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Optimal Nutrition and the Ever-Changing Dietary Landscape
 CRN-I, Hamburg

Role of Food Supplements in the Dietary Landscape

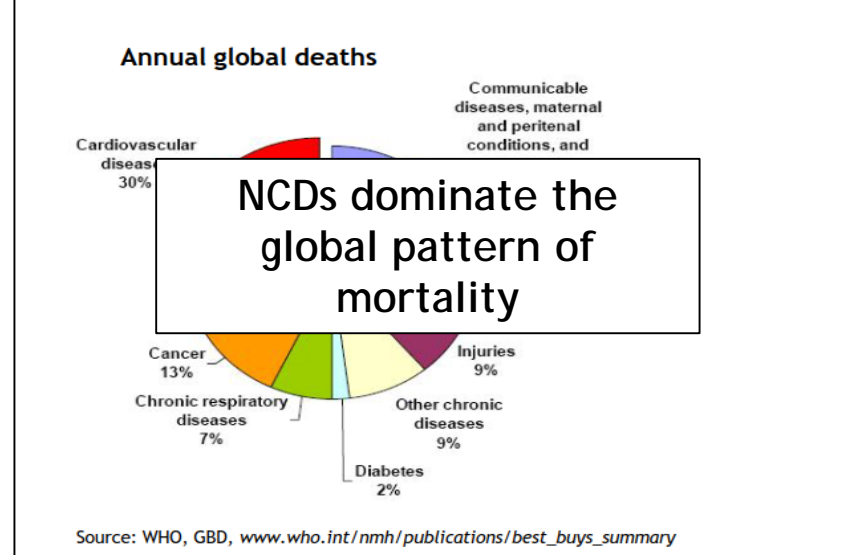
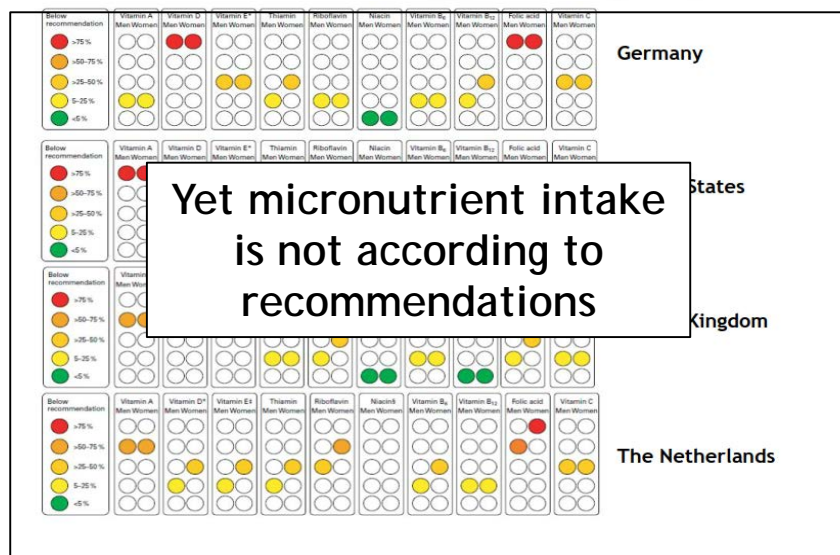
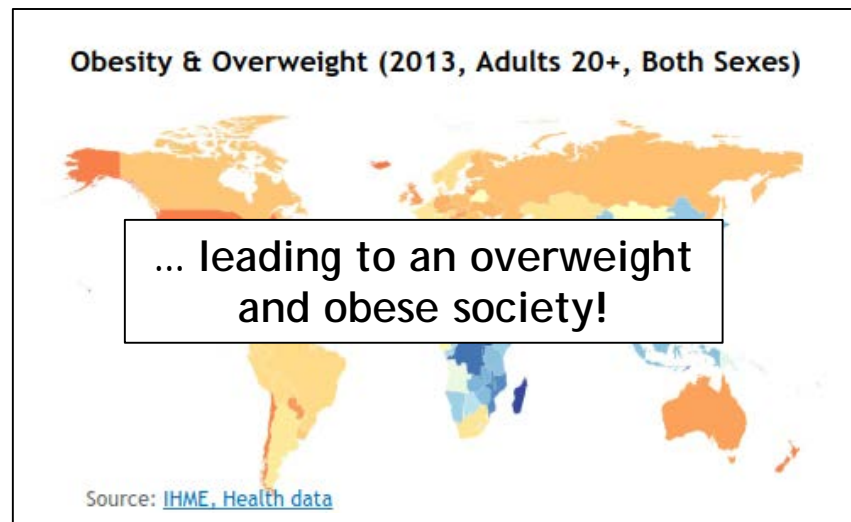
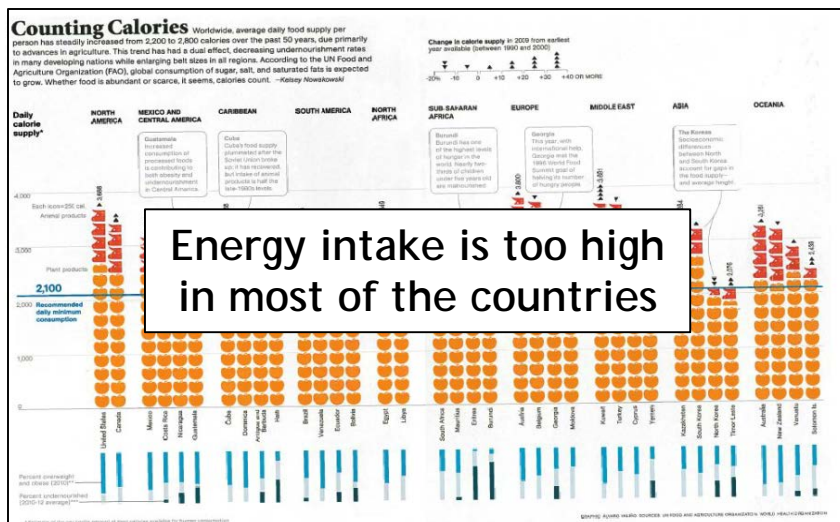
December 2, 2016

Manfred Eggersdorfer, PhD
 Professor for Healthy Ageing
 DSM Nutrition Science & Advocacy

Micronutrient challenges and opportunities: Where do we stand?

- Inadequate micronutrient intake is a global issue
- Opportunities: Case studies
 - Vitamin D
 - Vitamin E
 - Vitamin C
 - Omega-3
- Challenges in micronutrients
- Summary and outlook

A healthy nutrition for all is one of the most pressing topics in the 21st century



Challenges and adverse developments might be ahead

The NEW ENGLAND JOURNAL of MEDICINE

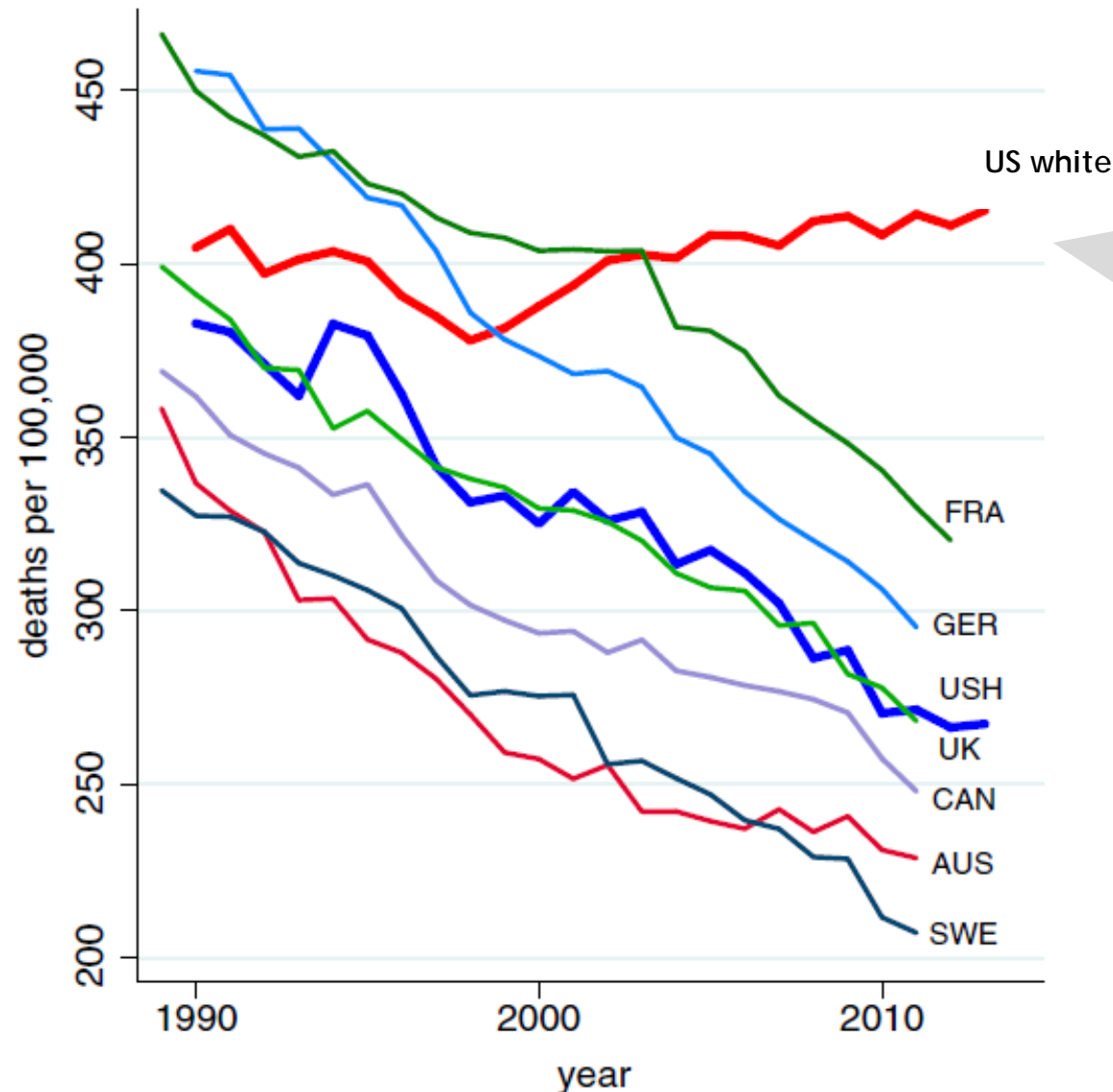
SPECIAL REPORT

A Potential Decline in Life Expectancy in the United States in the 21st Century

S. Jay Olshansky, Ph.D., Douglas J. Passaro, M.D., Ronald C. Hershow, M.D., Jennifer Layden, M.P.H., Bruce A. Carnes, Ph.D., Jacob Brody, M.D., Leonard Hayflick, Ph.D., Robert N. Butler, M.D., David B. Allison, Ph.D., and David S. Ludwig, M.D., Ph.D.

Unless effective population-level interventions to reduce obesity are developed, the steady rise in life expectancy observed in the modern era may come to an end and the youth of today may live less healthy and possibly even shorter lives than their parents (NEJM 2005)

...and the rise in life expectancy may come to an end



Potential consequences lifestyle, nutrition, stress and other factors in the last decades?

WHO proposes to act and UN declared the decade of Action on Nutrition

- **More than 40% of nutrition related diseases take place before the age of 70.**
- **Approximately one third of cancers can be prevented.**
- **Up to 80% of heart disease, stroke and diabetes type 2 deaths are preventable.**

Source: www.who.int/gho/ncd/en/index.html



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Health consequences of insufficient status is the challenge in today's societies

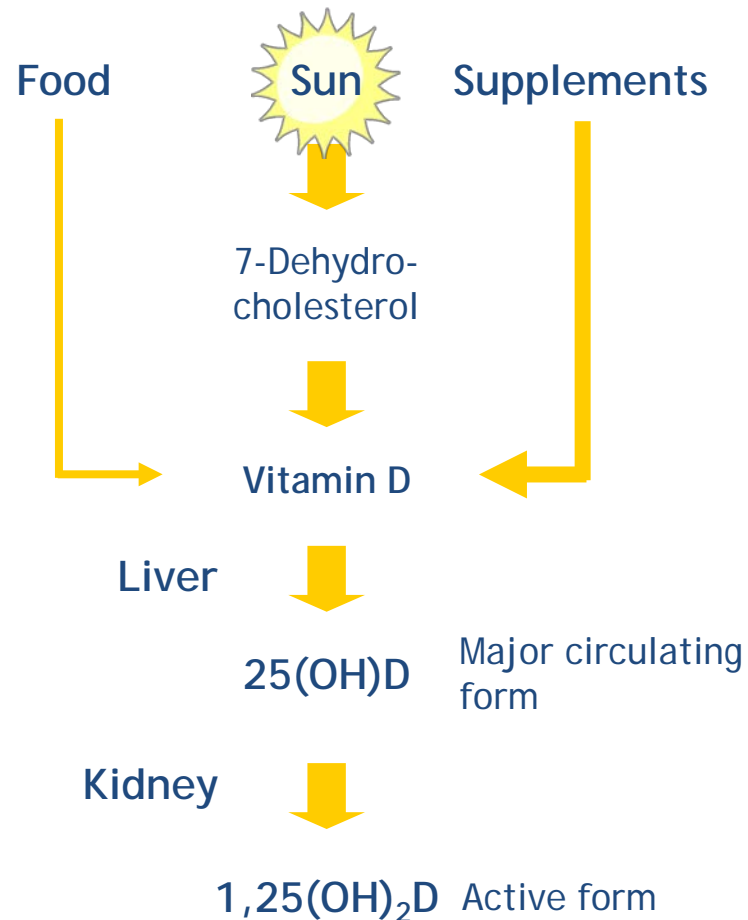


Nutrient	Deficiency	Insufficiency	Optimal status
Iodine	Goiter	Impaired cognitive development	<div>Optimal health</div> <div>Strong immune system</div> <div>Healthy ageing</div>
Vitamin D	Rickets	Osteopenia, Osteoporosis	
Vitamin E	Ataxia, still birth	CVD risk, ageing	
Folate	Neural tube defect (NTD)	Homocysteine, CVD risk	
Omega-3	Depression, poor memory	CVD risk, cognitive decline in elderly	
Vitamin C	Scurvy	Risk for CVD, impact on immunity	

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Vitamin D comes from different sources



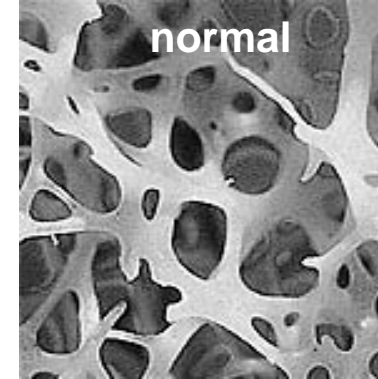
25(OH)D serum level is the relevant indicator of Vitamin D status (IOM 1997)

nmol/L	< 25	25 - 50	50 - 75	> 75
	<i>deficient</i>	<i>insufficient</i>	<i>(in)adequate</i>	<i>desirable</i>
ng/ml	< 10	10 - 20	20 - 30	> 30

Vitamin D: the inadequate status impacts a number body functions

Classical role of vitamin D: bone health

- Improves **bone mineral density** through calcium absorption and deposition
- Necessary to prevent rickets & osteomalacia



Emerging health benefits of vitamin D

- Muscle
 - Reduces risk of falling by improving muscle strength
- Immunity
 - Strengthens the immune system
 - Reduces risk of multiple sclerosis and diabetes type
- Cardiovascular
 - Lowers blood pressure
- Cancer
 - Inhibits cell proliferation



Systematic review of vitamin D status in populations worldwide

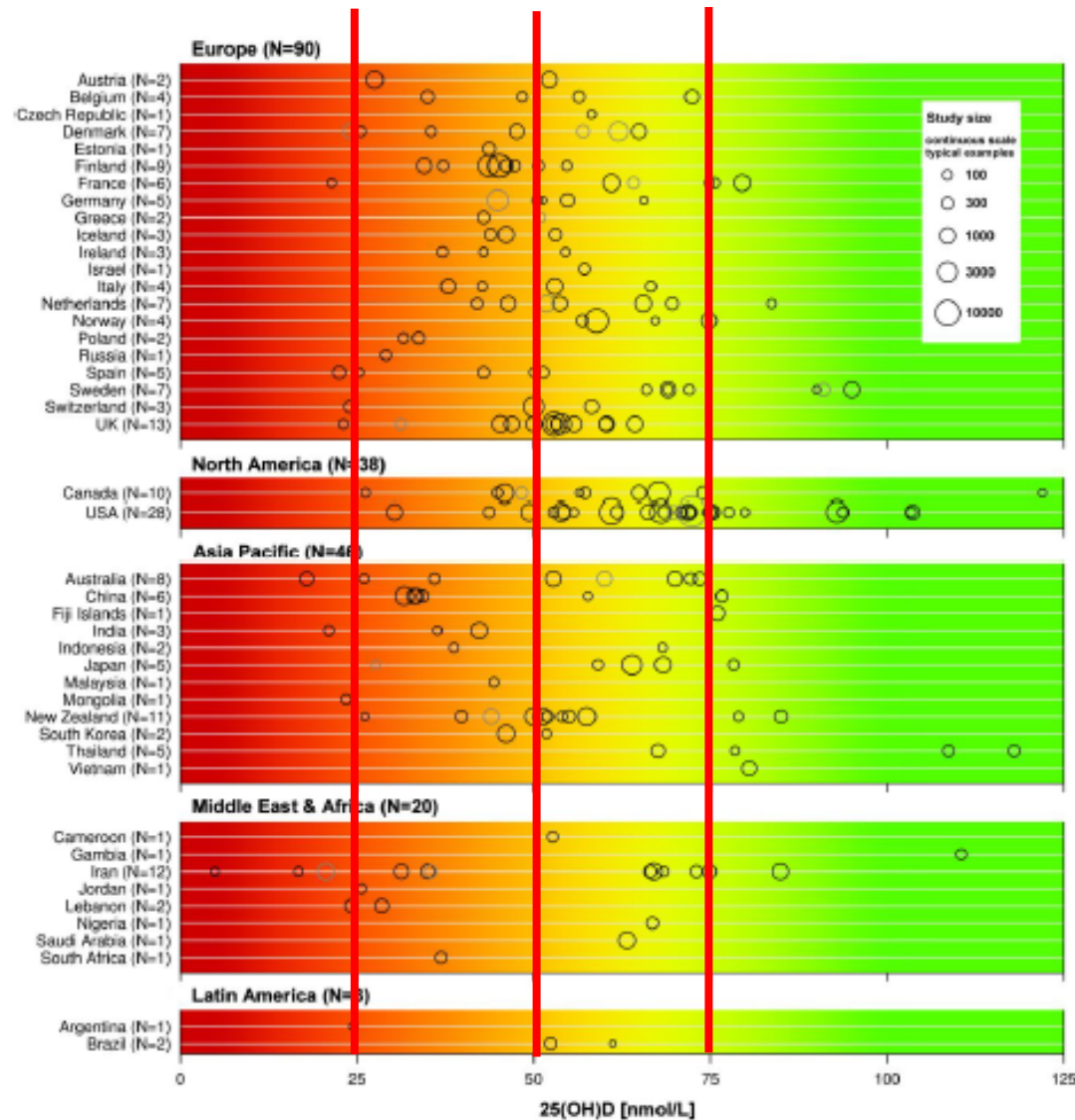
Mean 25(OH)D levels:

- 6.7% below 25 nmol/l
- 37.3% below 50 nmol/l
- 88.1% below 75 nmol/l

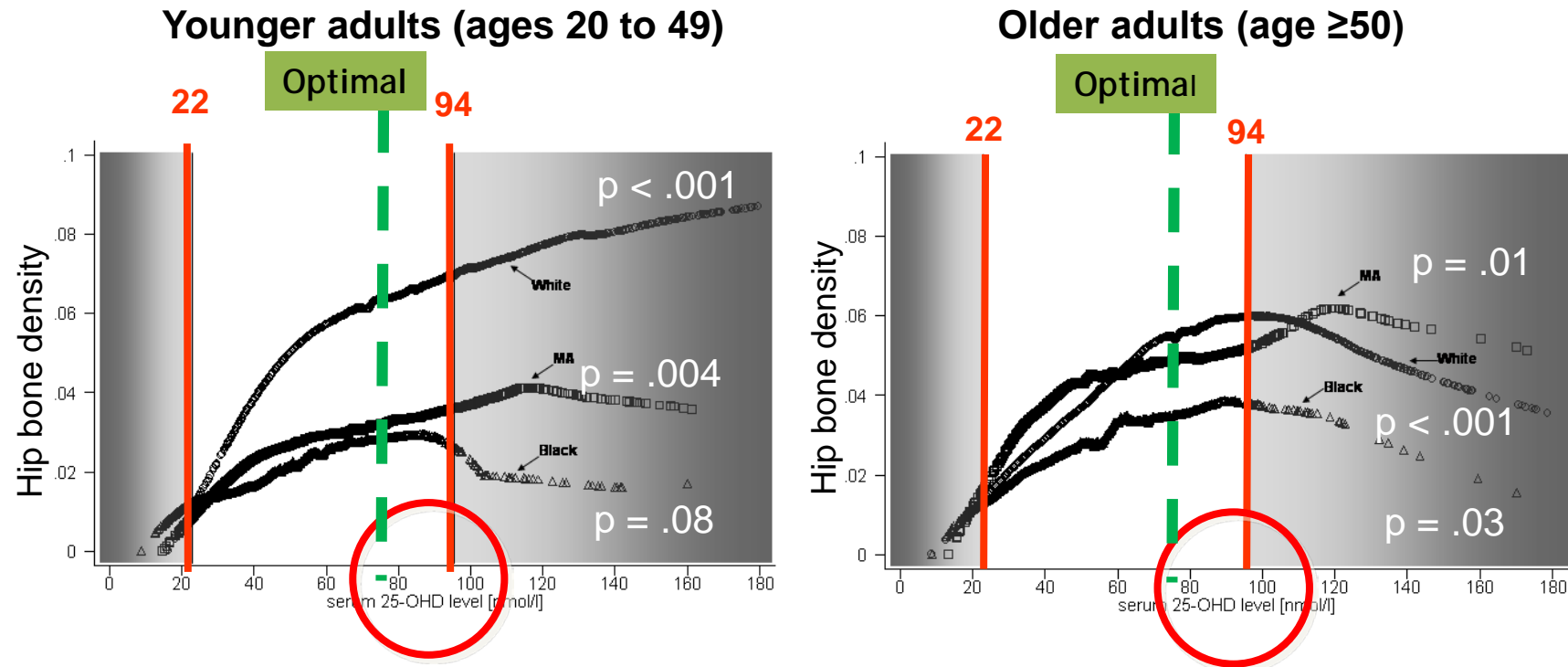


Reference:

J. Hilger, Angelika, F. Raphael
Herr, T. Rausch, F. Roos, D.A.
Wahl, D.D. Pierroz, P. Weber, K.
Hoffmann, BJN 2013



A higher hip bone density depends on the 25(OH)D plasma levels*



Bone mass density (BMD) increases with higher 25(OH)D plasma level in younger and in older adults of different ethnicities

Adjustments: sex, age, BMI, smoking, daily calcium intake, and estrogen use

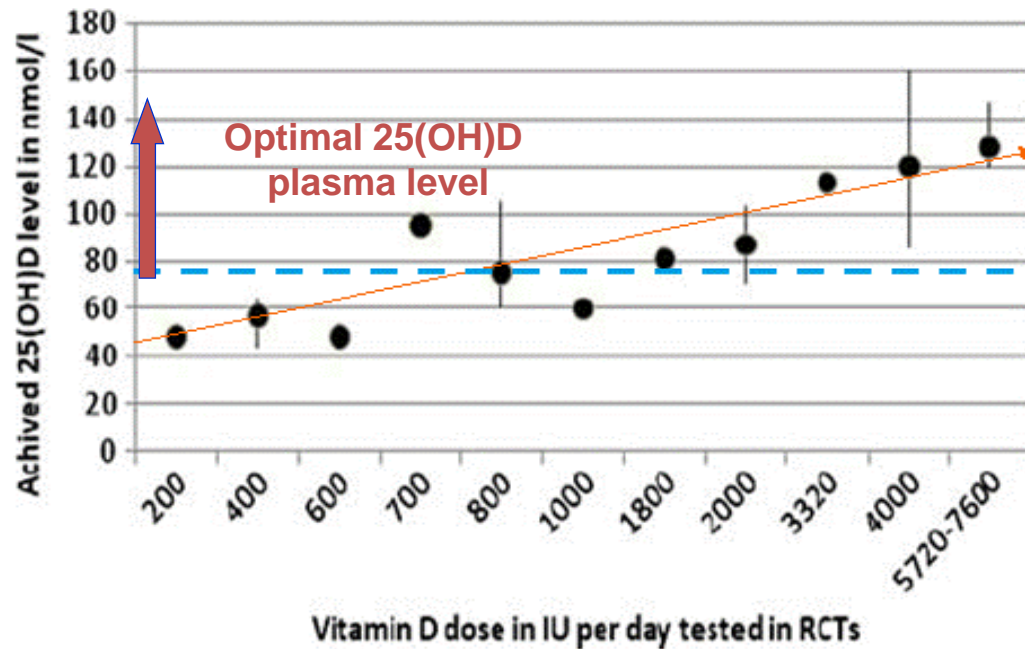
*in 13'432 individuals in population-based NHANES III study

Bischoff-Ferrari HA, Stähelin HB, et al. Am J Med 2004

Intake of vitamin D and achieved 25(OH)D plasma level, a clear dose-relationship

RCTs analyzed

RCTs with vitamin D less than 10'000 IU per day and duration of at least 4 weeks



Conclusion

- Optimal 25(OH)D range between 75 -110 nmol/L
- These levels can be best obtained with oral doses in the range of 700 IU - 1000 IU
- Benefit is clearly dose dependent

Bischoff-Ferrari, 2009 Osteoporos Int

One in three women and one in five men over the age of 50 years will sustain an osteoporotic fracture

Germany: Health care cost impact of low vitamin D status

Hip and vertebral fractures have the most „cost-intense“ medical implications

- Number of people at risk for osteoporosis: 8-10 million (2010)*
- Number of hip and vertebral fractures p.a.: 19,000

Optimized vitamin-D status reduces number of fractures by 20 %

- Reduction of 5.478 hip fractures and 19,000 vertebral fractures (in osteoporosis-diagnosed population)

Net socio-economic benefit:

Including medical costs for prevention, treatment and rehabilitation costs vitamin D

up to

Including societal perspective, e.g. family care, reha costs

➔ 585 mio €

➔ 778 mio €

Costs of vit D supplementation for women > 55 with low vit D status: 180 -200 mio EUR

Source: * Sproll 2011



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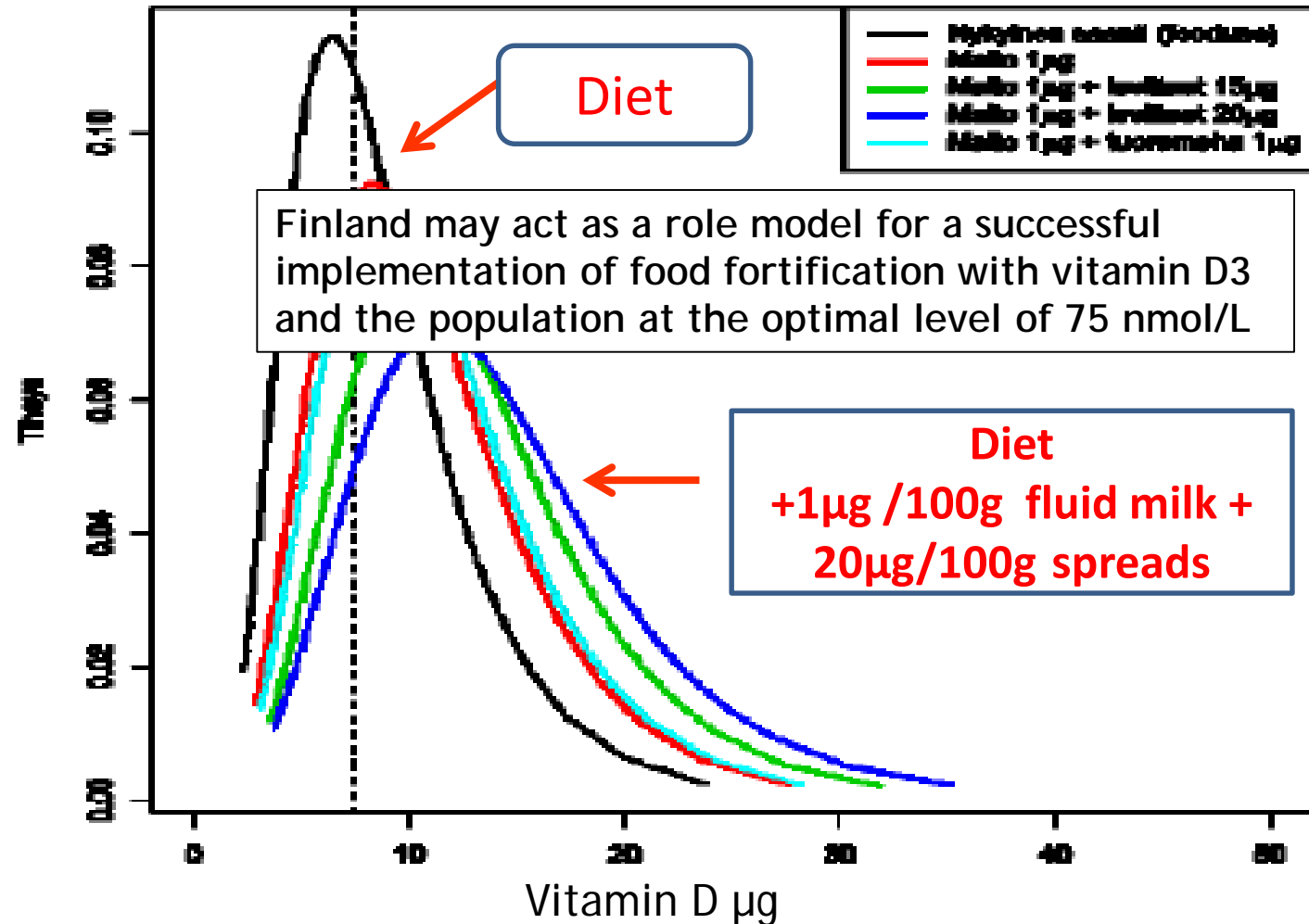


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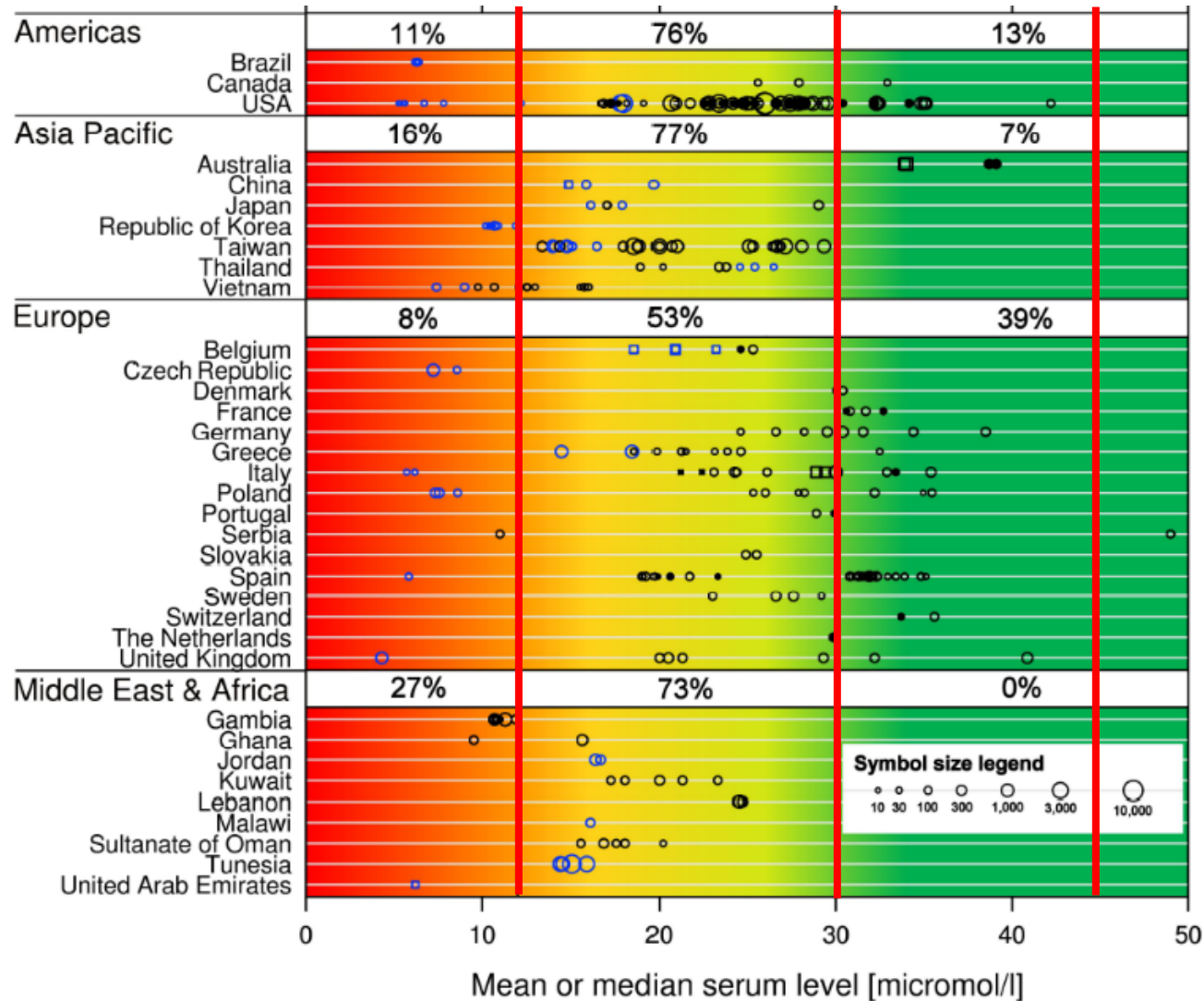
Finland acted and implemented mandatory food fortification, other countries follow

Simulation of Vitamin D intake via the different carriers



Source: THL, Helsinki, 2009

Vitamin E status by country and region



Szabolcs Péter, Angelika Friedel,
Franz F. Roos, Adrian Wyss, Manfred
Eggersdorfer, Kristina Hoffmann,
Peter Weber:

A systematic review of global alpha-
tocopherol status as assessed by
nutritional intake levels and blood
serum concentrations

*International Journal for Vitamin and
Nutrition Research*

13% in deficient range
66% in insufficient range
21% in desired range

We engage for vitamin E reference values to be used in the nutrition and medical community

	ESSENTIALITY		HEALTH BENEFITS	
SERUM CC.	≤12 µmol/L	13-29 µmol/L	30-44 µmol/L	≥45 µmol/L
VIT. E STATUS	Overt deficiency	Inadequacy	Adequacy	Therapeutic benefits
HEALTH IMPACT	Haemolysis Neurological symptoms Miscarriage	Increased NCD risk Increased mortality	Decreased NCD risk	Immune health Eye health CV health Liver health Cogn. function
REFERENCES	Horwitt 1960 Farrell 1977 Cynamon 1988 Elias 1981 Sokol 1989 Stead 1986 Winklhofer-Roob 1996(2) Shamim 2015	Biesalski 1997 Gey 1993, 1995 Lebold 2012 Mangialasche 2012 Wright 2006 Weinstein 2007 Goyal 2013 DACH 2008 Meydani 2004 Weber 1997 Ford 1999 Smetana 2000 Lopes da Silva 2014		Weber 1997 Meydani 1997 Meydani 2004 Stephens 1996 Lavine 2011 Sano 1997

Example Vitamin C: deficiency is common – also in the Western world

Table 1. Prevalence of vitamin C deficiency in larger cross sectional population studies

Study	Subjects (n)	Severe vitamin C deficiency (< 11 µmol/l)	Marginal vitamin C deficiency (11–23 µmol/l)	Suboptimal vitamin C status (23–50 µmol/l)	Comment
NHANES III ⁽⁵⁰⁾	15 769	14 % (M) 10 % (F)	20 % (M) 17 % (F)	NR	31 % (M) and 25 % (F) of the smokers alone were diagnosed with severe vitamin C deficiency
NHANES II ⁽⁵¹⁾	11 592	2 %	8 %	NR	7 and 20 %, respectively, in smokers alone
NHANES II ⁽⁴¹⁾	8453	NR	9 % (NS) 30 % (S)	31 % (NS)* 35 % (S)	Subpopulation aged 30 years or older
CARDIA ⁽⁵²⁾	2637	NR	8 % (NS) 26 % (S)	33 % (NS)† 40 % (S)	Numbers with marginal vitamin C deficiency include those with severe vitamin C deficiency
Third Glasgow MONICA population survey ⁽⁵³⁾	1267	26 % (M) 14 % (F)	22 % (NSM) 16 % (NSF) 30 % (SM) 30 % (SF)	NR	36 % (M) and 23 % (F) of the smokers alone were diagnosed with severe vitamin C deficiency
French population study ⁽⁵⁴⁾	1039	7–12 % (M) 3–5 % (F)	10–46 % (M)‡ 3–15 % (F)	NR	Values are ranges of various age groups

NHANES III, Third National Health and Nutrition Examination Survey; M, males; F, females; NR, not reported; NHANES II, Second National Health and Nutrition Examination Survey; NS, non-smokers; S, smokers; CARDIA, Coronary Artery Risk Development in Young Adults Study; MONICA, Monitoring of Trends and Determinants in Cardiovascular Disease; NSM, non-smoking males; NSF, non-smoking females; SM, smoking males; SF, smoking females.

* Range used: 23 to 55 µmol/l.

† Range used: 23 to 45 µmol/l.

‡ Range used: 11 to 19 µmol/l.

> 10⁸ have chronic Vitamin C deficiency
No one knows the consequences...

Lykkesfeldt, Poulsen, Brit. J. Nutr. (2010)

Observational studies report positive health effects associated with elevated vitamin C plasma levels

Ref.	Study population	Mean vitamin C level associated with health effect	Disease outcome	Main results
Simon et al., 2001	8,453 adults	45.4 $\mu\text{mol/L}$ (normal) and 79.5 $\mu\text{mol/L}$	CVD, all-cause mortality	Subjects with normal or saturating serum ascorbic acid levels (45.4 $\mu\text{mol/L}$ and 79.5 $\mu\text{mol/L}$, respectively) had a "marginally" significant 21–25% decreased risk of fatal CVD and a significant 25–29% decreased risk of all-cause mortality compared to subjects with low serum ascorbic acid levels.
Boekholdt et al., 2006	979 cases and 1794 controls	77.1 $\mu\text{mol/L}$	CHD	Subjects in the top quartile, mean, 77.1 $\mu\text{mol/L}$, had a 20% lower risk of CHD compared to those in the bottom quartile, mean, 45.4 $\mu\text{mol/L}$.
Khaw et al., 2001	19,496 men and women	72.6 $\mu\text{mol/L}$ in men and 85.1 $\mu\text{mol/L}$ in women	CVD, cancer, all-cause mortality	Subjects in the top quartile of baseline plasma vitamin C (72.6 $\mu\text{mol/L}$ in men and 85.1 $\mu\text{mol/L}$ in women) had a 42% lower risk of CVD, a 20% lower risk of cancer, and a 20% lower risk of all-cause mortality compared to those in the bottom quartile (mean, 45.4 $\mu\text{mol/L}$ in men and 51.7 $\mu\text{mol/L}$ in women).
Simon et al., 1998	6,624 adults	Observational study	Stroke	Subjects with the highest vitamin C levels (saturation, 85.2 $\mu\text{mol/L}$) had a 20% reduction in stroke and 27% reduction in CHD compared to the lowest category (low to marginal, 17.0 $\mu\text{mol/L}$).
Nyyssonen et al., 1998	Observational study	Observational study	Stroke	Subjects with the lowest vitamin C plasma levels (deficiency, <11.4 $\mu\text{mol/L}$) had a 4-fold higher risk of myocardial infarction compared to subjects with the highest levels (> 64.8 $\mu\text{mol/L}$), after adjustment for age, season, and year of examination.
Langhorne et al., 2000	Observational study	Observational study	Peripheral arterial disease	Serum ascorbic acid concentrations were low among PAD patients (median, 27.8 $\mu\text{mol/L}$) despite comparable smoking status and dietary intake with the other groups (median, 51.7 $\mu\text{mol/L}$ in healthy subjects and 49.6 $\mu\text{mol/L}$ in hypertensive patients without PAD).
Gale et al., 2000	Observational study	Observational study	Stroke	Subjects with the highest vitamin C plasma levels (> 27.8 $\mu\text{mol/L}$) had a 30% lower risk of death from stroke compared to subjects with lower vitamin C levels.
Myint et al., 2000	Observational study	Observational study	Stroke	Subjects in the top quartile of baseline plasma vitamin C (78.1 $\mu\text{mol/L}$) had a 42% lower risk of stroke than those in the bottom quartile (28.2 $\mu\text{mol/L}$), independent of age, sex, BMI, systolic blood pressure, smoking, alcohol consumption, cholesterol, social class, physical activity, diabetes, myocardial infarction, or supplement use.
Yokoyama et al., 2000	2,121 men and women	64.0 $\mu\text{mol/L}$	Stroke	Subjects with the highest vitamin C serum levels ($\geq 64 \mu\text{mol/L}$, top quartile) had a 41% lower risk of all stroke than those with the lowest levels ($\leq 40 \mu\text{mol/L}$, bottom quartile). The corresponding risk reductions for cerebral infarction and hemorrhagic stroke were 49% and 55%, respectively.

A higher vitamin C level reduces CHD by 20 - 42 %
Talk, communicate, ...!!!

Vitamin C - reduces *duration, incidence and severity* of colds

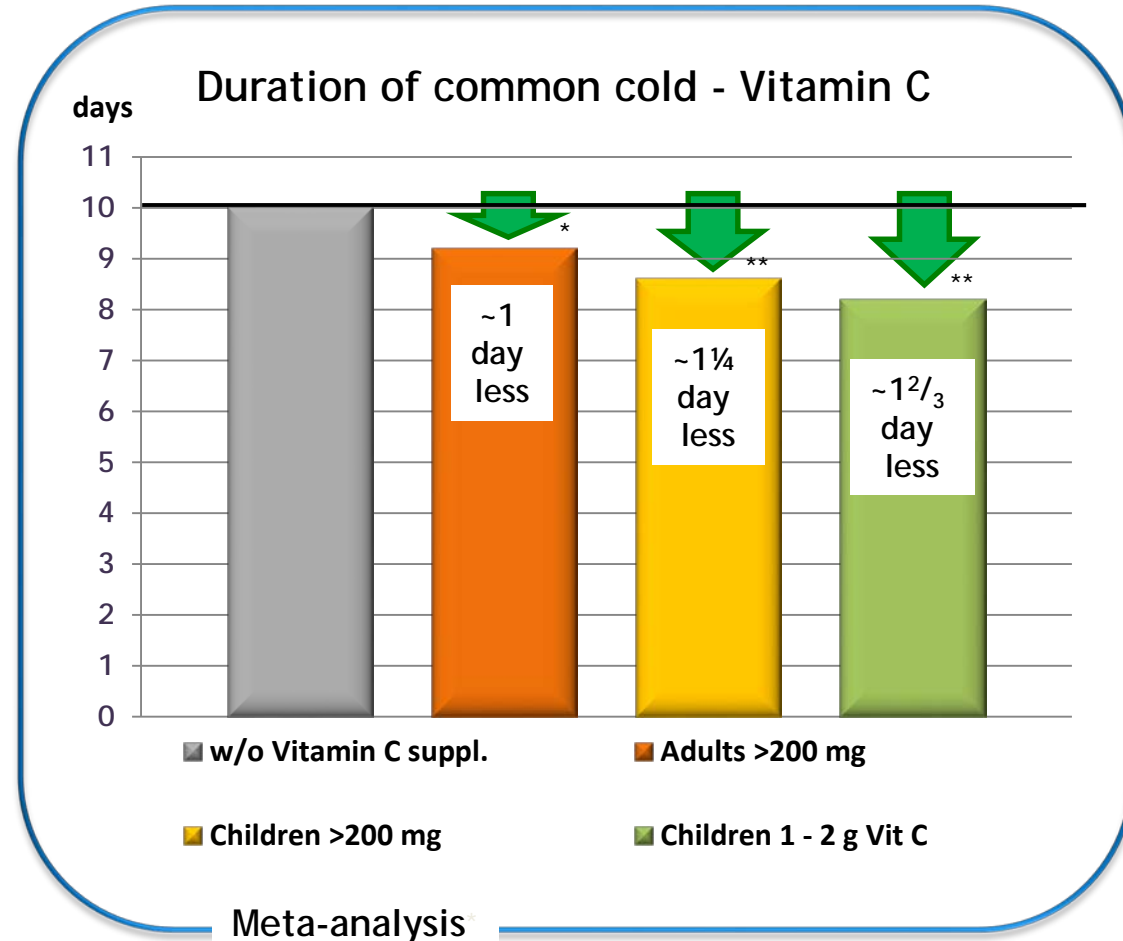
Taking regularly
≥ 200 mg/d Vitamin C

Regular supplementation with **Vitamin C** reduces the **duration** of colds in adults* and in children**

*(17 trials, 8%; p=0.0002)

** (14 trials, 14% / 18%; p<0.0001)

No drug has a similar benefit like vitamin C



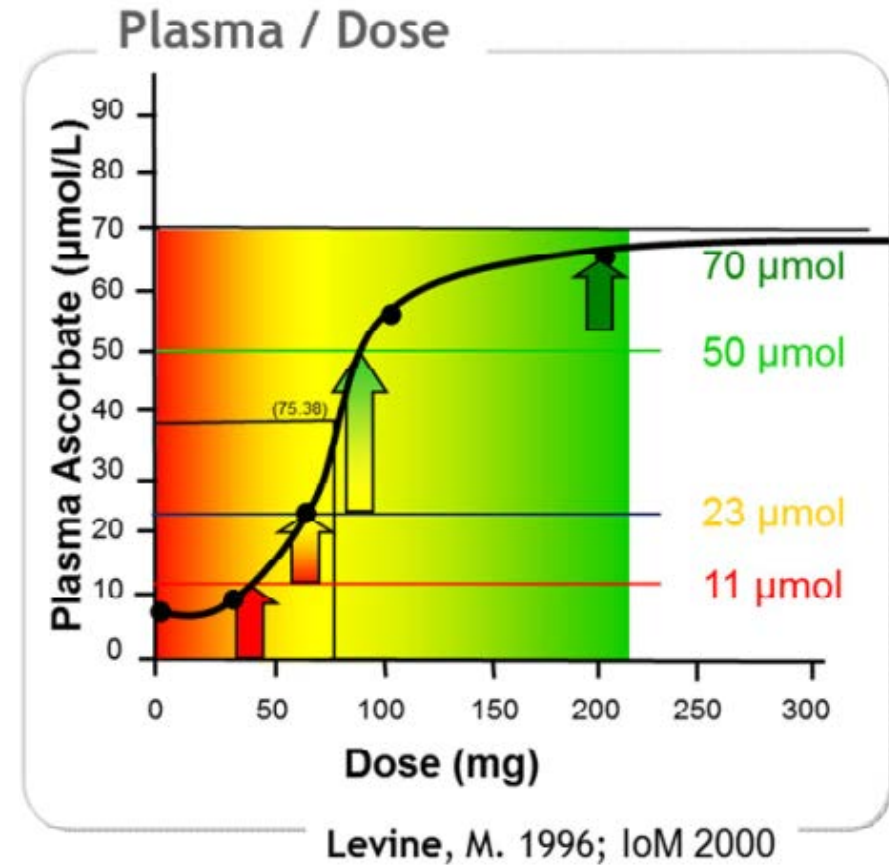
*Hemilä H., Chalker E.: Cochrane Database Syst Rev. 2013

Advocate for optimum intake of vitamin C of 200 mg/day

Based on the evidence from human metabolic, pharmacokinetic, and observational studies and RCTs, we conclude:

200 mg per day is the optimum dietary intake of vitamin C

to maximize the potential health benefits with the least risk of inadequacy or adverse health effects.

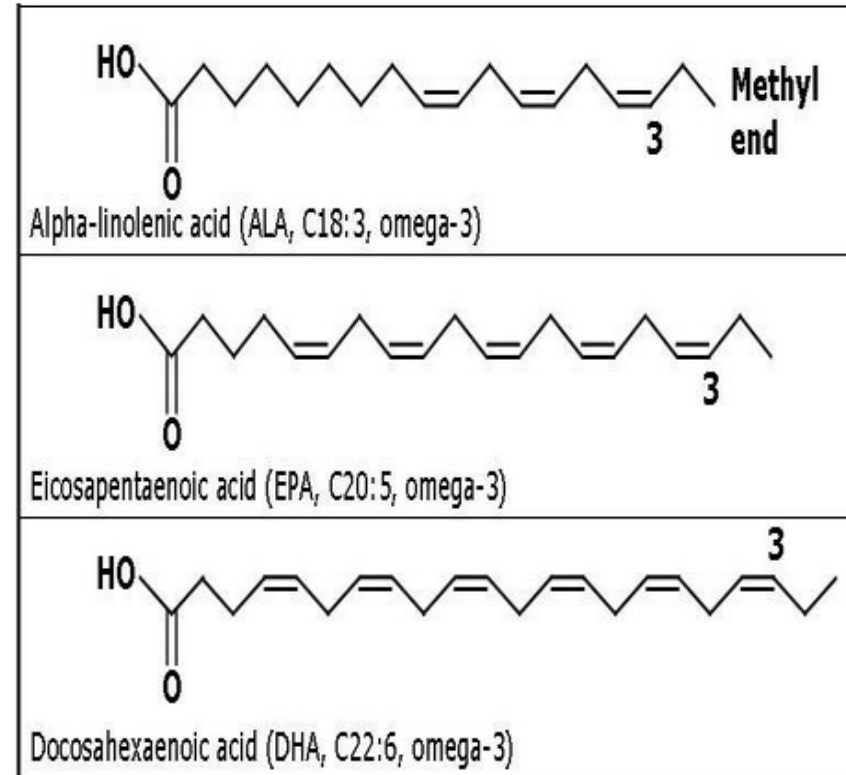
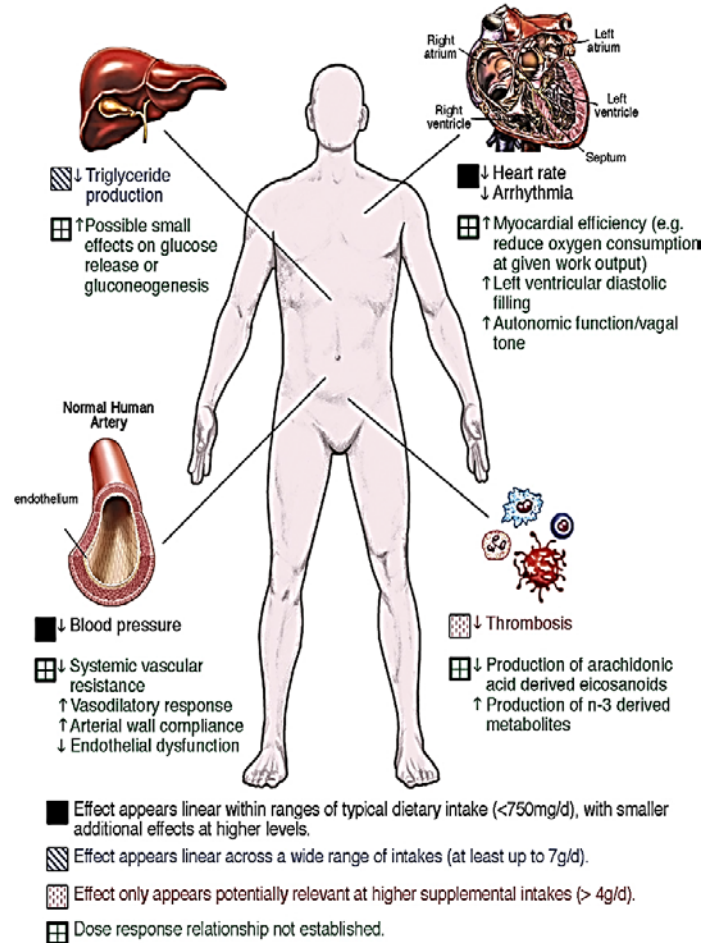


Source: http://www.cdc.gov/nutritionreport/pdf/NutritionBook_complete508_final.pdf



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Omega-3s affect several functions/structures



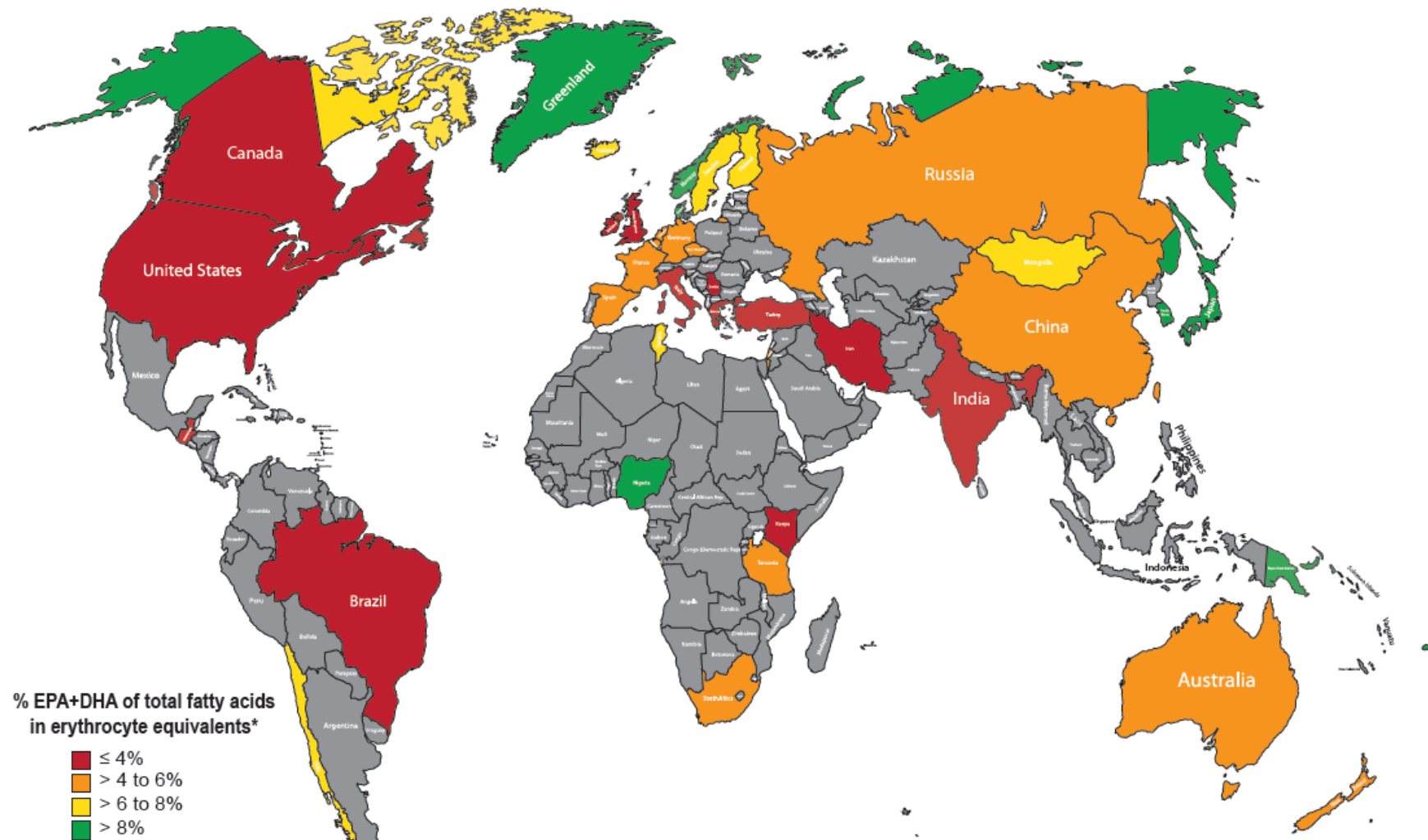
Taken from Mozaffarian et al. 2011 J Am Coll Cardiol 58:2047



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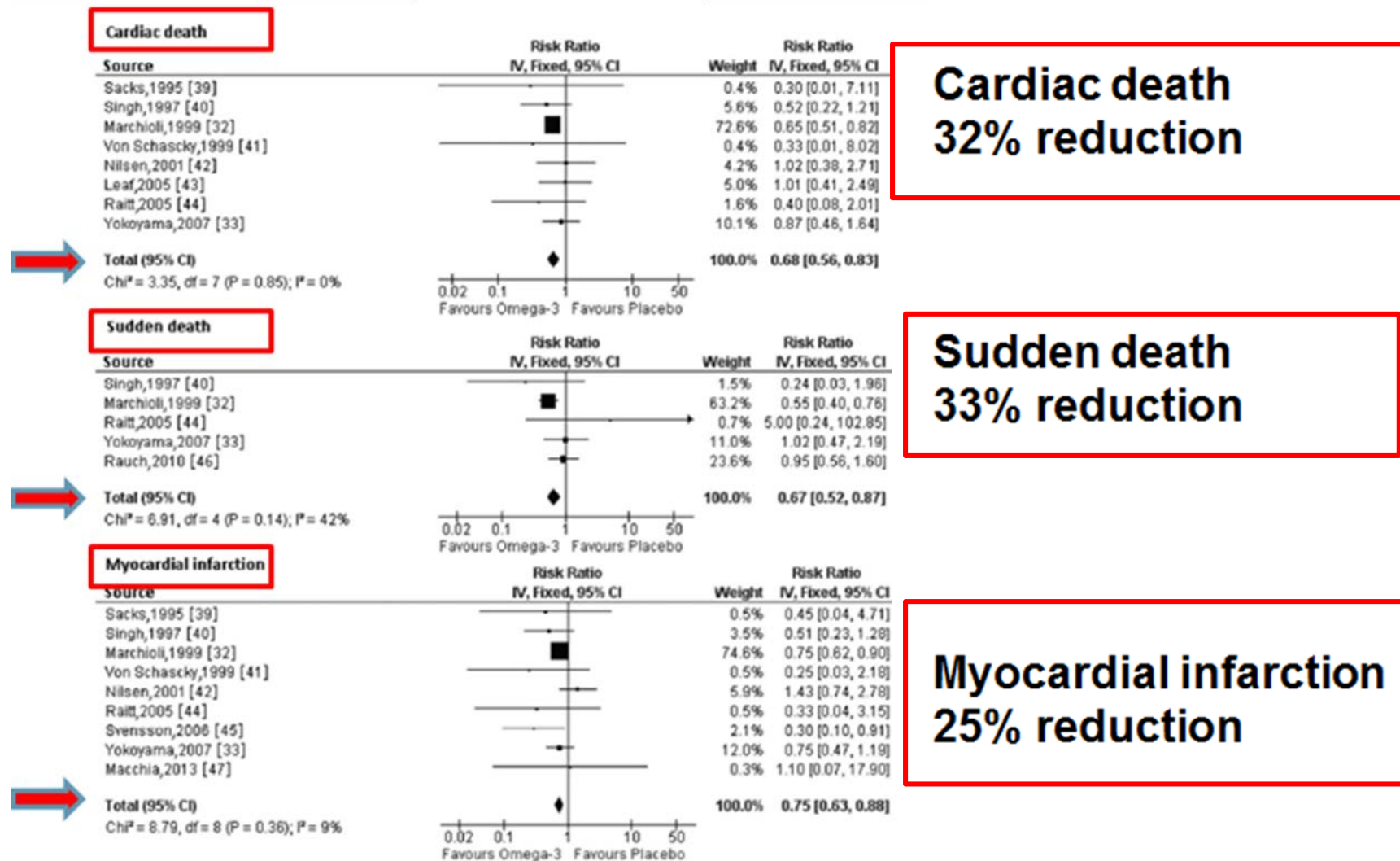


Omega-3 status is low in most countries



We face 2 deaths per minute (> 1.000.000 per year) due to low omega-3 status

Omega-3s are a major contributor to reduce CVD risk

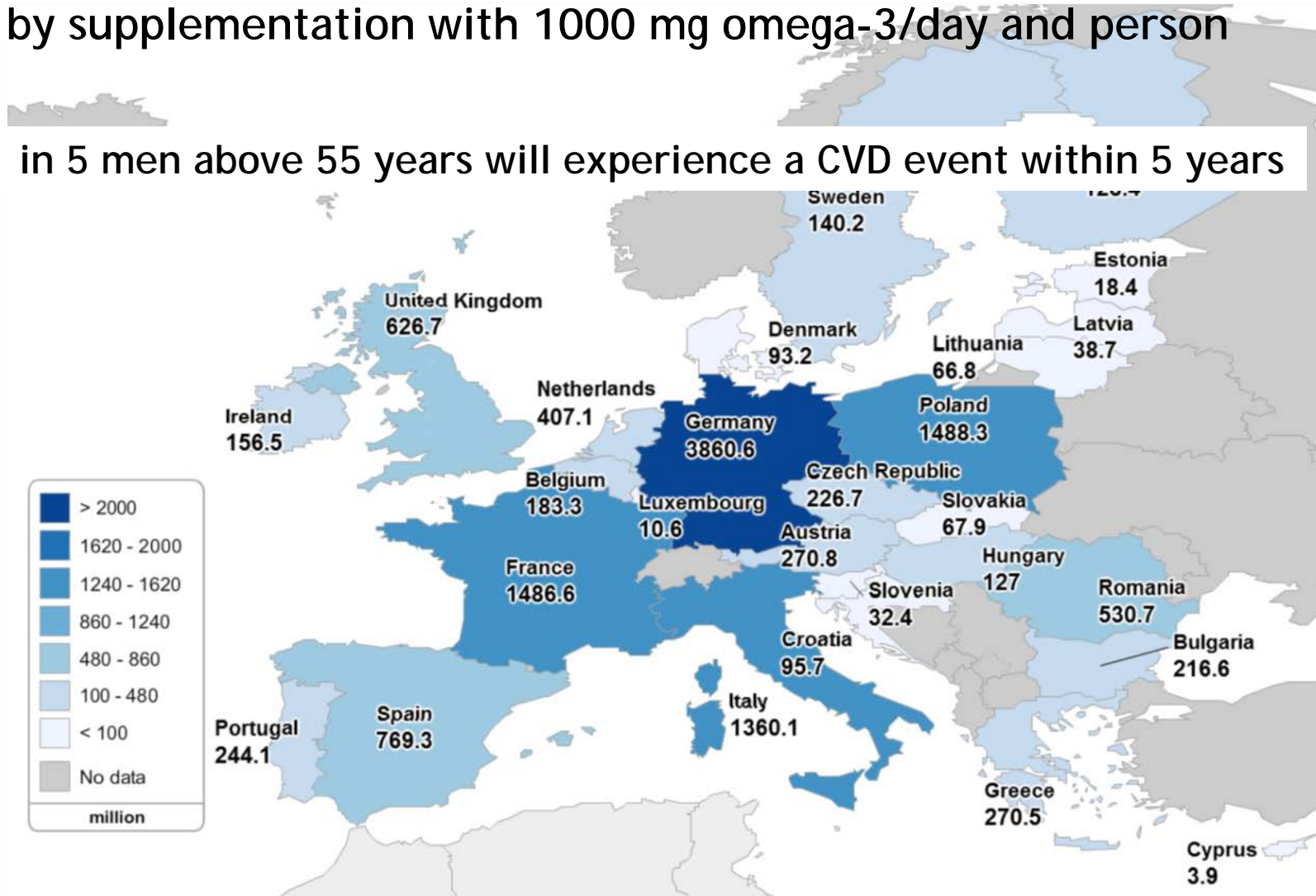


Source Atherosclerosis Supplements 14 (2013) 243-251

Total health care cost savings related to CVD in the EU would be €12.9 billion per year ...

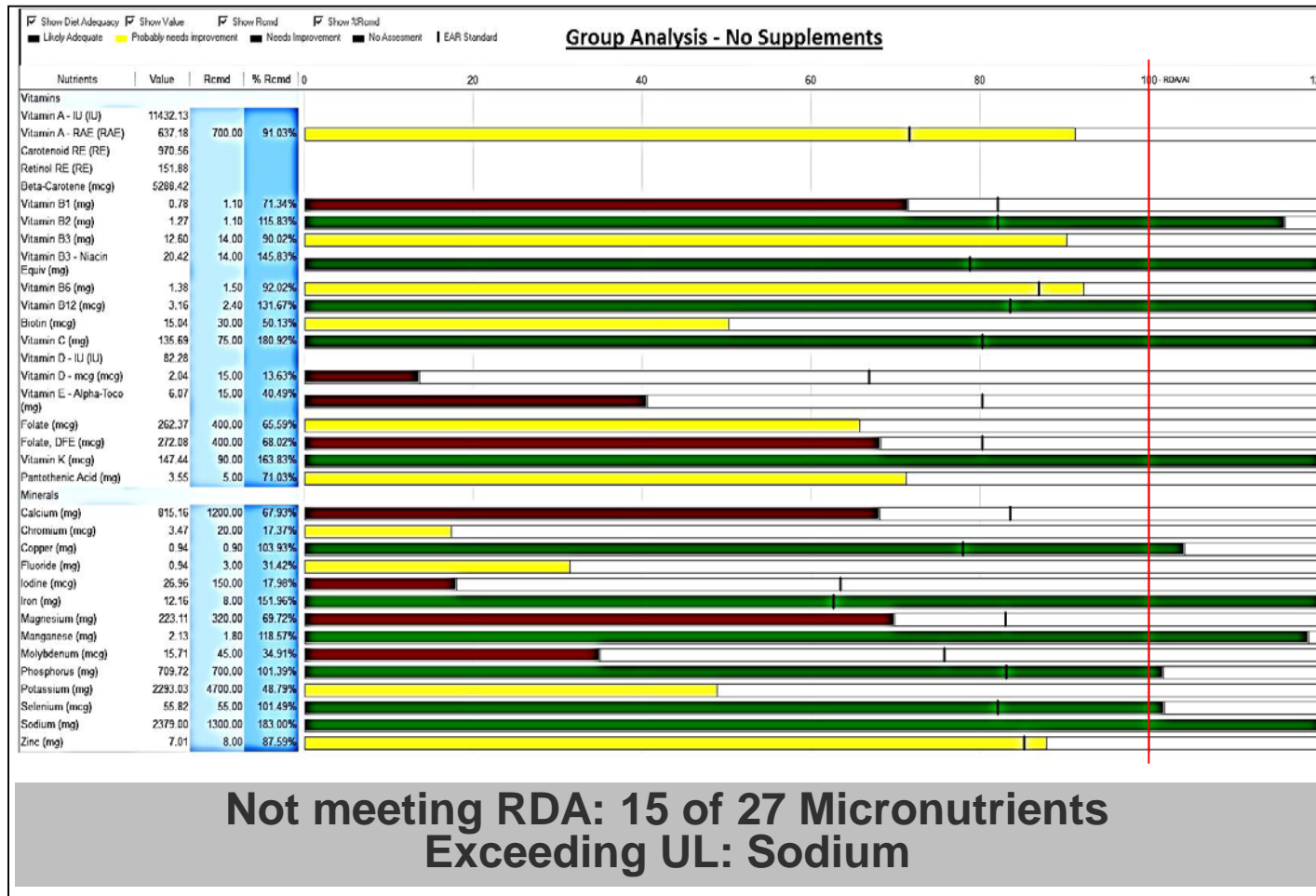
... by supplementation with 1000 mg omega-3/day and person

1 in 5 men above 55 years will experience a CVD event within 5 years



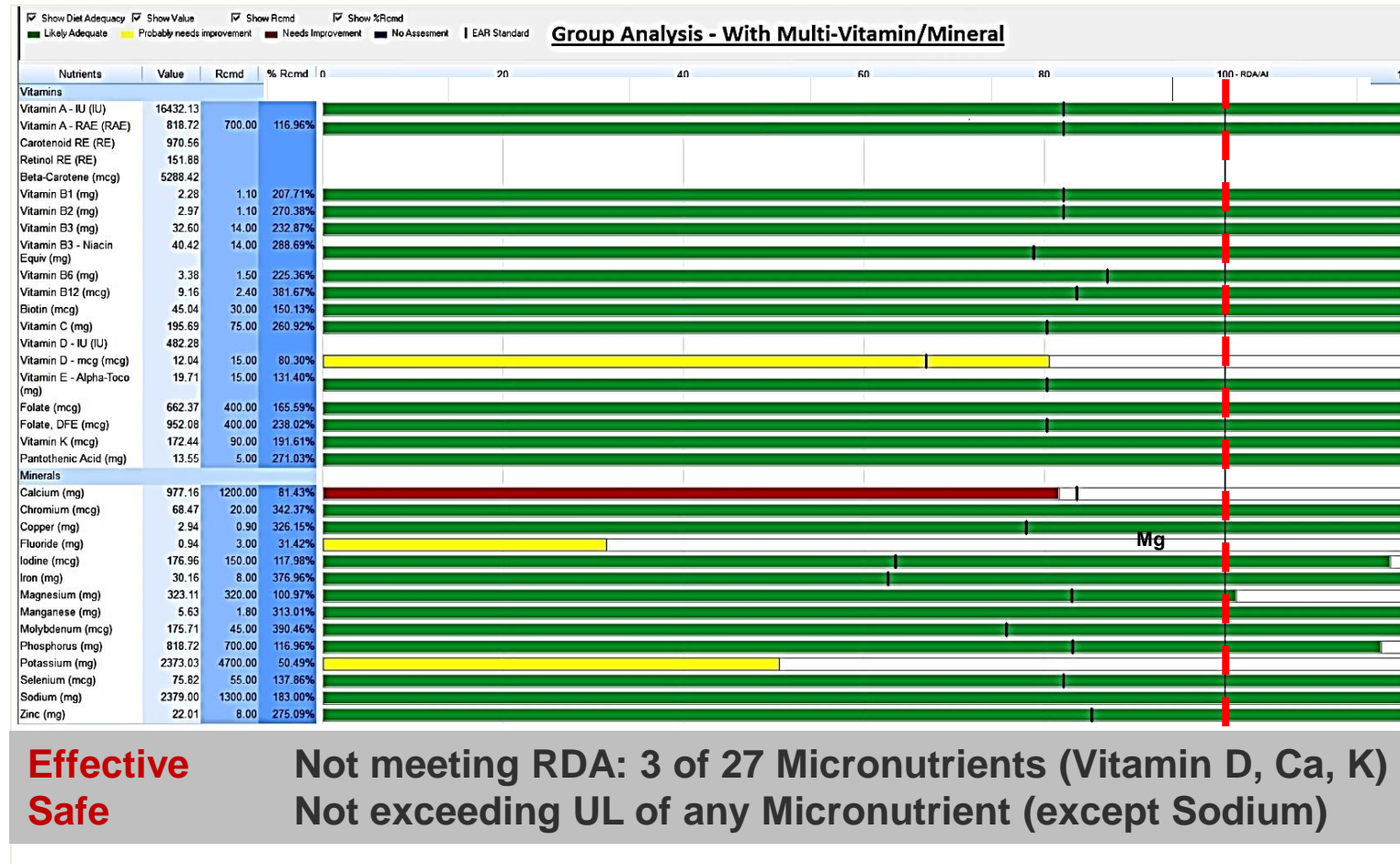
How to close micronutrient gaps?

3-day food diaries; "Food Processor" (USDA National Nutrient Database)



Supplements close most dietary micronutrient gaps

3-day food diaries; "Food Processor" (USDA National Nutrient Database)



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Challenges in micronutrients

- Media reports are often negative and challenging concerning the role of vitamins for health and well-being
- We need updated recommendations for nutrients (WHO, CODEX,...)
- We lack European harmonization
- We need more funding for nutrition science and the role of micronutrients
- Dietary risk are the key factor for mortality; we miss data

Micronutrient challenges and opportunities: Where do we stand?

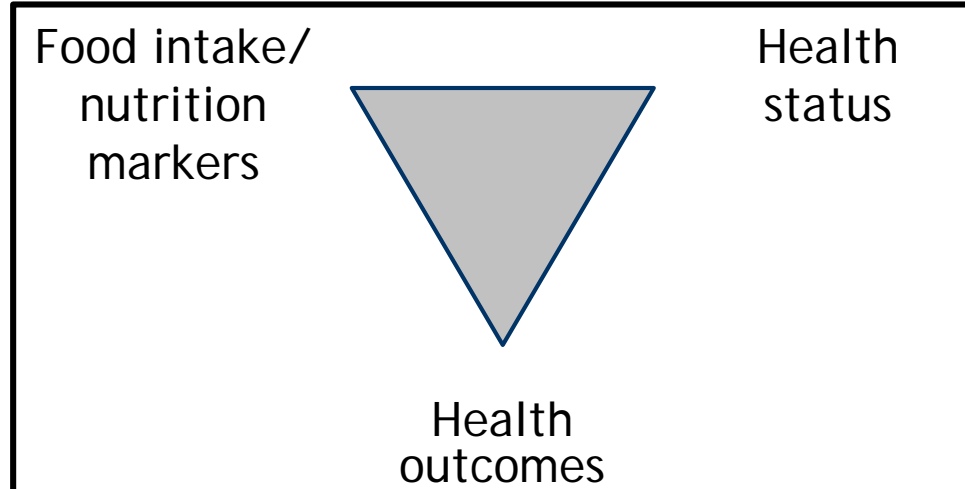
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We initiated an experiment: mapping vitamin and omega status connected to phenotype

.. an opportunity for generating data on vitamin status and health outcomes to understand underlying cause to define actions



Cohort with >160000 people
-Grandparents
-Parents
-Children



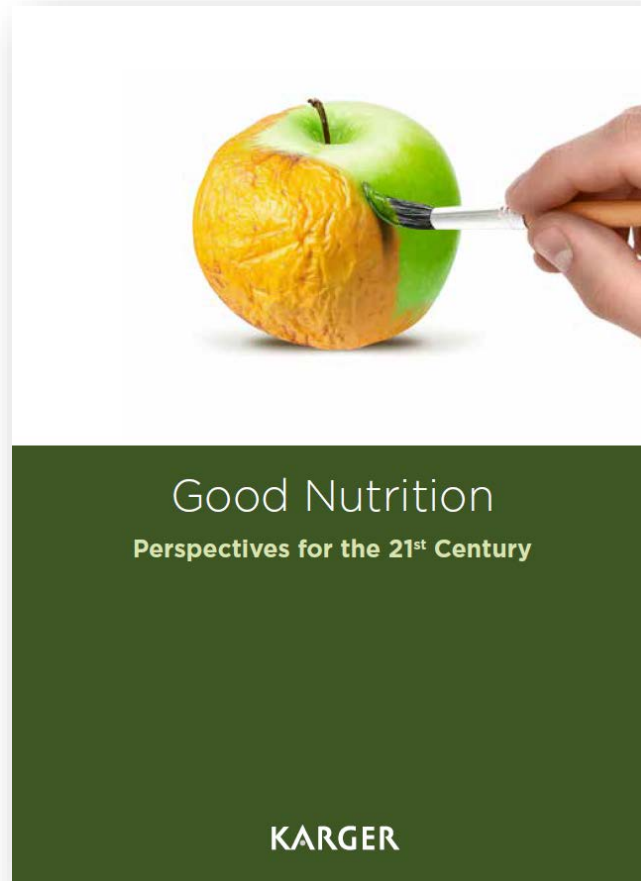
Assessment of vitamin status in low versus high socio-economic groups of the North-Netherlands LifeLines population and explore the phenotype of marginal/subclinical micro-nutrient deficiency

A healthy nutrition and reduction of health care costs is a realistic objective:

- A healthy diet including food fortification and use of supplements providing all nutrients is more influential than genetic factors to decrease morbidity, to support quality of life and healthy ageing
- Successful examples demonstrate that people understand the importance of eating healthfully, the realization requires support and education
- In communities where integrated programs have taken place - dramatic improvements in quality of life, healthier life and lower health care costs are reported
- Let's act now and bring relevant stakeholders together to develop and implement programs for healthy nutritional solutions to provide all essential nutrients and improve quality of life - solutions are available.

Good Nutrition: Perspectives for the 21st century

http://www.nutri-facts.org/en_US/news/Good-Nutrition-Perspectives-for-the-21st-Century.html



"Good Nutrition: Perspectives for the 21st Century" is a work of advocacy, whose prime objective is to call readers to action, to outline what action needs to be taken, and how this should be done, to achieve tangible outcomes and impact.

The publication draws on the input of globally recognized experts and presents their insights in a clear and accessible way. The book is a 'one-stop information source', paving the way for further science-led publications on this topic.

"Good Nutrition: Perspectives for the 21st Century" aims to reach the agenda of policymakers, donors, academics, private sector organizations and civil society, as well as of organizations dedicated to the nutrition space.

Who has health has hope,
who has hope has everything

Thank you!

manfred.eggorsdorfer@dsm.com

 [@eggorsdorfer](https://twitter.com/eggorsdorfer)

Please visit: www.vitaminsinmotion.com



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