



SICOM & AOCO 2024

SOMS International Conference on Obesity & Metabolism
in conjunction with **Asia-Oceania Conference on Obesity**

Hosted by

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Empowering Health, Inspiring Change: Practical Solutions for Obesity

Date October 24 (Thu)~26 (Sat), 2024

Venue aT Center, Seoul, Republic of Korea
(3F Segyero Room & 4F Changjo Room)



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Obesity and Trans-fatty Acid

Assoc Prof Dr Geeta Appannah, PhD (Cantab)

MASO/UPM

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Understanding the Impact of TFAs on Obesity

- 1. The Worldwide Weight Woes**
- 2. What's the Deal with TFAs?**
- 3. TFA and Its Connection to Obesity**
- 4. TFA and Other Health Effects**
- 5. The Global and National Game Plan Against TFA**
- 6. The TFA Ban: Did It Work?**
- 7. Conclusion**

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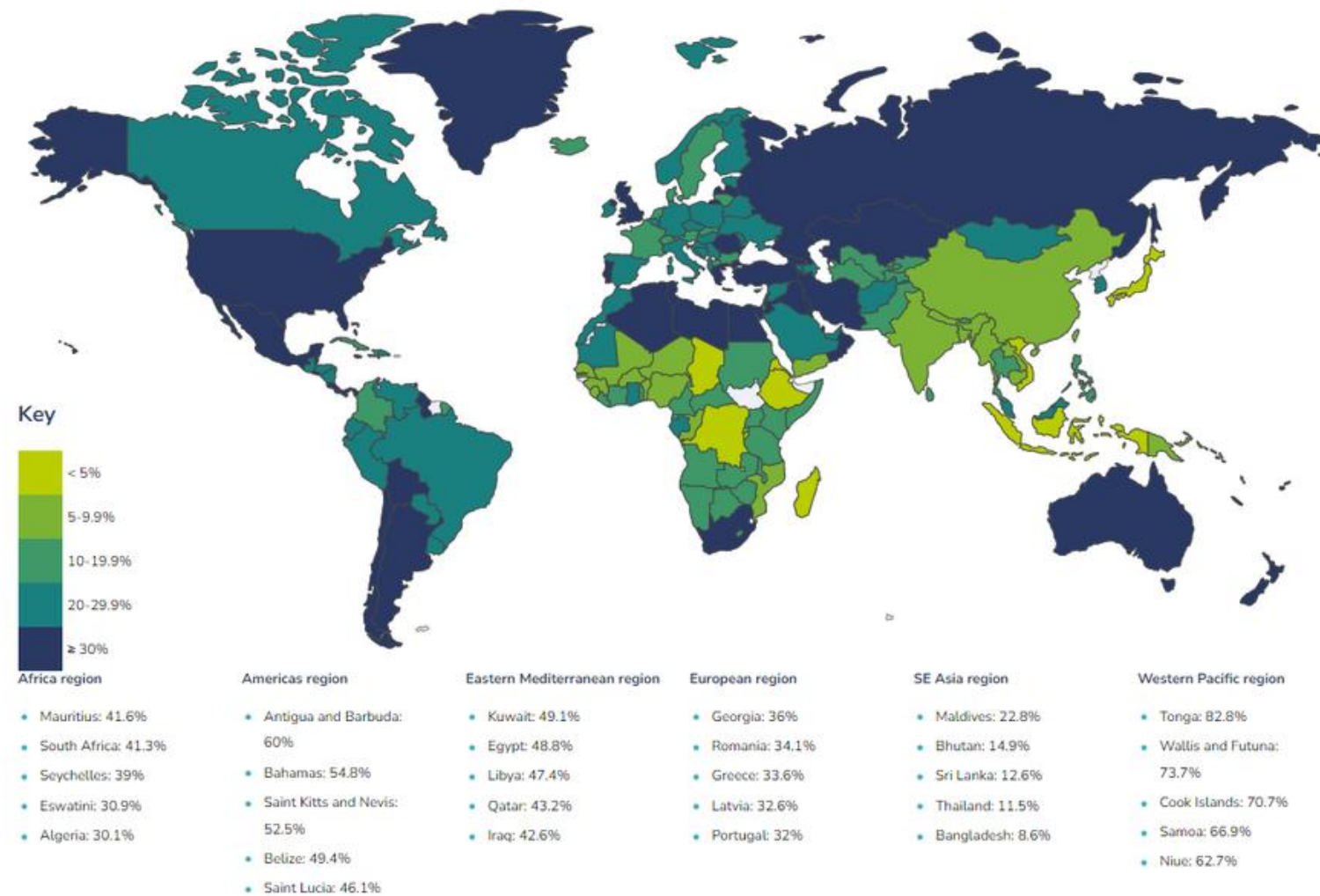
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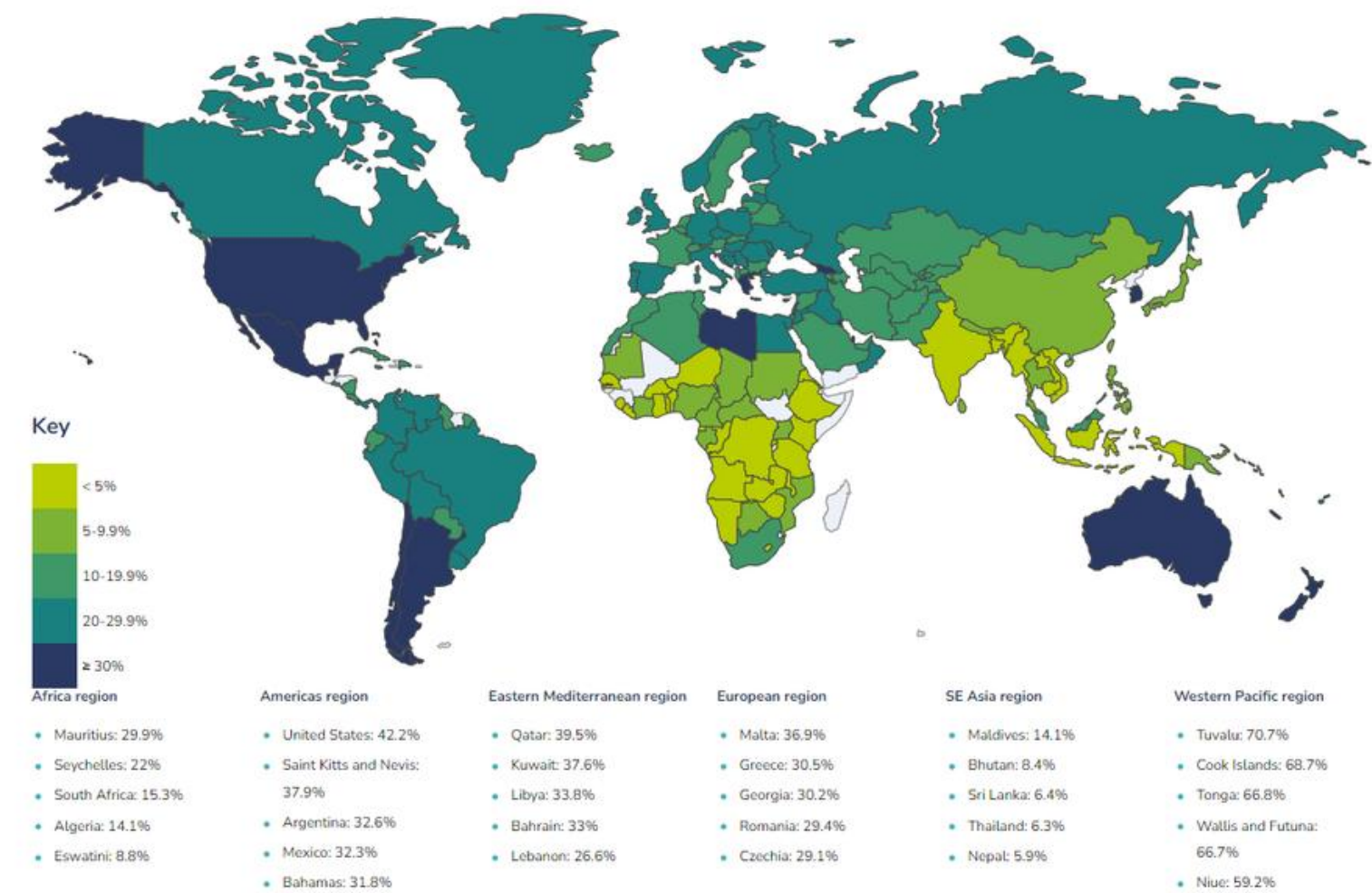


The Worldwide Weight Woes

Women living with obesity. Newest available data



Men living with obesity. Newest available data



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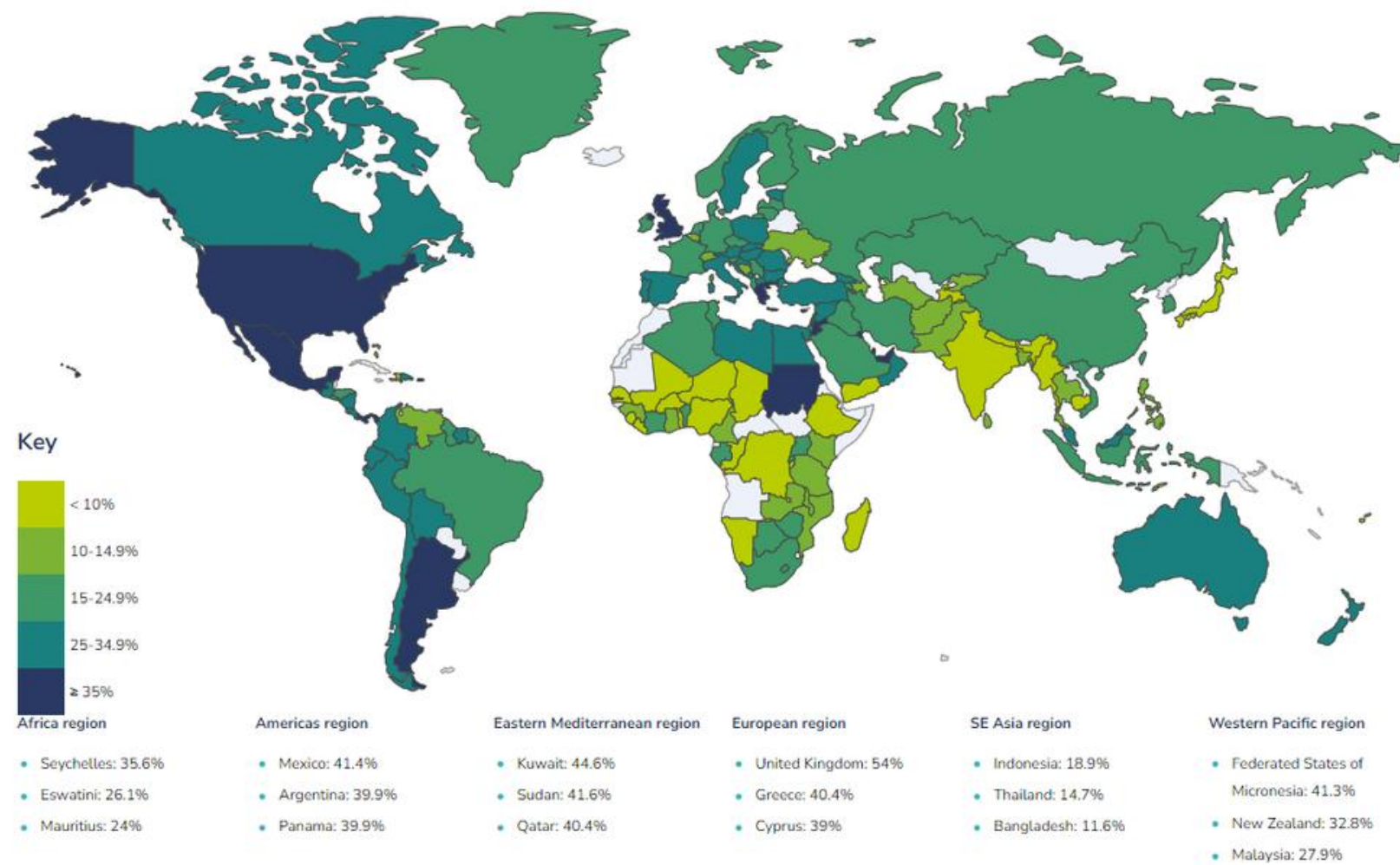
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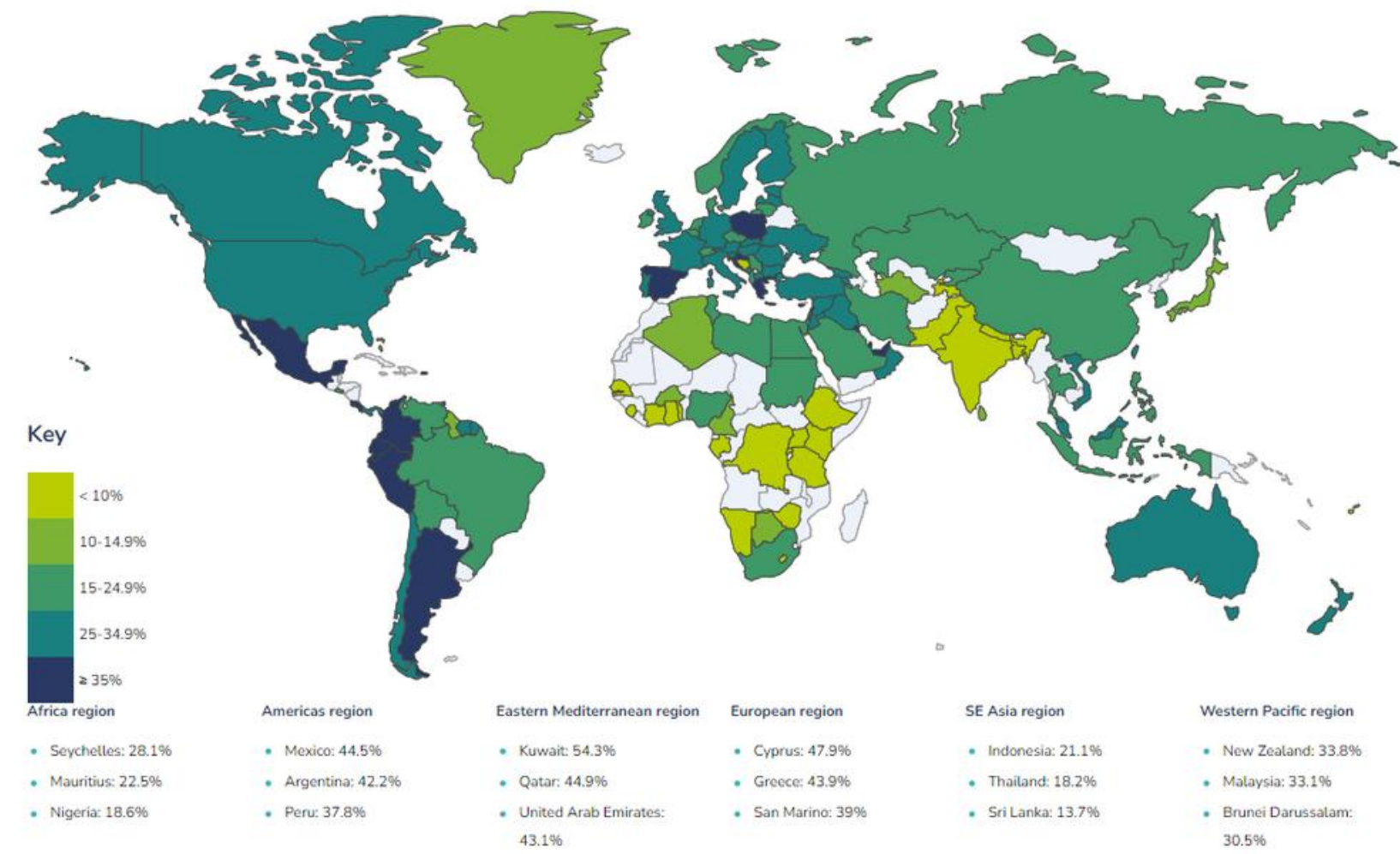


Global Childhood Obesity

Girls living with either overweight or obesity. Newest available data



Boys living with either overweight or obesity. Newest available data



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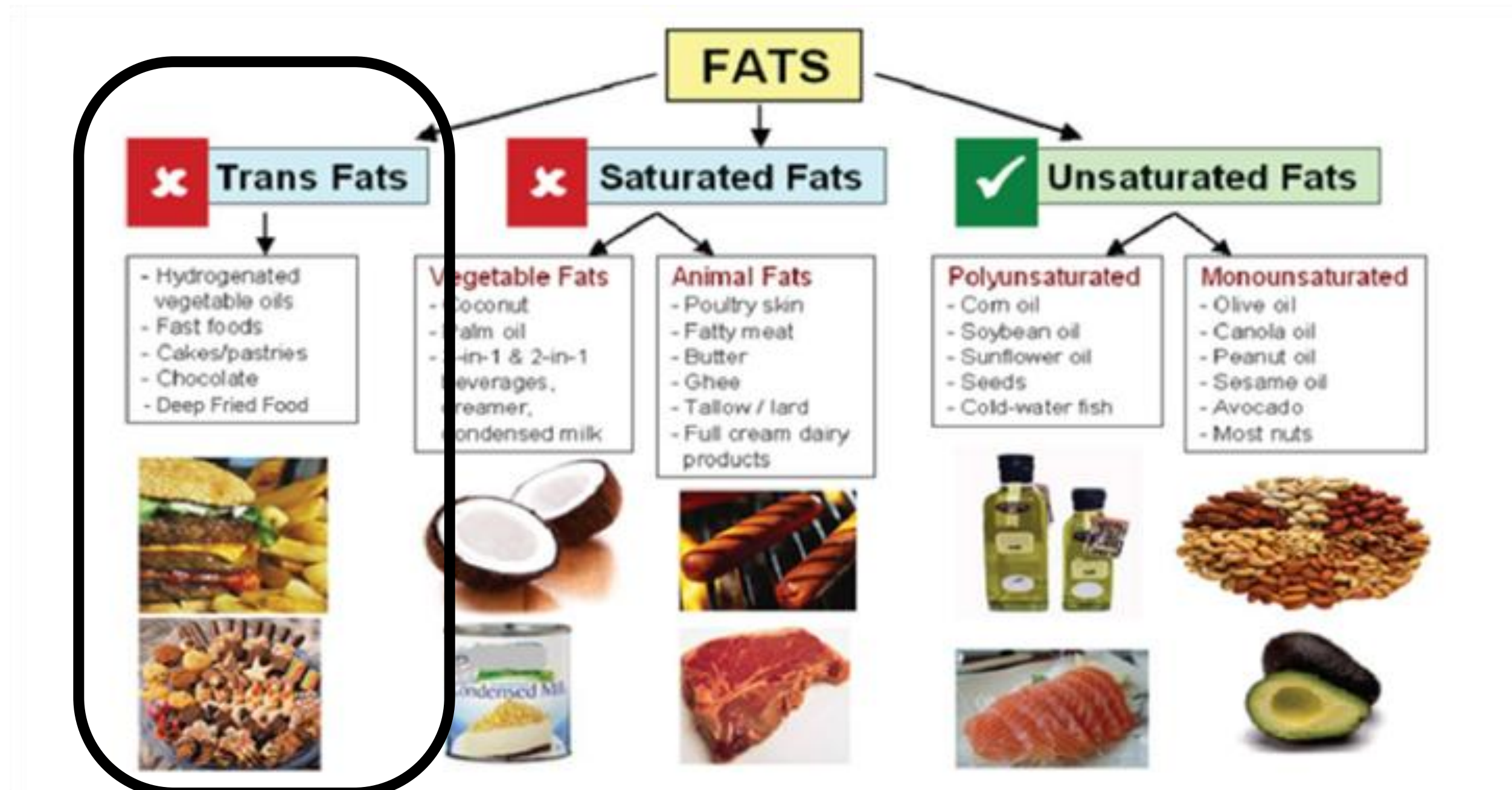
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Fats: The Good and The Bad!



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Hydrogenation

- The process in which missing hydrogen atoms are added to an unsaturated fat to make it firmer in texture
 - This forms a new type of fatty acid called TFA
 - aka as ‘partially hydrogenated oils/fats’ or ‘shortening’
 - TFAs have many of the same properties as saturated fats

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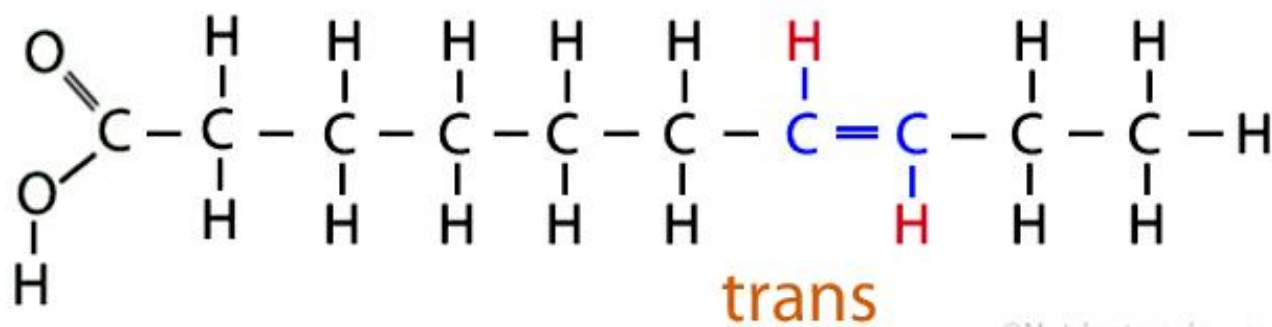
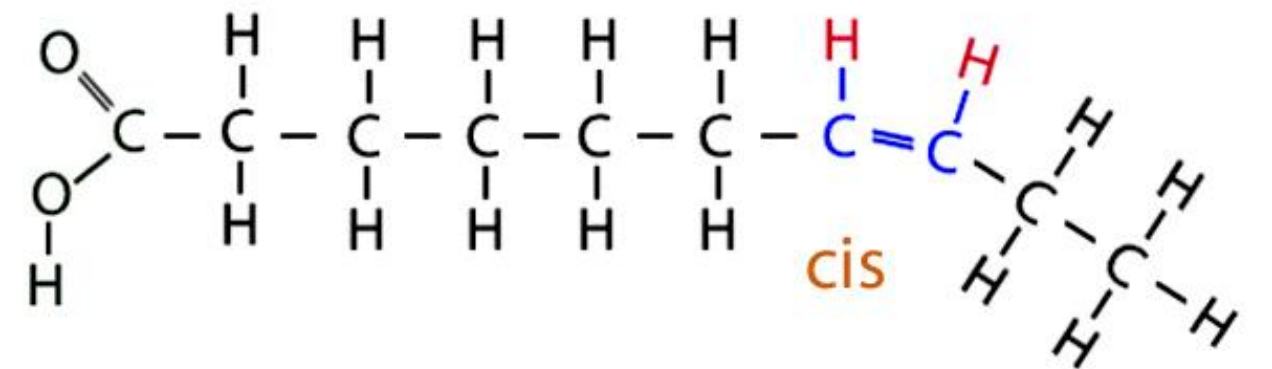
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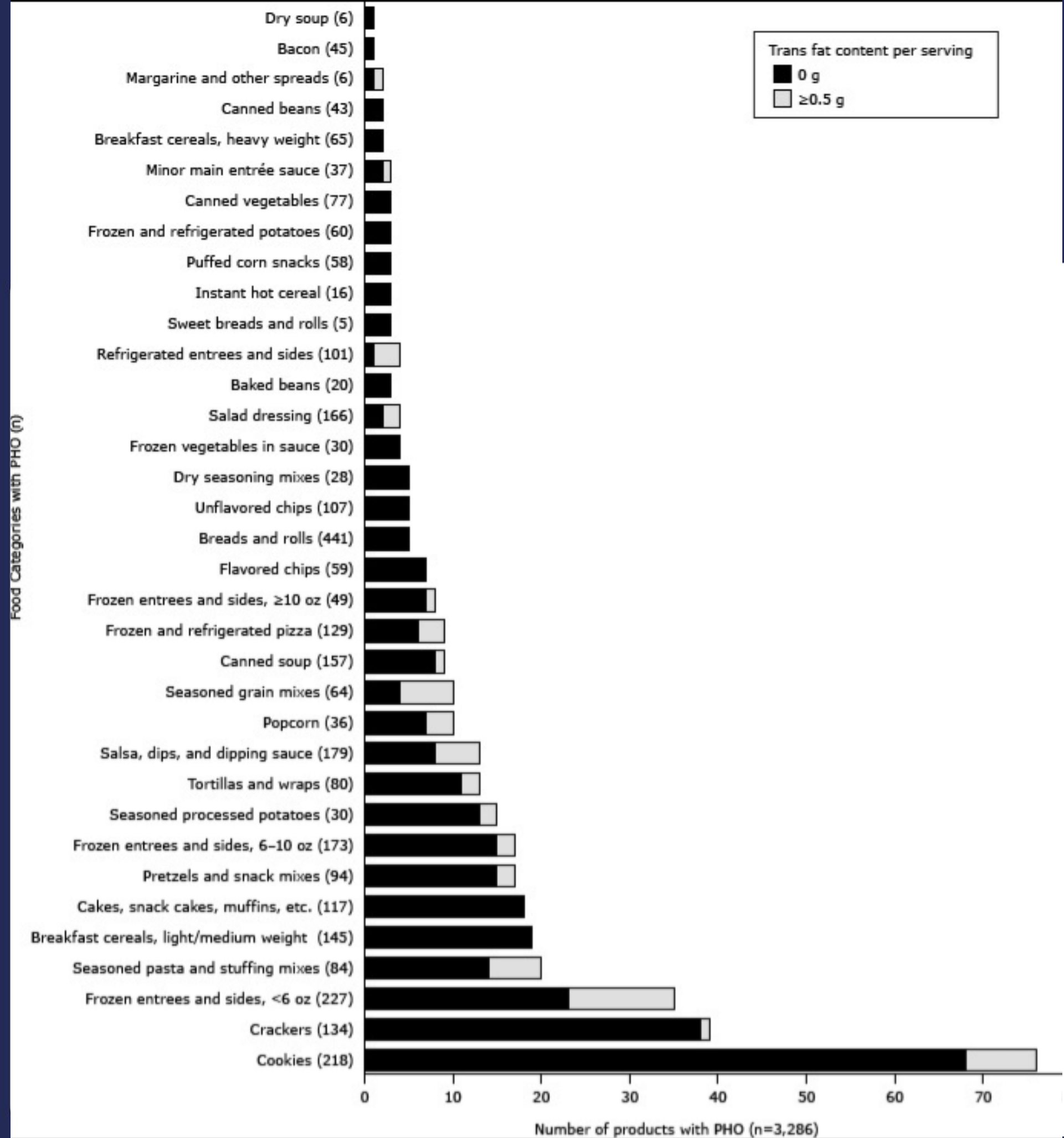
Structure and Properties of TFAs

Cis- and Trans-Fatty Acids



©Nutrientsreview.com

- Cis fatty acids have hydrogen atoms on the same side (large component of olive oil), making them flexible and liquid.
- Trans fatty acids have hydrogen atoms on opposite sides, making them straight, rigid, and solid.



Food Category	Number of Products
Baked Goods	20
Snacks	12
Miscellaneous	3

Number of products made with partially hydrogenated oils, by National Salt Reduction Initiative food category, 2012 (n = 35)

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Table 4. Percentage contributions of the major food groups to the total fat, SFA and TFA intakes in Tunisian children.

Total Fat			SFA ^a			TFA ^b		
Rank	Food Group	% ^c	Rank	Food Group	%	Rank	Food Group	%
1	Ultra-processed foods	32.5	1	Ultra-processed foods	29.0	1	Ultra-processed foods	48.4
2	Breakfast cereals	20.5	2	Dairy products	22.7	2	Dairy products	47.1
3	Vegetables, legumes and fruits	16.1	3	Breakfast cereals	17.3	3	Fat and oils	4.4
4	Dairy products	11.7	4	Vegetables, legumes and fruits	12.9	4	Breakfast cereals	0.1
5	Meat, fish and eggs	10.7	5	Meat, fish and eggs	10.8	5	Beverages and industrial juices	0.0
6	Fat and oils	5.8	6	Fat and oils	5.2	6	Meat, fish and eggs	0.0
7	Potatoes and grains	2.0	7	Potatoes and grains	1.6	7	Potatoes and grains	0.0
8	Beverages and industrial juices	0.2	8	Beverages and industrial juices	0.2	8	Vegetables, legumes and fruits	0.0

^a Saturated fatty acids. ^b Trans fatty acids. ^c Percentage contributions of food groups.

Dietary Intake in Tunisian Children

- Ultra-processed foods are major sources of total fat, SFA, and TFA.
- Cheese, package cakes, pies, and biscuits contribute significantly.
- Percentage contributions are 32.5% for total fat, 28.9% for SFA, and 48.4% for TFA.

Dogui, D. et al. Children 2022

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What's the Deal with TFAs?

Cost and
Convenience

Taste and
Texture
Preferences

Lack of
Awareness



Marketing and
Availability

Cultural and
Habitual Factors

Slow Policy
Change

Processed foods, baked goods, margarine, fried foods, etc.

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TFA and Its Connection to Obesity

- **Following major changes in our nutritional patterns in the late twentieth century - sugar rich foods & fast-food meals**
- **Association between TFAs and obesity was reported in NHS as early as 1990s**

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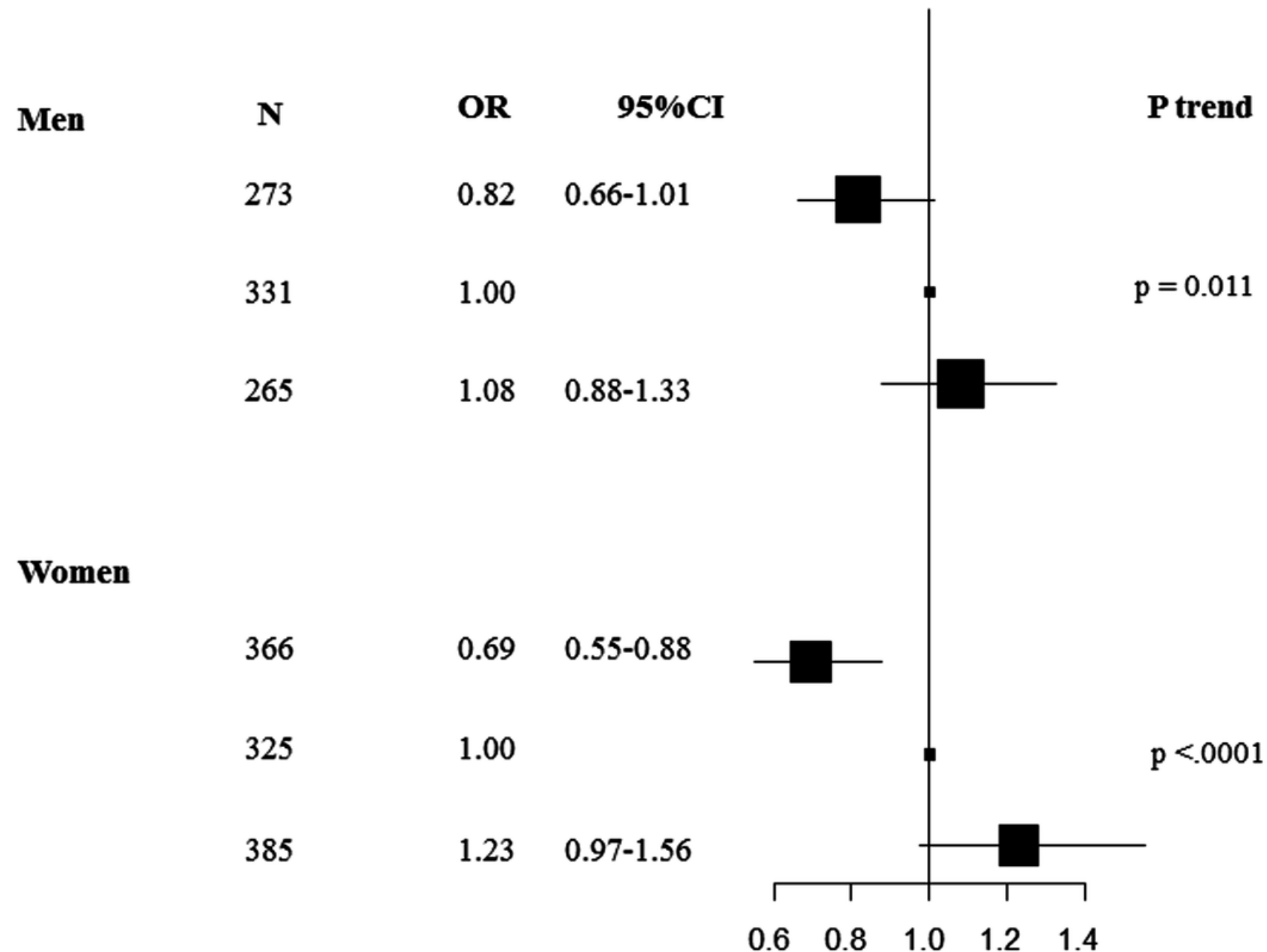
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TFA and Its Connection to Obesity



TFA and Weight Changes

- Men show a slight reduction in weight loss with TFA intakes (trans 18:1n-9), but no strong link to weight gain.
- Women with higher TFA intakes (trans 18:1n-9) are less likely to lose weight and may gain weight over five years.

Chajès et al. Plos One. 2015

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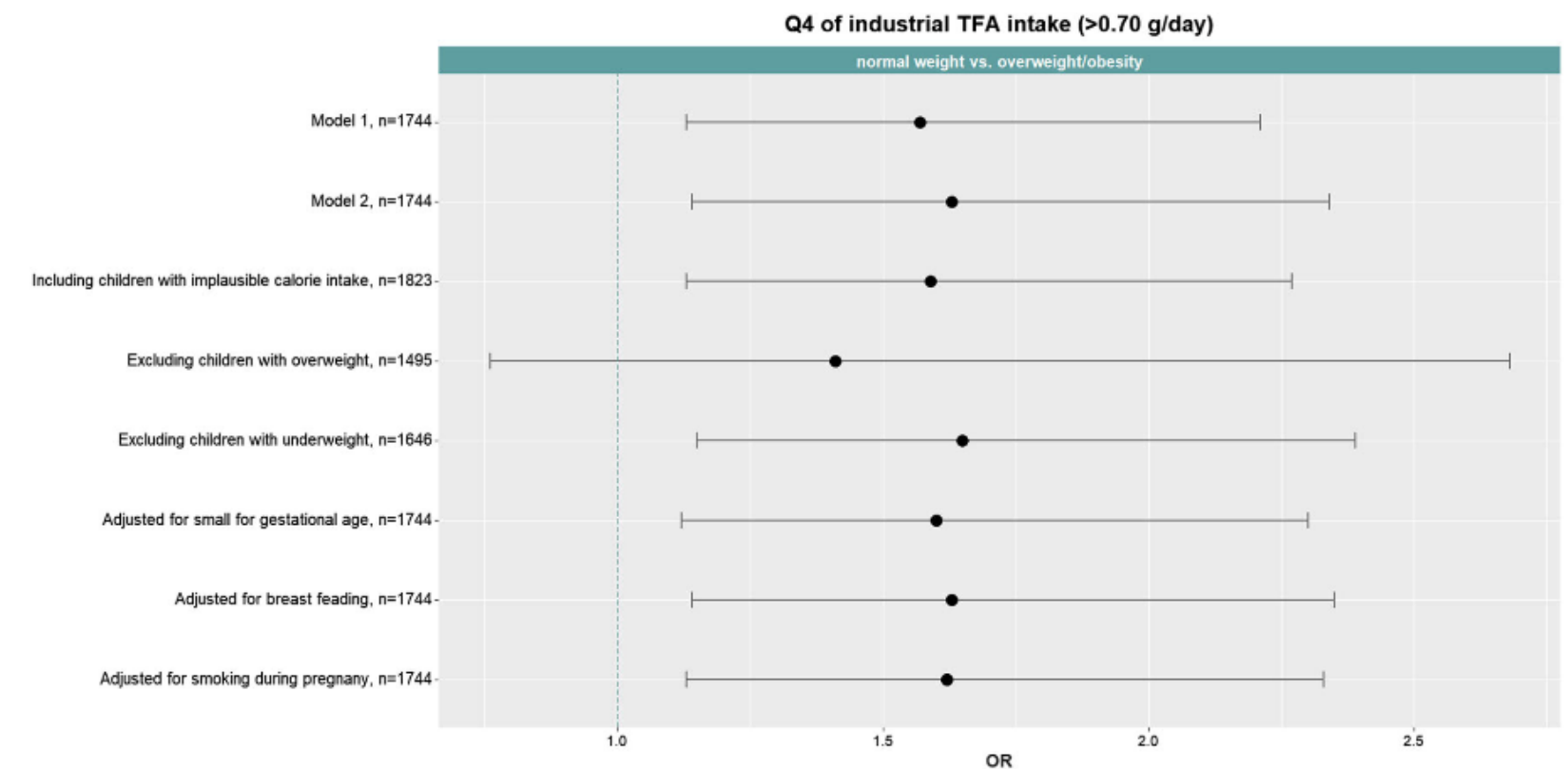
TFA and Its Connection to Obesity

Quartiles of TFA intake	Normal Weight (n = 1397) vs Overweight Including Obesity (n = 347) MODEL 1 ^b			Normal Weight (n = 1397) vs Overweight Including Obesity (n = 347) MODEL 2 ^c		
	OR ^a	95% CI	P	OR ^a	95% CI	P
Total TFA, g/day						
Q1 (<1.11)	1.00	(reference)		1.00	(reference)	
Q2 (1.11-1.30)	0.87	0.61; 1.23	0.434	0.88	0.61; 1.27	0.494
Q3 (1.31-1.50)	0.99	0.70; 1.40	0.958	1.08	0.75; 1.55	0.690
Q4 (>1.50)	1.32	0.95; 1.84	0.104	1.44	1.00; 2.08	0.052
P for trend			0.070			0.027
Industrial TFA, g/day						
Q1 (<0.44)	1.00	(reference)		1.00	(reference)	
Q2 (0.44-0.55)	1.03	0.73; 1.46	0.859	1.05	0.73; 1.51	0.787
Q3 (0.56-0.70)	1.00	0.70; 1.42	0.994	1.06	0.74; 1.53	0.740
Q4 (>0.70)	1.57	1.13; 2.21	0.008	1.63	1.14; 2.34	0.008
P for trend			0.012			0.010
Natural TFA, g/day						
Q1 (<0.55)	1.00	(reference)		1.00	(reference)	
Q2 (0.55-0.68)	1.16	0.83; 1.63	0.391	1.20	0.84; 1.71	0.316
Q3 (0.69-0.81)	1.21	0.87; 1.71	0.260	1.27	0.89; 1.82	0.185
Q4 (>0.81)	0.97	0.68; 1.38	0.862	1.07	0.73; 1.56	0.741
P for trend			0.931			0.682

^aOR was obtained by logistic regression.

^bAdjusted for sex, age, total energy intake, and study cohort.

^cAdditionally adjusted for maternal educational level, maternal social class, maternal BMI, paternal BMI, parental country of origin, physical activity, TV viewing, fruit and vegetable intake, and soft drink intake.



Scholz A et al. *Pediatr Obes.* 2019

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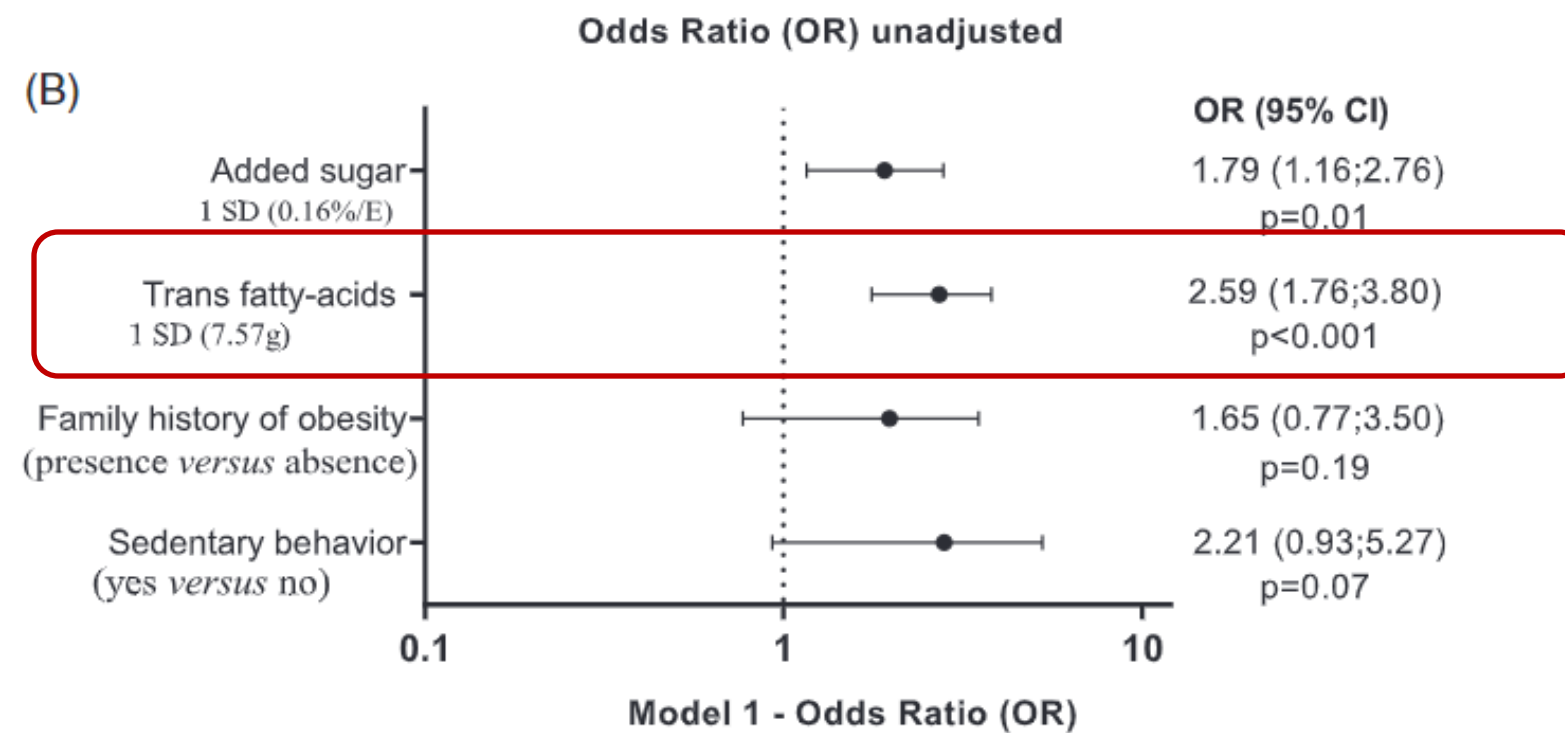
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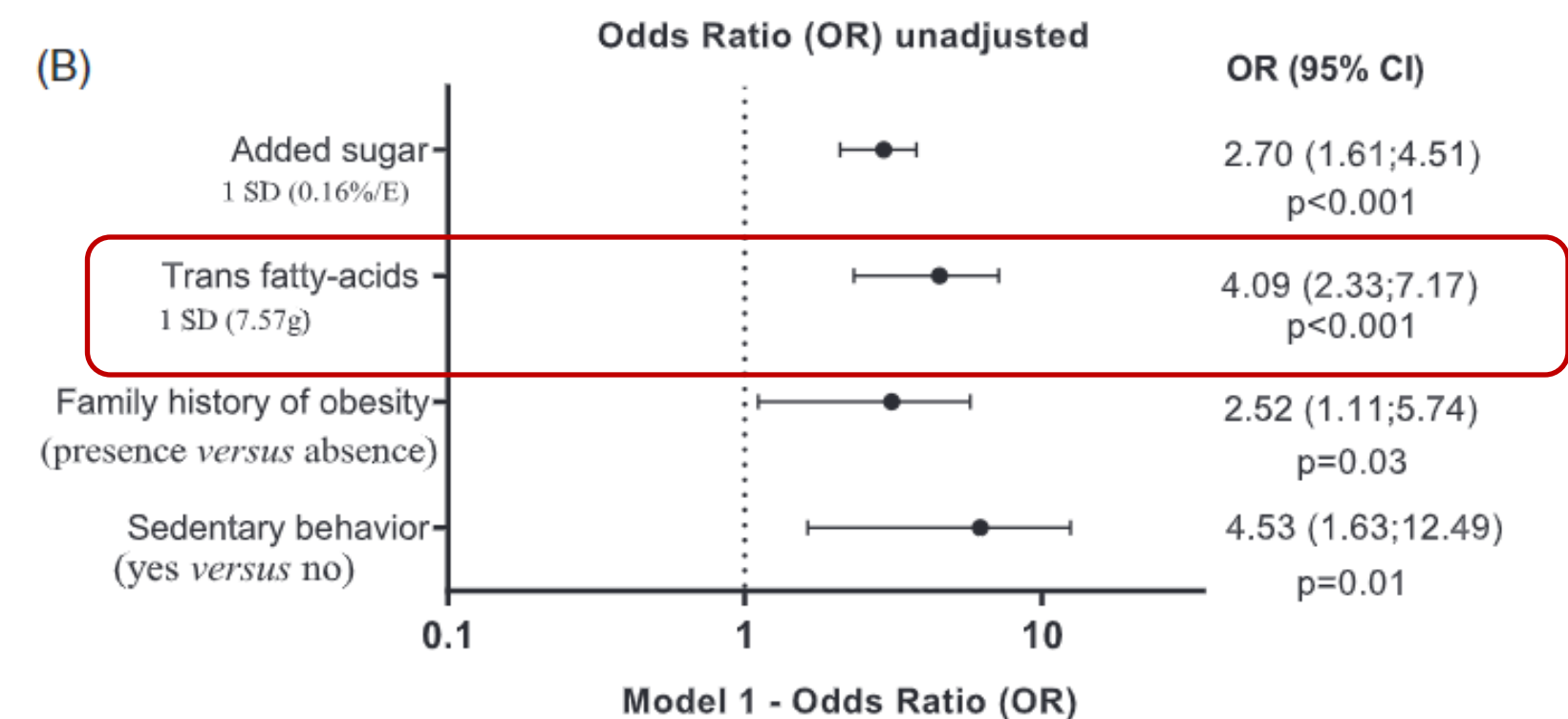
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TFA and Its Connection to Obesity



Obesity



Central Obesity

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Asia Oceania
Association for
the Study of
Obesity

Table 5 Multivariate logistic regression of independent predictors of percent body fat $\geq 30\%$ ($N=96$)

Variable	Odds ratio	95% CI
<i>Mother^a</i>		
Trans fat intake		
> 4.5 g	5.81	1.05, 32.32
≤ 4.5 g	1.00	
Pre-pregnancy weight	1.38	1.17, 1.63
Weight gain during pregnancy	1.24	1.19, 1.52
Sugar intake	0.96	0.91, 0.99
<i>Infant^b</i>		
Maternal age		
≥ 30 years	4.20	1.44, 12.29
< 30 years	1.000	
Infant birth weight	6.54	1.70, 25.13
Trans fat intake		
> 4.5 g	2.13	0.75, 6.01
≤ 4.5 g	1.000	

^aHosmer and Lemeshow test of good fit: $\chi^2 = 4.194$; $P = 0.839$. Adjusted for marital status, physical activity, parity, total energy intake, fat intake, type of infant feeding, maternal age, pre-pregnancy BMI and ethnicity.

^bHosmer and Lemeshow test of good fit: $\chi^2 = 13.314$; $P = 0.065$. Adjusted for type of infant feeding, total maternal fat intake, total maternal energy intake, maternal pre-pregnancy BMI, pre-pregnancy weight and pregnancy weight gain.

Mothers who consumed at least 4.5 g of trans fatty acids/day were 5.8 times more likely to have body fat $\geq 30\%$ than those consuming less.



Higher maternal intake of trans fatty acid (44.5 g per day) is associated with increased maternal and infant body fat at 3 months postpartum.

Anderson A et al. Eur J Clin Nutr, 2010

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Table 4 Overall summary of human and primate studies assessing impact of TFA intake on aspects of weight gain

Paper	Population	TFA intake	Outcome measures	Significant negative effect of TFA
<i>Population and case-control studies (human)</i>				
Merchant <i>et al.</i> ³⁸	Canada N = 617, M+F	0.43 ± 0.52 g day ⁻¹	Waist:hip ratio	X
Larque <i>et al.</i> ³²	Spain Obese (N = 34) and non-obese (N = 20), M+F children	<1 g TFA per day	Plasma TFA between obese and normal weight	X
Bortolotto <i>et al.</i> ³¹	Brazil Morbidly obese and non-obese (N = NR), M+F	NR	Correlation between BMI and TFA in adipose tissue	X
<i>Prospective cohort studies (human)</i>				
Colditz <i>et al.</i> ³⁹	USA, Nurses' Health Study N = 31 940, W, 8 years	NR	Association between BMI and TFA intake	✓
Field <i>et al.</i> ⁴⁰	USA, Nurses' Health Study N = 41 518, W, 8 years	Mean for cohort 1.7 ± 0.5%	Association between increases in TFA intake and weight gain	✓
Wannamethee <i>et al.</i> ⁴¹	USA, Nurses' Health Study N = 49 324, W, 8 years	NR	Association between TFA intake and weight gain in heavy drinkers	X
Koh-Banerjee <i>et al.</i> ⁴²	USA, HPFS N = 16 587, M	Mean for cohort 1.3 ± 0.6% of E	Waist circumference	✓
Oken <i>et al.</i> ⁴⁴	USA N = 902, F, post-partum	Median intake 1.1–1.3% of E	Post-partum weight retention	✓

Epidemiological studies provide limited but consistent evidence to support a weak association between TFA consumption and a small increase in weight gain!

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TFA and Other Health Effects

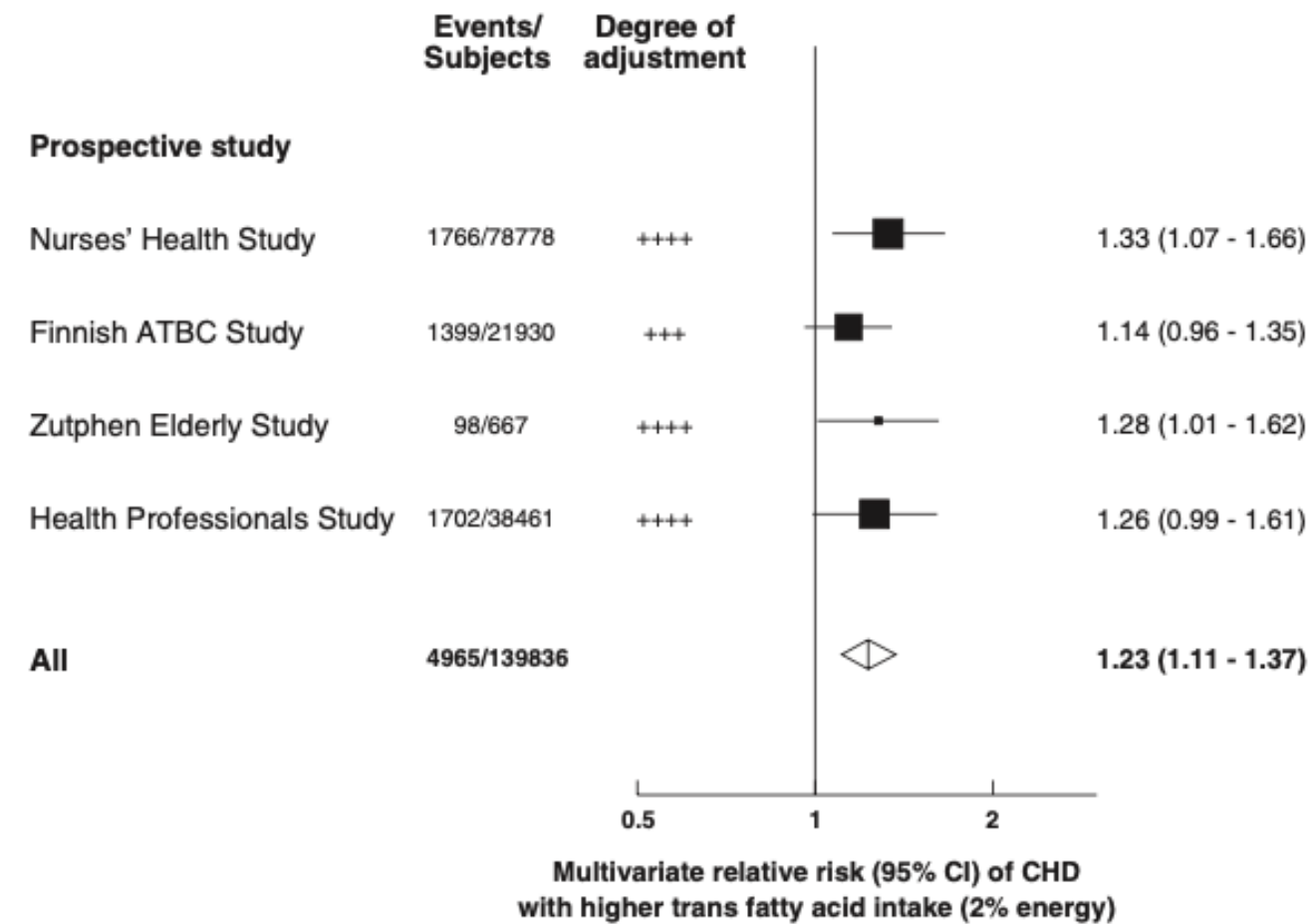


Figure 2 Meta-analysis of prospective cohort studies of habitual TFA consumption and CHD risk, including 5215 incident CHD events among 140 542 participants. The black squares and horizontal lines indicate the RR and 95% CI in each study; the size of the black squares is proportional to the inverse-variance weight in the meta-analysis. The unshaded diamond indicates the combined RR and 95% CI. The degree of adjustment for confounders is denoted as + + + (adjusted for age, smoking, education, BMI, blood pressure, physical activity, alcohol intake and consumption of fiber and total energy) and + + + + (further adjusted for consumption of other dietary fats and protein). Reproduced with permission from (Mozaffarian and Clarke, 2009). BMI, body mass index; CI, confidence interval; CHD, coronary heart disease; RR, relative risk; TFA, *trans*-fatty acid. Adapted from Mozaffarian *et al.* (2006).

Mozaffarian D, Aro A, Willett WC. *Eur J Clin Nutr.* 2009

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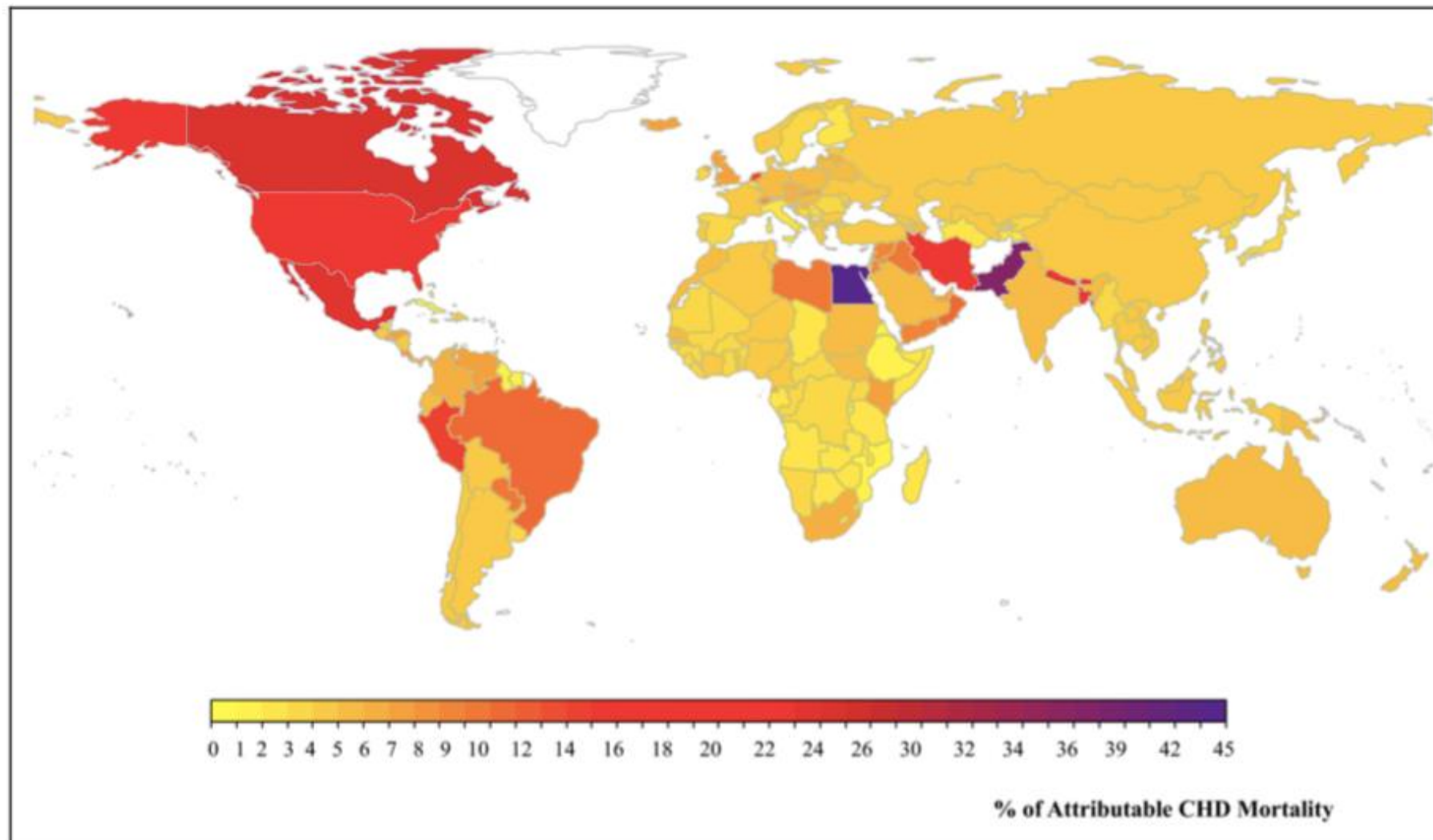
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TFA and Other Health Effects



The highest TFA-attributable absolute CHD mortality was found in Egypt. Other countries with substantial TFA-associated CHD mortality included Canada, Pakistan, and the United States. In these countries, excess TFA accounted for >17% of corresponding national CHD mortality. In comparison, 33 of 186 countries had proportional TFA-attributable mortality <3%.

Figure 6. Global proportional CHD mortality attributable to higher TFA intake in 2010. The proportion of CHD mortality attributable to TFA was calculated by dividing the number of attributable CHD deaths by the total number of CHD deaths within each country. The color scale of each map indicates the proportional CHD mortality in 186 countries attributable to TFA. The optimal level is $0.5 \pm 0.05\%E$ (percentage of total energy intake). CHD indicates coronary heart disease; TFA, trans fat.

Wang Q et al. J Am Heart Assoc. 2016

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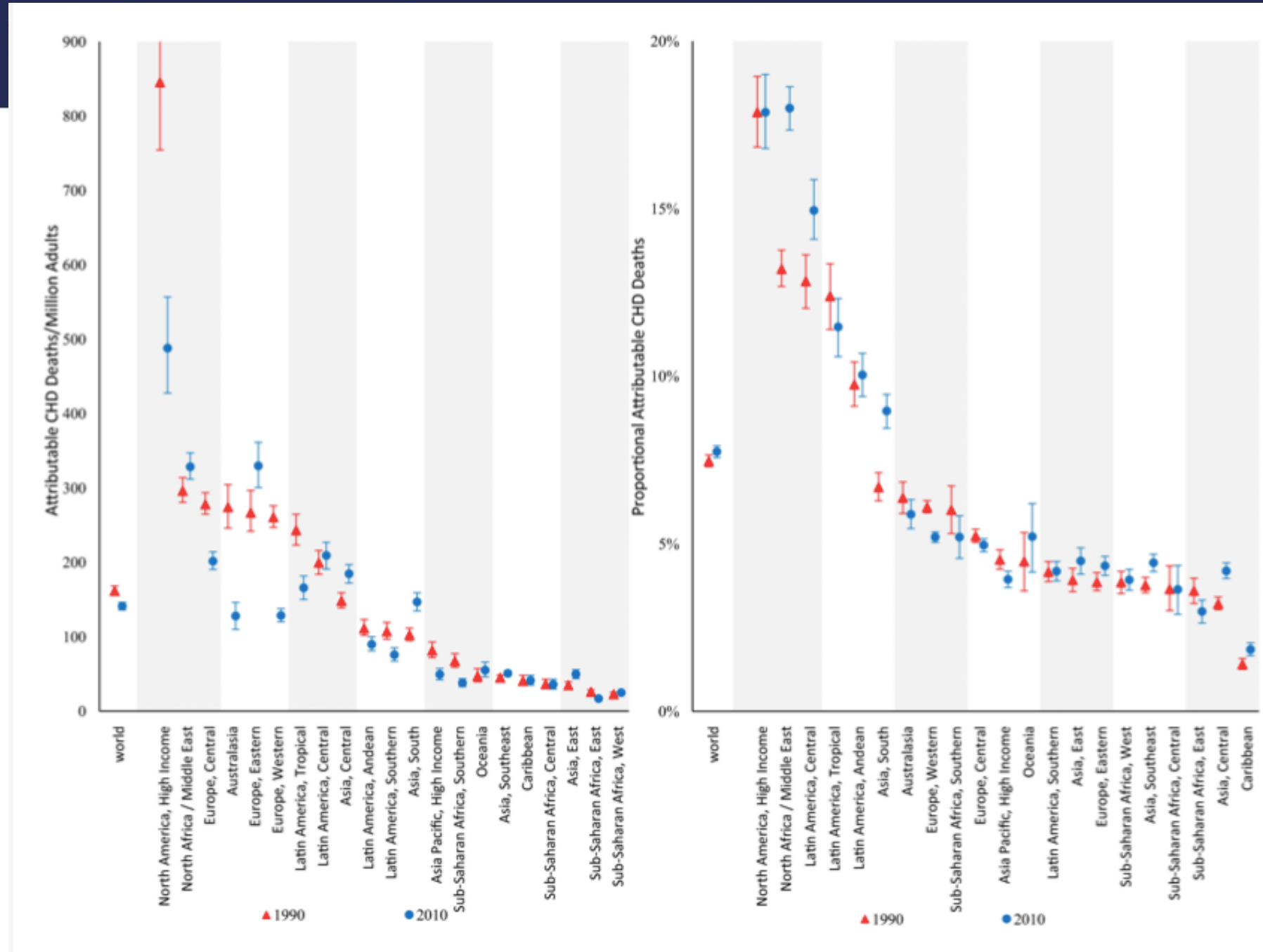


Figure 2. Regional CHD mortality attributable to higher TFA intake in 1990 and 2010. The y-axis represents the CHD deaths per 1 million adults (on the left) or the proportion of CHD deaths (on the right) attributable to higher TFA consumption. The x-axis includes the world estimates and the estimates for the 21 regions. Red triangles indicate estimates in 1990, whereas blue circles indicate estimates in 2010. The error bars represent the 95% uncertainty level of each estimate. CHD indicates coronary heart disease; TFA, trans fat.

Wang Q et al. J Am Heart Assoc. 2016

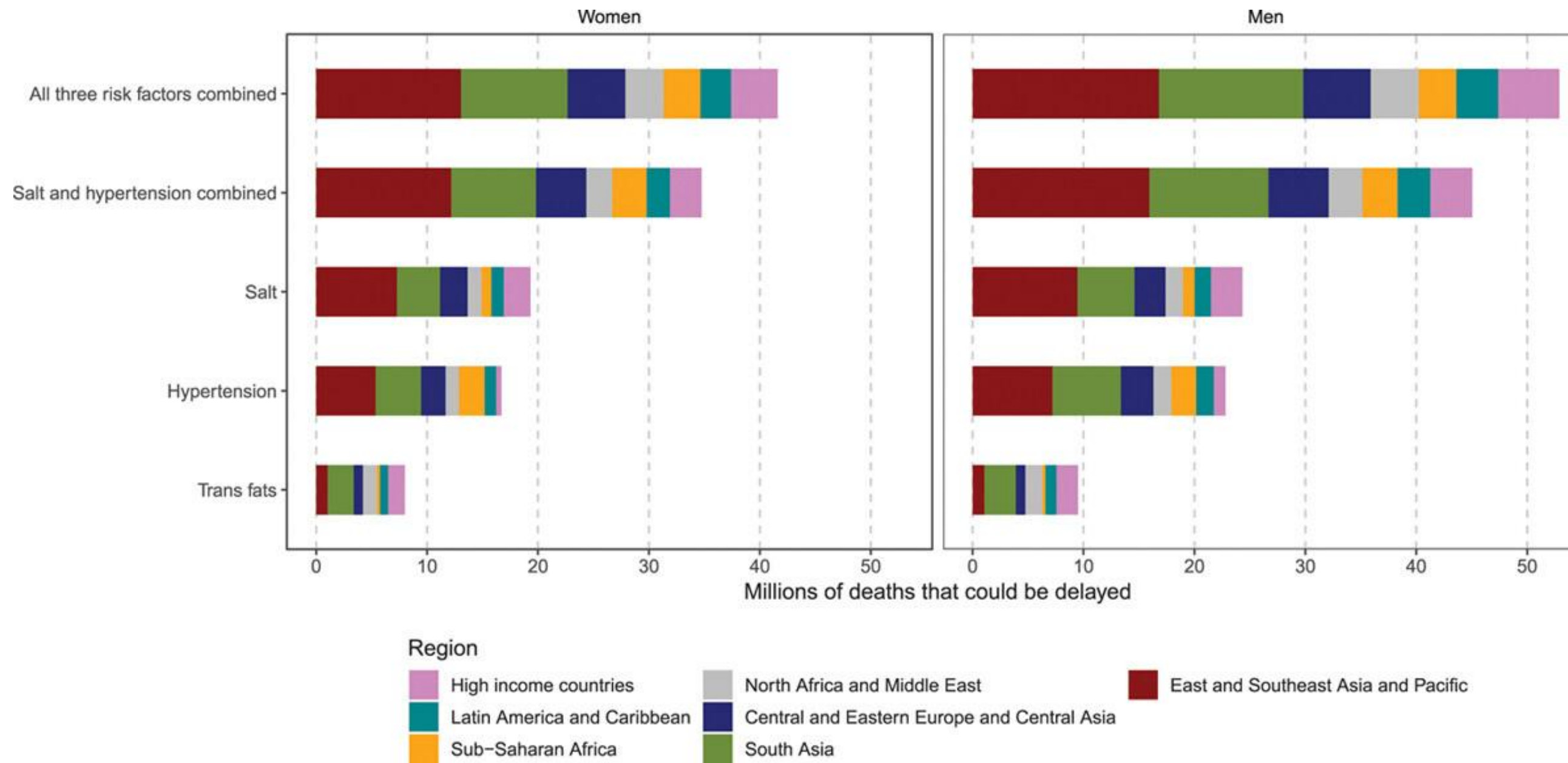
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Kontis V et al. Circulation. 2019

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TFA and Other Health Effects

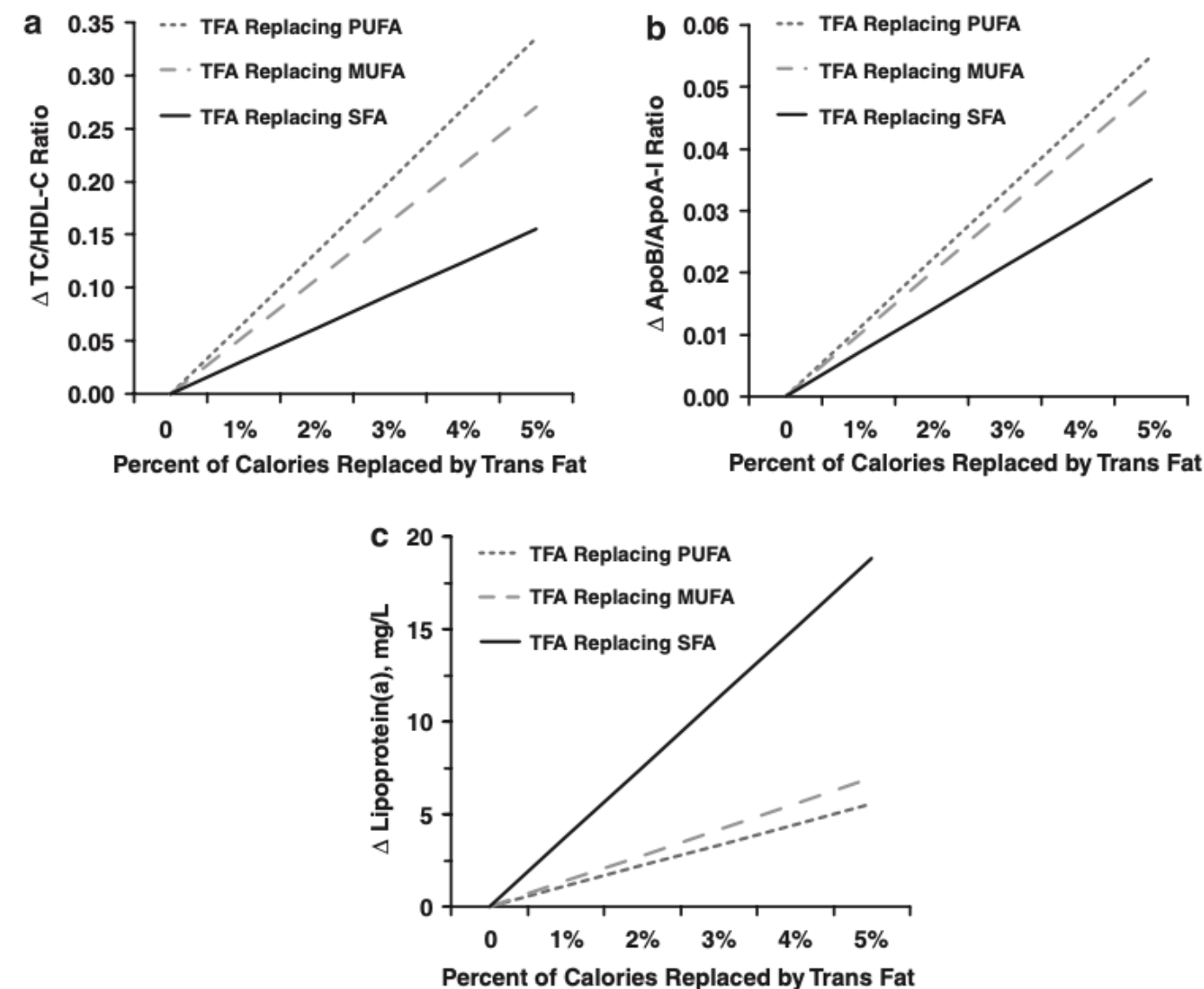


Figure 1 Effects of TFA consumption on serum lipids and lipoproteins, as an isocaloric replacement for PUFA, MUFA or SFA, in a meta-analysis of 13 randomized controlled trials ($P < 0.05$ for each effect) (Mozaffarian and Clarke, 2009). (a) TC HDL-C ratio, (b) ApoB/ApoA-I ratio, (c) lipoprotein(a). MUFA, *cis*-monounsaturated fatty acid; PUFA, *cis*-polyunsaturated fatty acid; SFA, saturated fatty acid; TFA, *trans*-fatty acid.

Mozaffarian D, Aro A, Willett WC. Eur J Clin Nutr. 2009

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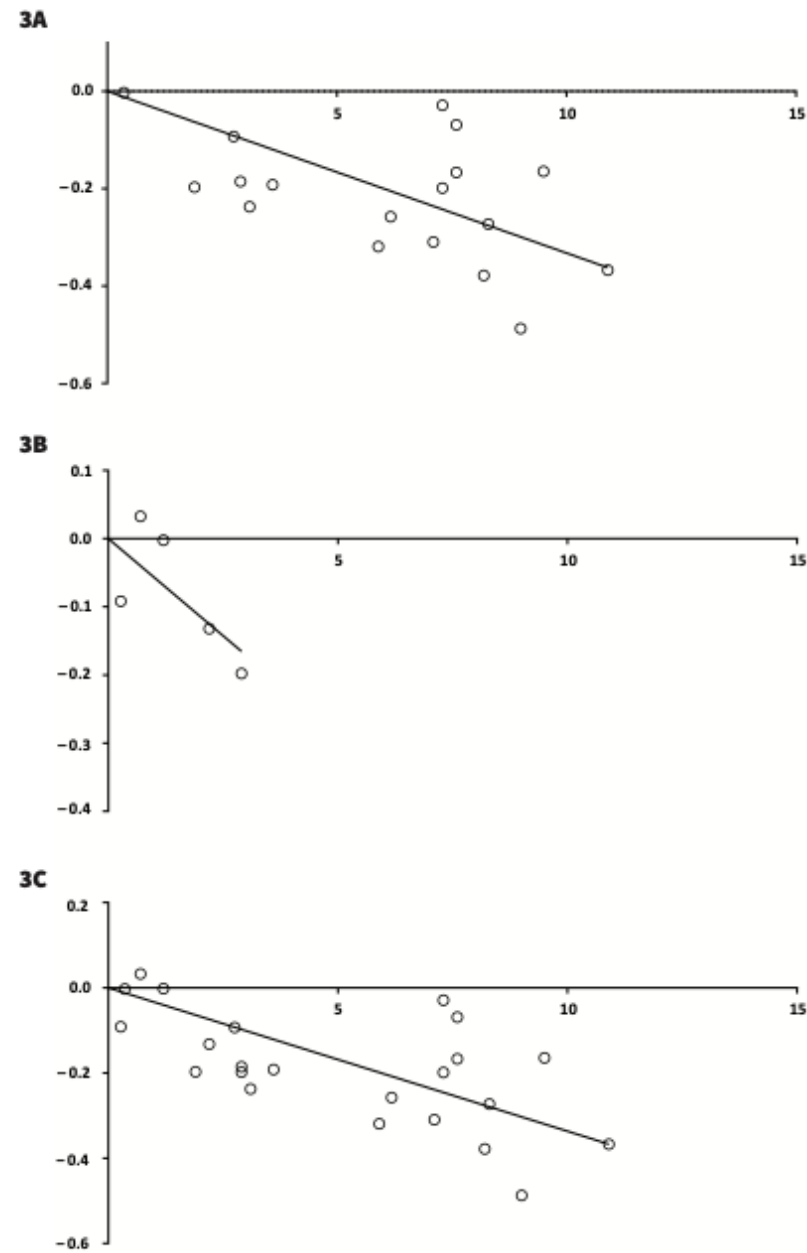
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Figure 3. Effect on LDL cholesterol of replacing TFA with *cis*-MUFA

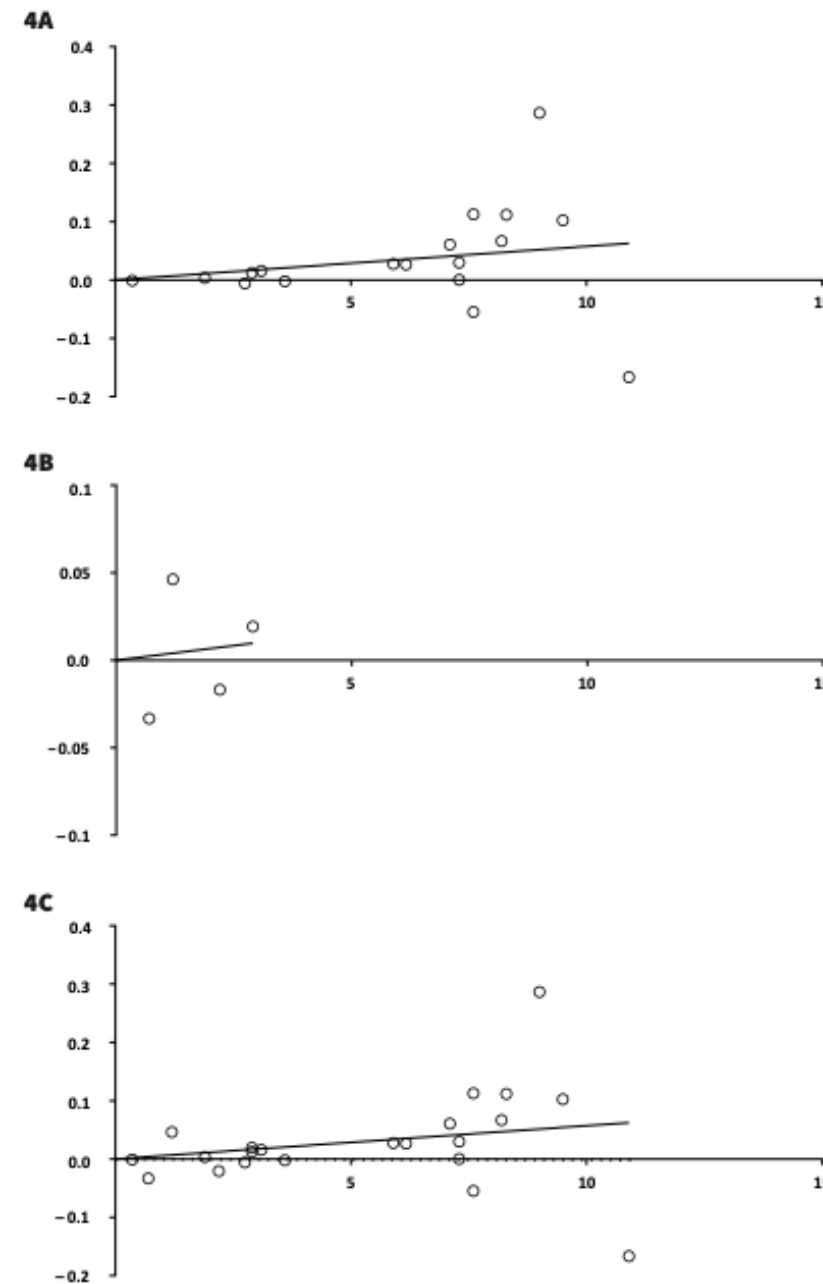
Effects on LDL cholesterol when *cis*-MUFA isocalorically replaces industrial TFA (3A), ruminant TFA (3B) or total TFA (3C). Y axis = change in LDL cholesterol (mmol/L); X axis = amount of TFA replaced with *cis*-MUFA as a percentage of energy intake. Regression lines are not weighted for study size.



cis-MUFA, *cis*-monounsaturated fatty acids; en%, percentage of total energy intake; LDL, low-density lipoprotein; TFA, *trans*-fatty acids

Figure 4. Effect on HDL cholesterol of replacing TFA with *cis*-MUFA

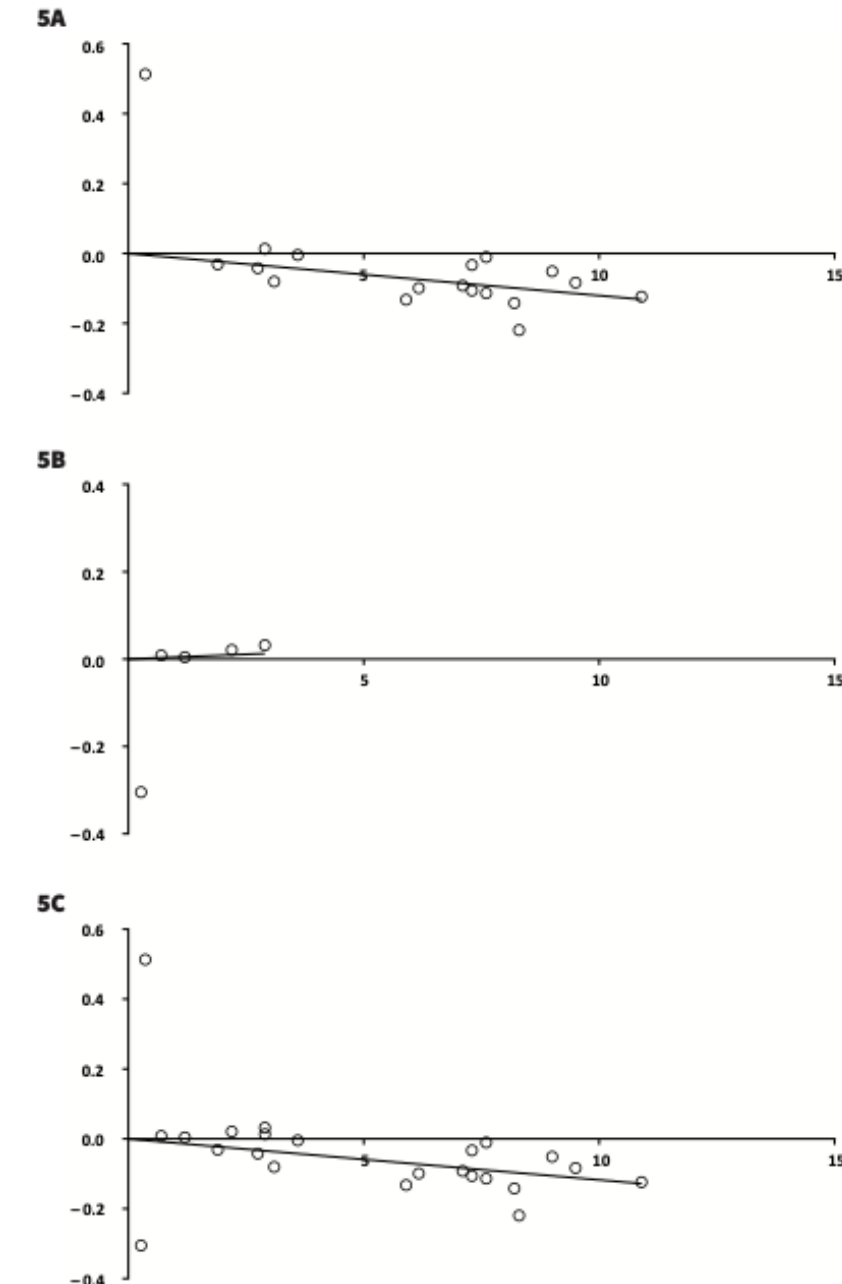
Effects on HDL cholesterol when *cis*-MUFA isocalorically replaces industrial TFA (4A), ruminant TFA (4B) or total TFA (4C). Y axis = change in HDL cholesterol (mmol/L); X axis = amount of TFA replaced with *cis*-MUFA as a percentage of energy intake. Regression lines are not weighted for study size.



cis-MUFA, *cis*-monounsaturated fatty acids; en%, percentage of total energy intake; HDL, high-density lipoprotein; TFA, *trans*-fatty acids

Figure 5. Effect on triglycerides of replacing TFA with *cis*-MUFA

Effects on triglycerides when *cis*-MUFA isocalorically replaces industrial TFA (5A), ruminant TFA (5B) or total TFA (5C). Y axis = change in triglycerides (mmol/L); X axis = amount of TFA replaced with *cis*-MUFA as a percentage of energy intake. Regression lines are not weighted for study size.



cis-MUFA, *cis*-monounsaturated fatty acids; en%, percentage of total energy intake; TFA, *trans*-fatty acids

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The TFA Ban: Did It Work?

Strong science, free press

Mounting pressure from scientists and the media throughout the late 1990's enabled Denmark become the first country in the world to adopt a best practice TFA elimination policy. The press gave extensive positive coverage to the new regulation, and as a result, no media outreach or public campaigns were required to spark industry change. Once the regulation was adopted, laboratory support from the National Food Institute at the Technical University of Denmark (DTU) was essential for Denmark's success in enforcing the iTFA limit, and DTU's ongoing scientific research continues to generate convincing evidence on the harmfulness of iTFA.

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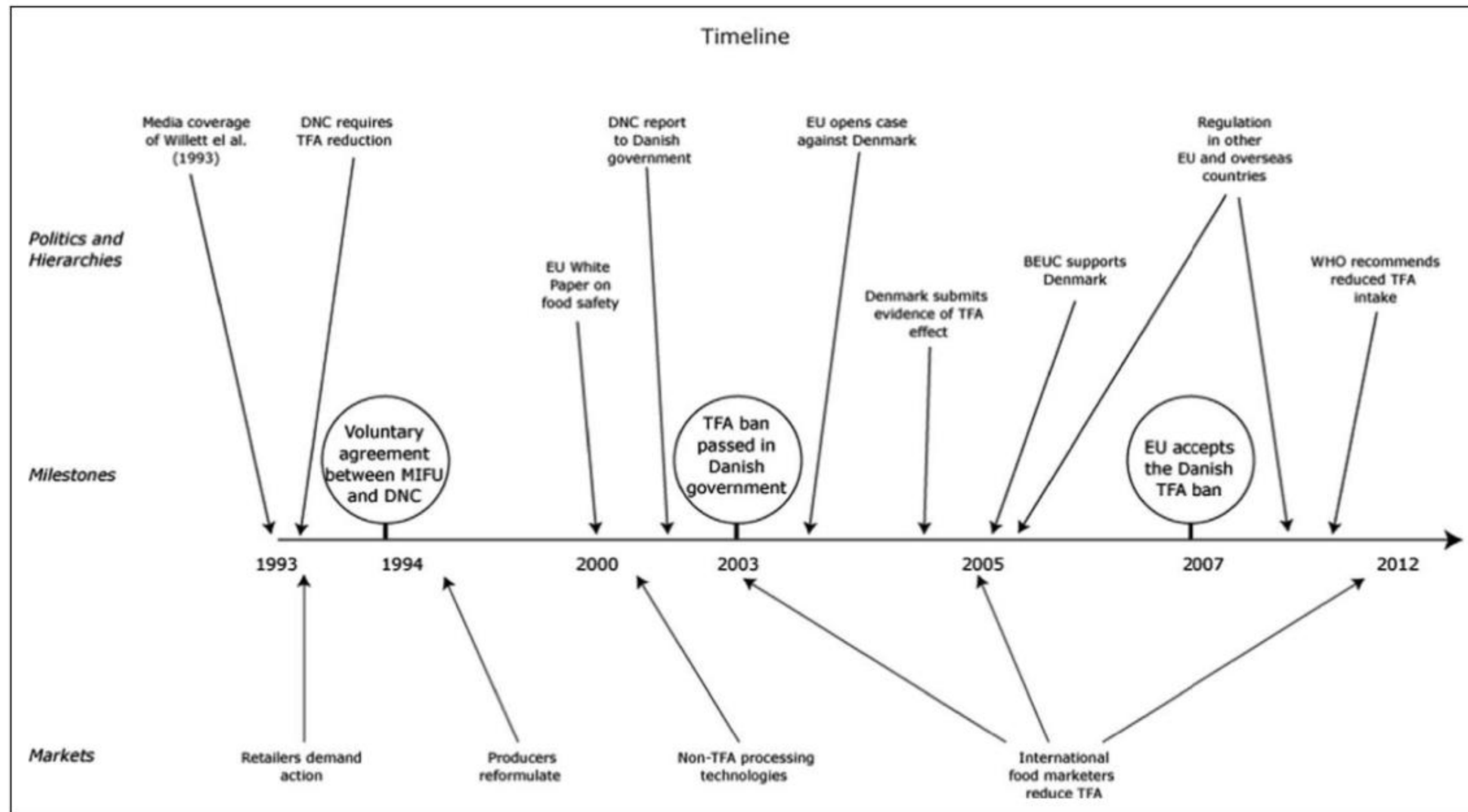


Figure 2. Timeline of Danish trans-fat regulation.

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Danish iTFA Limit. Did it work?

- Product compliance improved from 89% in 2005 to 94% in 2013.
- Average intake of industrial trans fatty acids (iTFA) decreased across all demographics, with most consuming less than the WHO's recommended 2.2 grams per day.
- Danish iTFA restrictions reduced cardiovascular disease mortality by 10%.
- Replacing iTFA with monounsaturated fats in products like margarines and French fries resulted in healthier options.

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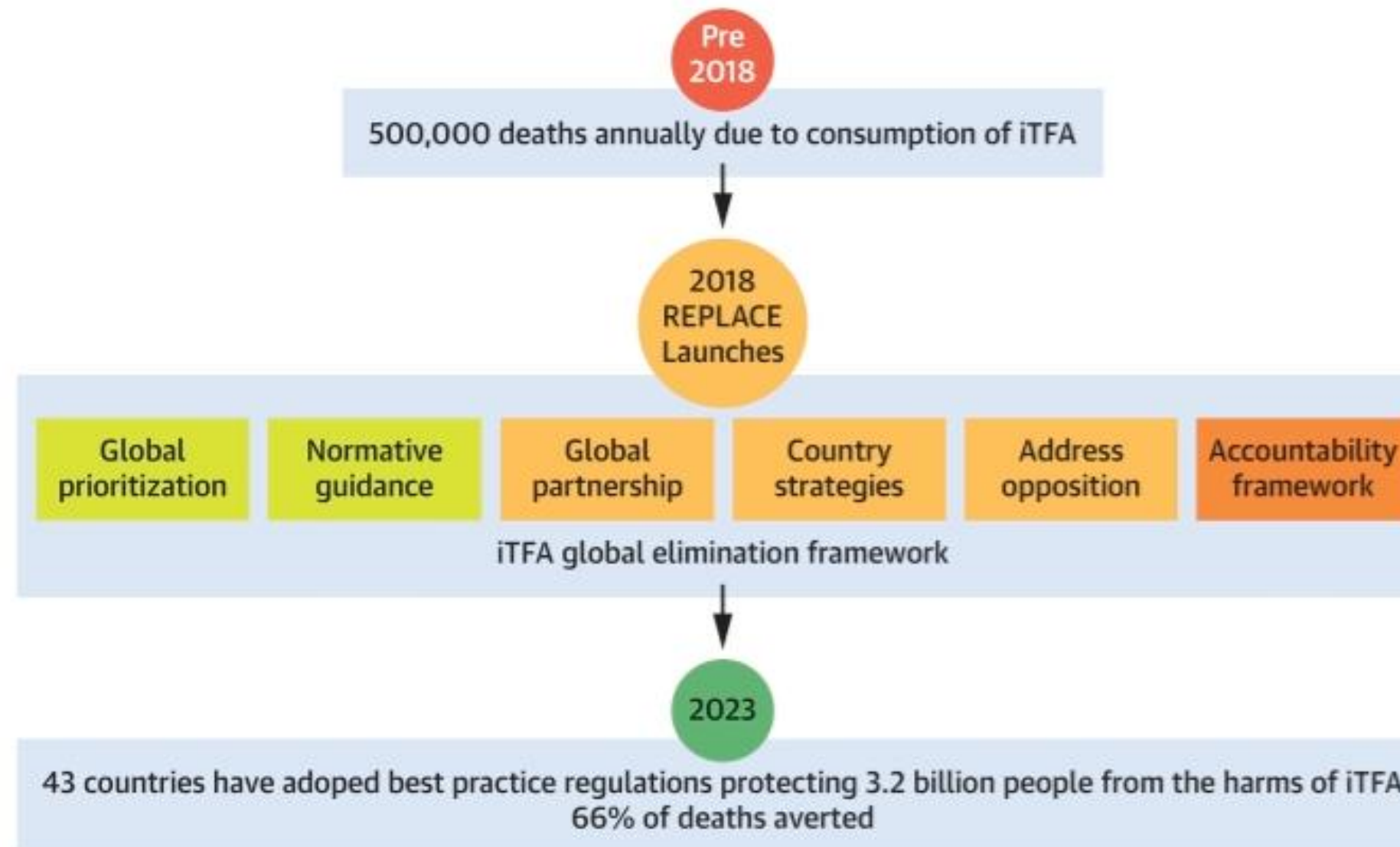
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The Global Plan Against TFA

CENTRAL ILLUSTRATION: The Global Industrially Produced Trans Fat Elimination Framework



Steele L, et al. J Am Coll Cardiol. 2024;84(7):663-674.

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REPLACE

REVIEW	PROMOTE	LEGISLATE	ASSESS	CREATE	ENFORCE
dietary sources of industrially-produced trans fat and the landscape for required policy change	the replacement of industrially-produced trans fat with healthier fats and oils	or enact regulatory actions to eliminate industrially-produced trans fat	and monitor trans fat content in the food supply and changes in trans fat consumption in the population	awareness of the negative health impact of trans fat among policy-makers, producers, suppliers, and the public	compliance with policies and regulations

WHO launched REPLACE in 2018 for eliminating TFA from global food supply by 2023.

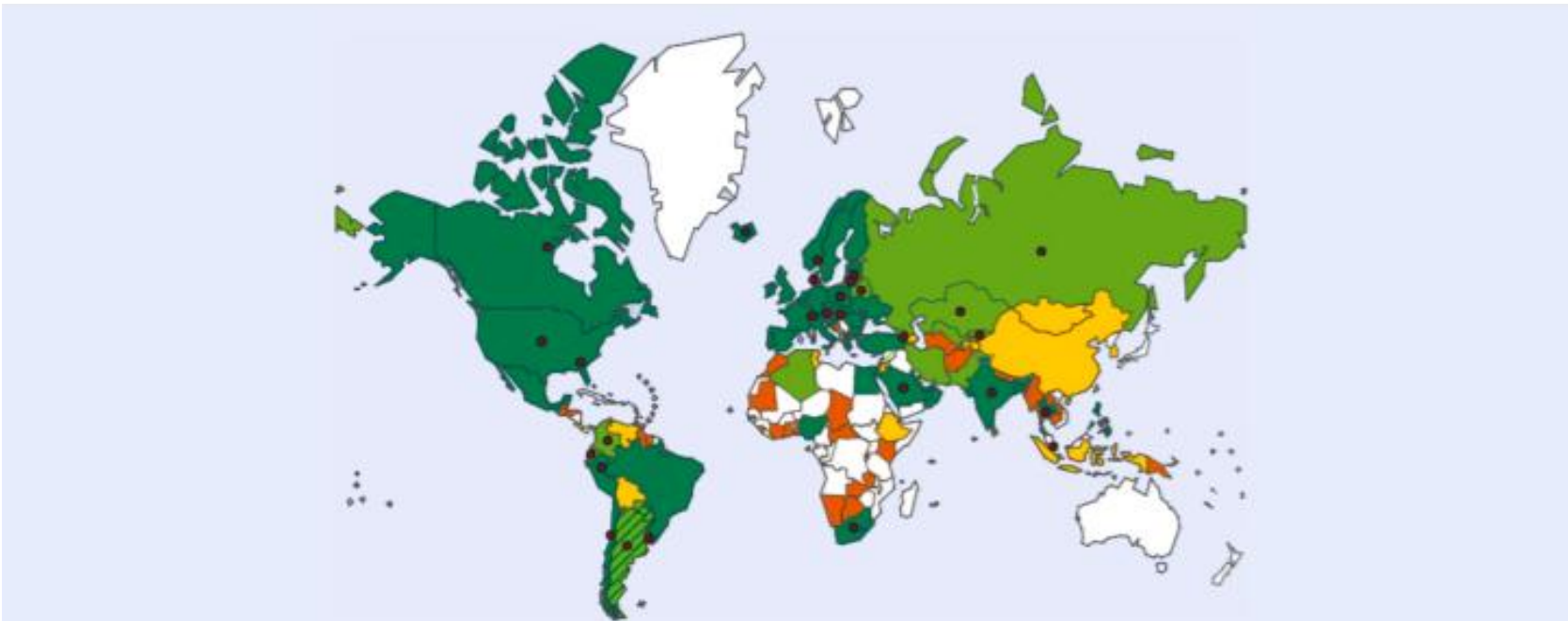
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- **1. National policy commitment to eliminate TFA:** National policies, strategies, or action plans that express a commitment to reduce industrially produced TFA in the food supply
- **2. Other complementary measures:** Legislative or other measures that encourage consumers to make healthier choices about industrially produced TFA or mandatory limits on industrially produced TFA in foods in specific settings
- **3. Less restrictive TFA limits:** Legislative or regulatory measures that limit industrially produced TFA in foods in all settings, but are less restrictive than the recommended approach
- **4. Best-practices TFA policy:** Legislative or regulatory measures that limit industrially produced TFA in foods in all settings, and are in line with the recommended approach
- ▨ Best-practice TFA policy passed but not yet in effect
- Monitoring mechanism for mandatory TFA limits
- ▨ Less restrictive TFA policy passed but not yet in effect
- Missing data

The Global Plan Against TFA

WHO TFA Policy Implementation Map

- Global scorecard for country TFA policy implementation as of December 2023.

Steele et al. J Am Coll Cardiol. 2024

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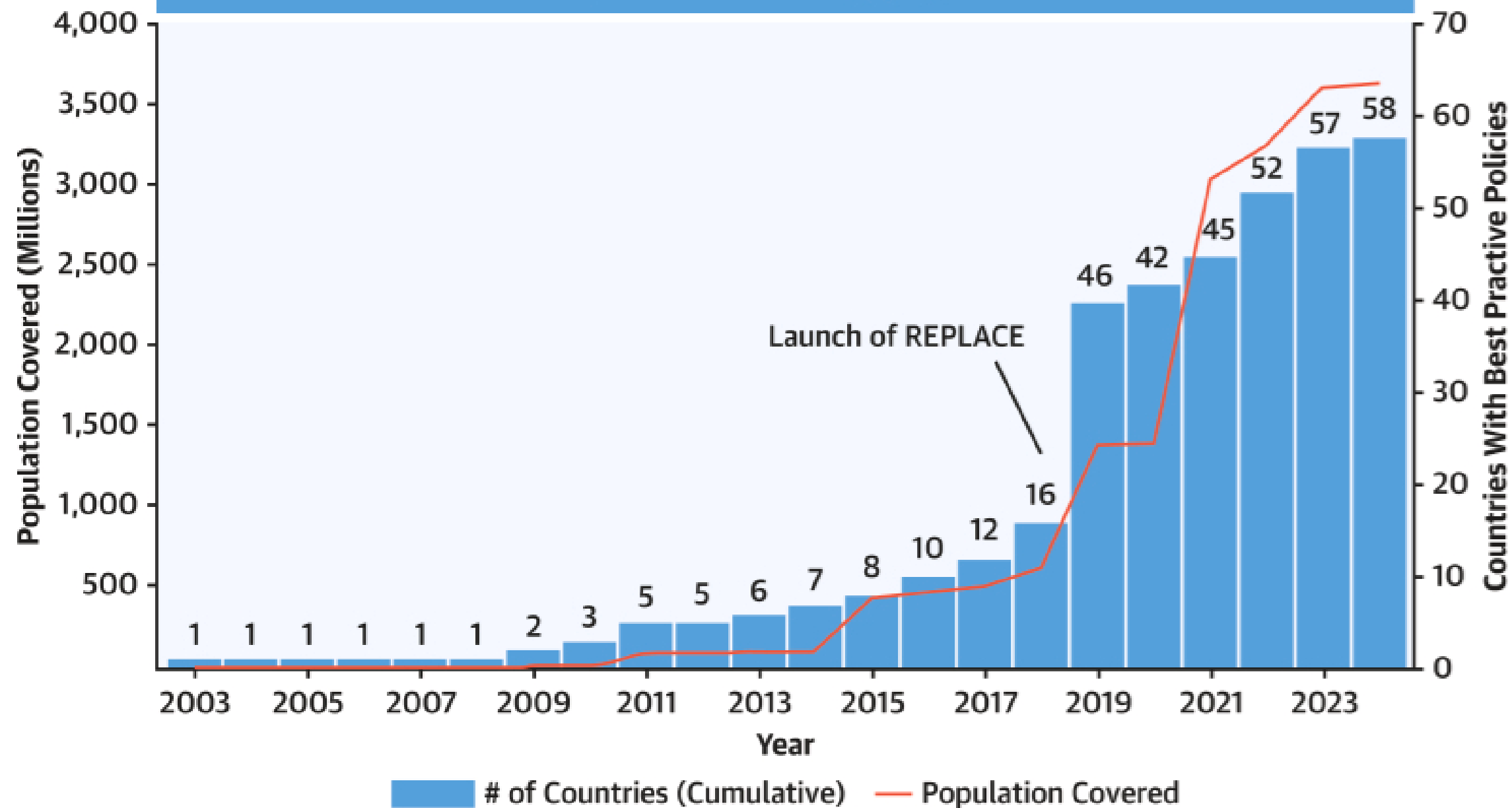
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Number of Countries With Best Practice TFA Policies Adopted With Population Coverage, by Year

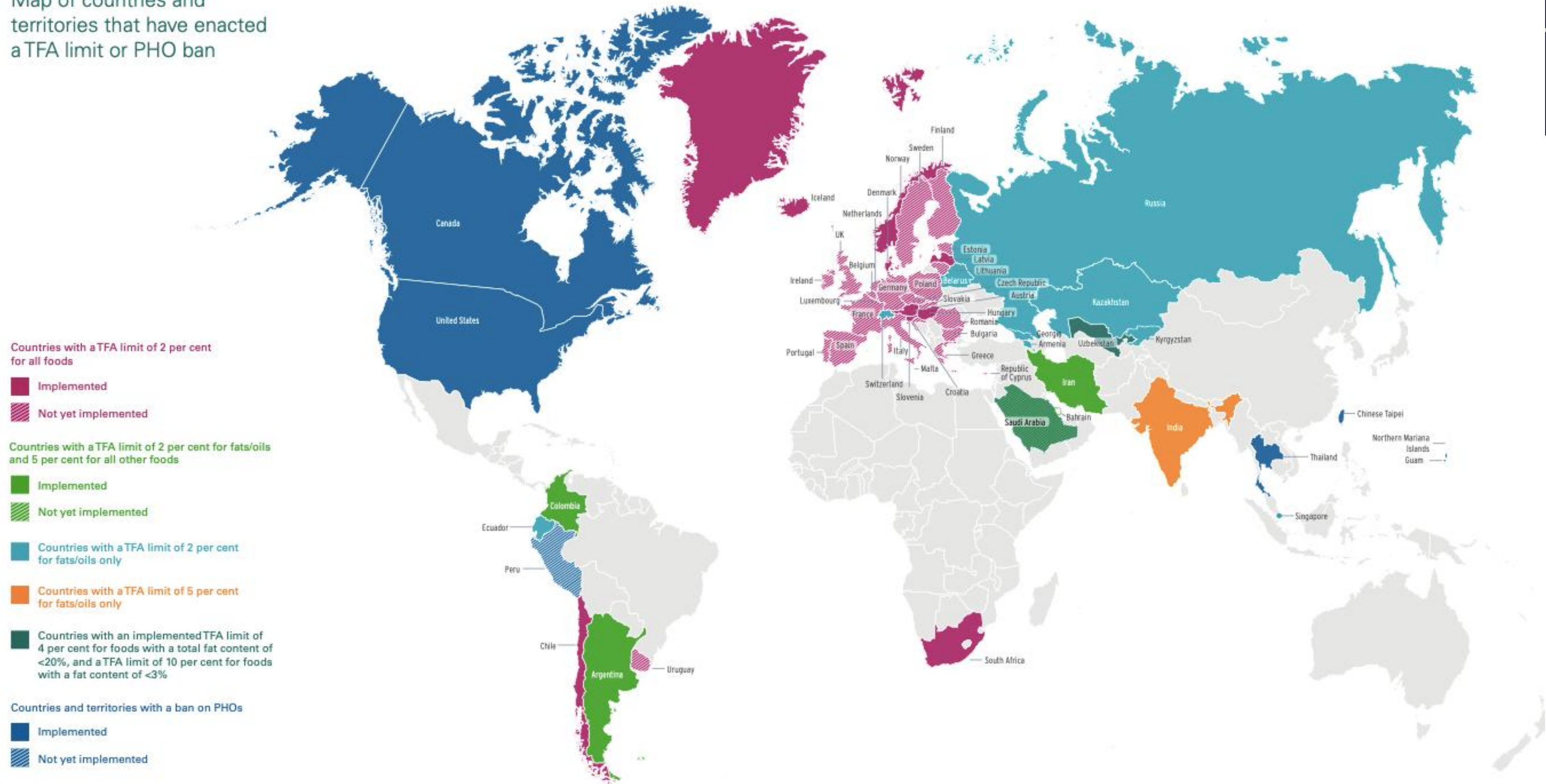


Adoption of Best Practice TFA Policies

- Shows cumulative growth in countries adopting trans fat elimination policies from 2001 to 2024.

Steele et al. J Am Coll Cardiol. 2024

Map of countries and territories that have enacted a TFA limit or PHO ban



Source: Global database on the Implementation of Nutrition Action (GINA). Available at <https://extranet.who.int/nutrition/gina/en>. Supplemented by additional research by author. Includes policies enacted as of March 2019.

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What about other country?

MALAYSIA

- **Added provision 'Regulation 38B' to Food Regulations 1985 on TFA**
- **Sets max content of TFA of not more than 2g/100g of fat, other than TFA of animal origin**

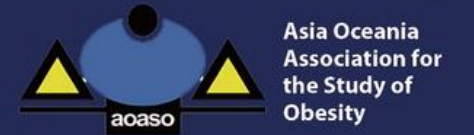
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How to avoid TFAs? Simple tips, but yet.....

- Learn to read food labels and the Nutrition Information Panel (NIP).
- Look for the Healthier Choice Symbol.
- Reduce intake of junk and processed foods.
- Opt for healthier oils.
- Eat less red meat and increase fruit and vegetable consumption.

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THANK YOU!

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