COST/BENEFIT OF OPTIMAL HEALTH WITH SUNSHINE, VITAMIN D

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DISCLOSURES

- William B. Grant

Disclosure

I receive funding from Bio-Tech Pharmacal (Fayetteville, AR), the Sunlight Research Forum (Veldhoven), and Medi-Sun Engineering, LLC (Highland Park, IL).

OBJECTIVE

- Discuss costs and benefits of increasing vitamin D-related behavior

LEARNING OBJECTIVES

1) Identify cost reductions of increased vitamin D
2) Compare to costs of skin cancers

APPROACH

1) Obtain 25(OH)D concentrations
2) Associate them with disease incidence
3) Estimate reductions in disease incidence and mortality rates for increasing 25(OH)D to >40 ng/mL
4) Estimate reductions in deaths, years of life lost, and costs

DISEASES HIGHLIGHTED

- Cardiovascular disease
- Diabetes mellitus
- Cancer – several types
- Alzheimer's disease
- Falls and fractures

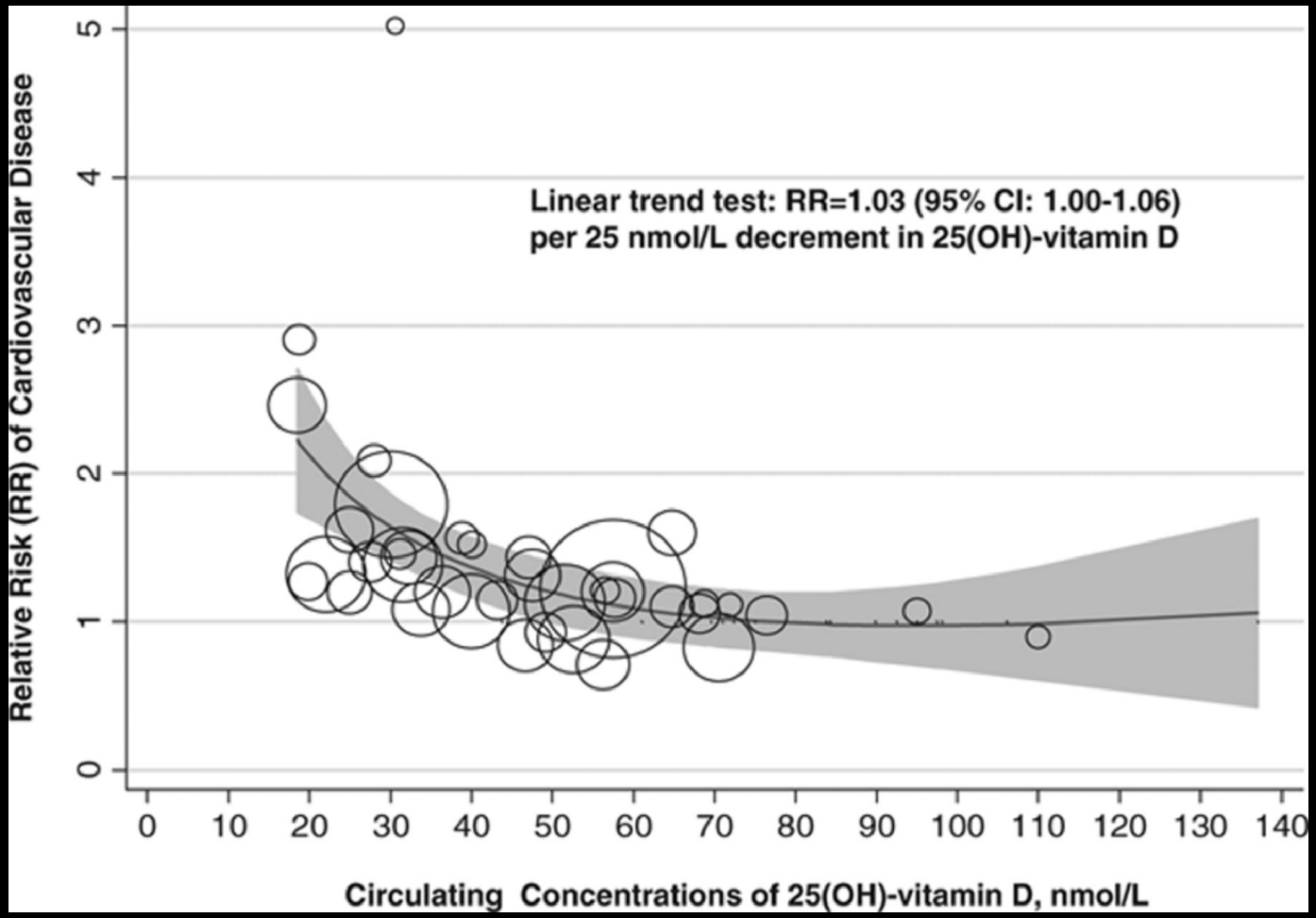
CARDIOVASCULAR DISEASE

- Cardiovascular disease (CVD) sub-categories:
  - Ischemic heart disease
  - Stroke
  - Cardiomyopathy (heart failure)
  - Hypertensive heart disease
  - Other CVD

CARDIOVASCULAR DISEASE

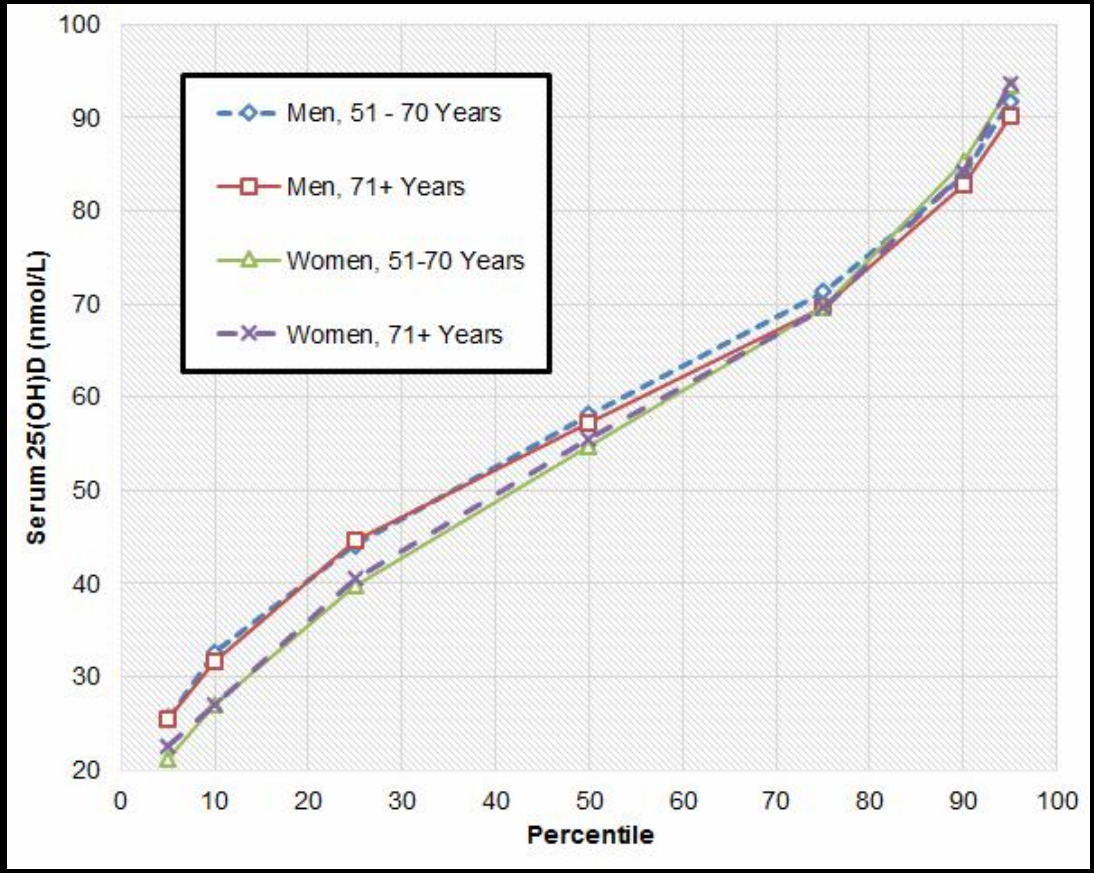
- Mechanisms whereby vitamin D prevents CVD:
  - Blunts renin-angiotensin system
  - Reduces risk of arterial stiffness, diabetes, and insulin resistance
  - Helps maintain glucose regulation and healthy lipid profile

META-ANALYSIS: CVD VS. 25(OH)D



Wang et al., 2012

25(OH)D DISTRIBUTION - USA



Looker, et al., 2011

CARDIOVASCULAR DISEASE

- Raising 25(OH)D concentrations in the U.S. above 40 ng/mL is estimated to reduce risk of CVD (including subtypes) by 20%.
- The beneficial effects would phase in over several years.

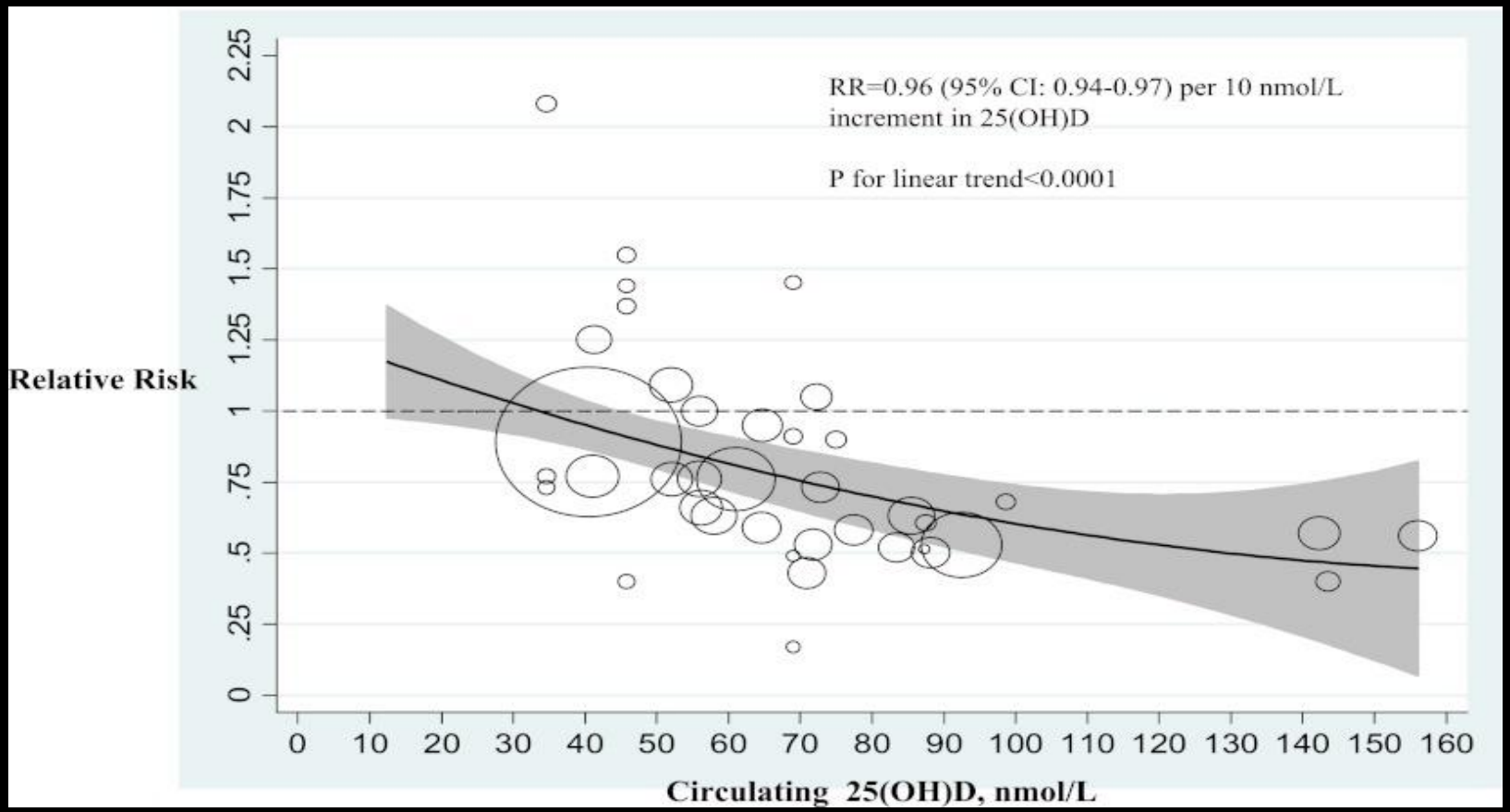
DIABETES MELLITUS

- Those with higher 25(OH)D concentrations have reduced risk of developing diabetes types 1 and 2.
- One randomized controlled trial found a reduced progression from prediabetes to diabetes.
- Mechanisms include effects on insulin secretion, insulin sensitivity and inflammation.

DIABETES MELLITUS

- However, vitamin D has limited effect on existing diabetes mellitus.
- Estimated 21 million persons in the U.S. had diagnosed diabetes and another 8 million had undiagnosed diabetes. (CDC 2014)
- One million develop diabetes in the U.S. annually (CDC)

DIABETES MELLITUS VS 25(OH)D



Song et al., 2013

VITAMIN D AND DIABETES

- Higher 25(OH)D concentrations could reduce the incidence of diabetes mellitus by about 25%.
- In the short run, increasing vitamin D would not reduce costs or years of life lost.
- In the long run, increasing vitamin D could have a major impact on diabetes.

CANCER

- Cedric Garland, along with his brother Frank Garland, proposed the UVB-vitamin D-cancer hypothesis in 1980 to explain the geographical variations of colon cancer mortality in the U.S.
- Very strong evidence for many types of cancer

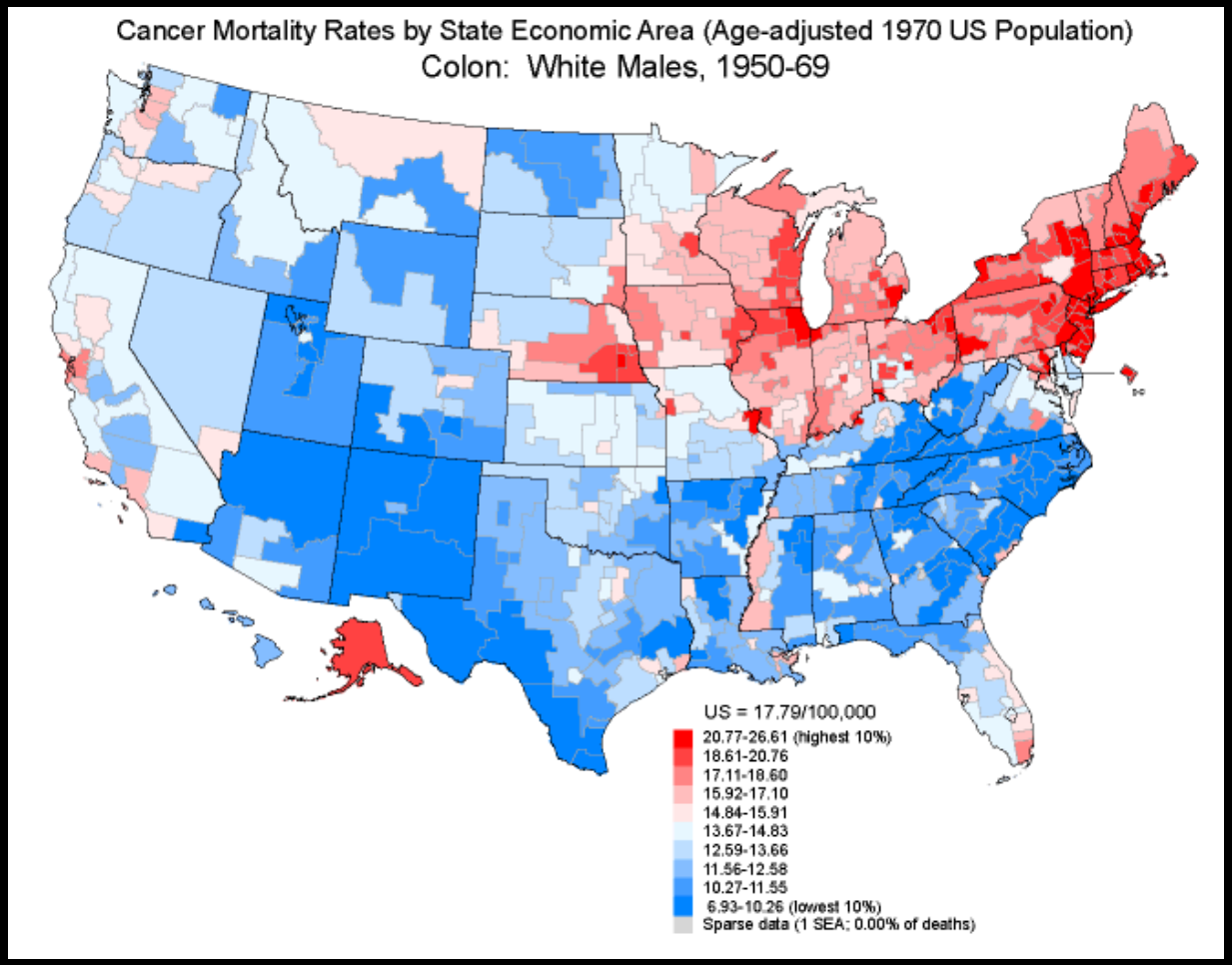
CANCER

- Mechanisms whereby vitamin D reduces cancer incidence:
  - Effects on cellular differentiation, proliferation, and apoptosis
- Mechanisms whereby vitamin D reduces cancer mortality:
  - Reduced angiogenesis around tumors
  - Reduced metastasis

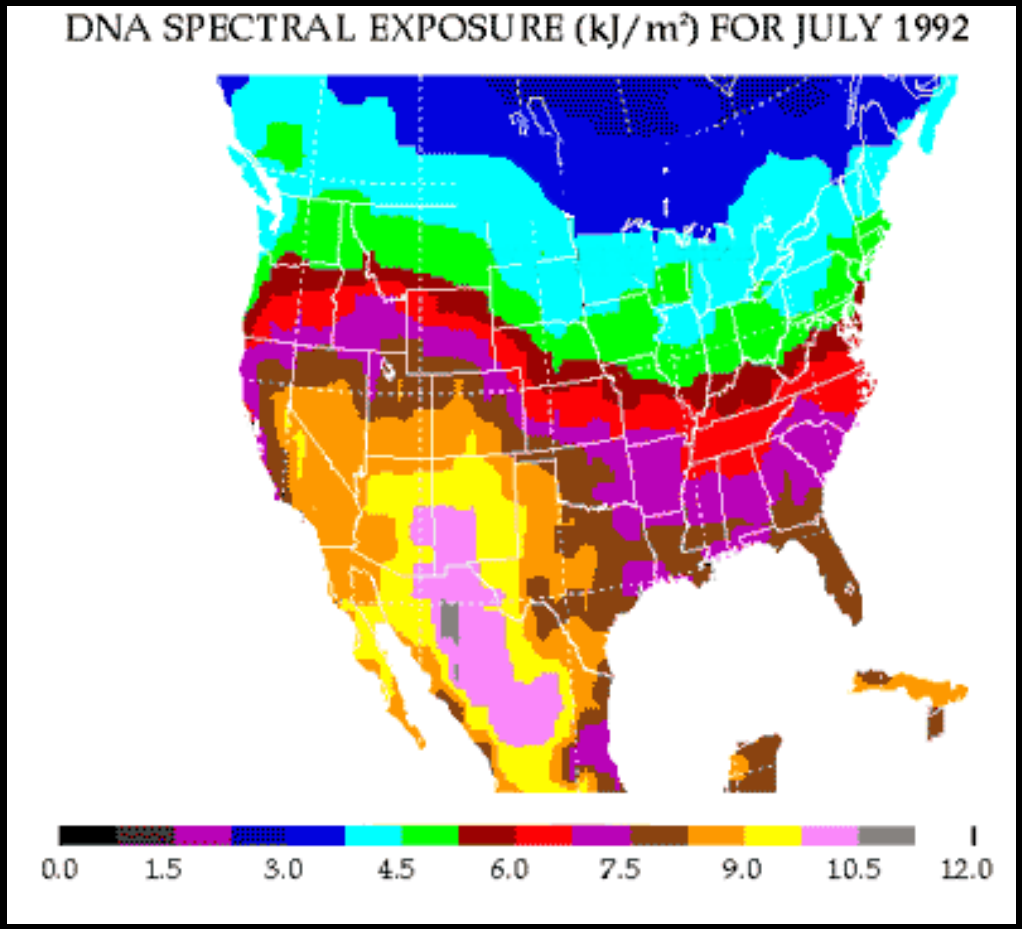
CANCER

- Strongest evidence from ecological studies where UVB doses are well known and other risk-modifying factors can be modeled

COLON CANCER, WHITE MALES



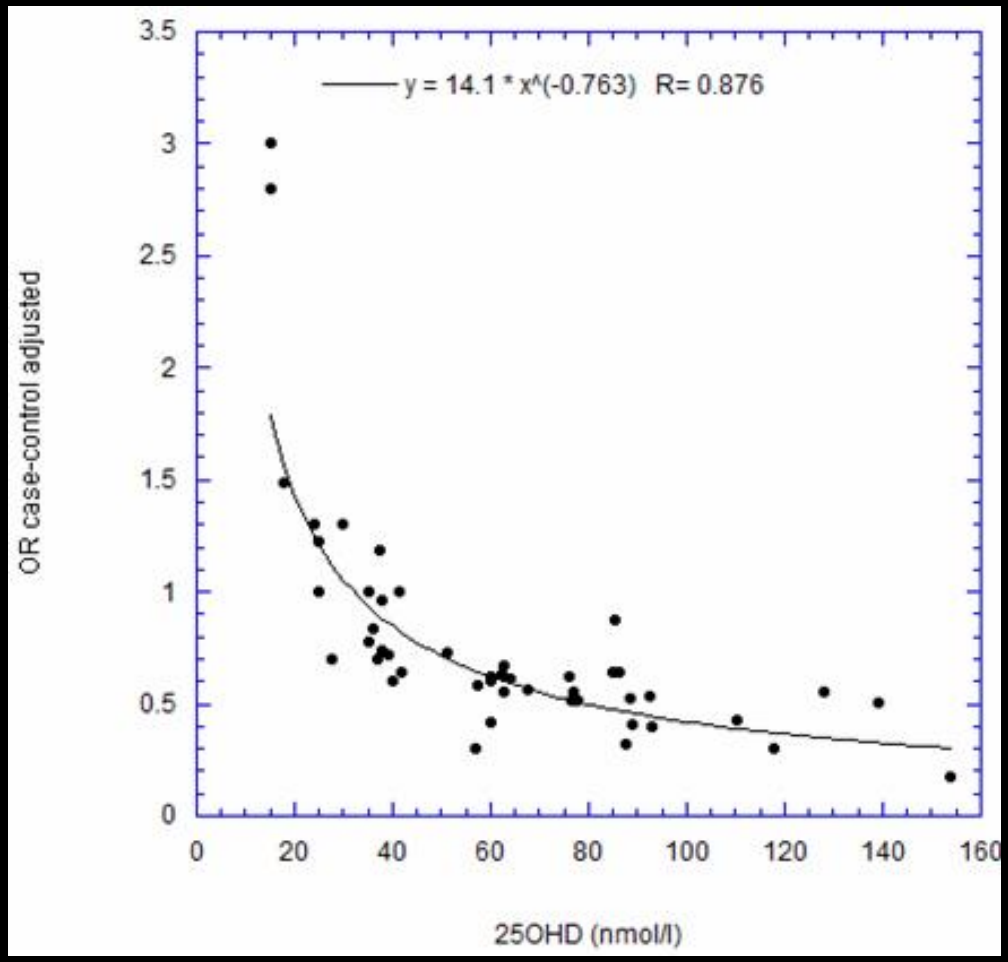
SOLAR UVB DOSE FOR JULY 1992



CANCER STUDIES

- Observational studies have also supported prevention for the following cancers:
  - Breast
  - Colorectal
  - Lung
  - Prostate cancer
  - Non-Hodgkin's lymphoma
- A mouse model study found that UVB was more effective at reducing progression of intestinal cancer than was oral vitamin D for the same 25(OH)D [Rebel, 2014]

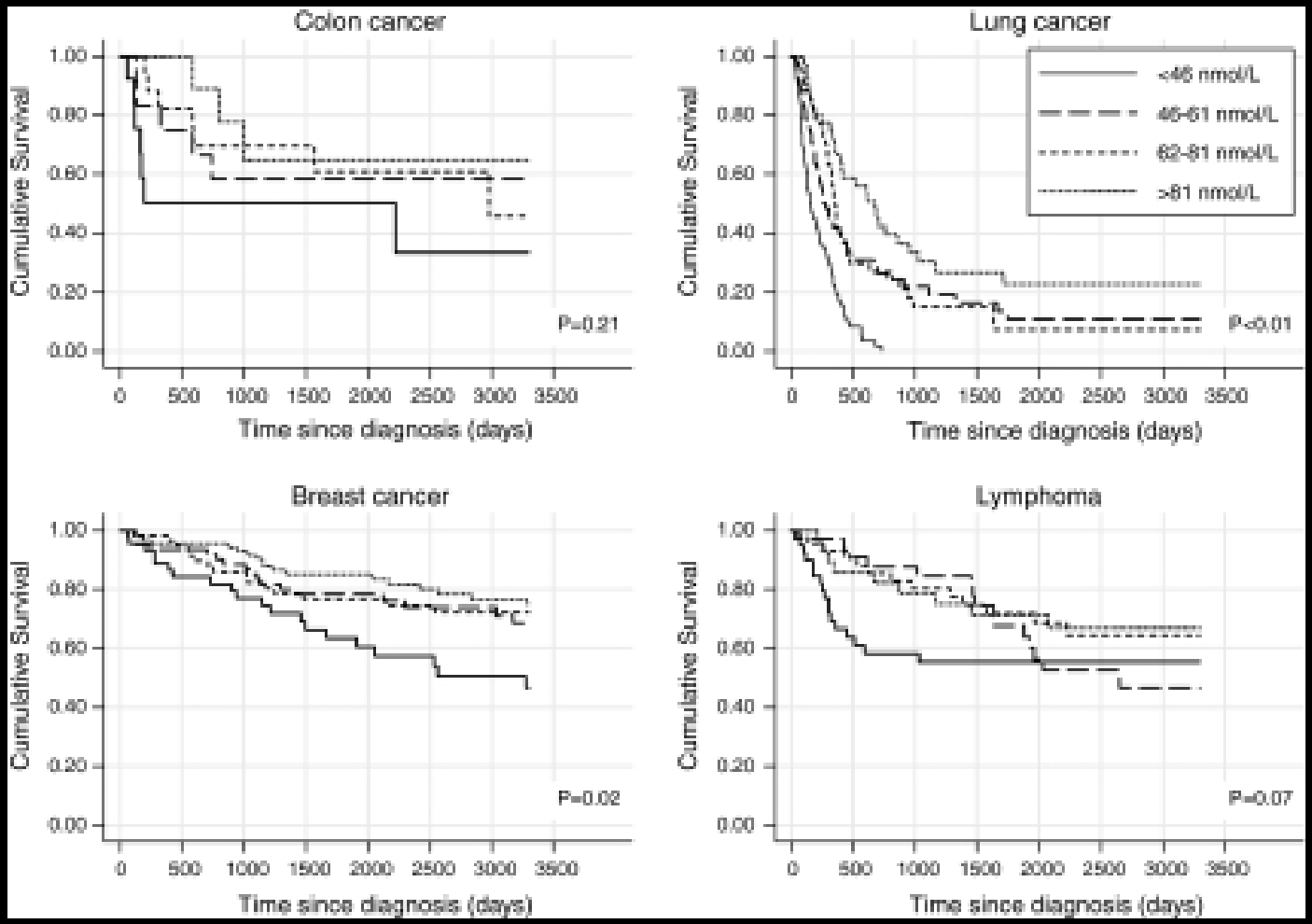
BREAST CANCER INCIDENCE VS 25(OH)D



[Lowe, 2005]	UK
[Abbas, 2008]	Germany
[Abbas, 2009]	Germany
[Crew, 2009]	U.S.
[Yao, 2011]	New York, U.S.
[Fedirko, 2012]	Mexico
[Peppone, 2012]	New York, U.S.
[Bilinski, 2013]	Australia
[Mohr, 2013]	U.S.
[Yousef, 2013	Iran

Grant WB. 2015

CANCER SURVIVAL VS. 25(OH)D



CANCER – VITAMIN D EFFECTS

- Raising 25(OH)D concentrations to >40 ng/mL should reduce mortality rates:
  - Colorectal cancer – 30%
  - Breast, renal cancer – 25%
  - Non-Hodgkin's lymphoma – 20%
  - Liver, lung, pancreatic, prostate cancer – 10%

ALZHEIMER'S DISEASE

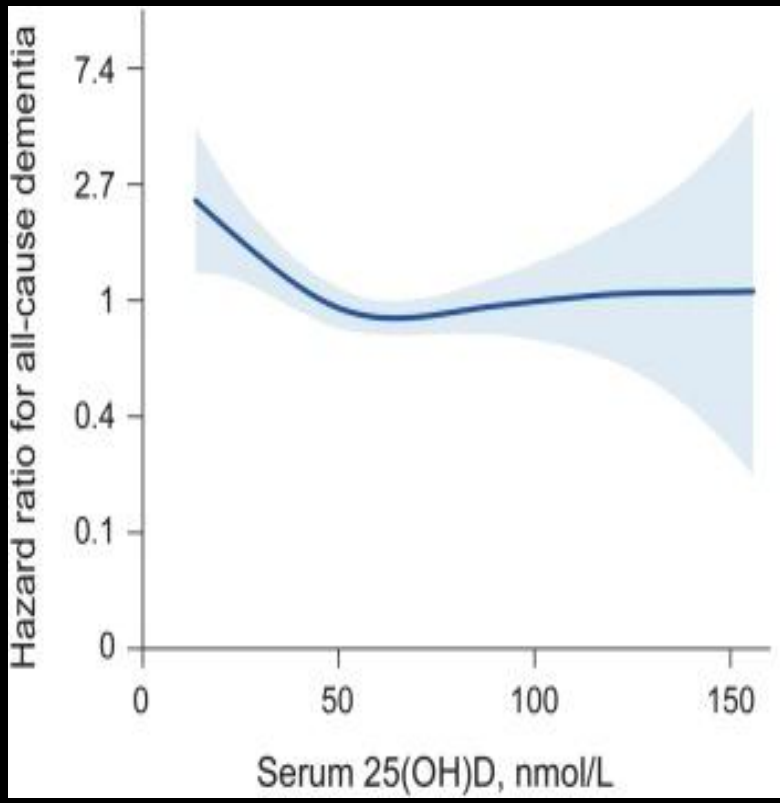
- 4-5 million people in the U.S. with Alzheimer's disease
- Official death rate from AD = 160,000 deaths/year
- However, a recent paper estimated that 500,000 Americans over the age of 75 years die from AD each year [James et al., 2014]

ALZHEIMER'S DISEASE

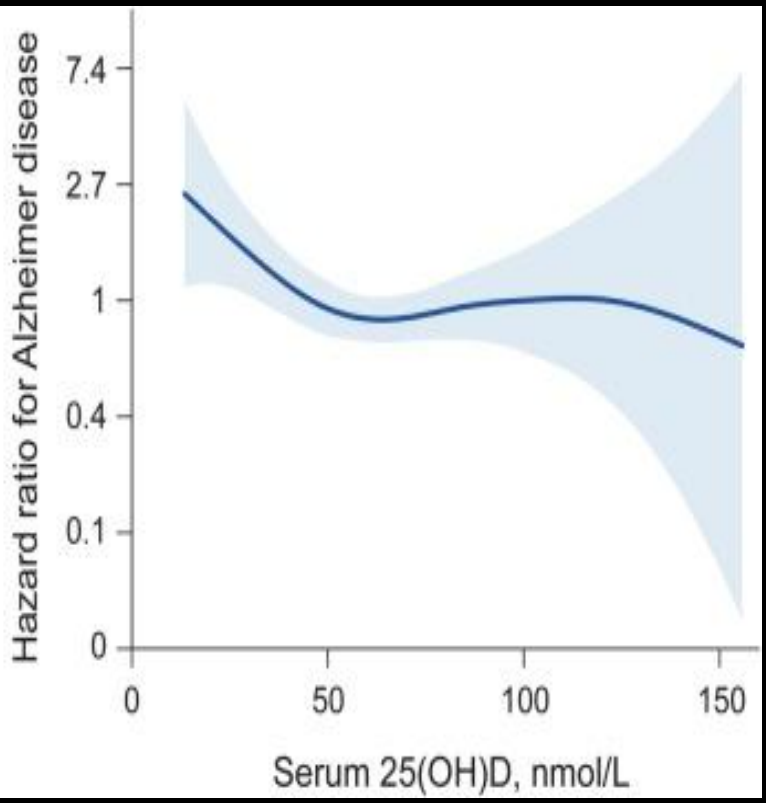
- 1,658 elderly disease-free adults participated in the US population-based Cardiovascular Health Study between 1992 and1999
- During mean follow-up of 5.6 years, 171 participants developed all-cause dementia, including 102 cases of Alzheimer disease.

ALZHEIMER'S DISEASE

All-cause dementia



Alzheimer's Disease



Littlejohns et al.

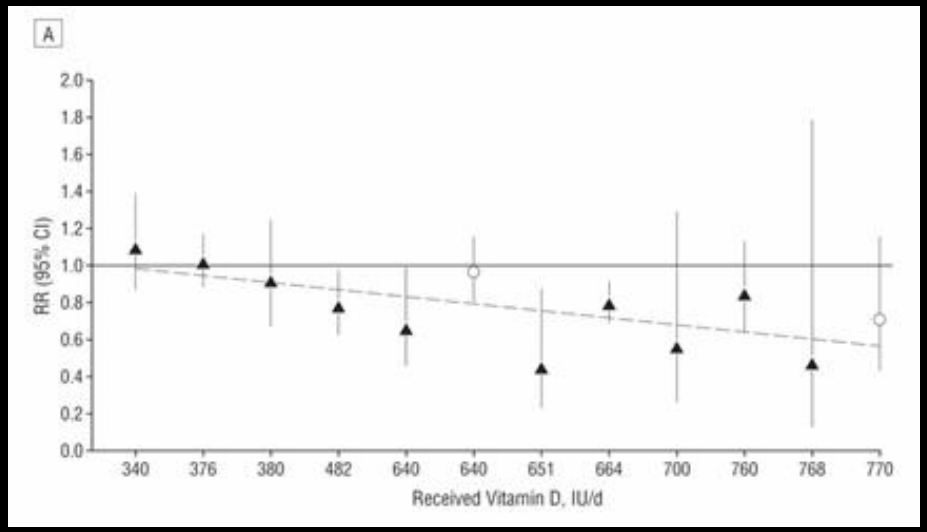
ALZHEIMER'S DISEASE

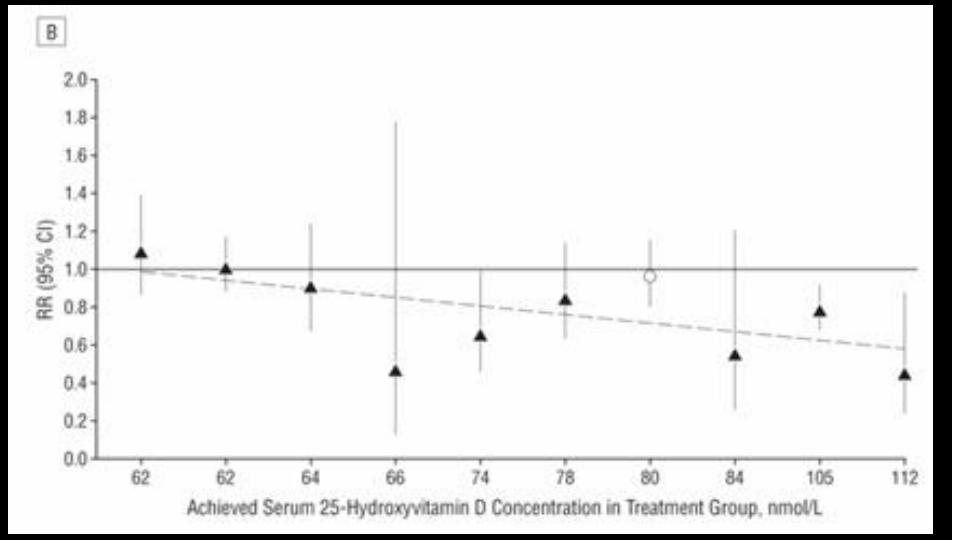
- From this study, raising 25(OH)D concentrations would reduce estimated incidence and mortality rates of AD by an estimated10%.

FALLS AND FRACTURES

- Falls and fractures = 10,000 deaths/year in U.S.
- Mechanisms whereby vitamin D prevents falls and fractures:
  - Effects on calcium absorption and metabolism
  - Supporting neuromuscular control

NONVERTEBRAL FRACTURE, 25(OH)D



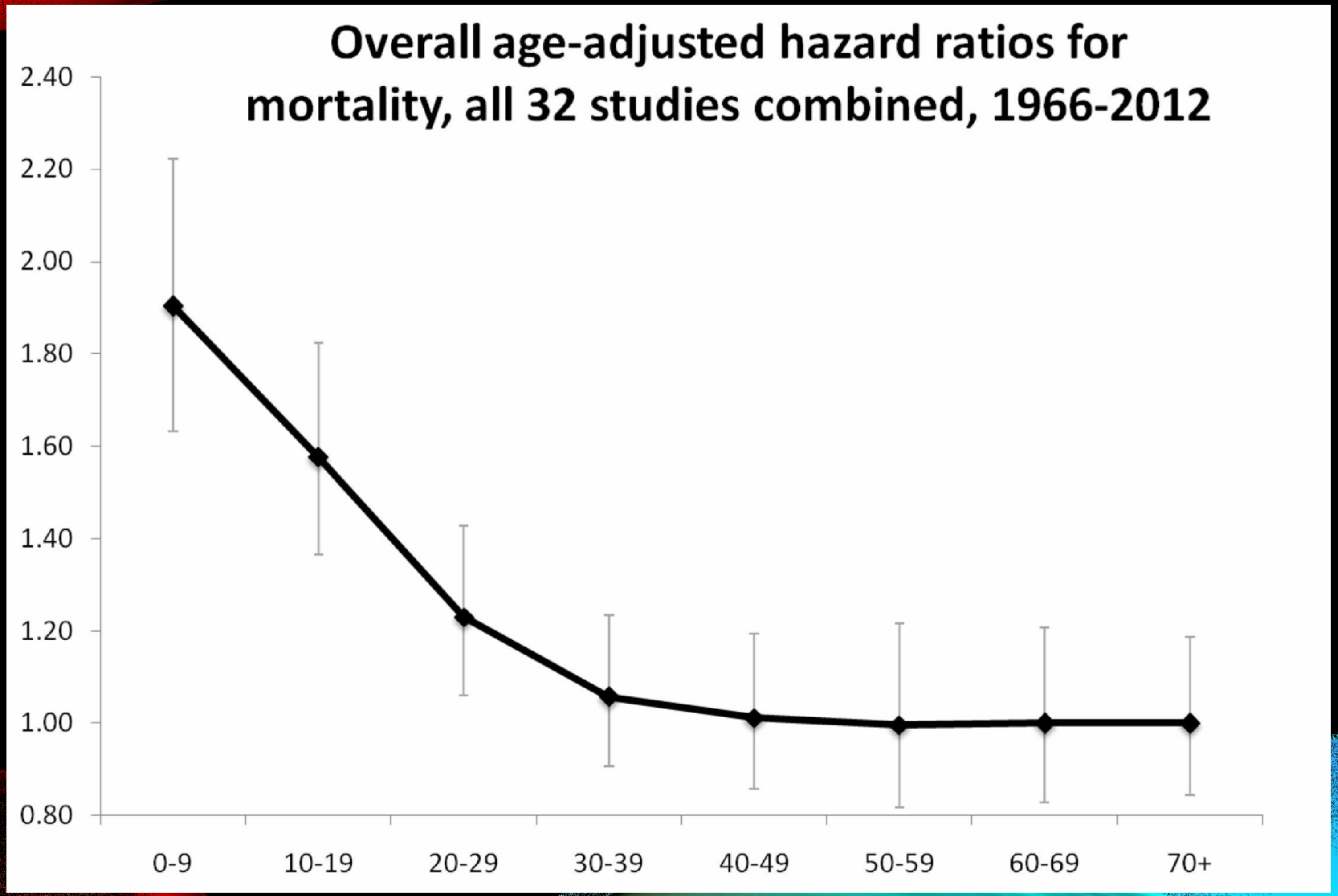


Bischoff-Ferrari et al., 2009

FALLS AND FRACTURES

- From that meta-analysis and other studies, 25(OH)D concentrations >40 ng/mL should reduce the burden of falls and fractures by an estimated 20%.

ALL-CAUSE MORTALITY RATE VS. 25(OH)D



Garland et al., 2014

DEATH AND YEARS LIFE LOST

- Deaths and YLLs data source:
  - US Burden of Disease Collaborators. The state of US health, 1990-2010: burden of diseases, injuries, and risk factors. JAMA. 2013;310(6):591-608.
- I used the data for the causes of death linked to low 25(OH)D concentrations.

DEATHS IN THE U.S. IN 2010

- Of the 30 leading causes of death, 19 are linked to low 25(OH)D

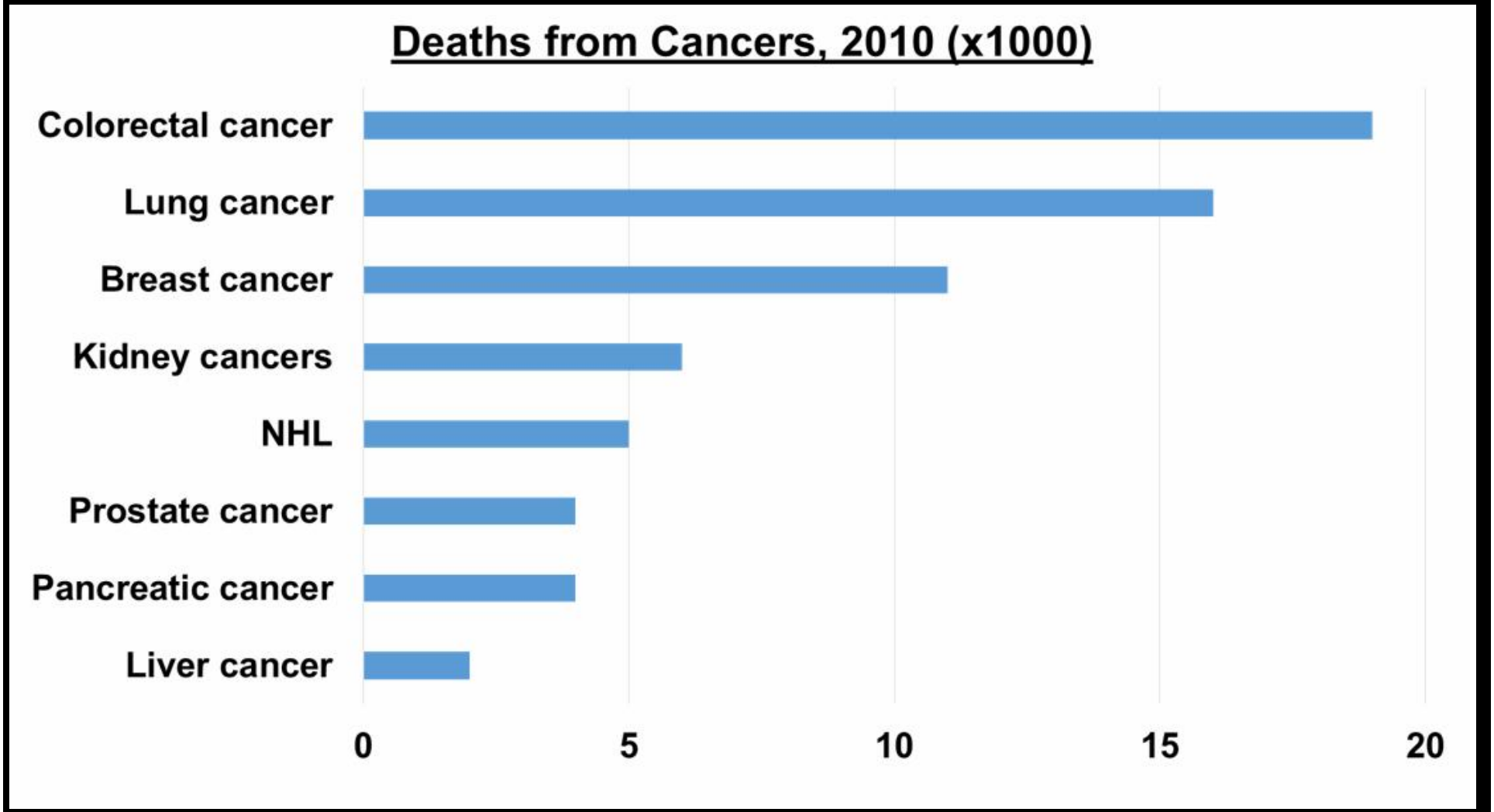
- 2,470,000 total deaths (2010)
- 1,860,000 million deaths from these 19 causes (2010)
- 260,000 deaths from other 11 causes (2010)

- Therefore, 336,000 reduced deaths out of 2,120,000 million (16% reduction)

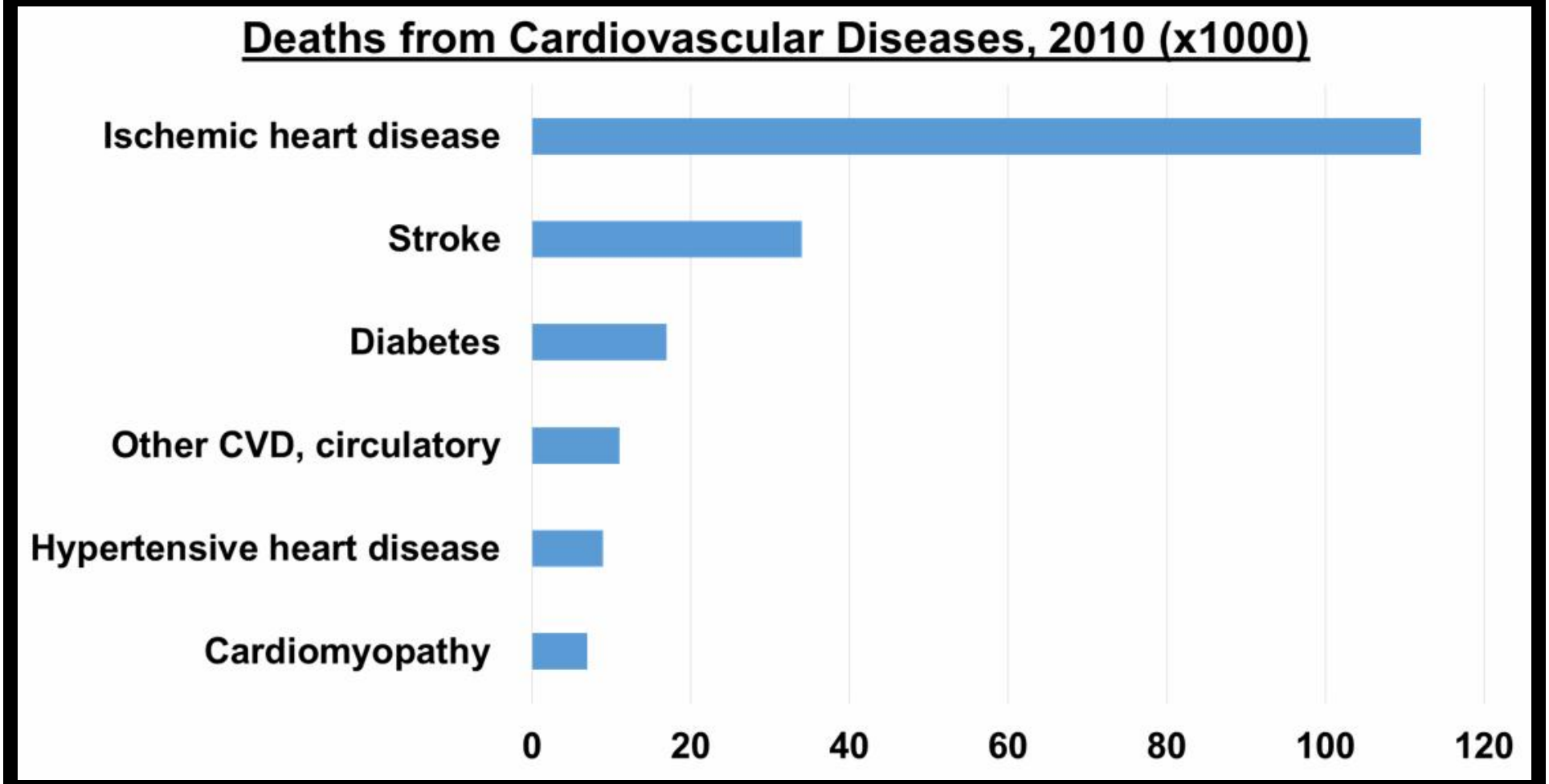
DIRECT COSTS OF DISEASE

- Costs for these diseases were obtained from various sources
- Assumption that the reduction in costs came from percent of incidence reduced by increasing 25(OH)D to above 40 ng/mL (except for diabetes, for which the percent is much lower)

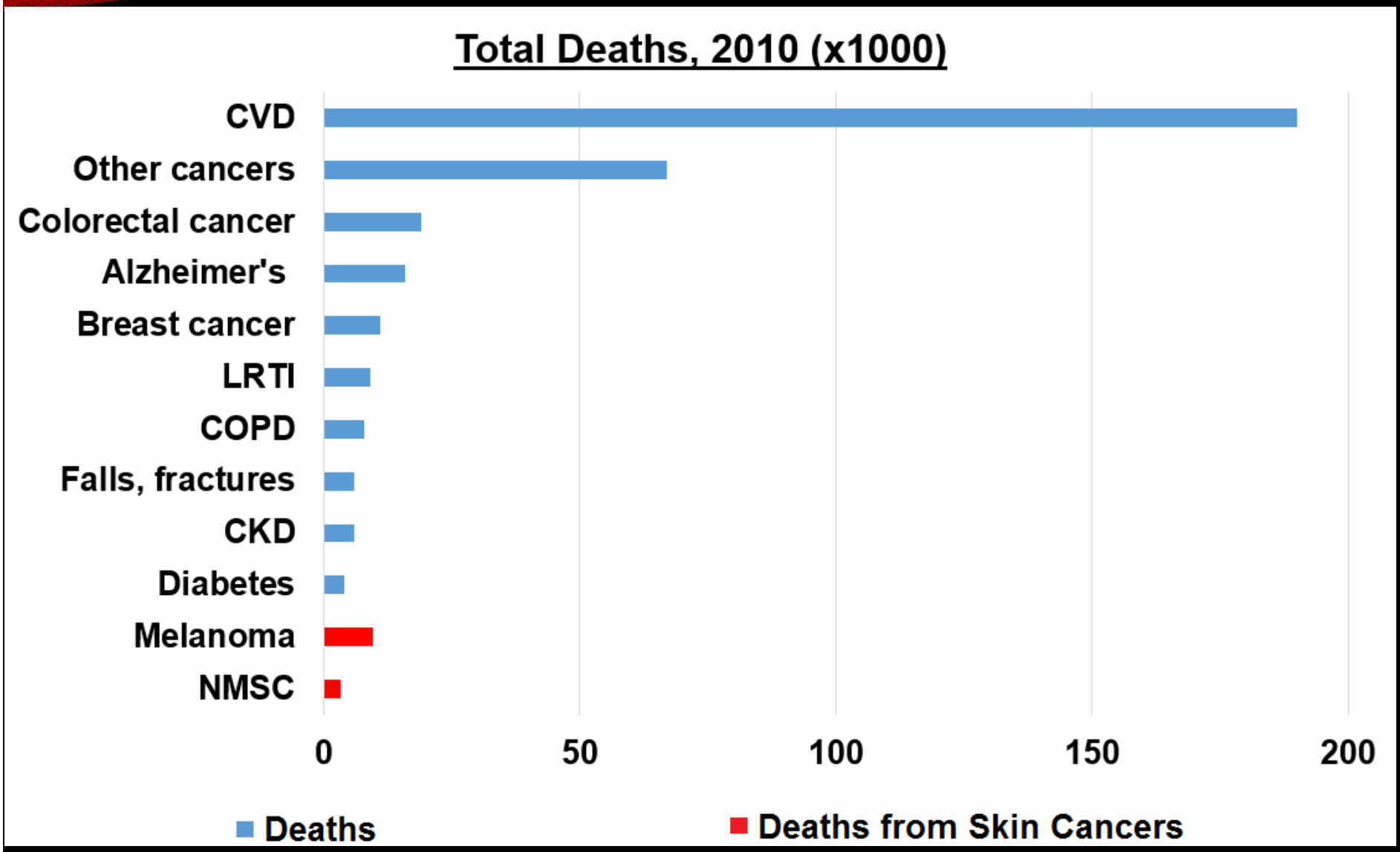
REDUCED DEATHS FROM CANCERS



REDUCED DEATHS FROM CVD



REDUCED TOTAL DEATHS



MY 2011 STUDY

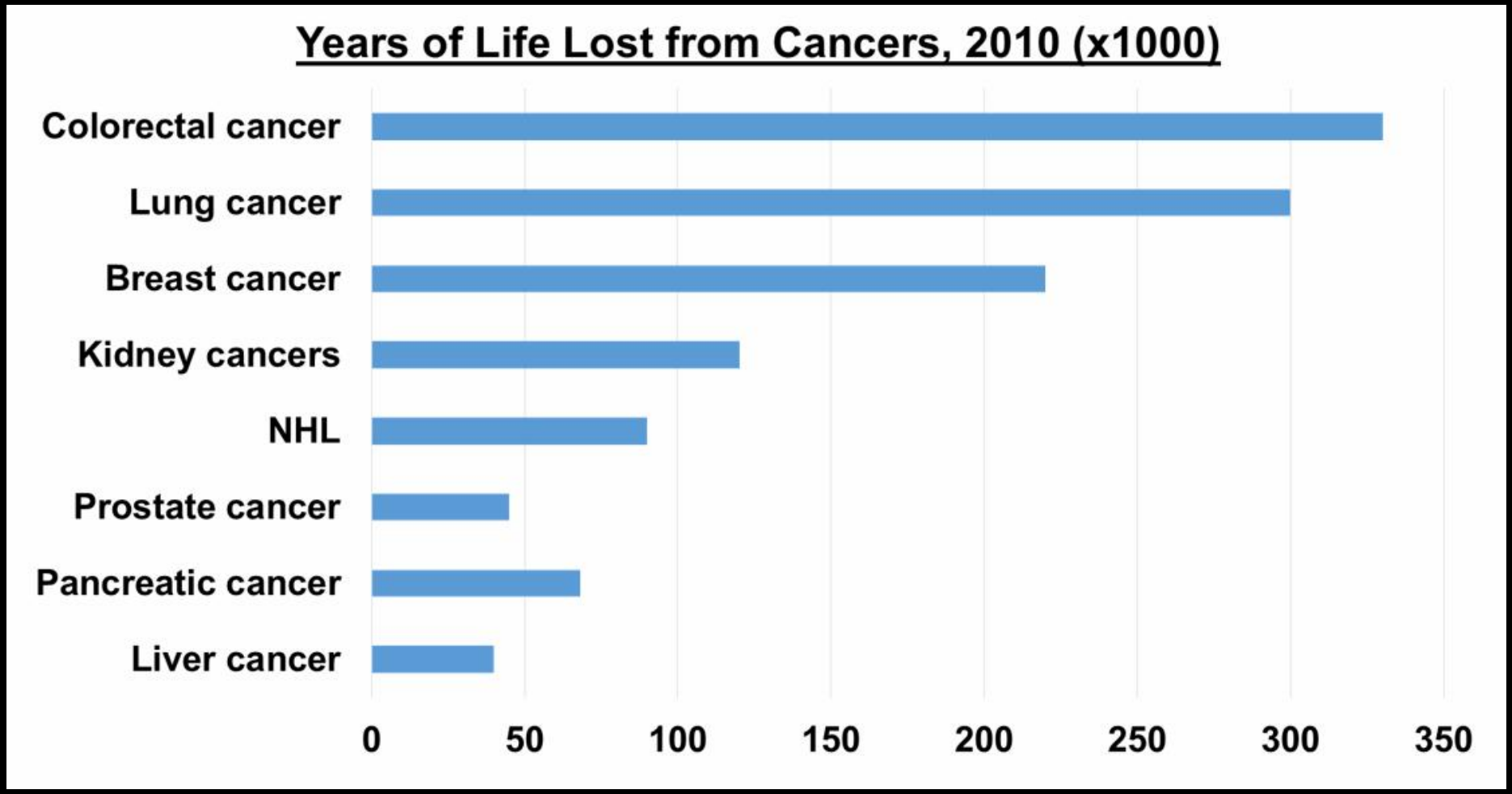
- My 2011 study had similar findings:
- Goal was estimation of mortality reduction for six global regions when 25(OH)D increases from 54 to 110 nmol/l

INCREASE IN LIFE EXPECTANCY

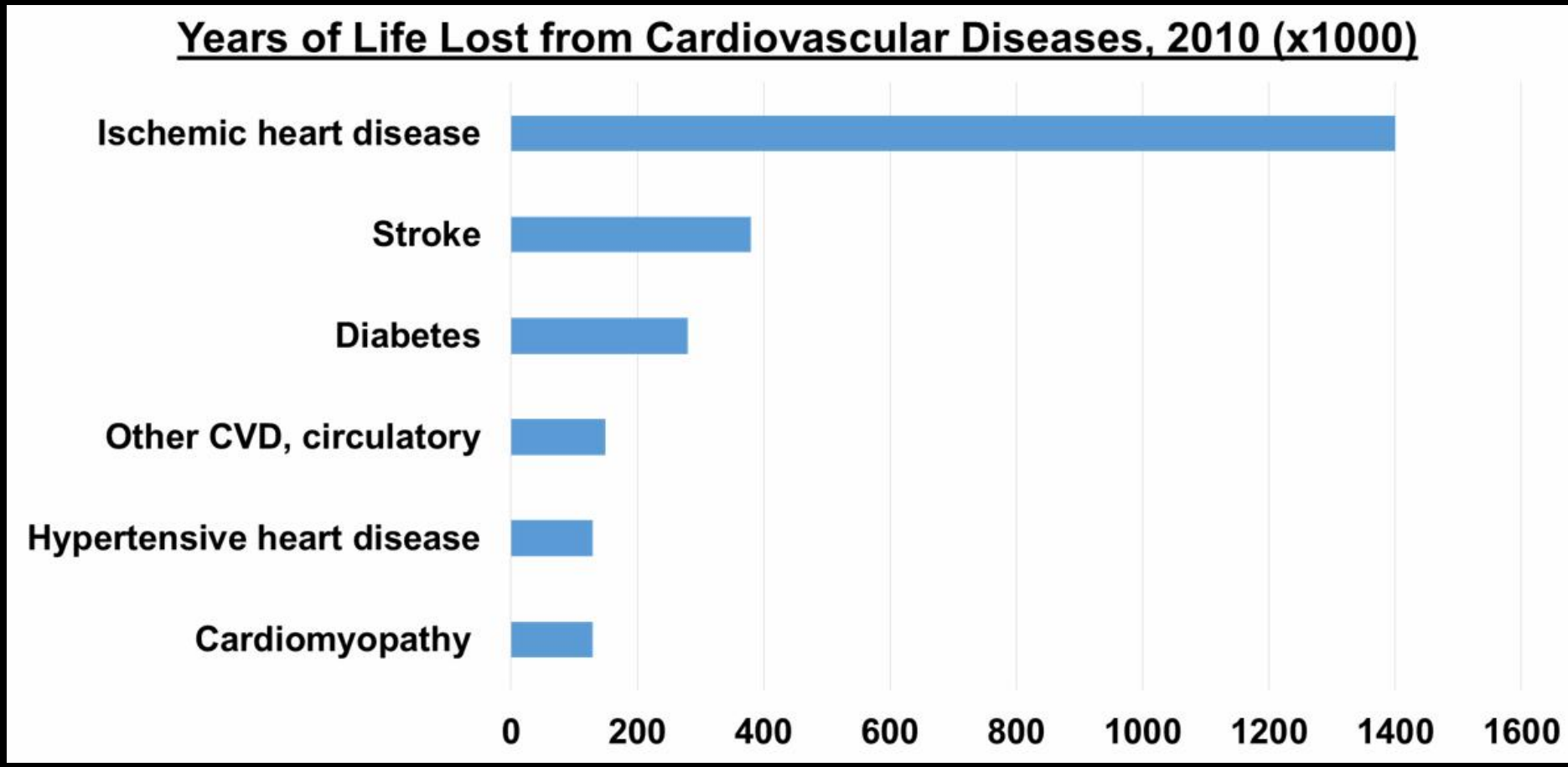
- Finding suggests that raising 25(OH)D to >40 ng/mL increases average U.S. life expectancy by 1.6 years

Grant WB. An estimate of the global reduction in mortality rates through doubling vitamin D levels. Eur J Clin Nutr. 2011;65(9):1016-26.

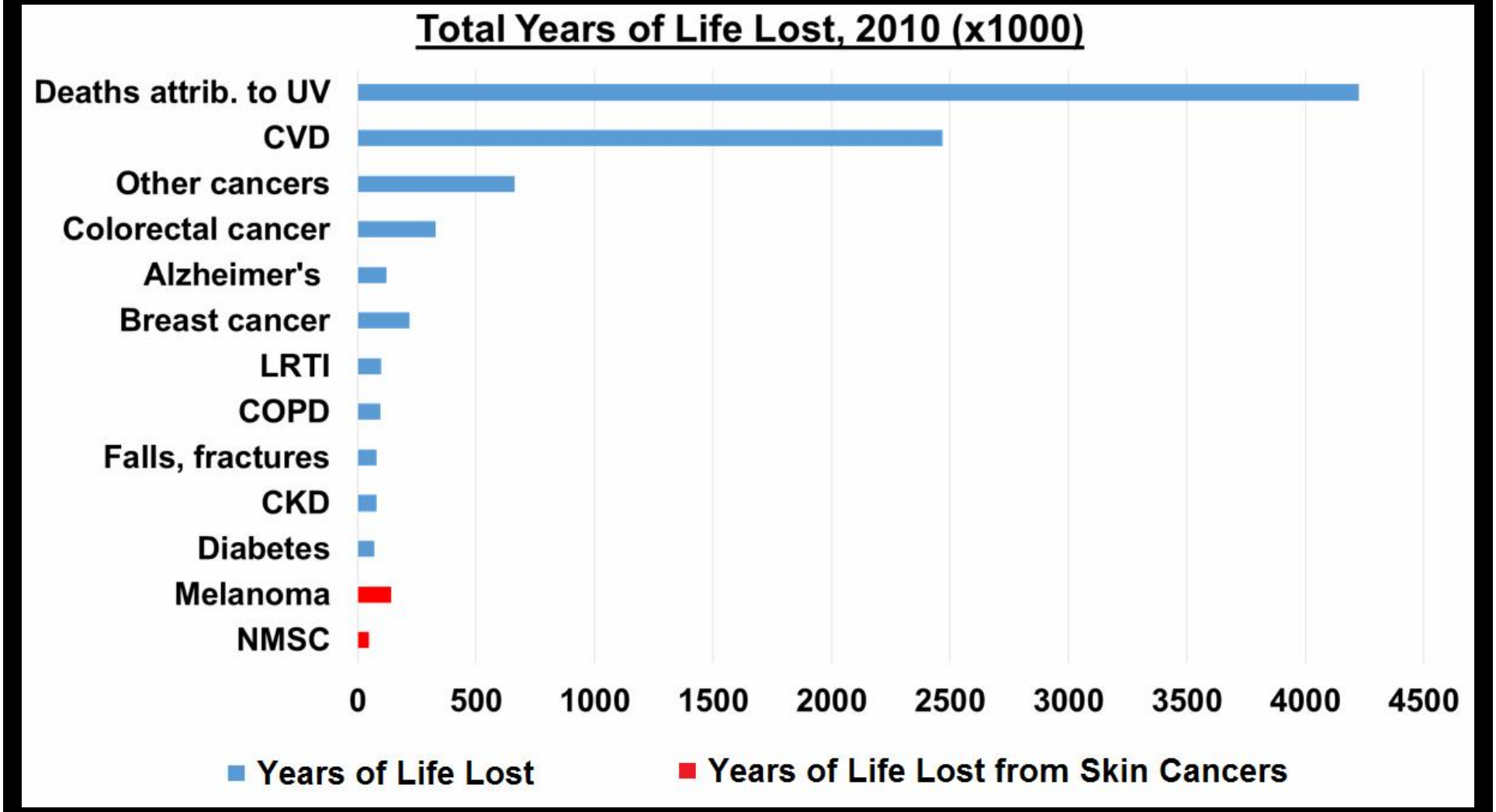
REDUCED YLL - CANCER



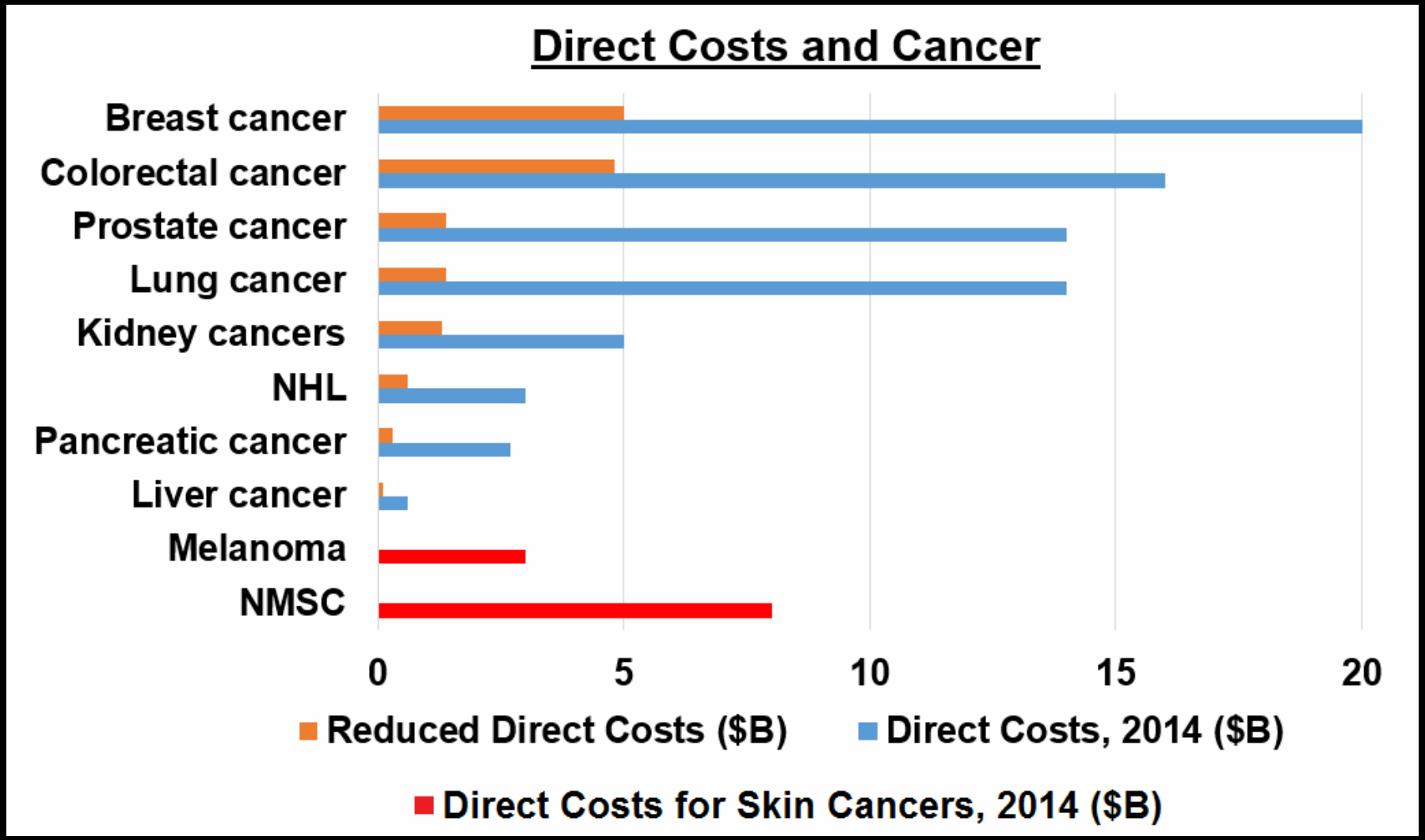
REDUCED YLL CVD



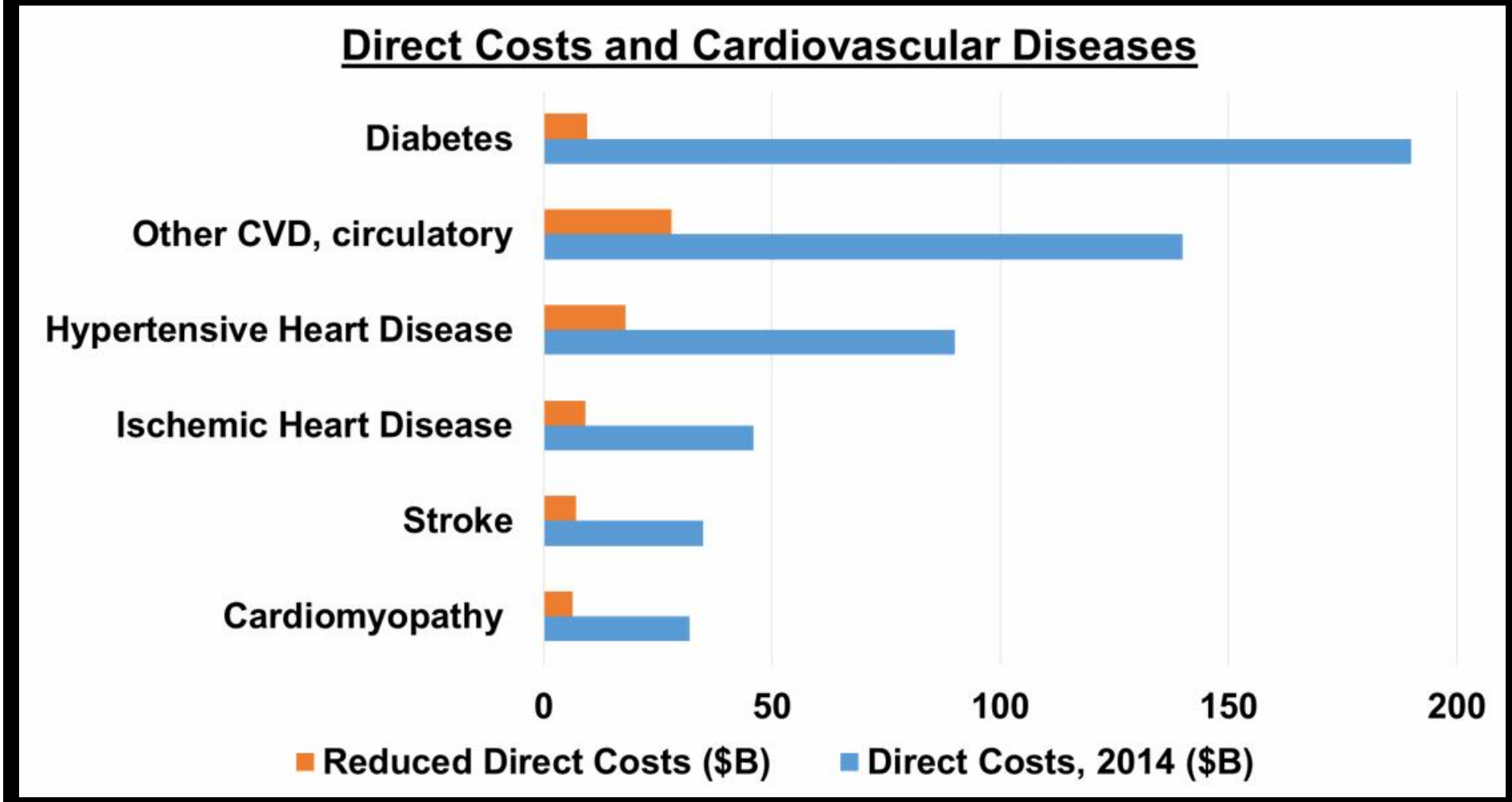
REDUCED TOTAL YEARS OF LIFE LOST



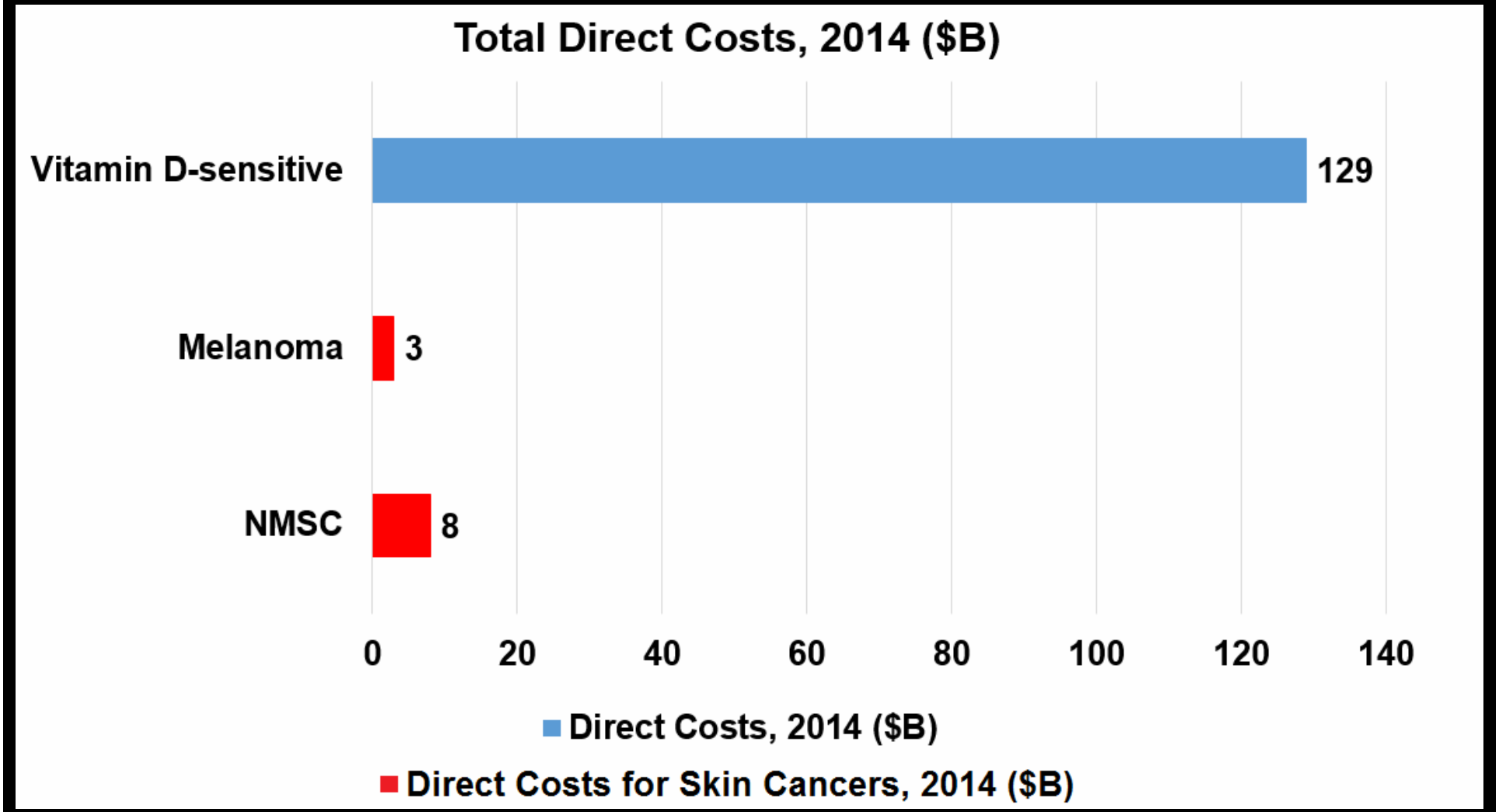
REDUCED DIRECT COSTS, CANCER



REDUCED DIRECT COSTS, CVD



TOTAL REDUCED DIRECT COSTS



CONCLUSIONS

- Raising 25(OH)D above 40 ng/mL for entire U.S. population can…
  - Reduce the annual death rate by 300 thousand
  - Reduce annual years of life lost by 4.2 million
  - Reduce cost of treatment by $129 billion
- By comparison, melanoma and other skin cancers have…
  - Annual death rate of 13 thousand
  - Annual years of life lost of 180 thousand
  - Cost of treatment of $8 billion

OBJECTIVE, REPEATED

- Discuss costs and benefits of increasing vitamin D-related behavior
- These objectives were met.

I thank the audience for your kind attention.