	99.8
All Cause mortality F	31.5%	48.3	87.3	98.2
Homicide mortality	28.4%	95.6	>99.9	>99.9
Postpartum depression	65.5%	55.7	91.3	98.9
Major depression	98.5%	38.5	83.2	99.2
Bipolar disorder	99.9%	56.1	92.3	99.5

Pick a mDRI number?

EPA+DHA (long chain omega-3's)

Upper Limit ~ none

EAR 0.20 en% 360 mg/d (2,000 Cal)

RDA 0.40 en% 900 mg/d (2,000 Cal)

Linoleate (short chain omega-6)

Upper Limit ~ 2 en% (>compromises EPA + DHA)

EAR ?

RDA ? 0.05en%

Replace LA with α -LNA or monounsaturates

Tissue target- 60% n-3 LCFA or omega-3 index=12

**Dietary requirements for EPA and DHA increase by 13-fold
with high background intakes of LA (18:2n-6)**

COUNTRY	n-3 HUFA intake required to meet Japanese tissue target		+	+ Background dietary intake (en%)			=	= Tissue target (Mature Japanese)	
	(mg/d)	(en%)		LA 18:2n-6	AA 20:4n-6	a-LNA 18:3n-3		% n-3 in HUFA	Omega-3 index
Philippines	278	0.125	+	0.80	0.06	0.08	60%	12	
Denmark	1,000	0.45	+	2.23	0.09	0.33	60%	12	
Iceland	1,200	0.54	+	2.48	0.10	0.33	60%	12	
Colombia	1,133	0.51	+	3.21	0.04	0.24	60%	12	
Ireland	1,378	0.62	+	3.57	0.06	0.42	60%	12	
UK	1,600	0.72	+	3.91	0.07	0.77	60%	12	
Netherlands	1,956	0.88	+	4.23	0.08	0.28	60%	12	
Australia	2,000	0.90	+	4.71	0.07	0.49	60%	12	
Italy	2,111	0.95	+	5.40	0.06	0.51	60%	12	
Germany	2,222	1.00	+	5.57	0.06	0.62	60%	12	
Bulgaria	2,778	1.25	+	7.02	0.05	0.06	60%	12	
Israel	3,222	1.45	+	7.79	0.07	0.67	60%	12	
USA	3,667	1.65	+	8.91	0.08	1.06	60%	12	