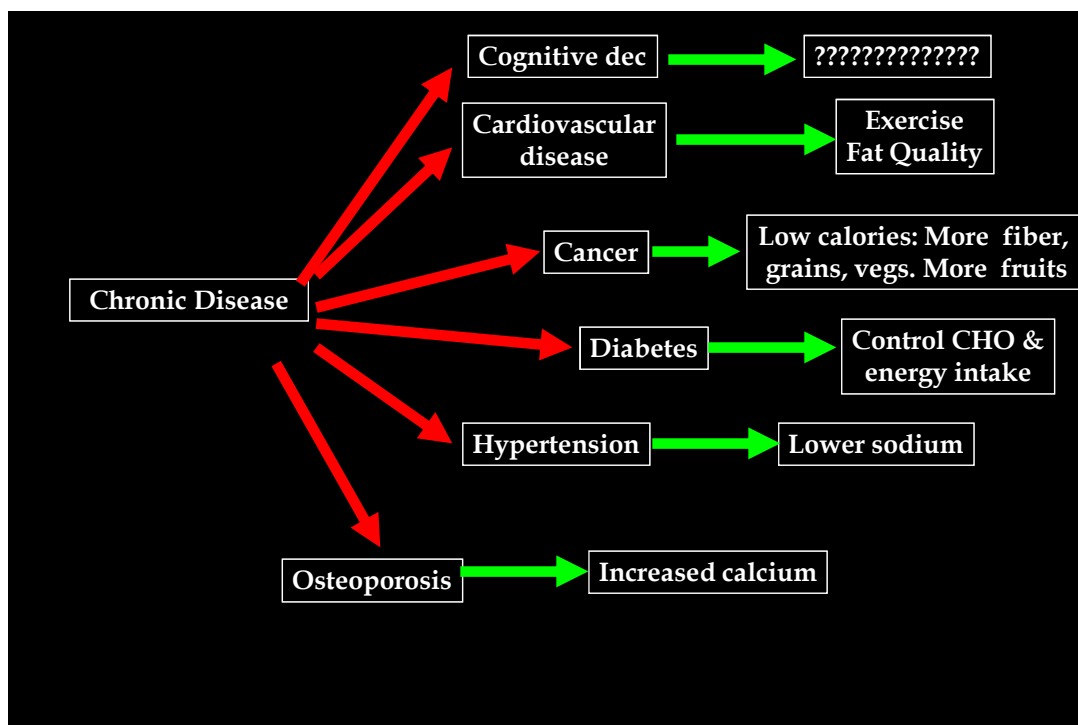
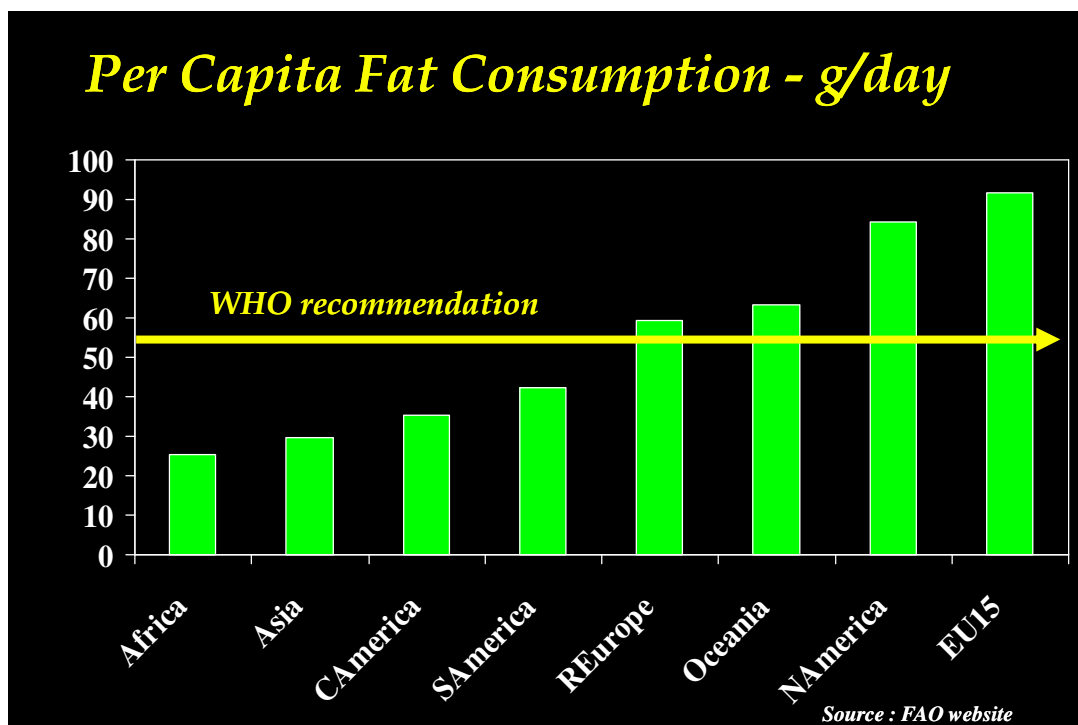
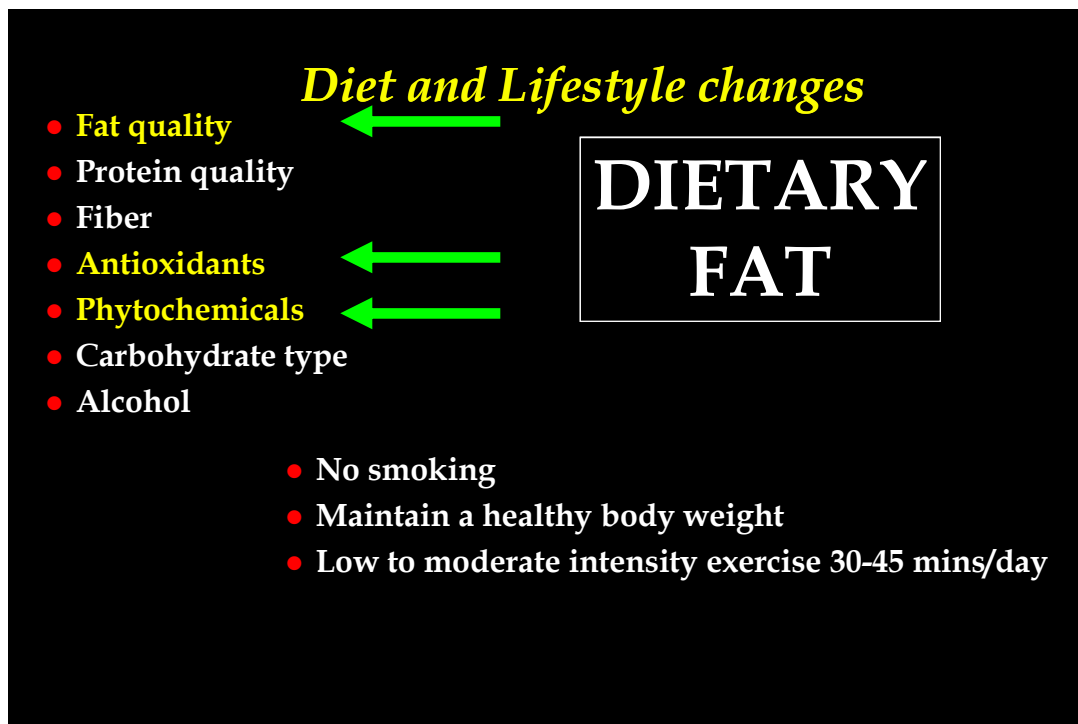


# Palm Oil: ...Health and Nutritional Benefits

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Associate Professor,  
Dept. of Nutrition & Food Science,  
Wayne State University,  
Detroit, MI 48202





## RISK FACTORS FOR CHD

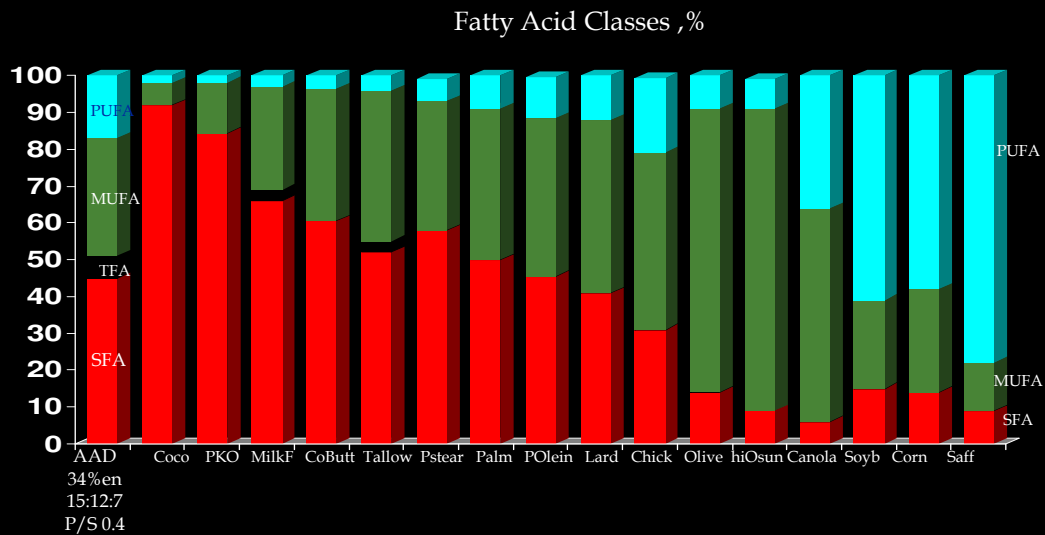
- Gender
- Increasing age
- Genetics: Family history of CHD

- High TC, LDL-C
- Low HDL-C
- Smoking
- Diabetes
- Obesity

DIET

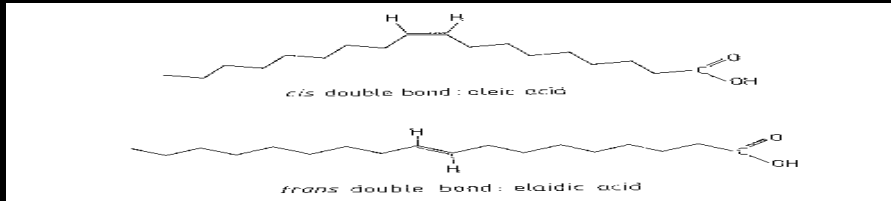
Fat quality  
Protein quality  
Fiber  
Antioxidants  
Phytochemicals  
Carbohydrate type  
Alcohol

## Dietary fat composition: by fatty acid classes



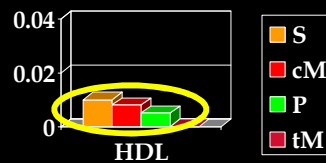
## What about trans fatty acids?

- Unsaturated fatty acids - at least one *trans* double bond

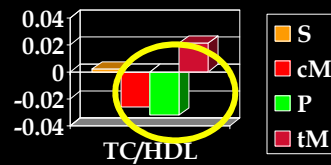


- Partial **hydrogenation** of polyunsaturated oils - isomerization and migration of double bonds - distribution of *cis* and *trans* double bonds (margarines, shortenings, salad & cooking oils)
- Partial hydrogenation → tFA. Full hydrogenation → SFA
- Major tFA - elaidic acid (t9 - 18:1)
- Dairy and meats have t9 - 16:1 and t11 - 18:1 (vaccenic acid)

*...what are the effects of fatty acid classes on lipoprotein cholesterol?*

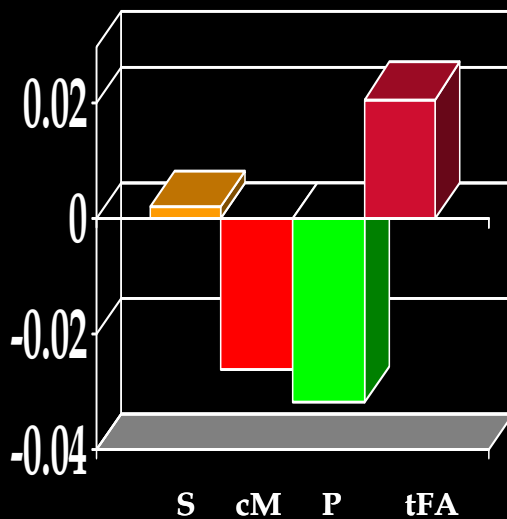


*MUFA & PUFA best.  
Trans worse than SFA*



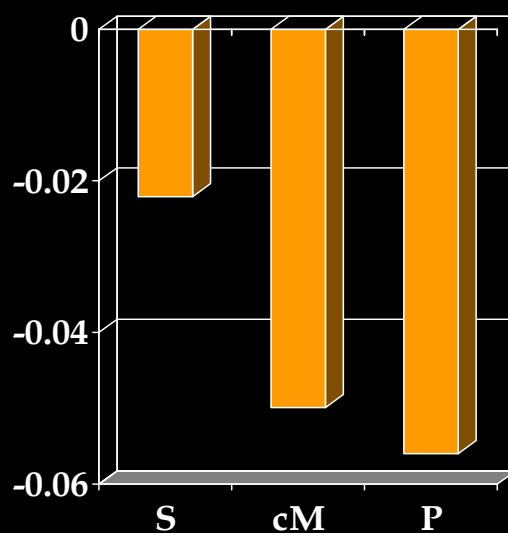
Changes shown in mmol/L for LDL and HDL. Adapted from Mensink et al Am J Clin Nutr (2003) 77: 1146-1155

### *Effects on the TC/HDL-C ratio*



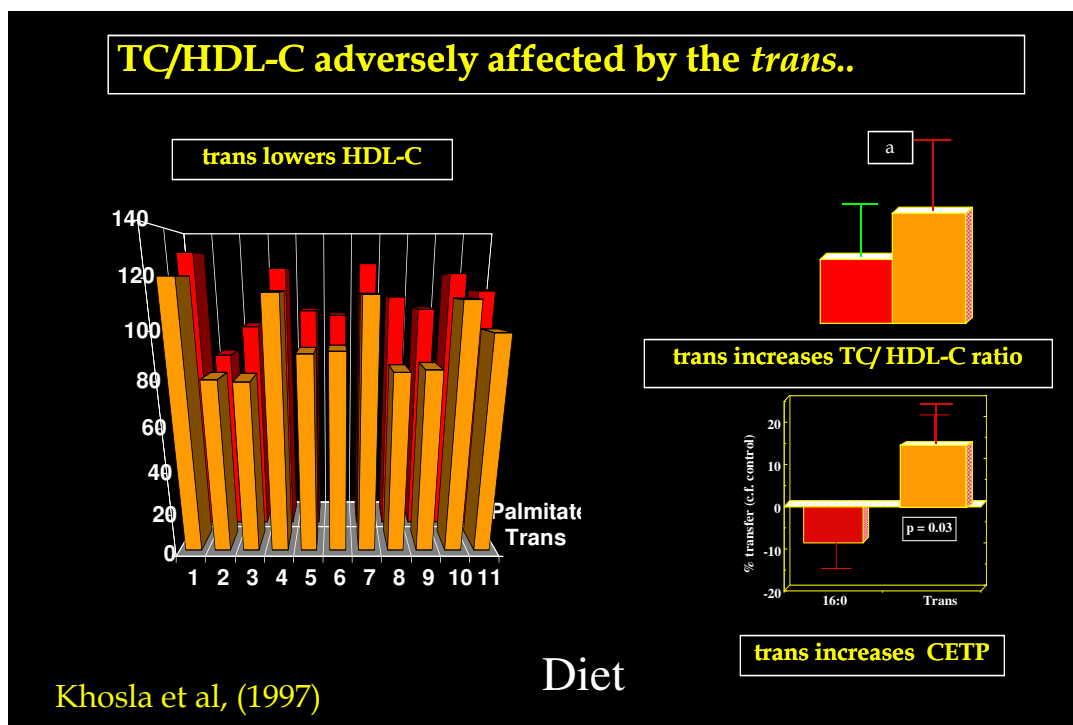
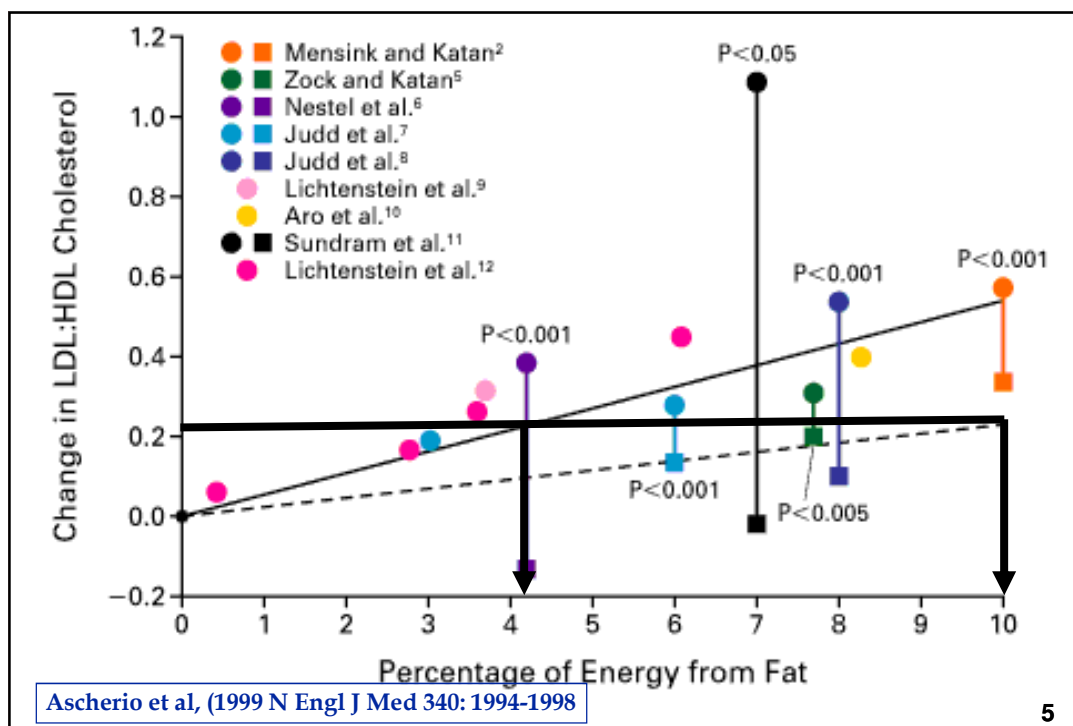
**CHO → FA**

Am J Clin Nutr (2003) 77: 1146-1155

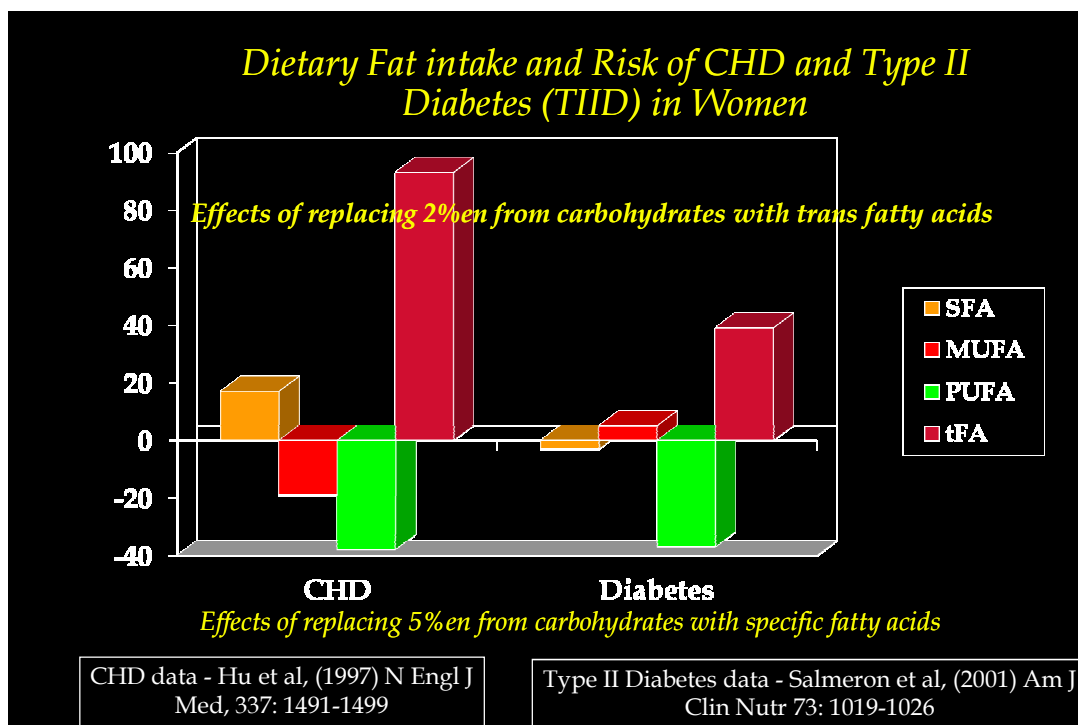


**tFA → FA**

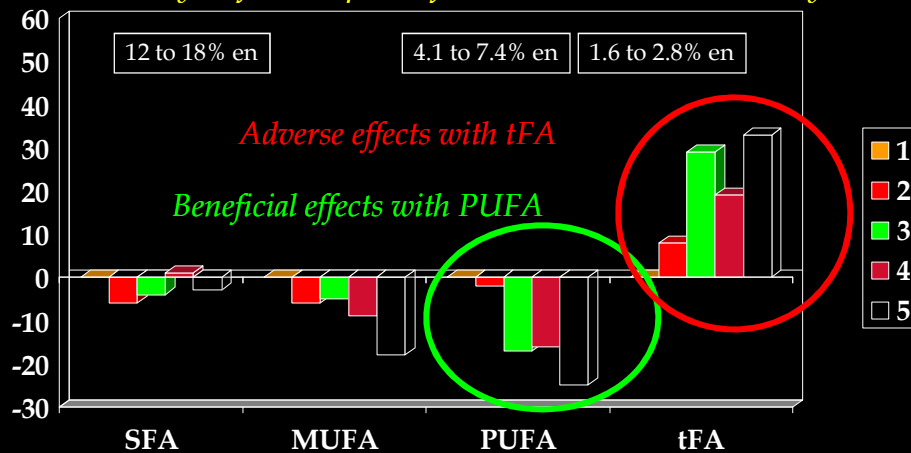
N Engl J Med (2006) 344: 1601-1613



*...so what about effects on CVD?*



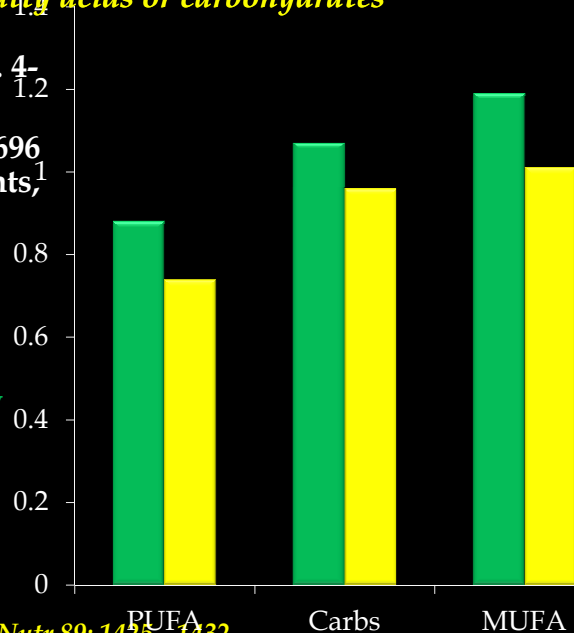
*Relative risk of CHD based on quintiles of dietary fatty acid intake  
(Multivariate analyses)  
20 year follow-up data from the Nurses Health Study*



from Oh et al (2005) Am J Epidemiol, 161: 672-679

*Replacing SFA with different fatty acids or carbohydrates*

- Pooled analysis of 11 studies. 4-10 year follow-up
- Pooled RR evaluated in 344,696 subjects (5,249 coronary events,<sup>1</sup> 2155 coronary deaths)
- Effect of 5% lower energy intake from SFA with a simultaneous higher energy intake from PUFA, carbs or MUFA is shown for **coronary events** and **coronary deaths**

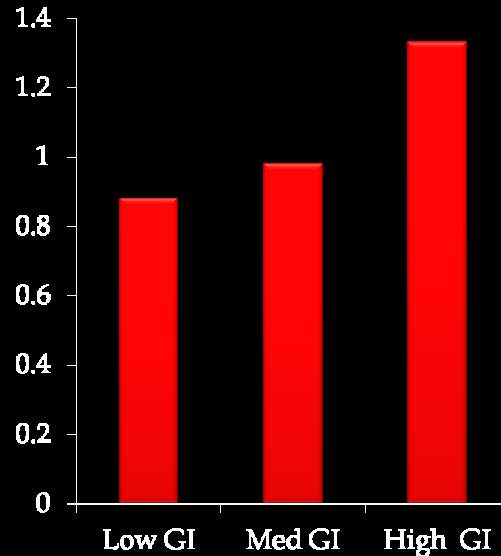


Jakobsen et al, (2009) Am J Clin Nutr 89: 1425 - 1432



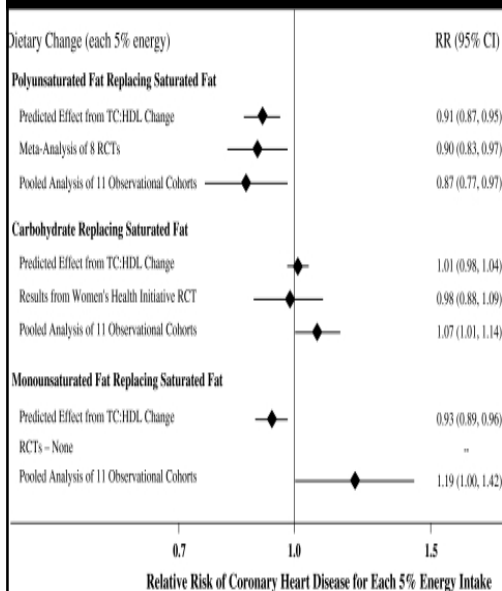
### Exchanging 5% calories from SFA with carbs of different GI values

- Prospective cohort study. Median 12 year follow-up
- Hazard Ratio evaluated in 53,644 subjects [1,943 cases of incident myocardial infarction (MI)]
- For a 5% lower energy intake from SFA with a simultaneous higher energy intake from carbs with different GI values
- Significant association with high GI carbs



*Jakobsen et al, (2009) Am J Clin Nutr 89: 1425 - 1432*

### Effects on CHD risk of consuming PUFA, carbs, or MUFA in place of SFA



*Predicted effects are based on changes in the TC:HDL-C ratio*

*Evidence from a meta-analysis of eight randomized controlled trials*

*Evidence for observed relationships of usual dietary habits with CHD events comes from a pooled analysis of 11 prospective cohort studies.*

*Micha and Mozaffarian, (2010) Lipids. 45: 893-905*

***Meta-analysis of 21 prospective epidemiologic studies showed no significant evidence for concluding SFA are associated with increased CHD risk***

- 5-23 year follow-up
- Pooled RR evaluated in 347, 747 subjects (11, 006 developed CHD or stroke)
- SFA intake was not associated with

CHD (Pooled RR - 1.07; 95% CI 0.96 - 1.19, p=0.22)

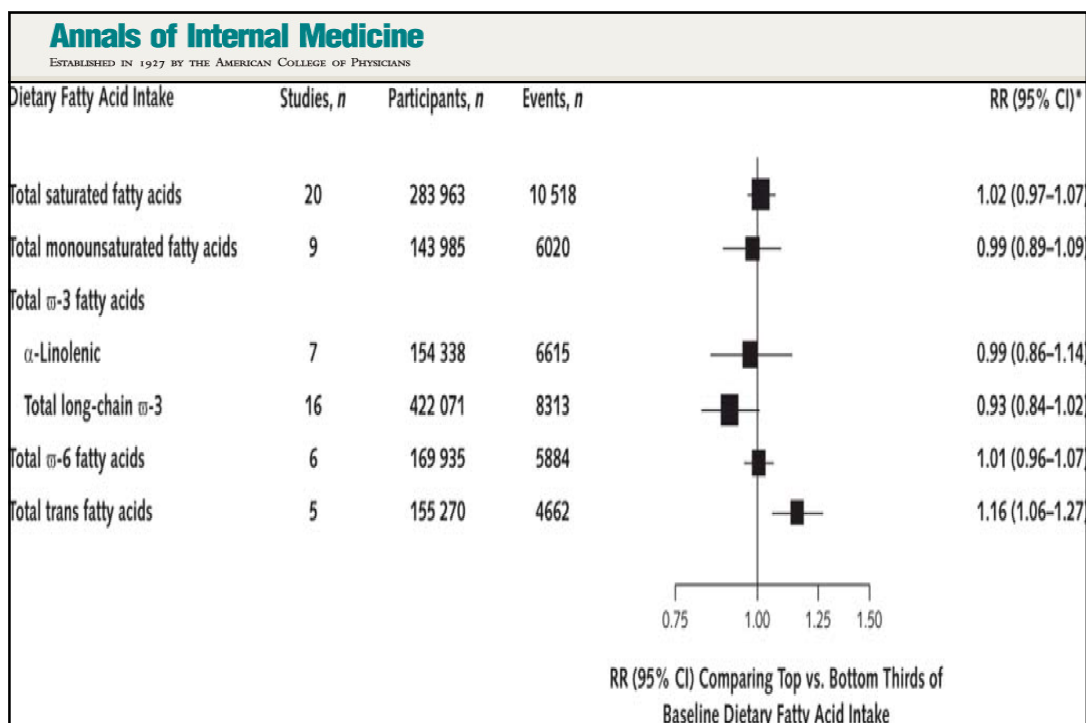
Stroke (Pooled RR - 0.81; 95% CI 0.62 - 1.05, p=0.11)

CVD - (Pooled RR - 1.00; 95% CI 0.89 - 1.11, p=0.95)

*Siri-Tarino et al , (2010 ) Am J Clin Nutr 91: 535 - 546*

## ***Association of Dietary, Circulating, and Supplement Fatty Acids With Coronary Risk: A Systematic Review and Meta-analysis***

*Chowdhury et al, (2014) Ann Int Med 160: 398-406*



***Skeaff and Miller, (2009) Ann. Nutr. Metab. 55: 173-201***

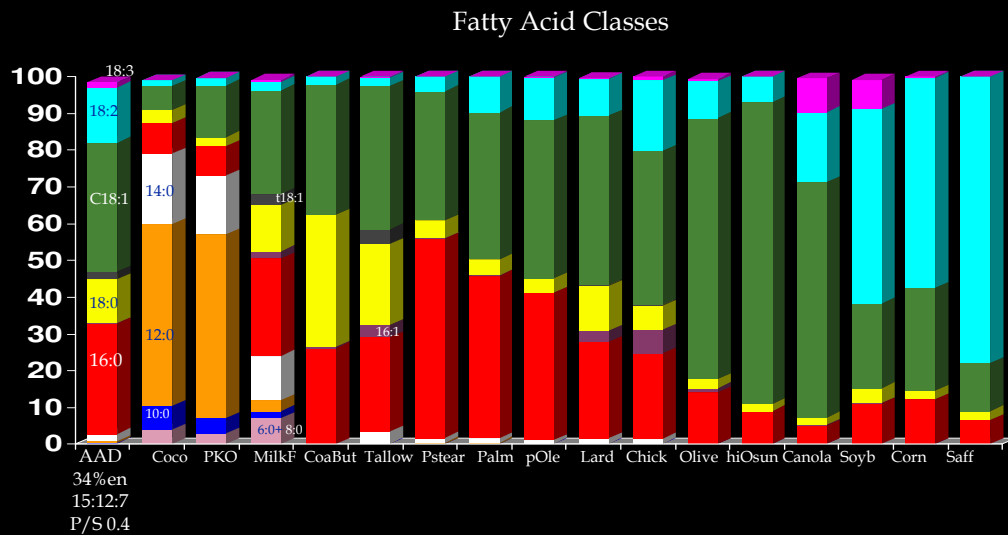
	Fatal CHD	CHD events
Total Fat	C-NR	C-NR
TFA	P	C
SFA/CHO	P-NR	P-NR
MUFA/SFA		
PUFA/SFA	C	C
Linoleic acid		
Alpha Linolenic		
n3 LCPUFA	P	C

### ***Dietary Fatty Acids and CHD: Summary of the Evidence***

***C = Convincing evidence; P = Probable evidence; NR – no relation; Red denotes increased risk while Green denotes decreased risk***

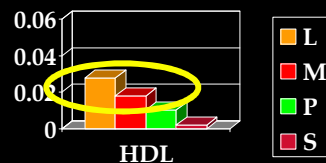
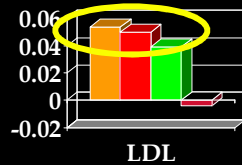
*...what about individual saturated FA?*

*Dietary fats comprised of individual fatty acids  
– especially important for SFA*



10/25

### *Effects of individual SFA on lipoprotein cholesterol*



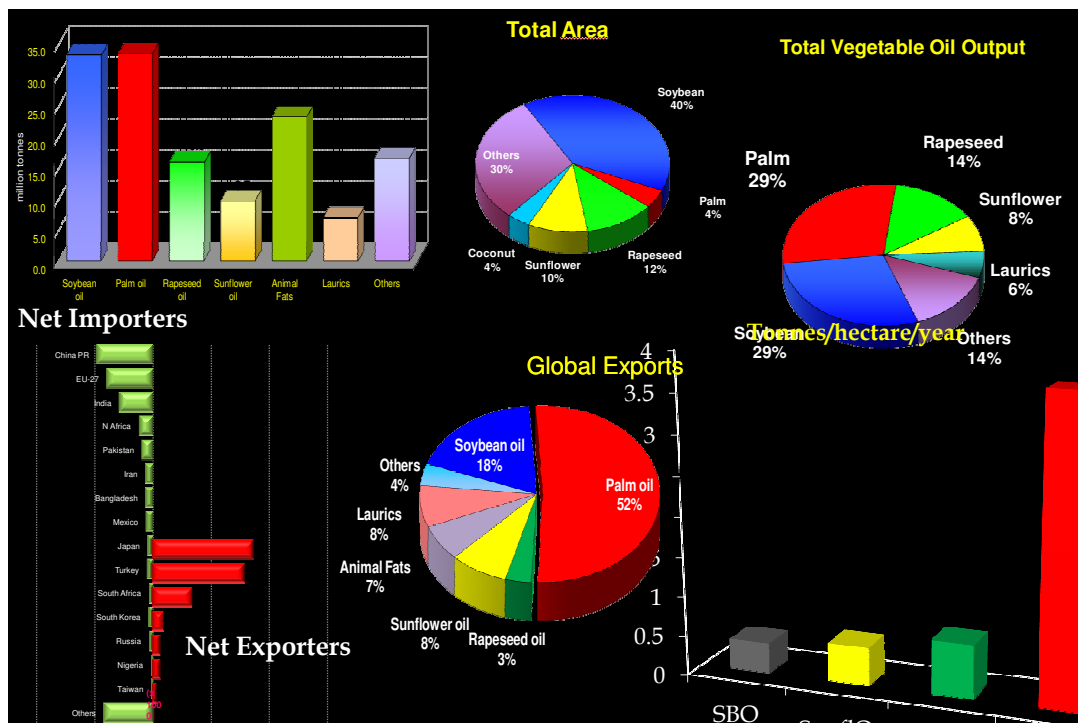
*14:0, 16:0 no effect  
18:0, 12:0 beneficial*

Changes shown in mmol/L for LDL and HDL. Adapted from Mensink et al Am J Clin Nutr (2003) 77: 1146-1155

### *Nutritional attributes of Palm Oil and Palm Olein*

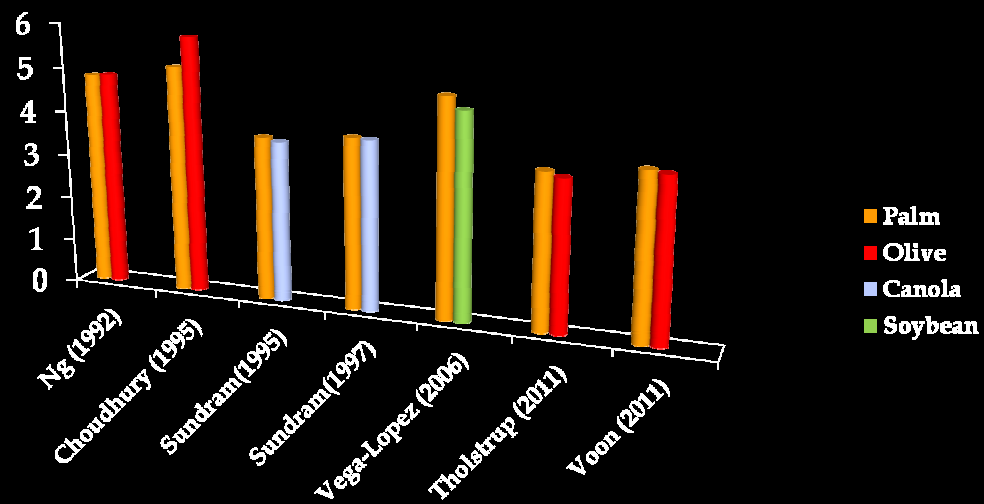
- The global importance of palm oil
- Effects of palm oil on the ration of TC/HDL-C...
- Replacement for trans fatty acids
- Variety of carotenoids - pro Vitamin A
- Vitamin E (tocopherols and tocotrienols)

*... the global importance of palm oil?*



*...effects of palm oil on the ratio of TC/HDL-C?*

*Palm Olein and MUFA-rich Oils exert similar effects on the ratio of Total cholesterol to HDL cholesterol (TC/HDL-C) in human subjects*



***Palm oil and blood lipid related markers  
of cardiovascular disease: a systematic  
review and meta-analysis of dietary  
intervention trials***

***Fattore et al, , (2014) Am J. Clin Nutr. doi: 10.3945/ajcn.113.081190***

***Synopsis of meta-analysis***

- 51 studies; 1526 volunteers (2/3 men); ages 16-70 y
- Studies from Australia, Canada, China, Denmark, Finland, France, India, Malaysia, Netherlands, Norway, Scotland, South Africa, Spain, Thailand, USA
- Feeding times 2 to 16 wks
- Studies in healthy volunteers who were normocholesterol-emic, hypercholesterolemic as well as n/h subjects
- Dietary fat content 28% to 53% of total calories (test fat 4% to 43% of total calories)



*Effects on plasma lipoproteins of substituting various fatty acids with palm oil*

	TC	LDL	VLDL	apoB	HDL	ApoAI	TG	Lp(a)	LDL/ HDL	TC/ HDL
Stearic	I	I	N	I	I	I	N	N	I	N
Lauric + Myristic	D	N	N	N	D	D	N	N	N	
MUFA	I	I	N	I	I	N	N	N	N	N
PUFA	I	N	N	I	I	I	N	N	N	N
transFA	N	N	N	D	I	I	D	N	N	D

*I- increase, D – decrease and N – no significant change*

*Adpated from Fattore et al, (2014). Am J Clin Nutr 99: 1331-1350*

*...palm oil as a replacement for trans fat?*

... .. *practical aspects*

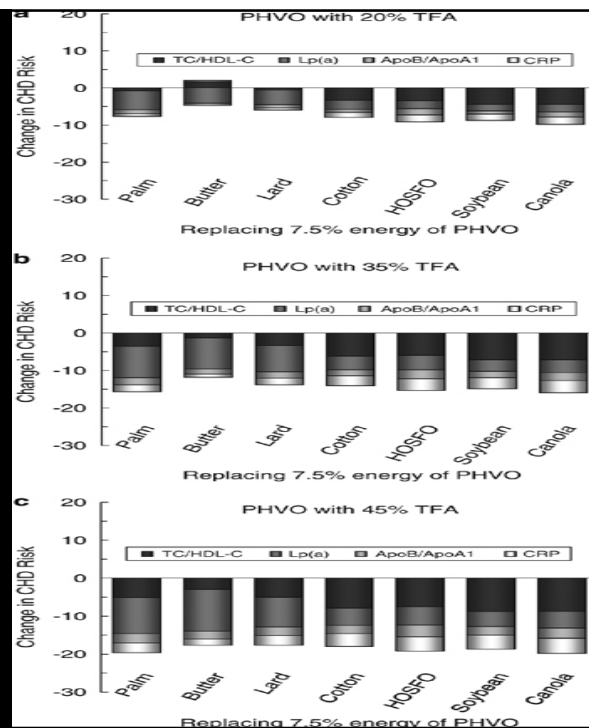
SFA vs tFA- not a realistic comparison

Look at specific fats/oils replacing PHVO containing tFA

CHD risk based not just on changes in plasma lipoproteins.

Report of [Mozaffarian and Clarke \(2009\)](#) is of interest

Also risk assessment papers ([Barraj et al 2008](#), [Mente et al 2009](#))



...so how much palm oil in the diet?

*conservative -- based on current recommendations for restricting SFA--can calculate the amount of palm oil in a prudent diet that satisfies various dietary guidelines*

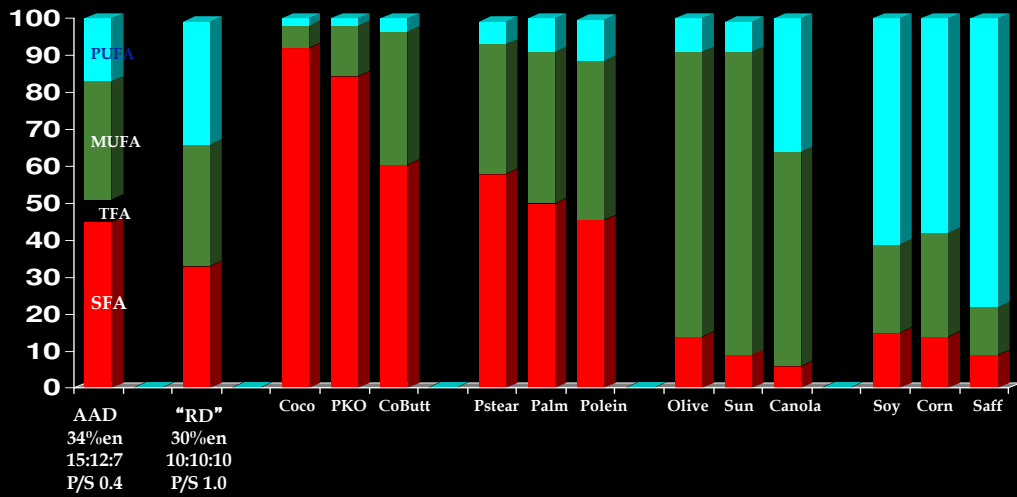
% calories from SFA	% calories from total fat				
	20	25	30	35	40
5	54	43	36	31	27
6	65	52	43	37	32
7	76	61	51	43	38
8	87	69	58	49	43
9	97	78	65	56	49
10	100**	87	72	62	54

Khosla (2006) J Agro Food Ind. 17: 21-23

Hayes and Khosla, Eur J Lipid Sci Tech (2007) 109: 453-464

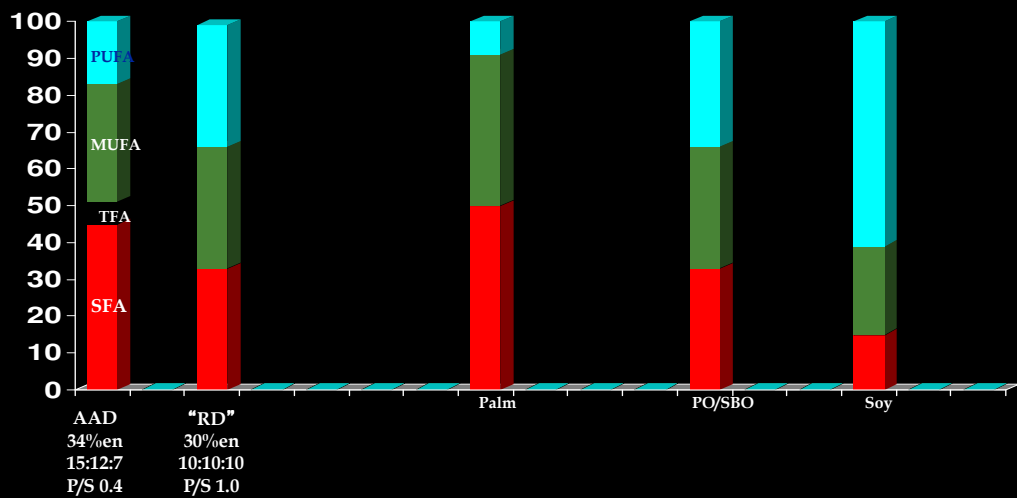
*...can readily replace trans by blending palm with local vegetable oils?*

### *Dietary fat composition: by fatty acid classes*



### *Dietary fat composition: by fatty acid classes*

*Palm/Soy 1:1 mix*



## *Nutritional attributes of Palm Oil and Palm Olein*

- The global importance of palm oil
- Effects of palm oil on the ration of TC/HDL-C...
- Replacement for trans fatty acids
- **Variety of carotenoids - pro Vitamin A**
- Vitamin E (tocopherols and tocotrienols)

### *“Vitamin A ” activity of red palm oil*

	RE Per 100 g	Relative quality (Times <red palm oil
Red Palm Oil	30,000	-
Carrots	2,000	15
Leafy Vegetables	685	44
Apricots	250	120
Tomatoes	100	300
Bananas	30	1000
Orange Juice	8	3,750

Phytoene	2.0%
Phytofluene	1.2%
Cis-β- Carotene	0.8%
β - Carotene	47.4%
α- Carotene	37.0%
Cis- α- Carotene	6.9%
ζ- Carotene	1.3%
δ - Carotene	0.6%
γ - Carotene	0.5%
Neurosporene	Tr
β - Zeacarotene	0.5%
α - Zeacarotene	0.3%
Lycopene	1.5%

*Numerous human studies showing efficacy of red palm oil in fighting Vitamin A deficiency*

*...studies have adopted different methods to provide Vitamin A naturally*

- Children fed traditional Indian sweets made with redPO
- School children fed biscuits baked with redPO
- School children given 5 – 10 mL redPO daily
- Cooking green leafy vegetables in redPO
- Also Vitamin A status improved by feeding redPO to pregnant mothers at various stages of pregnancy.
- Also lactating mothers



*Numerous human studies showing efficacy of red palm oil in fighting Vitamin A deficiency*

## *Nutritional attributes of Palm Oil and Palm Olein*

- The global importance of palm oil
- Effects of palm oil on the ration of TC/HDL-C...
- Replacement for trans fatty acids
- Variety of carotenoids - pro Vitamin A
- **Vitamin E (tocopherols and tocotrienols)**

## Nutritional attributes of Palm Oil & Palm Olein

- Variety of carotenoids (Vitamin A)
- Vitamin E (tocopherols and tocotrienols)

Oil	Tocopherols(ppm)				Tocotrienols(ppm)				Ppm T+T3
	$\alpha$ T	$\beta$ T	$\gamma$ T	$\delta$ T	$\alpha$ T3	$\beta$ T3	$\gamma$ T3	$\delta$ T3	
Red Palm Oil	152	-	-	-	205	-	439	94	890
Soyabean	101	-	593	264					985
Cornoil	112	50	602	18					782
Groundnut	130	-	216	21					367
Safflower	387	-	174	240					801
Sunflower	487	-	51	8					546

Numerous *in vitro* studies showing efficacy of tocotrienols in inhibiting cancer cell proliferation and decreasing neurodegeneration.

A pilot human breast cancer clinical trial was not definitive

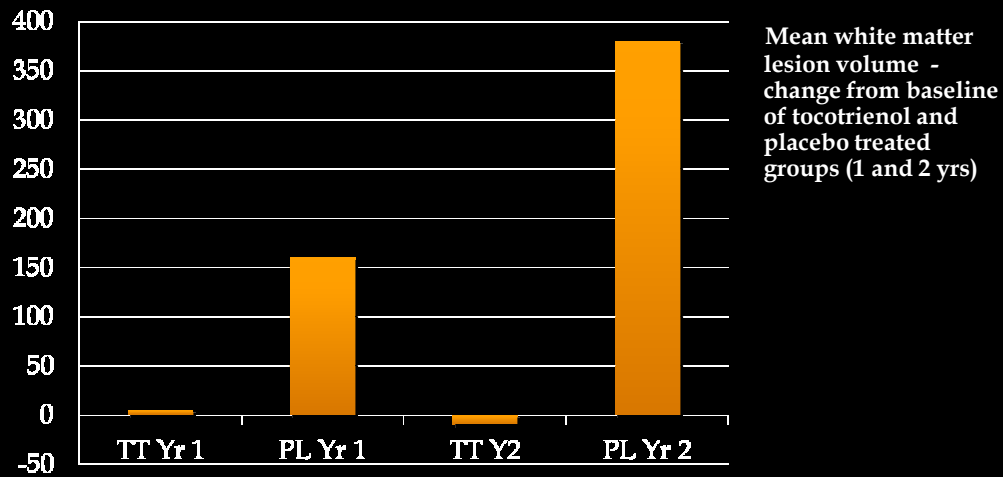
A series of studies show efficacy against lung cancer and Phase I human studies are the next logical step

Ongoing human stroke prevention trial is recruiting subjects. An earlier study from our lab helped establish the dose

Evidence that tocotrienols may lower blood lipids – and possible synergy with statin drugs has been suggested??

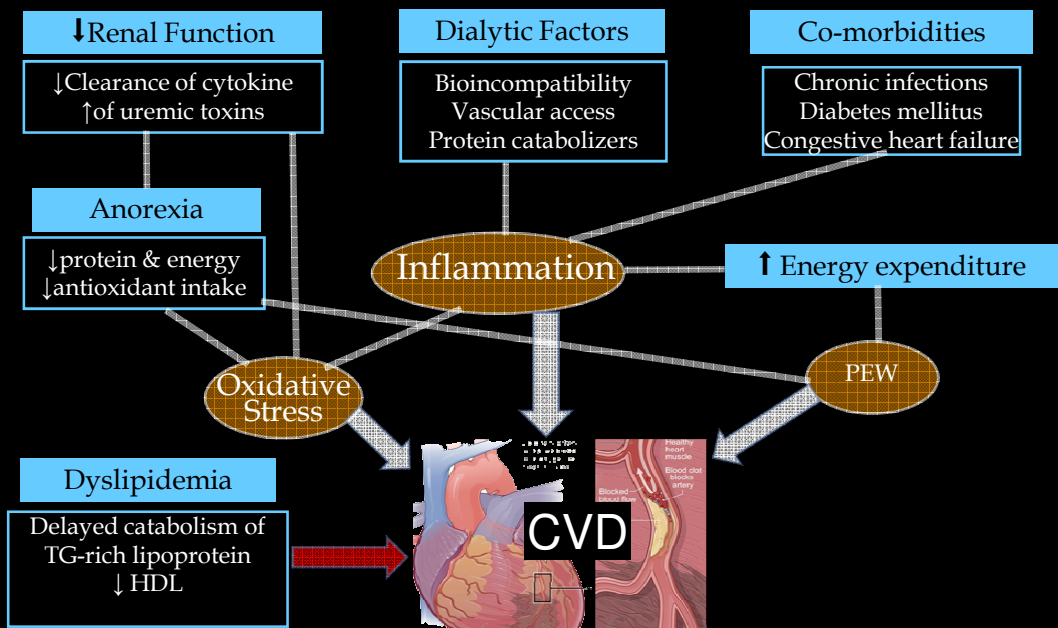
Recent Phase I study in dialysis patients from our laboratory.

## Tocotrienol effects on white matter lesions



Gopalan et al. *Stroke*, 2014

## Pathophysiology of CVD in CKD/ESRD



Adapted from: Ikizler et al 2004; Libetta et al 2011





### Oil Palm Phenolics – *the exciting future*

Oil palm fruit – water soluble phenolics – scaled production

First nutrition studies reported starting in 2011

Neuroprotective, anti-atherogenic, anti-diabetic and anti-cancer effects

### *Summary*

Diet and Lifestyle changes – first line of defense – can have profound effect on chronic disease (prevention)

Alcohol, smoking and lack of physical activity – major drivers

Numerous dietary changes shown to be effective

Palm Oil – serves a multitude of nutritional needs

Supply of palm oil makes it the important player globally and is an important factor in global food security

Fatty acid profile of palm eliminates need for hydrogenation

Minor components (antioxidant/phytochemicals) help alleviate micronutrient deficiencies using food-based approach AND show promise for preventative route in certain chronic disease

Additional details: [J. Am. Coll. Nutr. \(2010\), 29 \(3S\) 237-340](#)