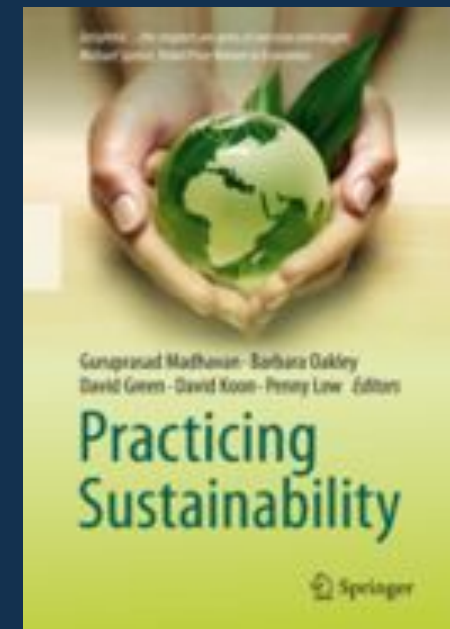
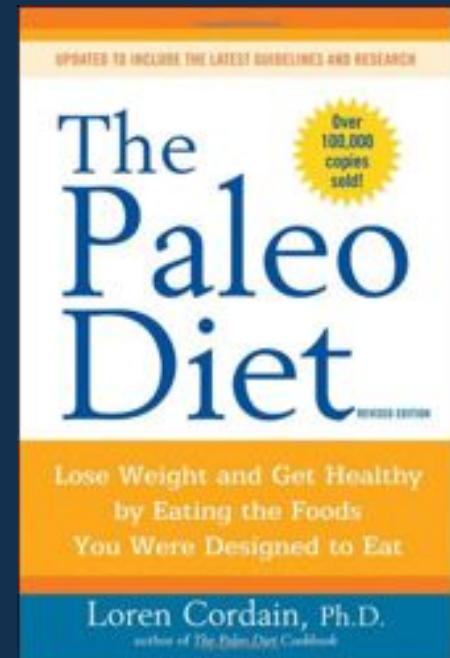


What makes sense about Paleo diets in a modern world?

S. Boyd Eaton, MD
Emory University
Atlanta, Georgia



Before considering the nutrition-sustainability interaction, let's assess the current status of health promotion/disease prevention.



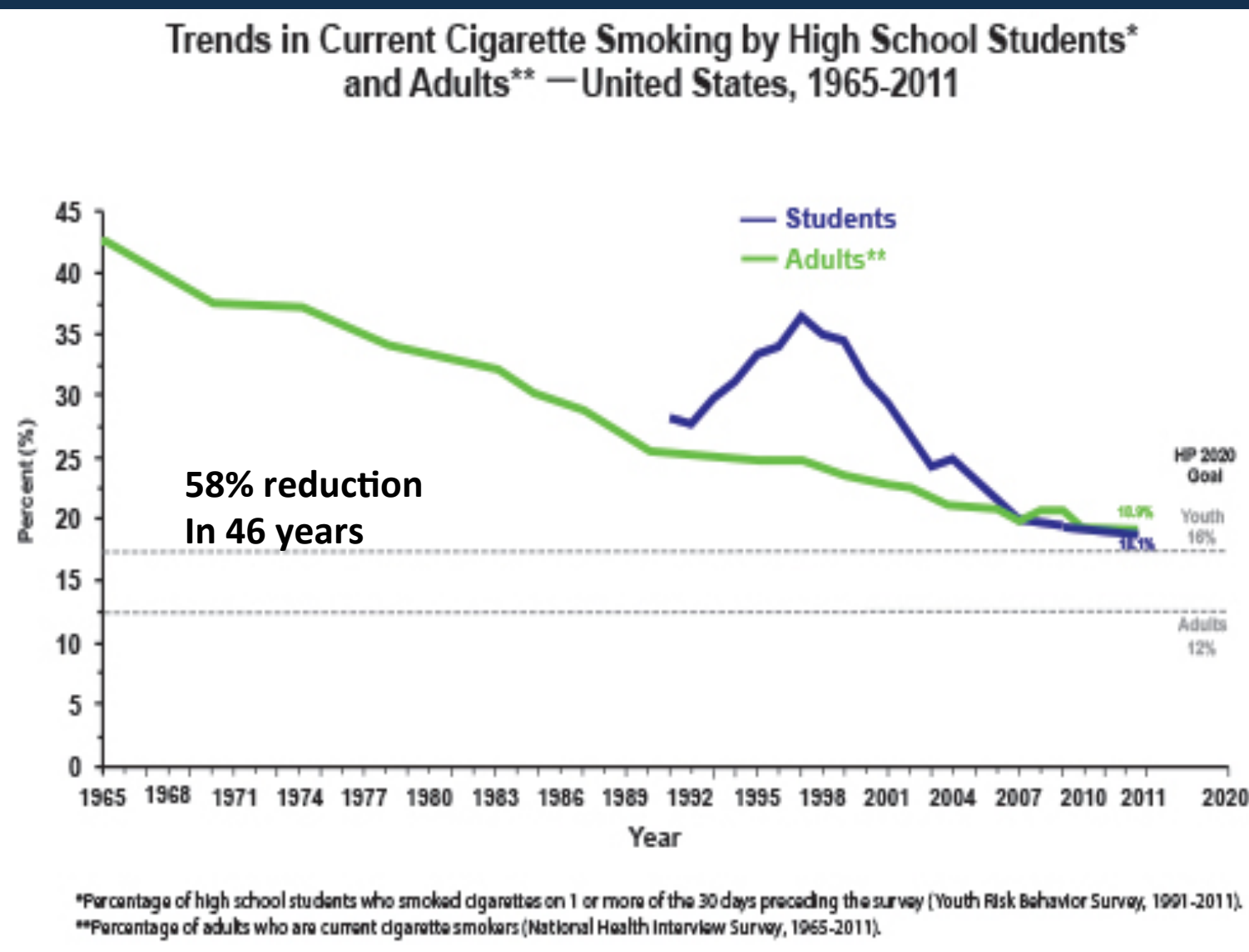
Are we promoting health



or not?

Are we progressing?

Smoking cessation has been a “success.”



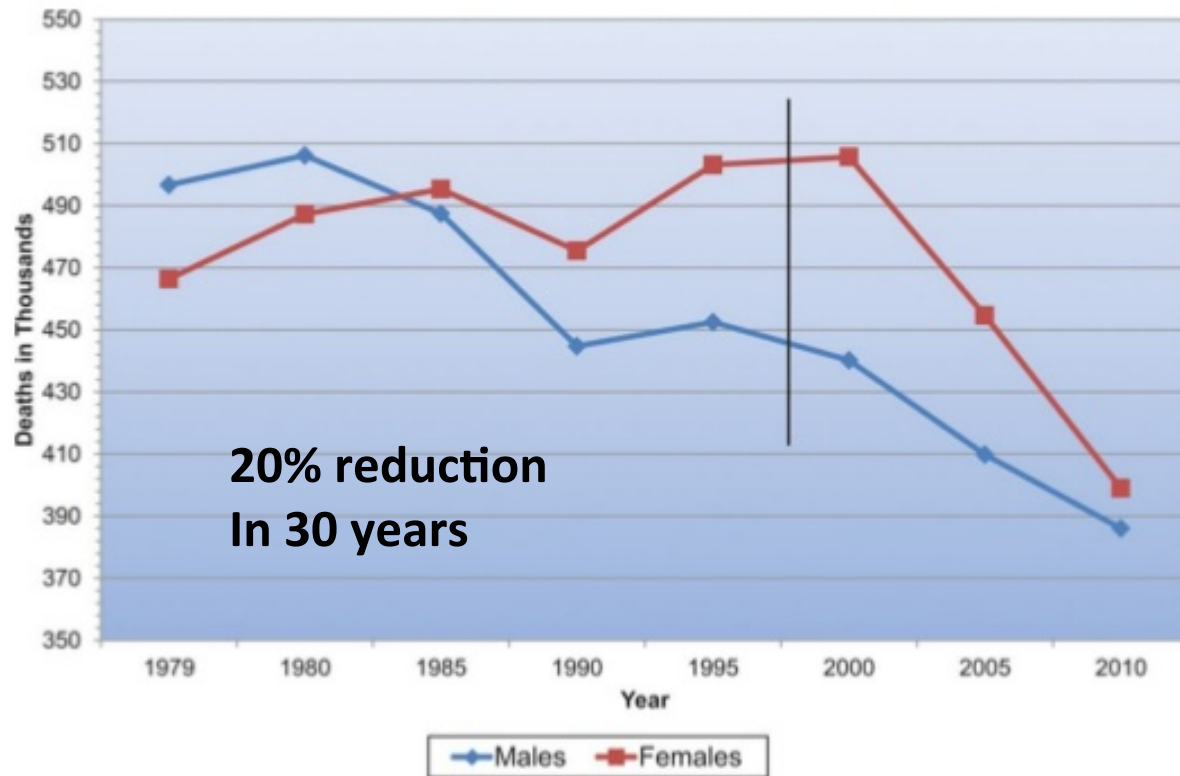
Still, 17.8% of American adults were smokers in 2013

And \$170 billion was spent on tobacco-related healthcare costs that year..



Coronary mortality is down.

Cardiovascular disease mortality trends for males and females (United States: 1979–2010).



Go A et al. Circulation 2014;129:e28-e292

Total Serum Cholesterol, mmHg

Mozaffarian D, et al
Circulation 2015;
131: e29-e322
(NHANES 2009-12)

NH White

206

196

204

191

NH Black

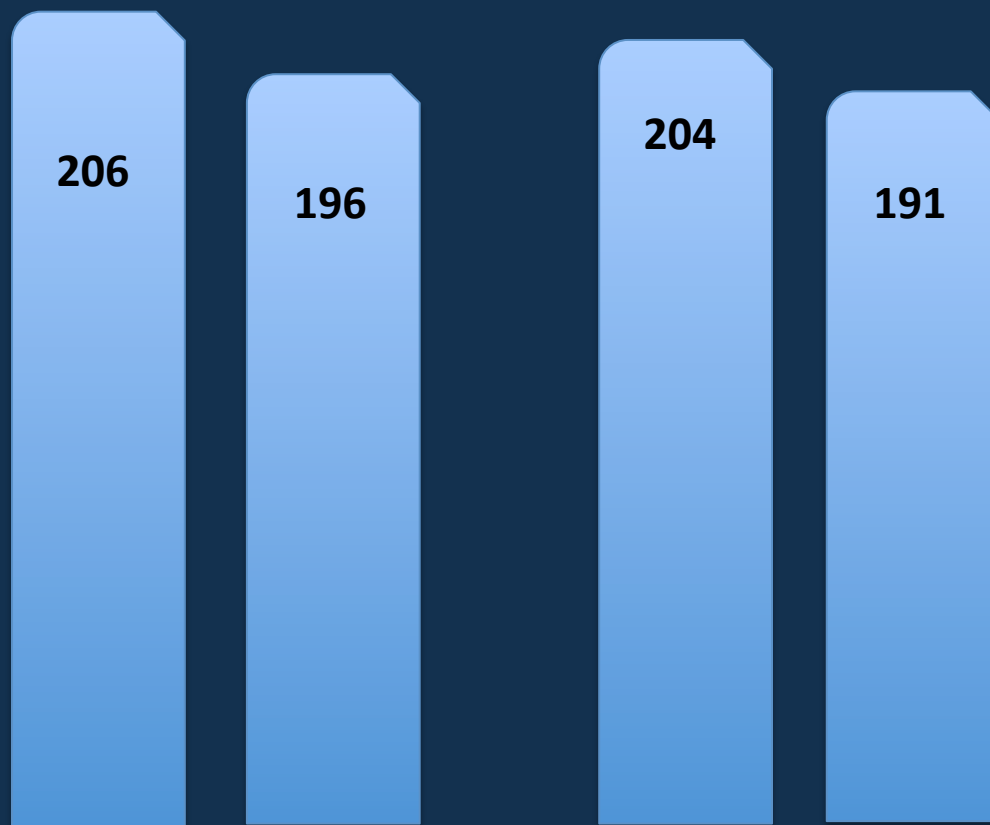
1988-94

2007-12

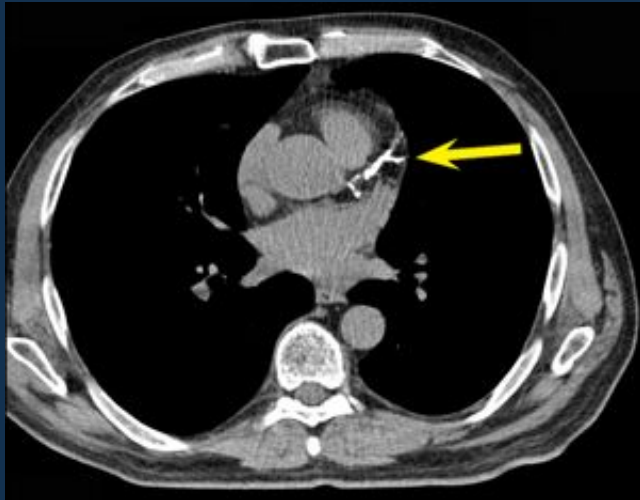
1988-94

2007-12

3% reduction
In 24 Years



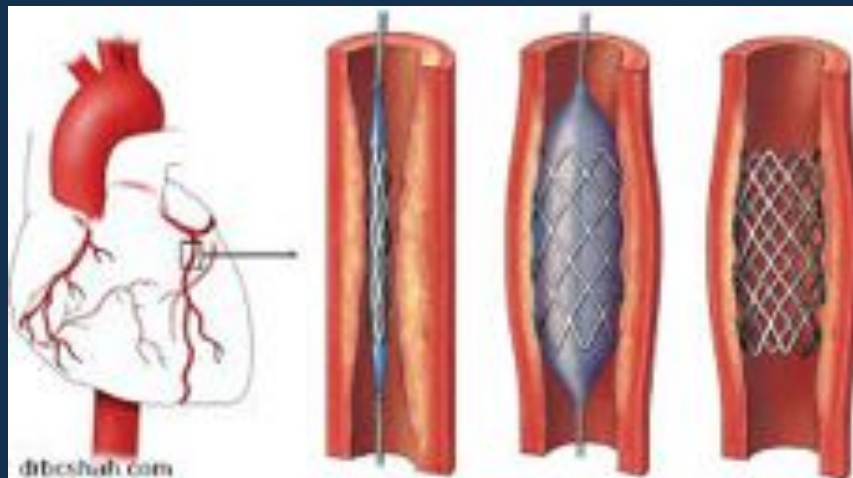
But the decline is largely the result of early diagnosis, prophylactic drugs and improved treatments –not primary prevention.



5 million CT calcium scans in 2014



41 million statin prescriptions
In 2011



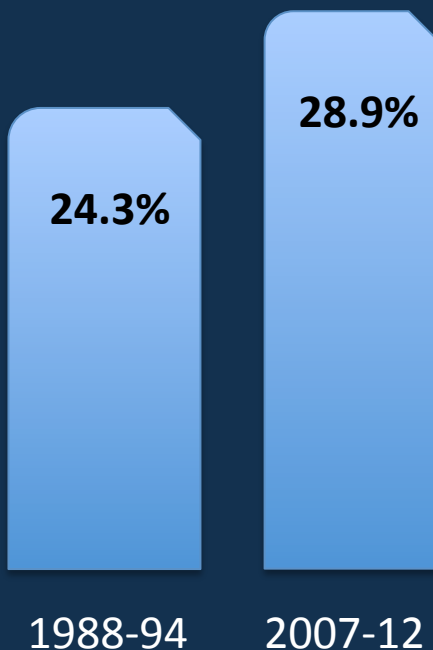
560,000
Angioplasties
in 2011

Hypertension Prevalence Adults, 1988-2012

Mozaffarian D, et al
Circulation 2015;
131: e29-e322
(NHANES 2009-12)

19% increase
in 24 years

Whites



9.5% increase
in 24 years

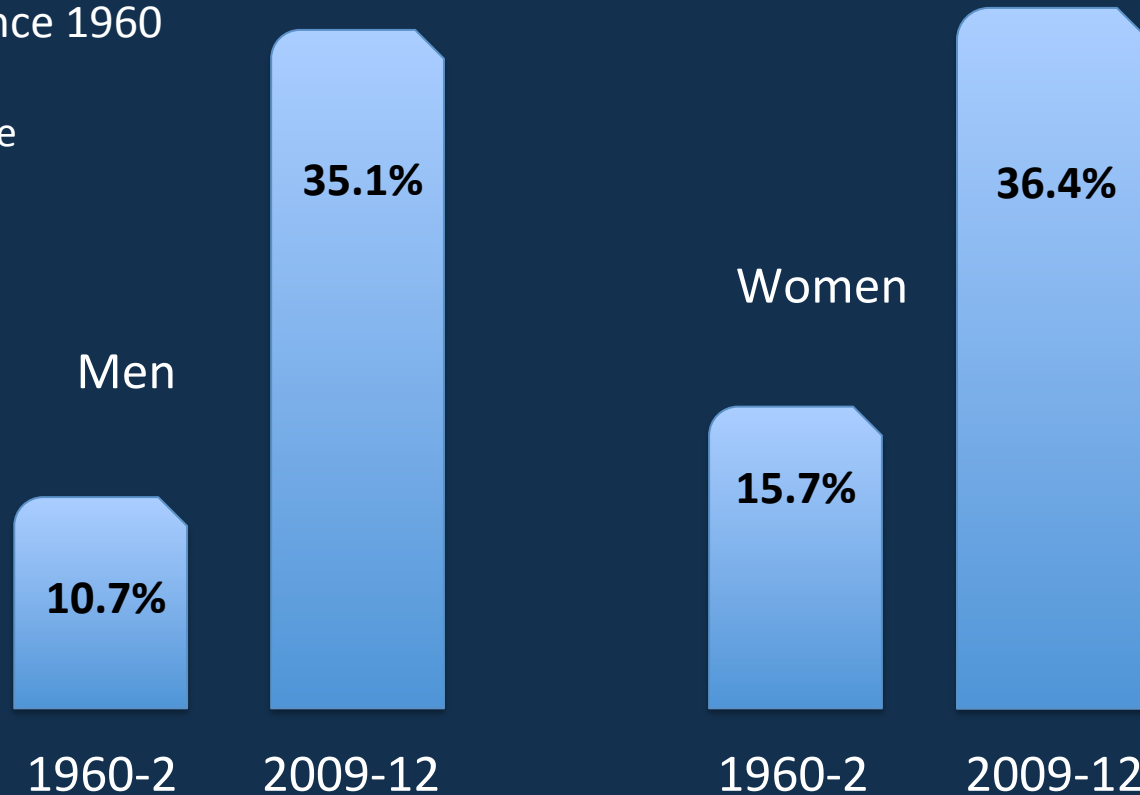
Blacks

Obesity in Adults, 20-74 (1960-2012)

Mozaffarian D, et al
Circulation 2015;
131: e29-e322
(NHANES 2009-12)

171% increase since 1960

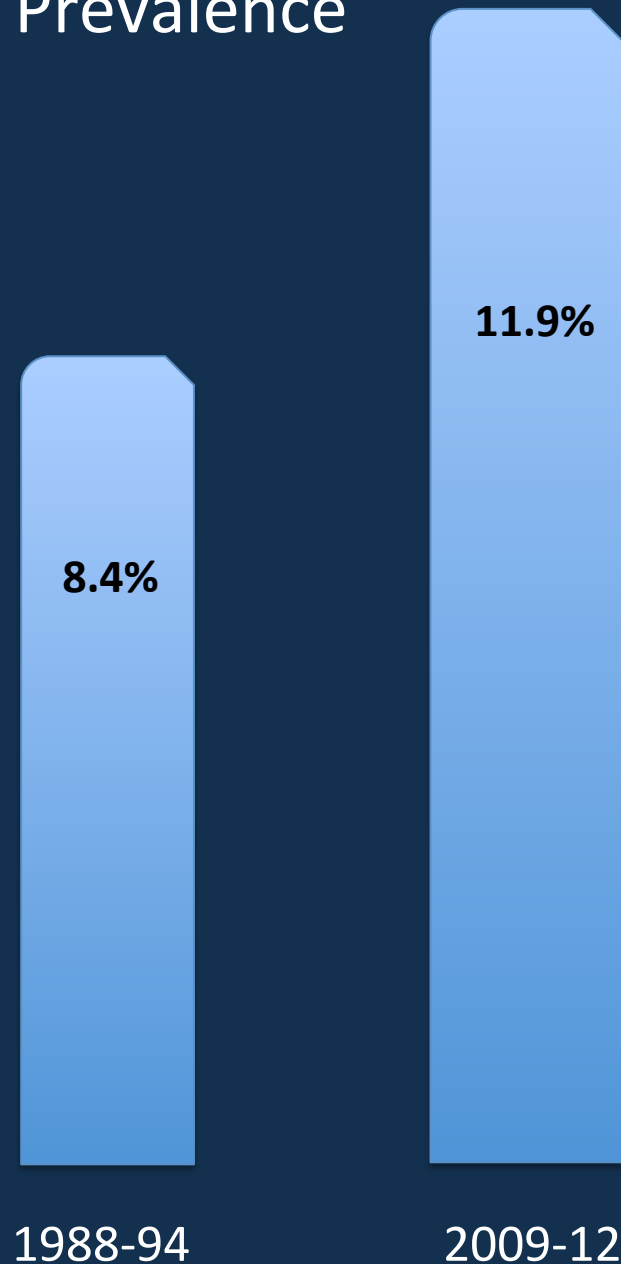
(only 4.7% increase
since 2003)



Type 2 **Diabetes** Prevalence

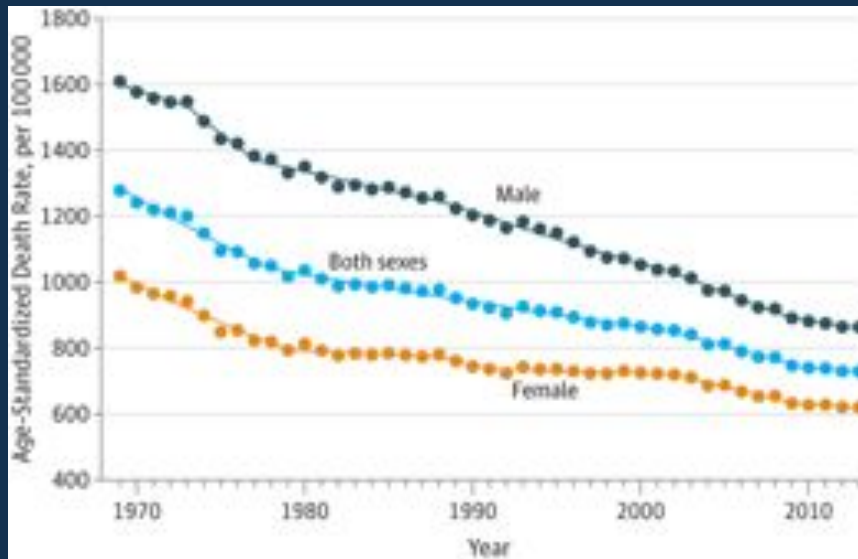
42% Increase
in 24 Years

(Six-fold increase
since 1960)



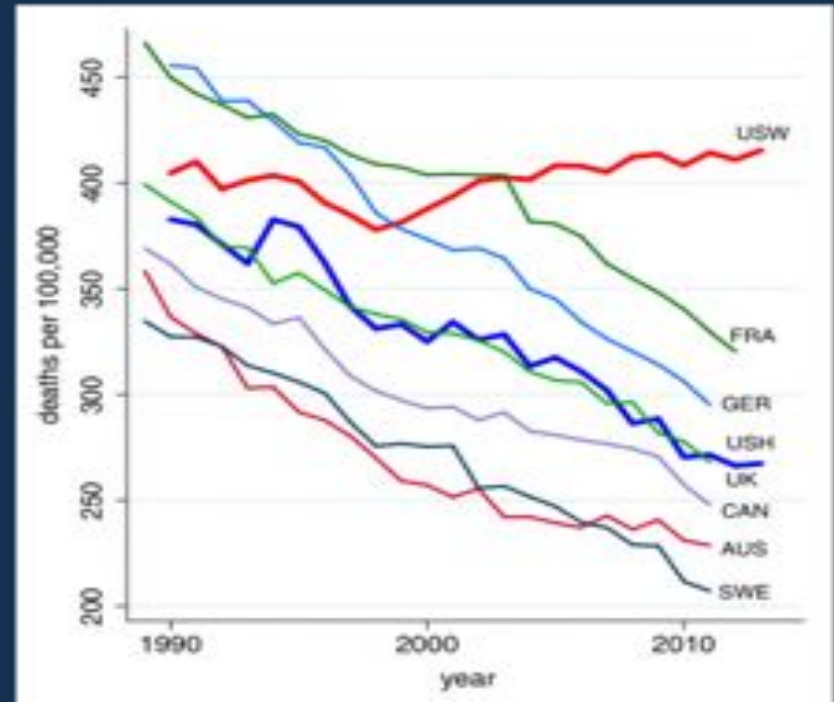
Mozaffarian D, et al
Circulation 2015;
131: e29-e322
(NHANES 2009-12)

The pace of American death rate decline is slowing.



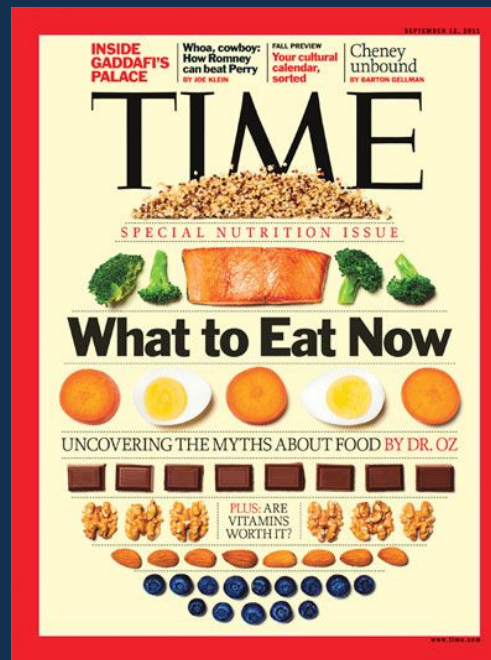
Ma J et al.
JAMA 2015; 314: 1731-9.

Mortality is rising for non-Hispanic Whites.



Case A, Deaton A.
PNAS 2015 Early Edition

How has nutrition science contributed ?



Have findings and recommendations been consistent?

“The ups and downs of nutrition advice have come to seem as capricious as the fluctuations of the stock market.” **Consumer Reports**, September, 1994“

Advice to the public about what to eat...and basically how to live, seems to do an about-face every time a new study is published in a medical journal.

New York Times, March 22, 1998

“The (United States) Institute of Medicine laments gaps and contradictions in nutrition research, suggesting that even the experts are struggling to sort out the information.” *Science* 2002; 297: 1788-9

Ioannides JPA. Why most published research findings are false. *PLoS Med* 2005; 2 e124““

“ It is simply no longer possible to believe much of the clinical research that is published....” Marcia Angell, MD, Former Editor, *NEJM*, 2009

Salt: Top experts give wildly conflicting advice....
Forbes September 17, 2014

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Scientific American April 22, 2015

Has the public been enlightened –or confused?

“Consumers today are deluged with constantly shifting health messages....instead of educating health care consumers, these shifting scientific studies often serve to confuse.” **USA Today**, June 12, 1998



One might argue that nutrition science:

- Has made suboptimal progress,
- Suffers from frequent disagreements,
- And has led to public confusion.

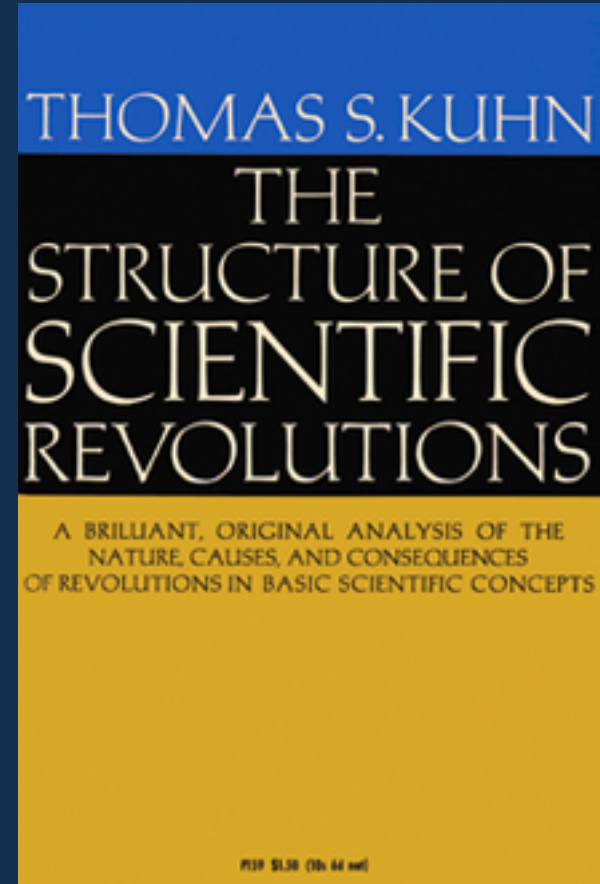
Thomas Kuhn would consider nutrition science a:
Pre-paradigmatic Emerging Discipline



The belief that nutrition scientists
keep changing their minds...



may lead people to doubt nutrition
and health recommendations.



Kuhn did for conceptions of science what Copernicus and Einstein did for astronomy and physics.

New York Times July 21, 2001

Kuhn: Mature sciences operate under the aegis of a **governing paradigm**.



Foundation for a research tradition.

Essential for selection of potentially fruitful investigative efforts.

Establishes gestalt through which investigators view natural phenomena.

At present there is **no such paradigm** for health promotion.

In epidemiology there is no consensus on what constitutes a **unifying body of principles** for explaining the distribution of disease in populations.

Koopman JJ, Weed DL.

Am J Epidemiol
1990;132:366-90

American Journal of EPIDEMIOLOGY

ISSN 0002-9262
Printed in the U.S.A.

Volume 144

Number 6

September 15, 1996

Published by The Johns Hopkins University
School of Hygiene and Public Health

Sponsored by the Society for Epidemiologic Research

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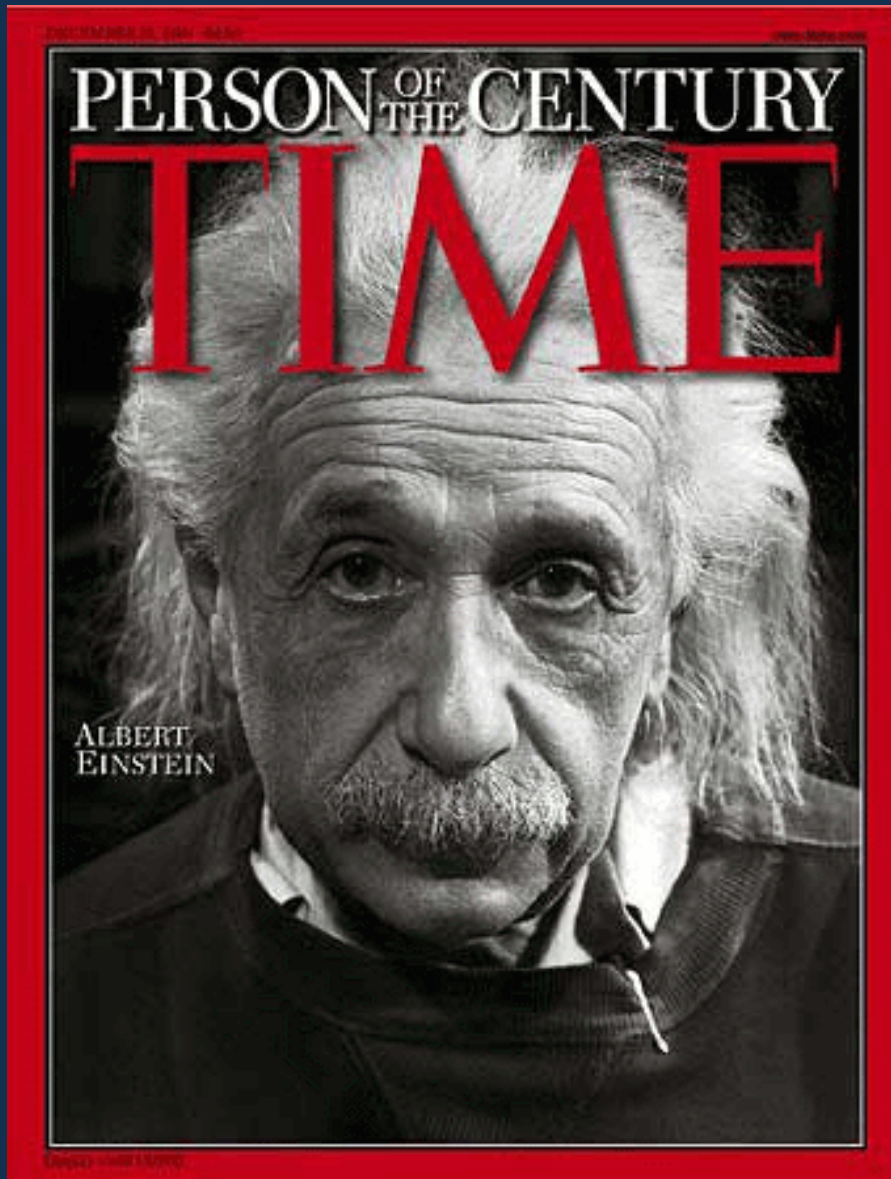
589 **Interviewer Effects on Epidemiologic Diagnoses of Posttraumatic Stress Disorder.** D. A. Grayson, B. I. O'Toole, R. P. Marshall, R. J. Schuck, M. Dobson, M. French, B. Pulverstein, and L. Meldrum

598 **Estimating Relative Risk Functions in Case-Control Studies Using a Nonparametric Logistic Regression.** Lue Ping Zhao, Alan R. Kristal, and Emily White

610 **Methods for Summarizing the Risk Associations of Quantitative Variables in Epidemiologic Studies in a Consistent Form.** Genevieve Chêne and Simon G. Thompson

622 **ERRATA**

Founded 1902 by W. H. Welch and W. H. Howell as the American Journal of Hygiene



Theorists must derive
basic postulates from
nature.

Absent
such principles, the
separate results of
empirical research
defy deductive
reasoning.

A. Einstein
Ideas and Opinions
New York: Bonanza Books;
1954:221



Theodosius Dobzhansky

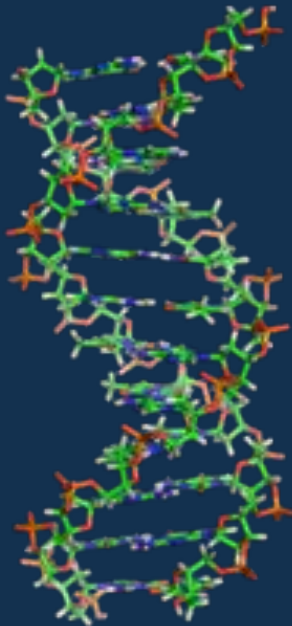
“Nothing in biology
makes sense except in
the light of evolution.”



American Biology Teacher 1973; 35: 125-9.

Evolutionary Health Promotion –Basic Postulate

An organism's biology functions best when it operates under conditions similar to those for which its genome was originally selected through evolution.



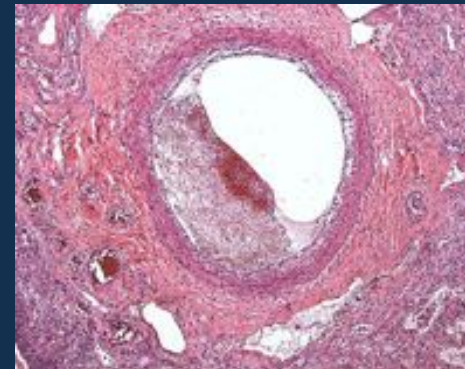
The Evolutionary Health Promotion Paradigm

We are genetic Stone-Agers.



25,000 BCE

Deviation from the Stone-Age lifestyle increases chronic disease risk.



Stenotic
Artery

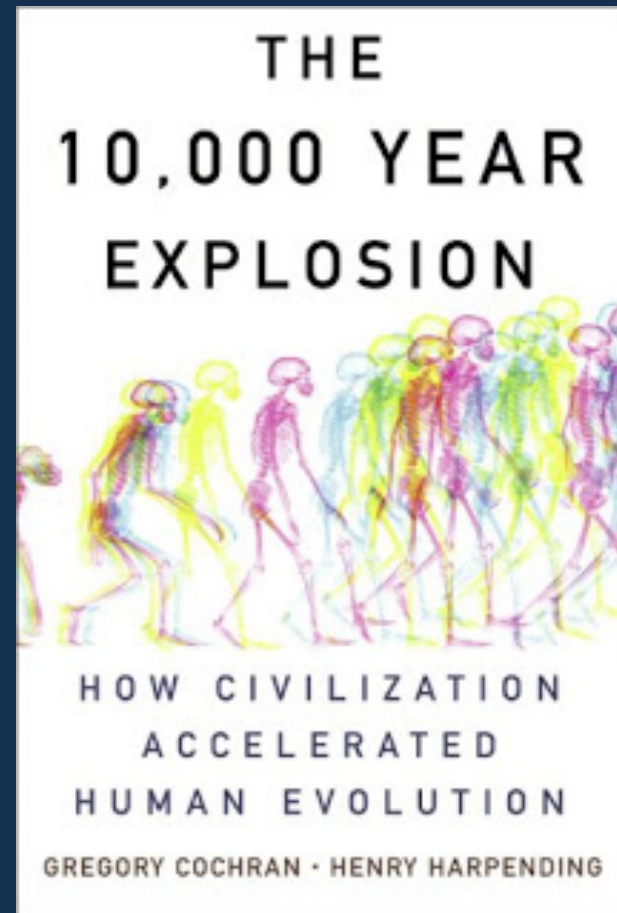
Reversion towards the Stone-Age lifestyle reduces chronic disease risk.



Normal
Artery

Criticism:

Evolution can be “rapid.”
We’re genetically different
from Stone Agers.

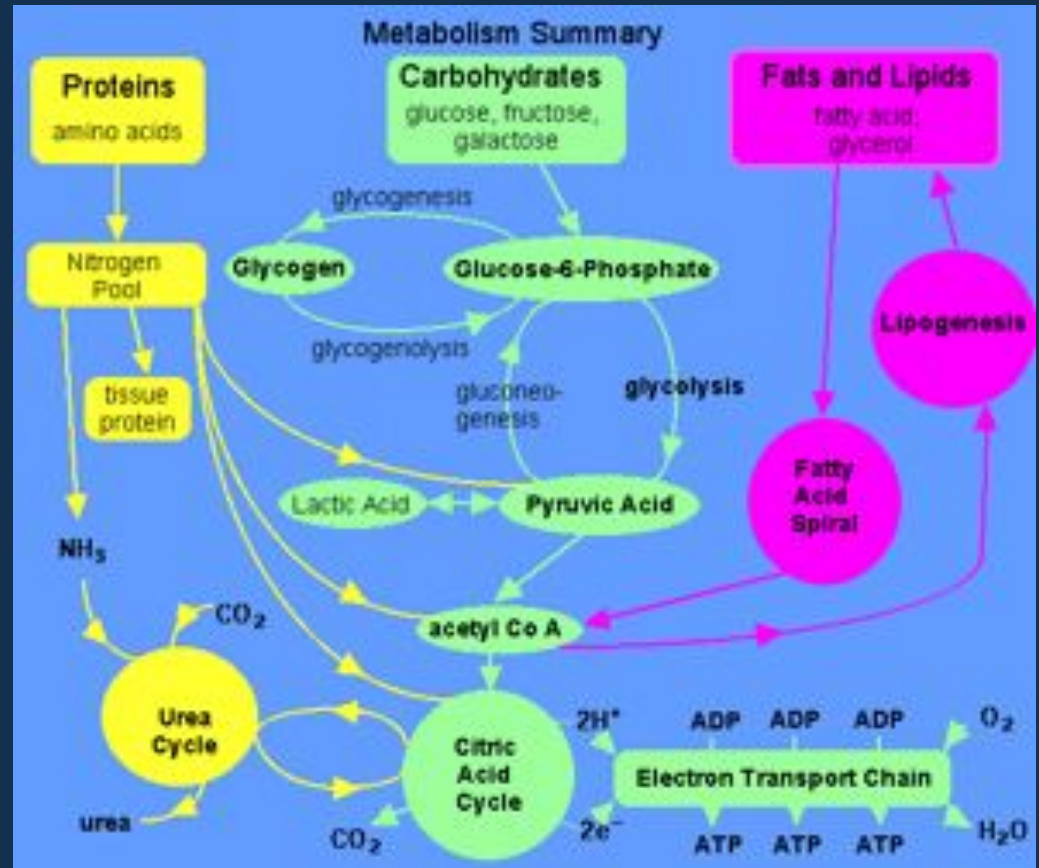


Recent genetic changes have involved traits controlled by **single** genes.

Lactase Persistence
CFTR (cystic fibrosis)
Blue Eyes
Hemoglobin S
Pale Skin
Blonde Hair



Traits affected by **multiple** genes are “conserved” over time.



Most of the genes involved in basic cellular processes are ancient and fundamental. Their expression seems to have remained consistent across the primate lineage for 70 million years.

Gilad Y et al. Nature 2006; 440:242-5

An Example of Genetic Conservation



The ancestors of humans and cats diverged 70+ million years ago, but we remain similarly susceptible to **obesity** and **Type 2 diabetes**.

-ergo-



The **genes** underlying these conditions were present in our common ancestor and have been **conserved for 70+ million years**.

PALEOFANTASY

WHAT EVOLUTION REALLY TELLS US
ABOUT SEX, DIET, and HOW WE LIVE

MARLENE ZUK

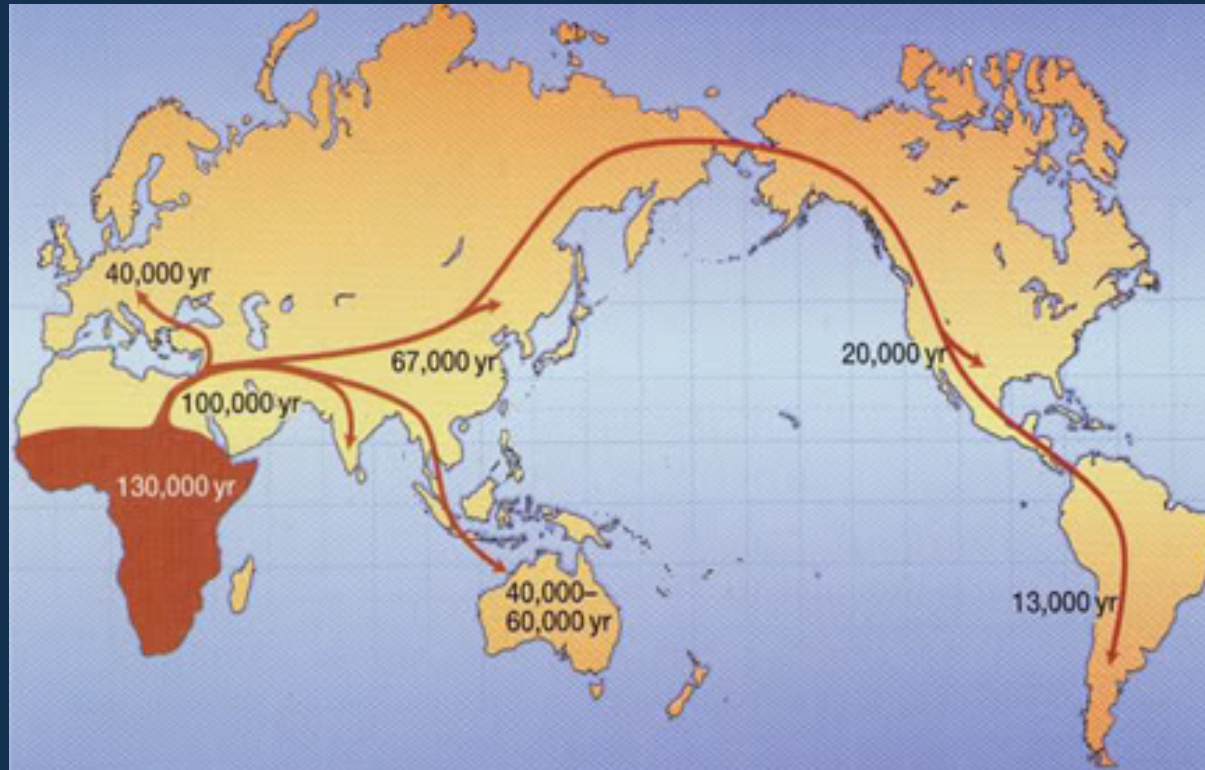


Criticism:

We cannot know the Past.

Who?
Where?
When?
What?

Who? Where? When?



Humanity's homeland was **Africa**. We remain adapted for lifestyle, including diet, as it was there 100,000 – 50,000 years ago.

Kuipers RS. et al. Brit J Nutr
2010; 104: 1666-87.

What?

Paleo Nutrition Data Sources

- Human Skeletal Remains
 - Gross Anatomy
 - Microscopic anatomy
 - Biomechanics
 - Radioisotopic and DNA analyses (bones, teeth, plaque etc.)
- Recent Hunter-Gatherers
 - Subsistence patterns
 - Physical activity
 - Biomarkers (e.g. blood pressure, serum cholesterol, BMI, glucose responsiveness, etc.)
- Archeological Finds
 - Bones of animals/fish consumed
 - Botanical remains (including EM of pollen, spores, seeds, husks, etc.)
 - Implements
 - Cave and rock wall paintings
- Proximate Nutrient Analyses
 - Wild game animals, fish, shellfish
 - Uncultivated plant foods

Late Paleolithic Macronutrients

% Energy Consumption

1985 Estimate

2015 Estimate

Protein

34

30

Carbohydrate

45

35

Fat

21

35



Paleo Dietary Recommendations

Strong Form

- More fruits and vegetables
- No sugar
- No dairy for adults
- No refined grains
- Modest whole grain intake
- More fiber
- Much less sodium
- More potassium
- More long-chain PUFA
- More protein

Paleo Dietary Recommendations

Strong Form

- More fruits and vegetables
- Little or no sugar
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- More long-chain PUFA
- More protein

DHA, EPA and AA

Kuipers RS, et al. Brit J Nutr
2010; 104: 1666-87.

DHA+EPA

6 g/d

AA

Paleolithic

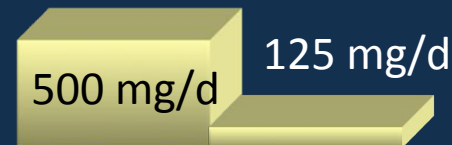
DHA+EPA

500 mg/d

125 mg/d

AA

Contemporary



Long Chain PUFA Intake and Brain Size

Correlation does not necessarily indicate causation, but I'm just sayin'

Eskimos & Cro-Magnons

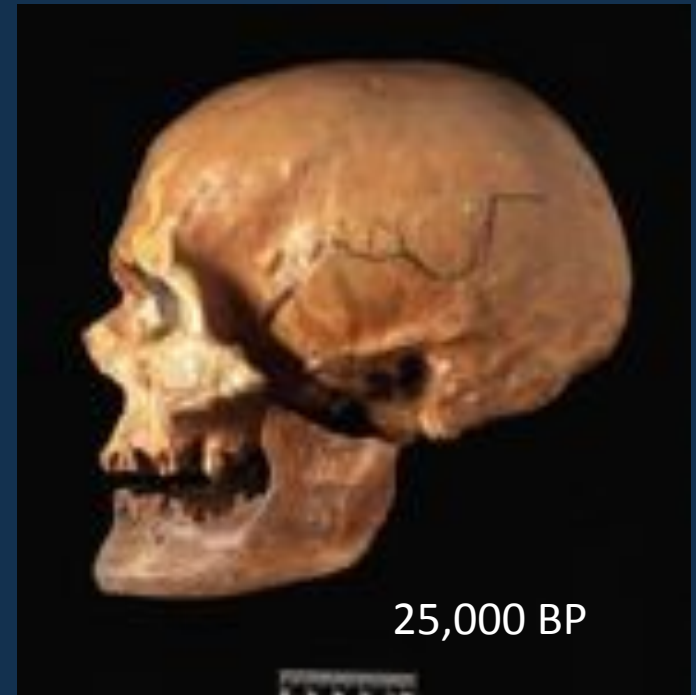
Cranial Capacity ~1550 cc

LC PUFA Intake EPA + DHA ~6g/d
AA ~3g/d

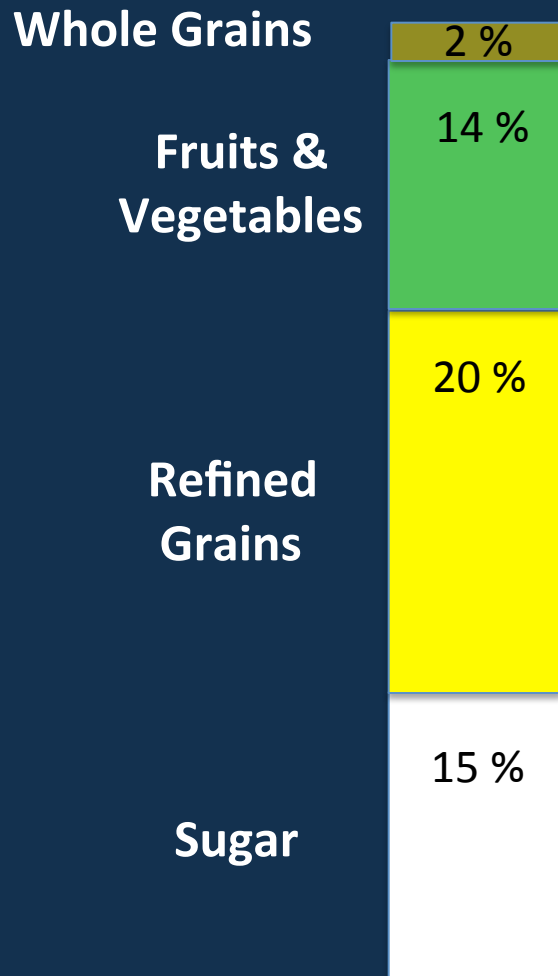
Current Westerners

Cranial Capacity ~1350 cc

LC PUFA Intake EPA + DHA ~500mg/d
AA ~200mg/d



Total CHO Consumption American vs Paleo



American CHO
50% Total kcal



Paleo CHO
35% Total kcal

Fruit and Vegetable Consumption % Total Energy



14%

Current
USA

48%

Paleolithic



Added Sugar – % Total Energy

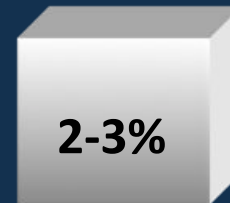


15%

Contemporary



Wild
Honey



2-3%

Paleolithic

Cereal Grains in the Stone Age

Readily available, but consumed only in times of shortage.



Processing with available technology was too labor intensive for routine use.

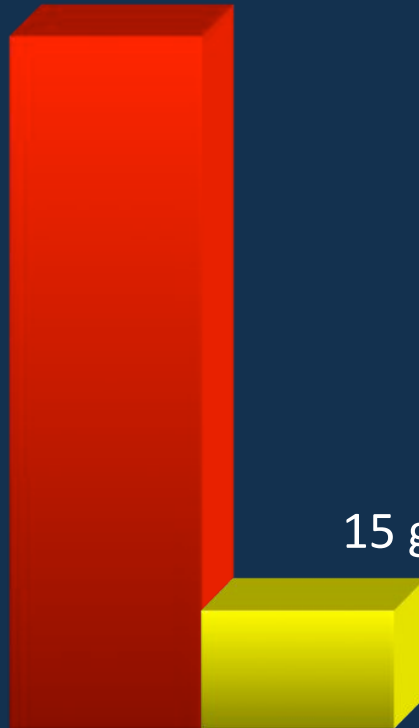


Daily Fiber Intake

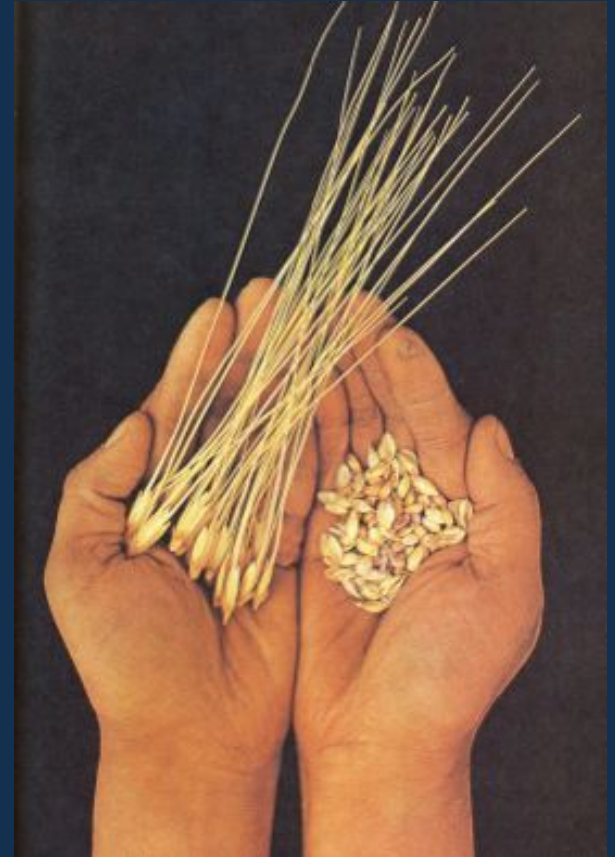


Paleolithic

100 gms



15 gms



USA

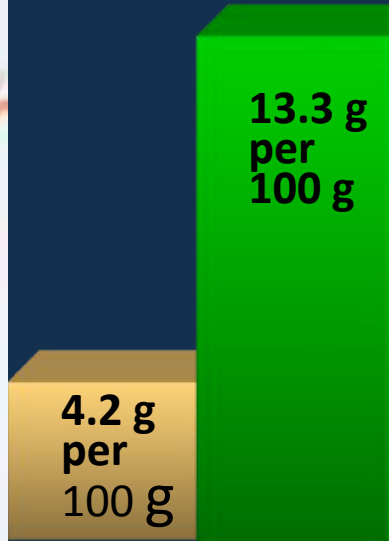
Fiber in Edible Plants

4.2 g/ 100 g



Cultivated

13.3 g/ 100 g



Wild

Mineral Intake

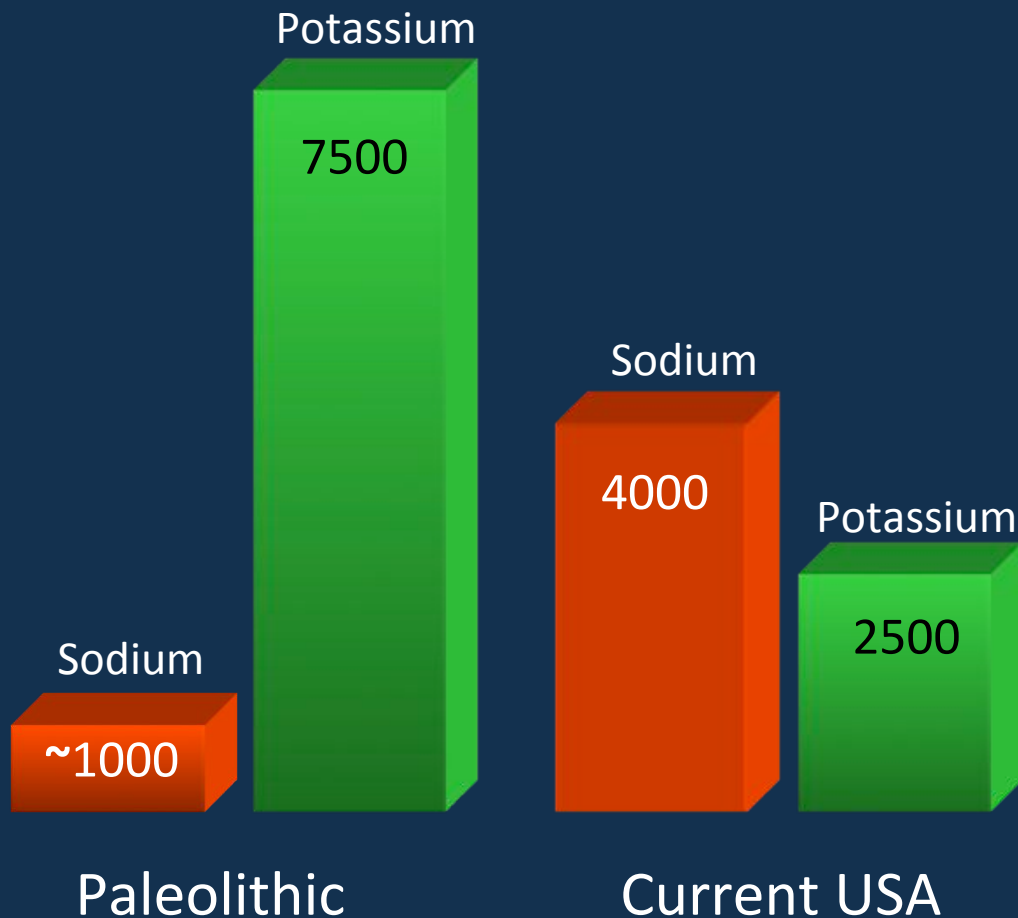
mg/d

	Paleolithic ¹	Current U.S. ²	Ratio
Calcium	1,622	920	1.8
Copper	12.2	1.2	10.2
Iron	87.4	10.5	8.3
Magnesium	1,223	320	3.8
Manganese	13.3	3.0	4.4
Phosphorus	3,223	1,510	2.1
Potassium	7,500	2,500	3.0
Sodium	~1000	4,000	0.25
Zinc	43.4	12.5	3.5

1. Based on 3000 kcal/d, 35% animal; 65% plant subsistence

2. Average of U.S. men and women; Food and Nutrition Board, 1989

Sodium and Potassium, mg/d



Potato chips have 47 times the **sodium**, but only half the **potassium** of baked potato.



Vitamin Intake

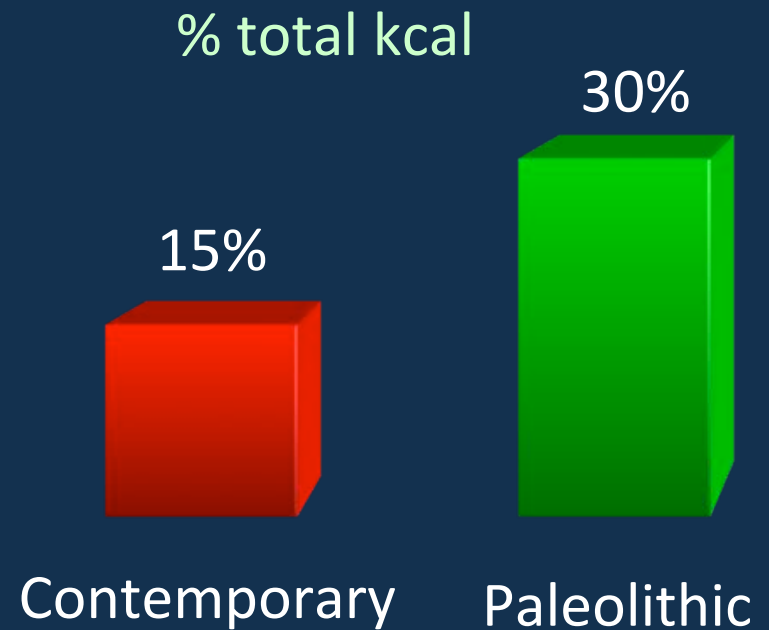
mg/d

	Paleolithic ¹	Current U.S. ²	Ratio
Ascorbate	604	93	6.5
Folate	0.36	0.18	2.0
Riboflavin	6.49	1.71	3.8
Thiamin	3.91	1.42	2.8
Vitamin A	17.2	7.8	2.2
Vitamin E	32.8	8.5	3.9

1. Based on 3000 kcal/d, 35% animal; 65% plant subsistence

2. Average of U.S. men and women; Food and Nutrition Board, 1989

Dietary Protein



IOM: Protein Intake

The acceptable micronutrient distribution range (AMDR) for protein is 10 to 35% of energy for adults. The IOM found no convincing association between protein intake and osteoporosis, urolithiasis, renal failure, coronary atherosclerosis, obesity or cancer.

Institute of Medicine, Dietary Reference Intakes.
Washington DC: National Academies Press
2002; 11-1, 51-52.

WHO's International Agency for Cancer Research

Red meat is “probably carcinogenic.”
Eating 100 grams of unprocessed beef,
lamb, veal, pork, etc. every day
“probably” **increases lifetime risk** of
colorectal cancer **from 5%**
(i.e. the background rate) **to 6%**.

Bouvard V, et al. (for IARC)
Carcinogenicity of consumption of
red and processed meat.
Lancet Oncology 2015



“...people who are trying to eat right...
are buffeted by health recommendations
that seem prone to being overturned
years later. “ TIME November 9, 2015

WHO/ IARC 2015
analyzed 800 studies

AICR/WCRF 1997
analyzed 3500 studies



Fruits, Vegetables and Cancer Risk

World Cancer Research Fund. Food, nutrition and the prevention of cancer: a global perspective. Washington, DC: American Institute for Cancer Research. 1997.

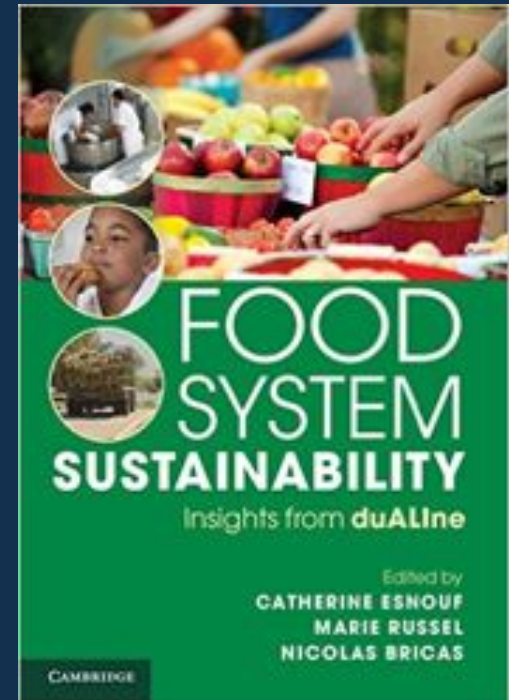
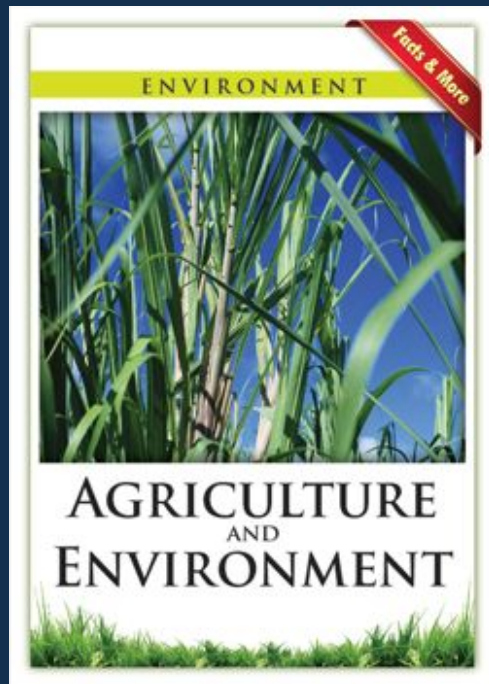
Non-starchy vegetables and fruits “probably” protect against several types of cancer.

Hung H-C, et al. Fruit and vegetable intake and risk of major chronic disease. J Natl Cancer Inst 2004; 96: 1577-84.

Fruit and vegetable consumption not associated with reduced cancer incidence.

Key TJ. Fruits, vegetables and cancer risk. Brit J Cancer 2010; 104: 6-11.
“No protective effects have been firmly established.”

In today's world, rational nutrition advice has to be consistent with sustainability.

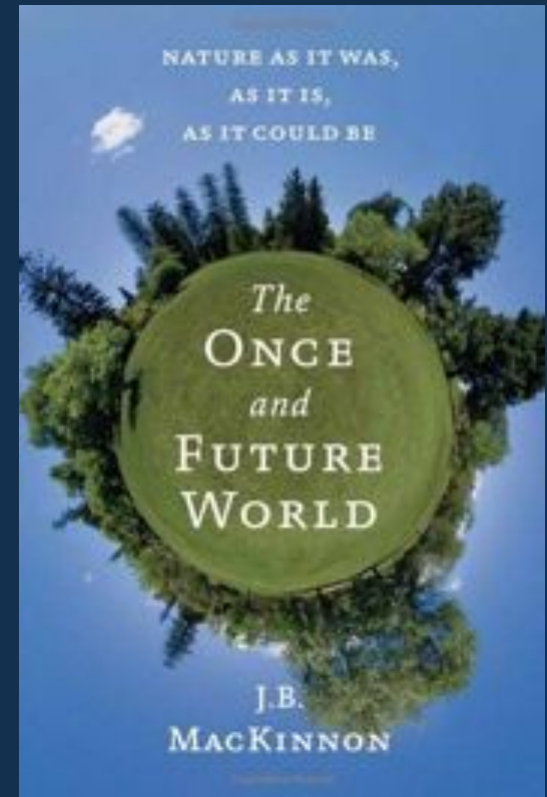
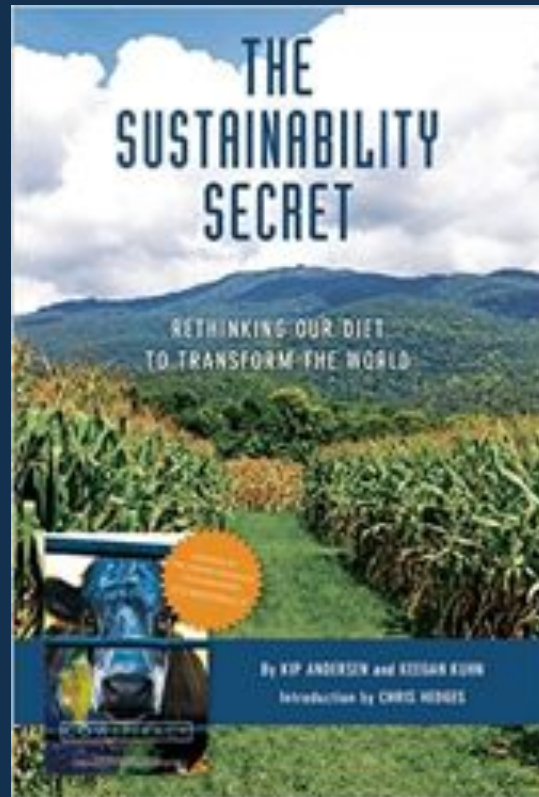
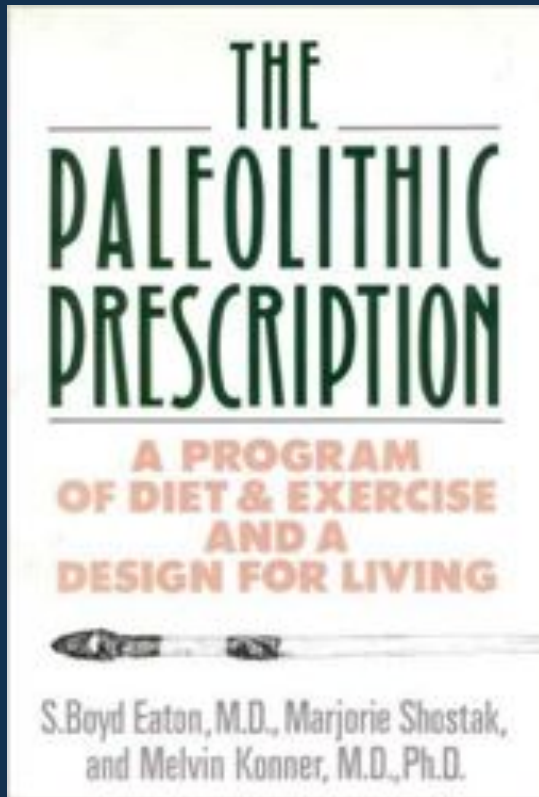


The FAO projects that a 70% increase in food production will be required to feed Earth's 9.1 billion people in 2050. This will magnify sustainability concerns.



Nutrition science should devise a program that offers:

- Sustainability
- Paleolithic Nutritional Content



Land Use, Energy Use, Water Use and CO₂ Emission Per Edible Ton

	Land, ha	Energy, TJ	GHG, tCO ₂	Water, 1000m ³
Wheat	0.14	2.5	0.8	3.6
Soybeans	0.42	3.0	1.3	2.2
Maize	0.14	2.4	0.7	1.4
Field Beans	0.30	2.0	1.0	3.0
Beef	4.30	52.5	29.8	11.8
Pork	0.99	22.3	8.5	4.9
Sheep	2.91	48.7	36.9	8.3
Salmon	--	25.4	1.8	--
Poultry	0.94	17.6	6.7	3.8
Eggs	0.55	11.8	4.6	3.4
Milk	0.12	2.5	1.1	1.1
Cheese	0.72	20.0	8.8	5.2

Mangrove Loss due to Shrimp Aquaculture

Country	% Mangrove Loss
Bangladesh	87%
Thailand	65%
Philippines	50%
Vietnam	80%

Environmental Impact



1lb beef

=



2,500 gallons H₂O



55ft² rainforest



16lbs grain



80kg CO₂

Comparing Carbon Footprints (t CO₂e)



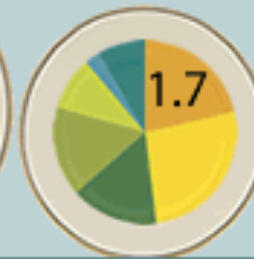
Meat Lover



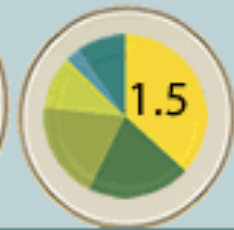
Average



No Beef



Vegetarian



Vegan

Shrink That Footprint

Sustainability: A Conflict

Red meat is incompatible with environmental health in the contemporary world.

However, humans have an innate desire for meat.





My favorite animal is steak.



Why is it delicious?
It's in our genes!

Desire for meat is a built-in human drive:

Robert Foley in *Meat-Eating and Human Evolution*:

“**Meat-eating** has played a significant role in the **evolution of Homo....**”

Ann Gibbons in *National Geographic*:

“...**hunter-Gatherers** around the world **crave meat** more than any other food.... ”

Leland Allbaugh in *Crete: a Case Study* (Rockefeller Foundation, 1948)

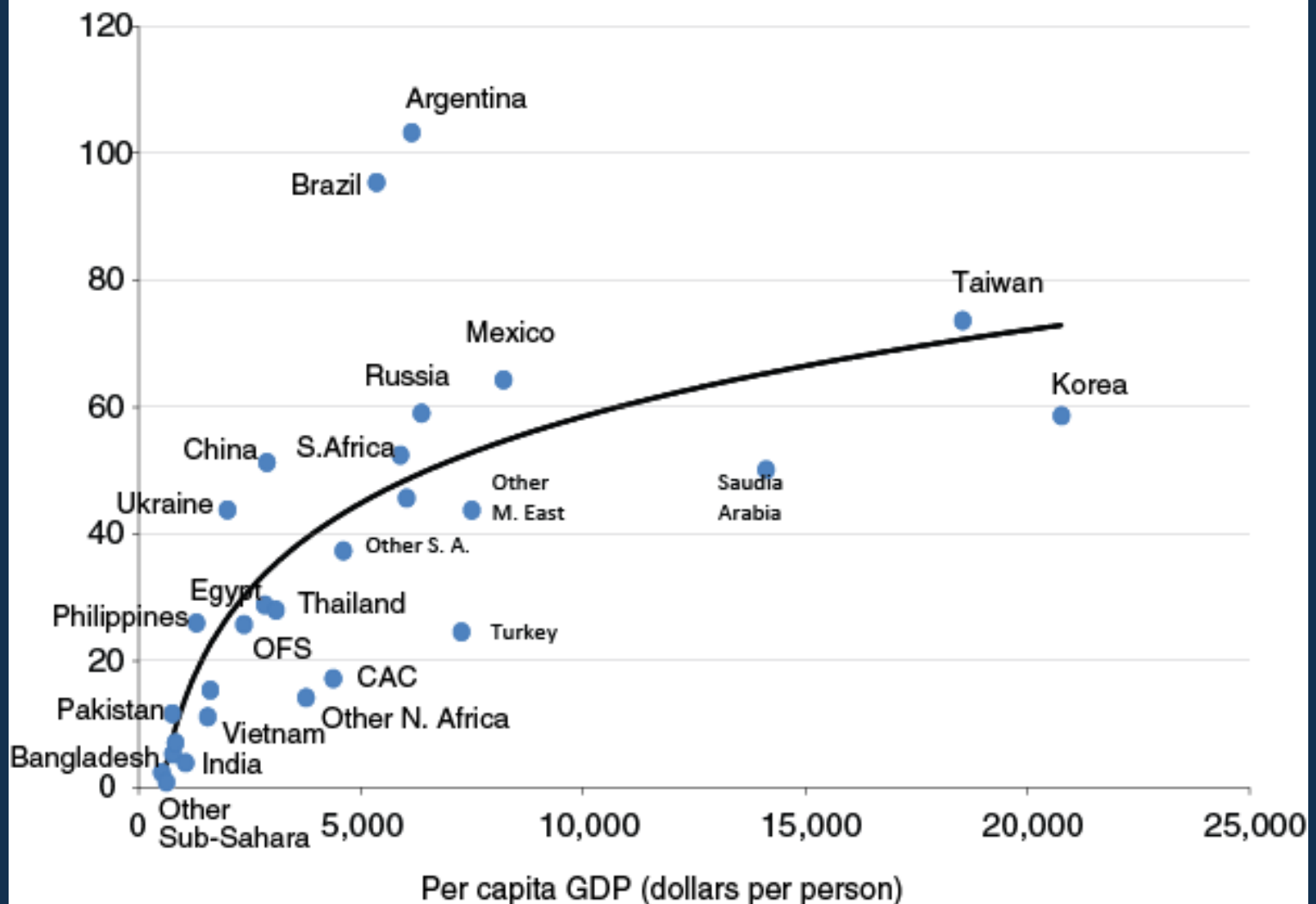
“A large majority of the respondents (72%) listed **meat as their favorite food.**”

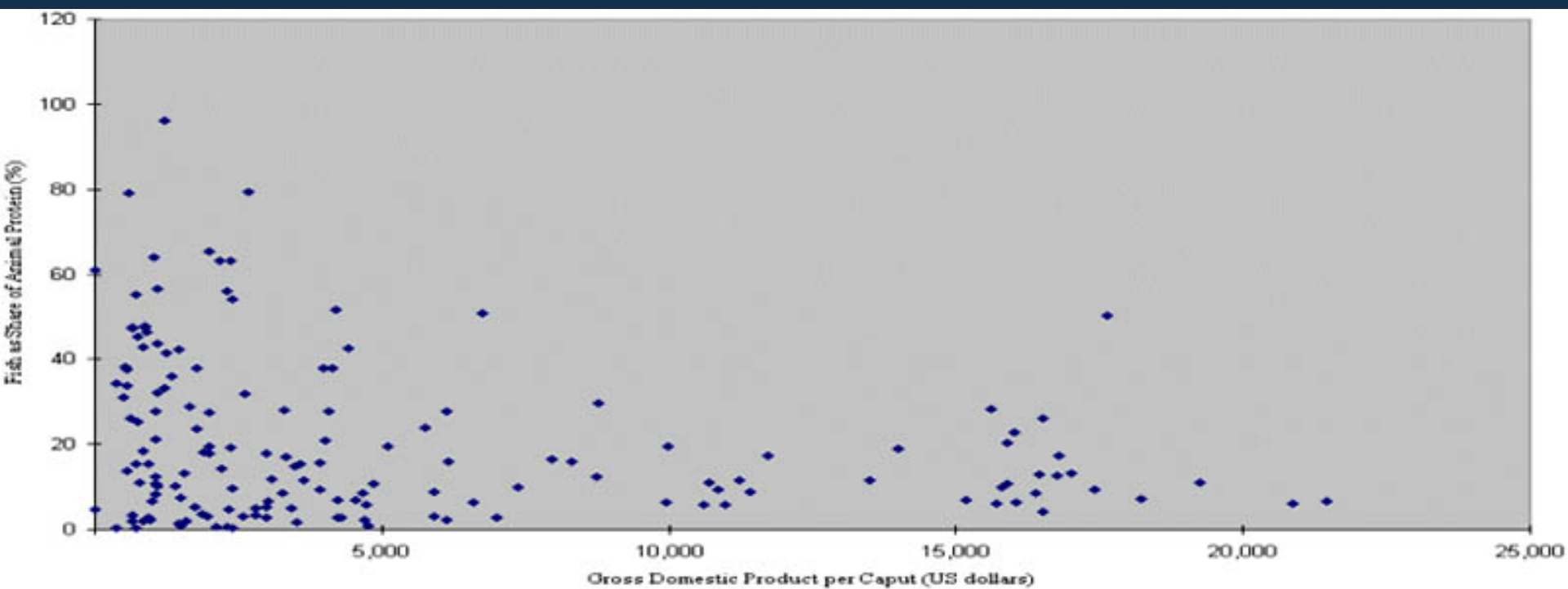
USDA, 2013:

“**As income rises**, consumers in low- and middle-income countries....**[increase]** their **consumption of meat**, dairy products [and] eggs....”

Per capita meat consumption and income, by country, 3-year average centered on 2010*

Per capita meat consumption (kg per year)





Ergo –There's a market for new “meat” products

Fortune May 11, 2015

“Sales of meatless meat are soaring; some companies are doubling their business annually. “

Atlantic August 19, 2013

“ No saturated fat, no heme iron, no growth hormone –cultured meat seems to have many potential benefits.”



Beast Burger

(Beyond Meat, pea protein, Bill Gates)



In Vitro Burger

(Modern Meat, stem cells, Sergey Brin)

Land Use, Energy Use, Water Use and CO₂ Emission Per Edible Ton

	Land, ha	Energy, TJ	GHG, tCO ₂	Water, 1000m ³
Wheat	0.14	2.5	0.8	3.6
Soybeans	0.42	3.0	1.3	2.2
Maize	0.14	2.4	0.7	1.4
Field Beans	0.30	2.0	1.0	3.0
Beef	4.30	52.5	29.8	11.8
Pork	0.99	22.3	8.5	4.9
Sheep	2.91	48.7	36.9	8.3
Salmon	--	25.4	1.8	--
Poultry	0.94	17.6	6.7	3.8
Cultured Meat	0.02	31.7	1.9	0.5
Eggs	0.55	11.8	4.6	3.4
Milk	0.12	2.5	1.1	1.1
Cheese	0.72	20.0	8.8	5.2

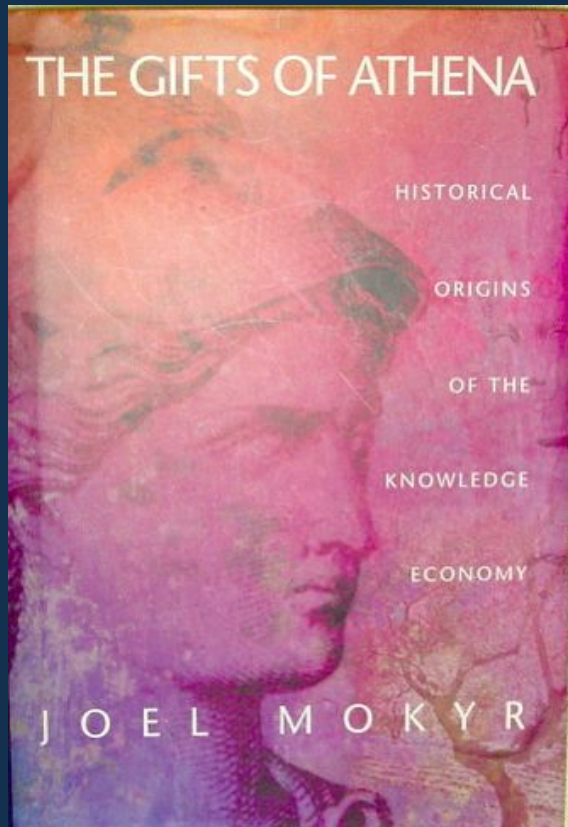
Why should a sustainable diet deliver Paleolithic level nutrients?



Paleo Dietary Recommendations

Sustainability Form

- More fruits and vegetables
- No sugar
- Some fat-free dairy
- No refined grains
- Moderate whole grain intake
- More fiber
- Less sodium
- More potassium
- More long-chain PUFA
- More protein –chiefly plant,
some poultry & sea food



Advice based solely on epidemiological statistics has limited effect on public behavior. What is needed to complement statistical insights –to maximize their impact –is a model, a **theory of disease**.

Paleo could be that theory



TIME Magazine January 7, 2014:

“The Paleo Diet Craze. What’s right and wrong about eating like a caveman?”

Wall Street Journal March 23, 2015:

“Is a Paleo diet healthy?”

The Washington Post January 12, 2015

“The Paleo Diet: Should you eat like a caveman?”

Huffington Post December 17, 2013

“Paleo diet tops most most-Googleed diets of 2013.”

Woman’s Health January 7, 2014

“5 tips for going Paleo.”

The Weekly Standard March 15, 2015

“The Paleo diet, Japanese style.”

National Geographic September, 2014

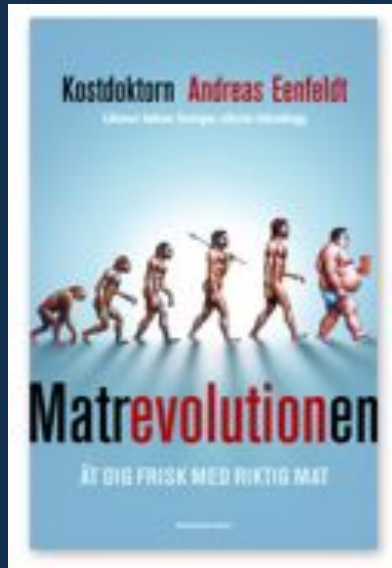
“The evolution of diet.”

The Atlantic July 27, 2011

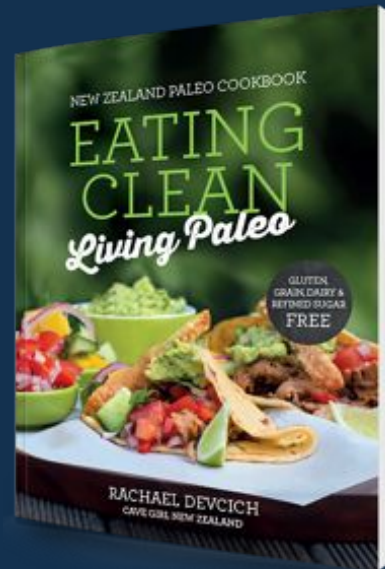
“The Paleo diet: Cave man cure-all or unhealthy fad?”

The Paleo concept
resonates with the public.

Sweden



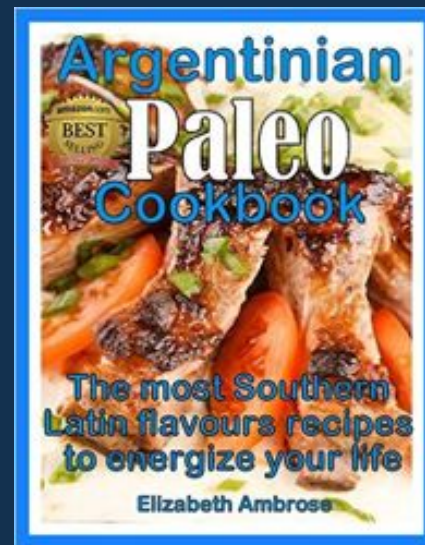
New Zealand



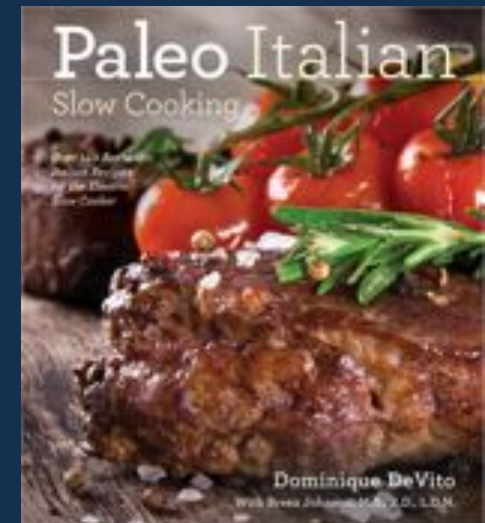
England



Australia



Argentina



Italy

Statistics-based Recommendations:

Highly “scientific,” but confusing for public
Strong research, no paradigm

Paleoanthropology-based Recommendations:

Investigatively-challenged, but attractive to public
Limited research, plausible paradigm

Paleoepidemiology-based Recommendations:

Combine attractive theory with investigative rigor
Evidence-based, gut-resonant advice

Sustainability-informed Recommendations:

Modified paleoepidemiological stance
Adaptive, not mitigative; hence “temporary”

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Adaptation –addresses symptoms
10 Billion humans existing
Earth's other life forms ↓
2100 C.E.



Mitigation –addresses causes
100 Million humans flourishing
Earth's other life forms ↑
2200 C.E.





Nonsustainable
(Now)



Adaptation
(Near Future)



Mitigation
(Far Future)

Current

–Unsustainable, unhealthful diets
2015 C.E.



Near Future

–Sustainable, pseudo-Paleo diets
2100 C.E.



Far Future

–sustainable, true Paleo diets
2200 C.E.



Overpopulation, climate change, and socioeconomic inequality –those are the megaproblems.

When world citizens address these issues, then nutrition scientists can advocate a true Paleo diet.



Mangrove Loss due to Shrimp Aquaculture

Country	% Mangrove Loss
Bangladesh	87%
Thailand	65%
Philippines	50%
Vietnam	80%

Wild-caught Seafood –CO₂ Emissions

Variety	tCO ₂ /t
Sardines	0.2
Mackerel	1.1
Scallops	1.4
Salmon	2.9
(Farmed)	(2.2)
Albacore	4.2
Sole	7.4
Shrimp/Lobster	7.6

Cereal Grains, CO₂ Emissions

Variety	tCO ₂ /t
Wheat	0.60
Oats	0.25
Maize	0.45
Rice	3.50