

# Dietary Sodium and Health – What is known, and not known

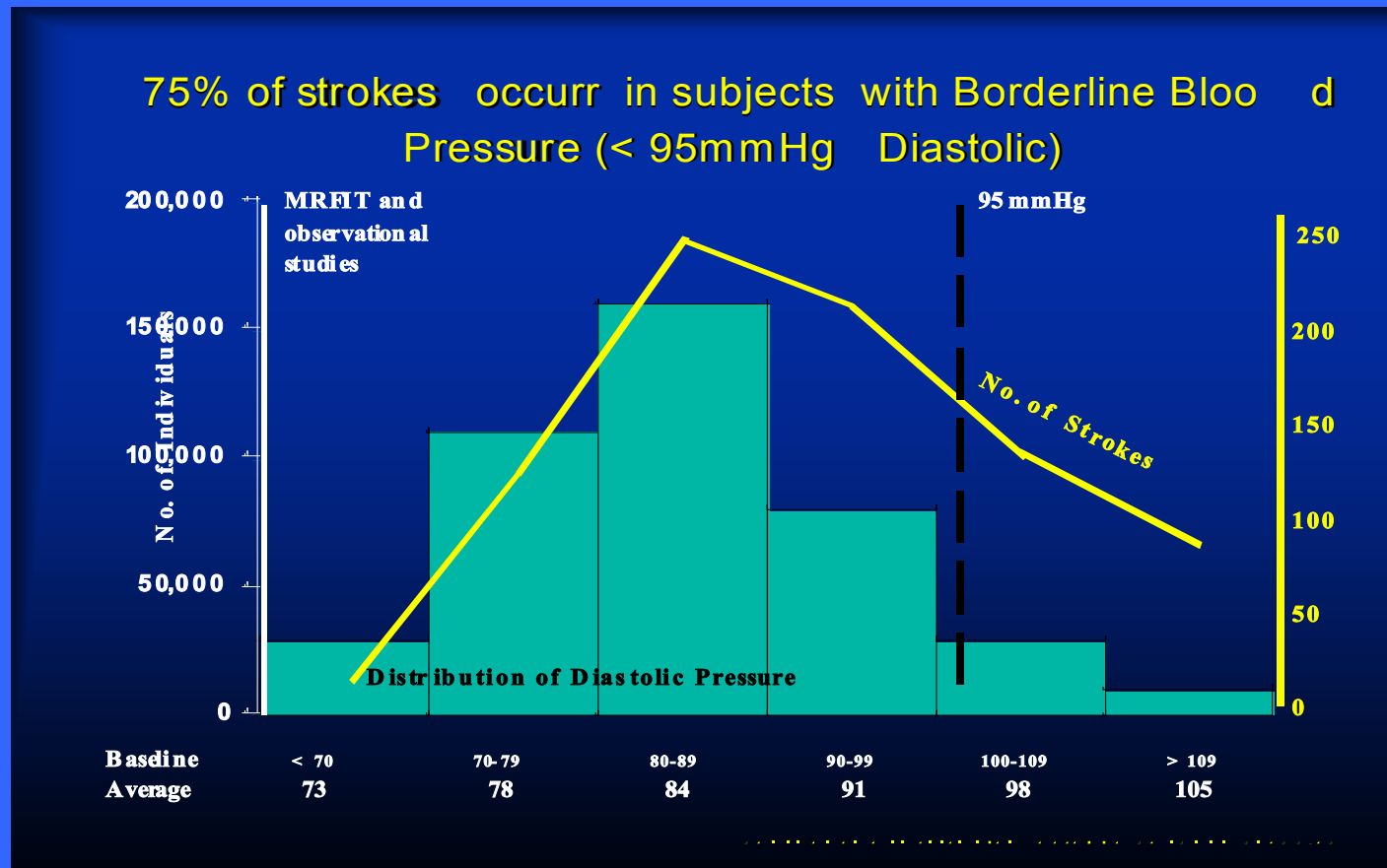
**MH Alderman**  
**World Salt Symposium**  
June 19, 2018  
Park city, Utah

# The Official Start

- “....it is essential to focus on the continuing **high salt** use of Americans. Precise data are non-existent ..... growing concern ....that somehow... salt intake sets the stage.....acts as a conditioner, so to speak ... **for the development of hypertension..**”

Stammler, J. Senate Select Committee 1977

Most CVD morbidity and mortality occurs below where drug Rx advised - hence population wide approach makes sense



# The Issue

- Most authoritative Guidelines recommend that all adults reduce sodium intake to less than 2.3g/day.
- This would affect about 90% of the population.
- Is the evidence sufficient to justify an intervention of this magnitude?

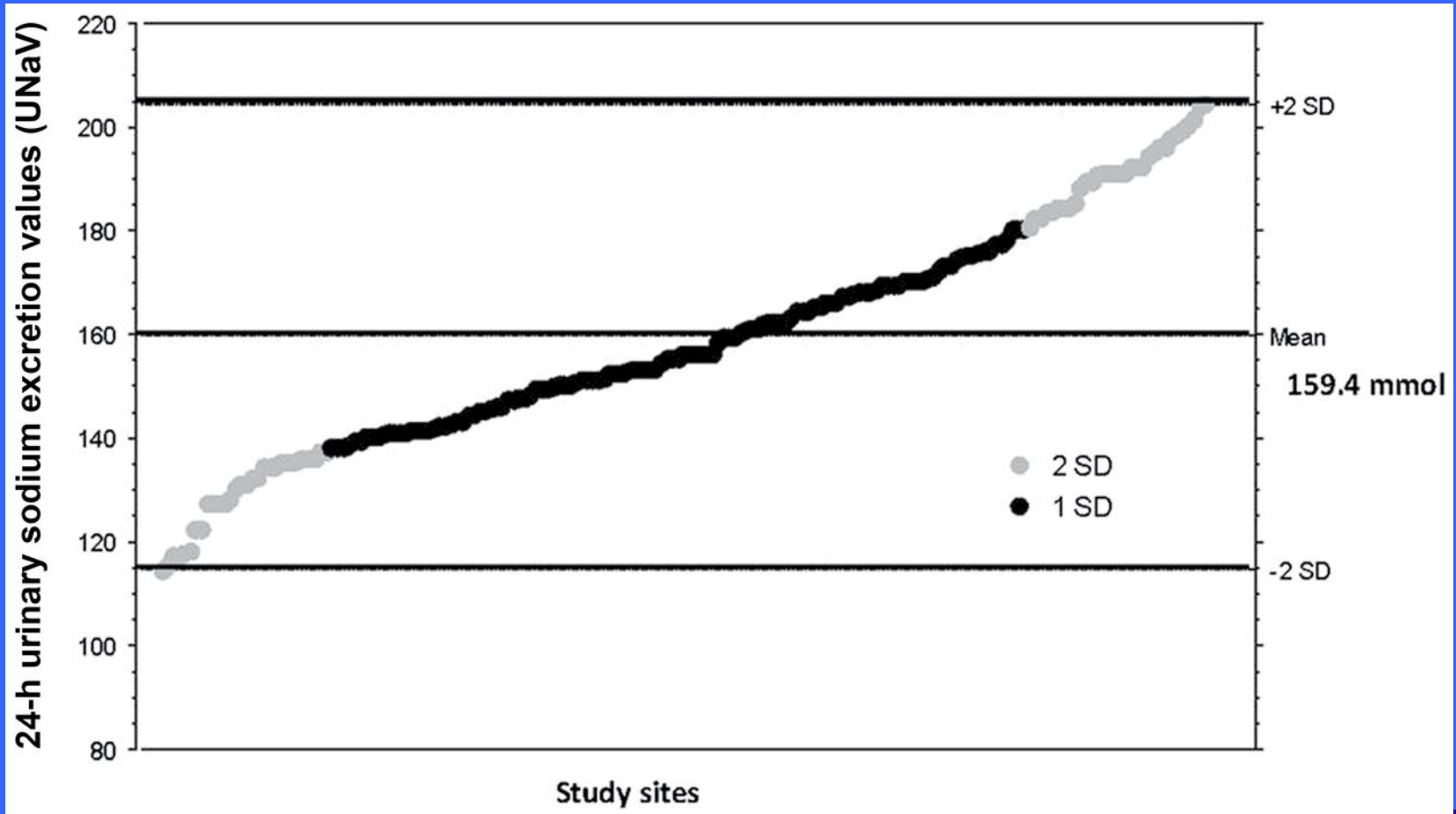
# What is known I

- Sodium is an essential nutrient.
- Sodium Intakes below some level are incompatible with human life.
- The sodium intake of about 85% of Americans, as well as most of the rest of the world, is between about 2.5 and 5.0g/d.

# What is known, II

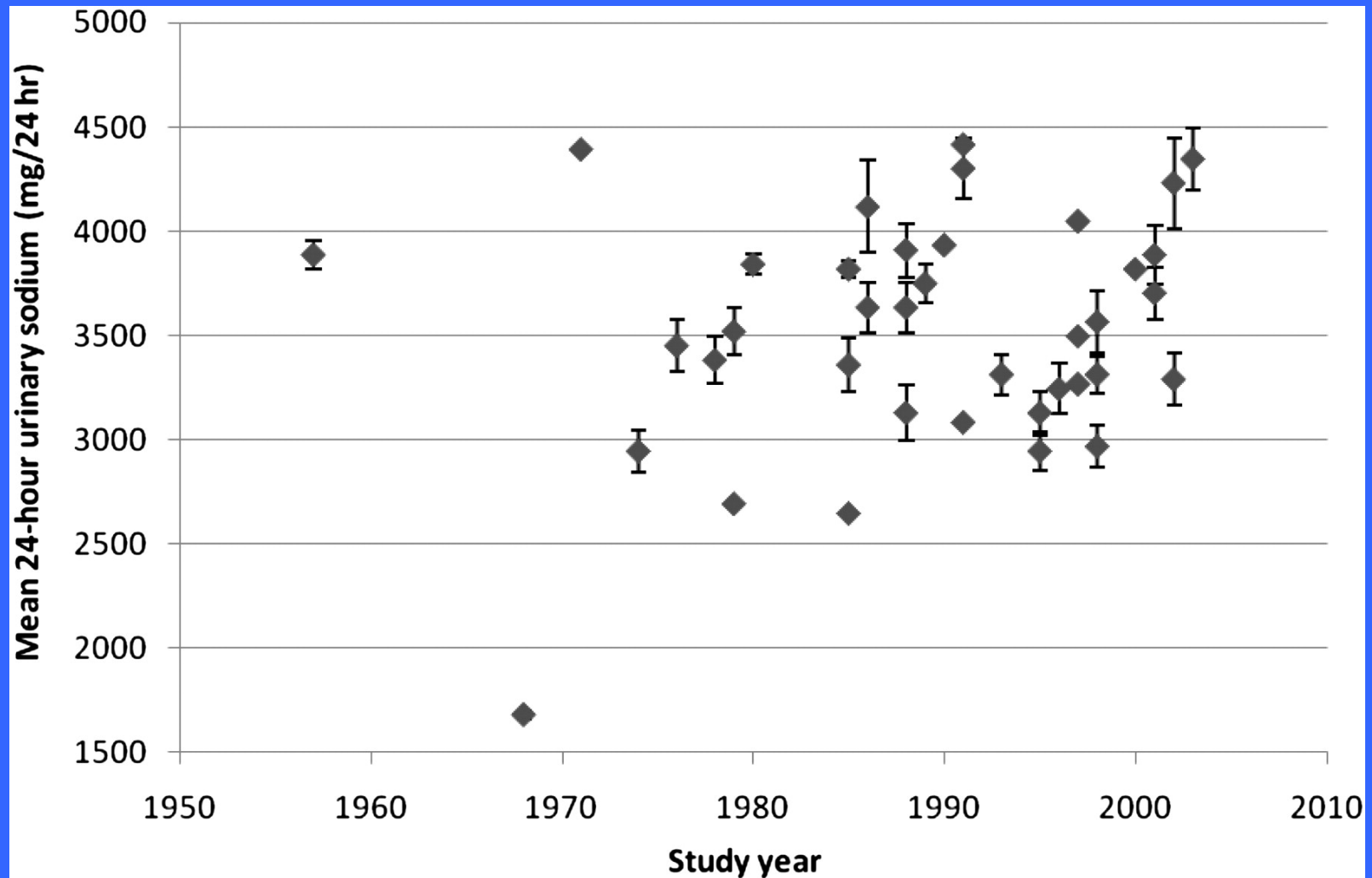
- Sodium intake has proved remarkably resistant to change.
- Sodium intake influences a variety of physiological factors, including blood pressure.
- Sodium intake is associated with cardiovascular and all cause mortality.

# Range of mean values for urinary sodium (UNaV; mmol/d) from 190 studies worldwide (160 mmol = 3600 mg/d)



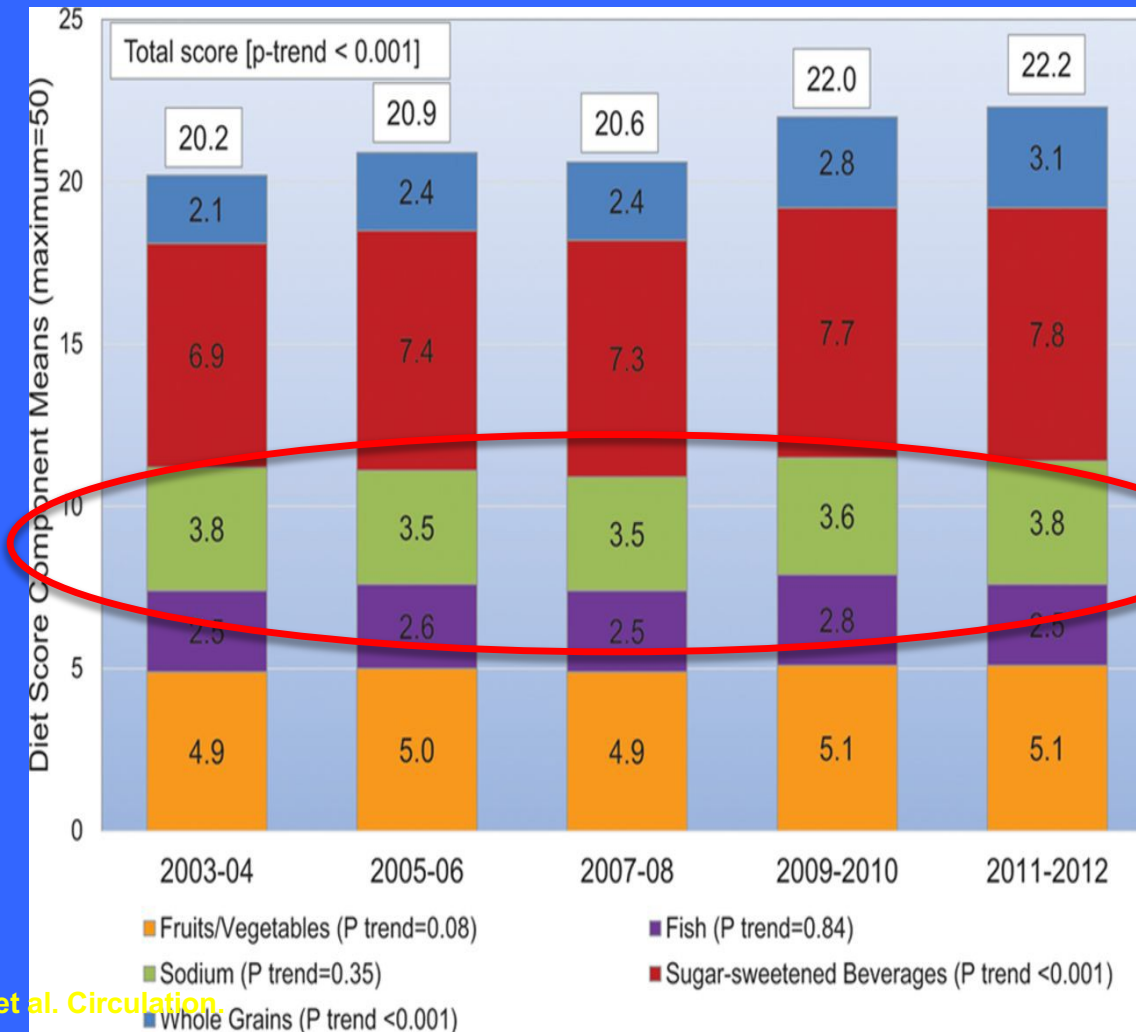
# 5 Decades of US Population $\text{UNa}^+$

(Mean sodium 160mg/d)





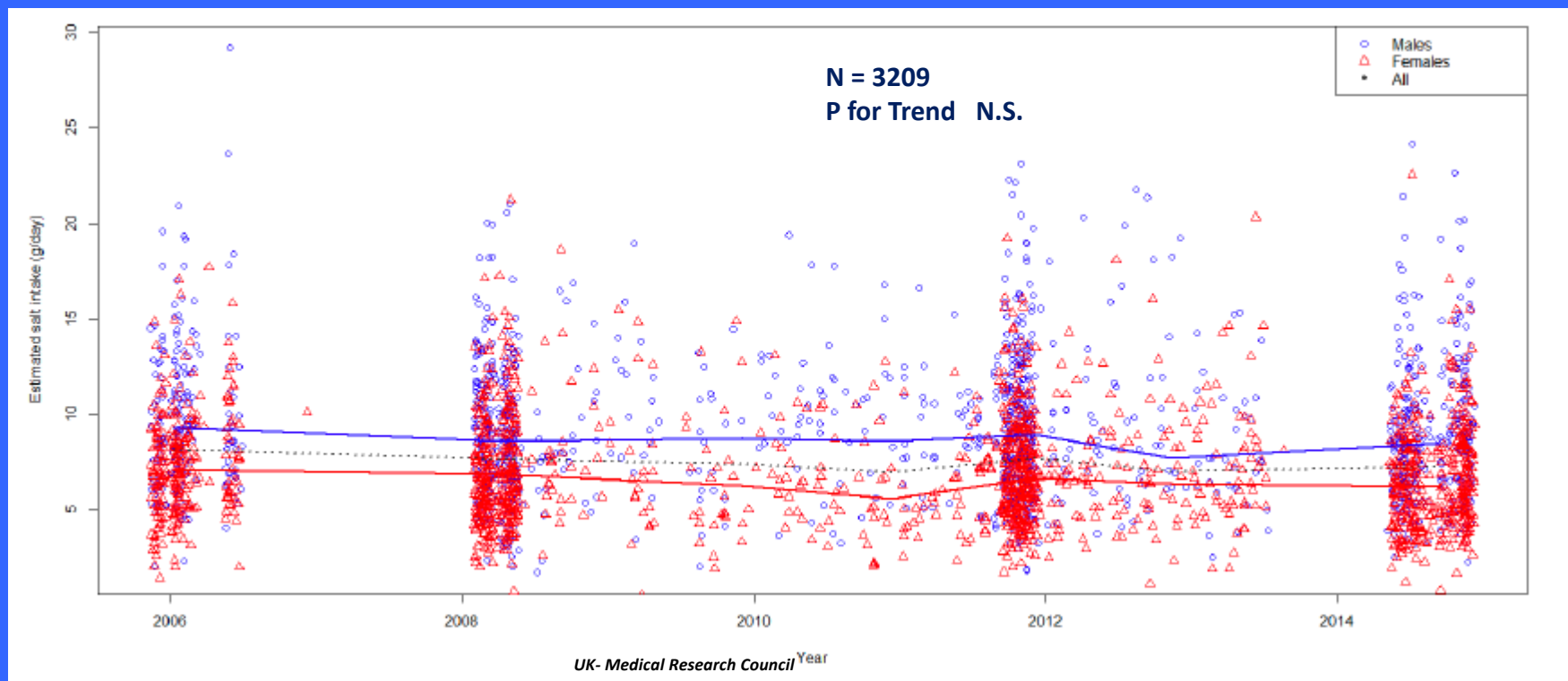
# Trends in (AHA) healthy diet score for adults By NHANES 2003 to 2012.



# NATIONAL DIET AND NUTRITION SURVEY

## ASSESSMENT OF DIET SODIUM (24 Hr UNaV)

### Adults 19-64 Years –England 2005-2014



# Effect of UK mandated reduction of Na<sup>+</sup> content in processed food 2008 -2014

“there was no statistically significant downward linear trend or further significant change between 2008-09 to 2014”

Department of Health. National Diet and Nutrition Survey - Assessment of dietary sodium in adults (aged 19 to 64 years) in England.

[www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/213420/Sodium-Survey-England-2011\\_Text\\_to-DH\\_FINAL1.pdf](http://www.gov.uk/government/uploads/system/uploads/attachment_data/file/213420/Sodium-Survey-England-2011_Text_to-DH_FINAL1.pdf).

The remarkable tenacity of sodium intake across time, place and diet.

In, short, it appears that free living subjects can not achieve a significant reduction of sodium intake, and, most consume between

2.8 – 5.0 g/d

Is it cosmic design.....or evolution?

# Impact of Current Upper Limit for Na<sup>+</sup> on PRA

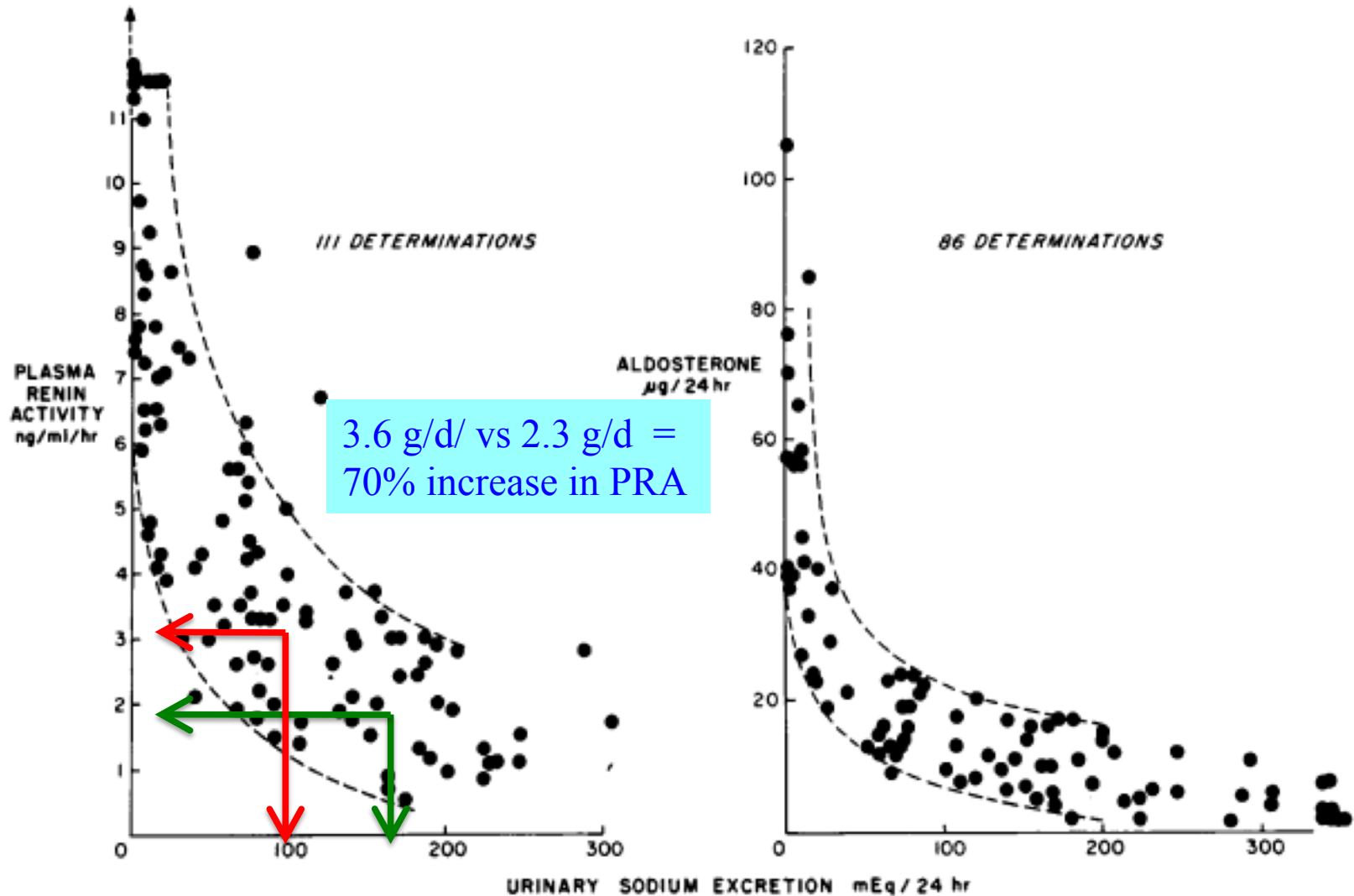
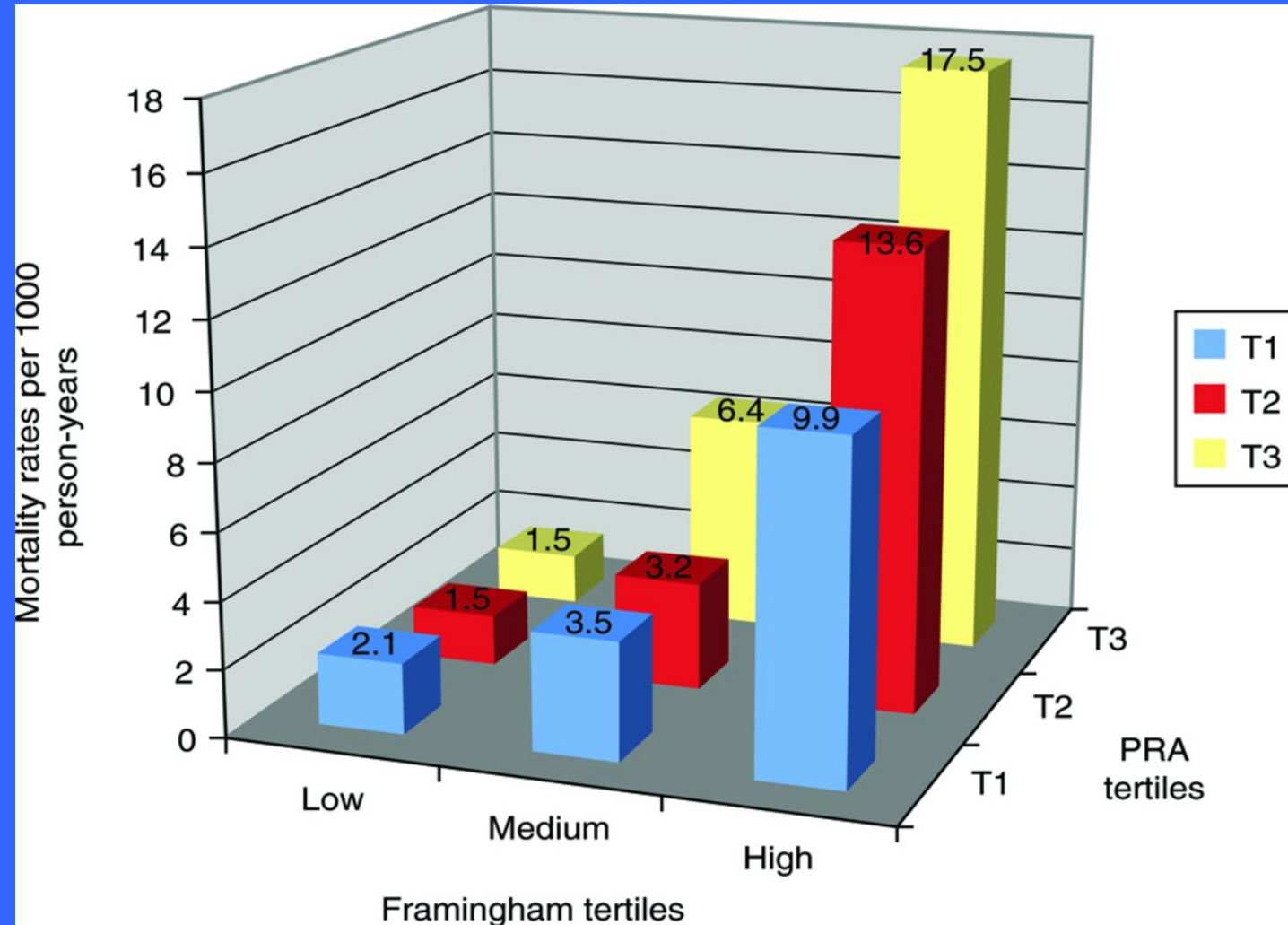
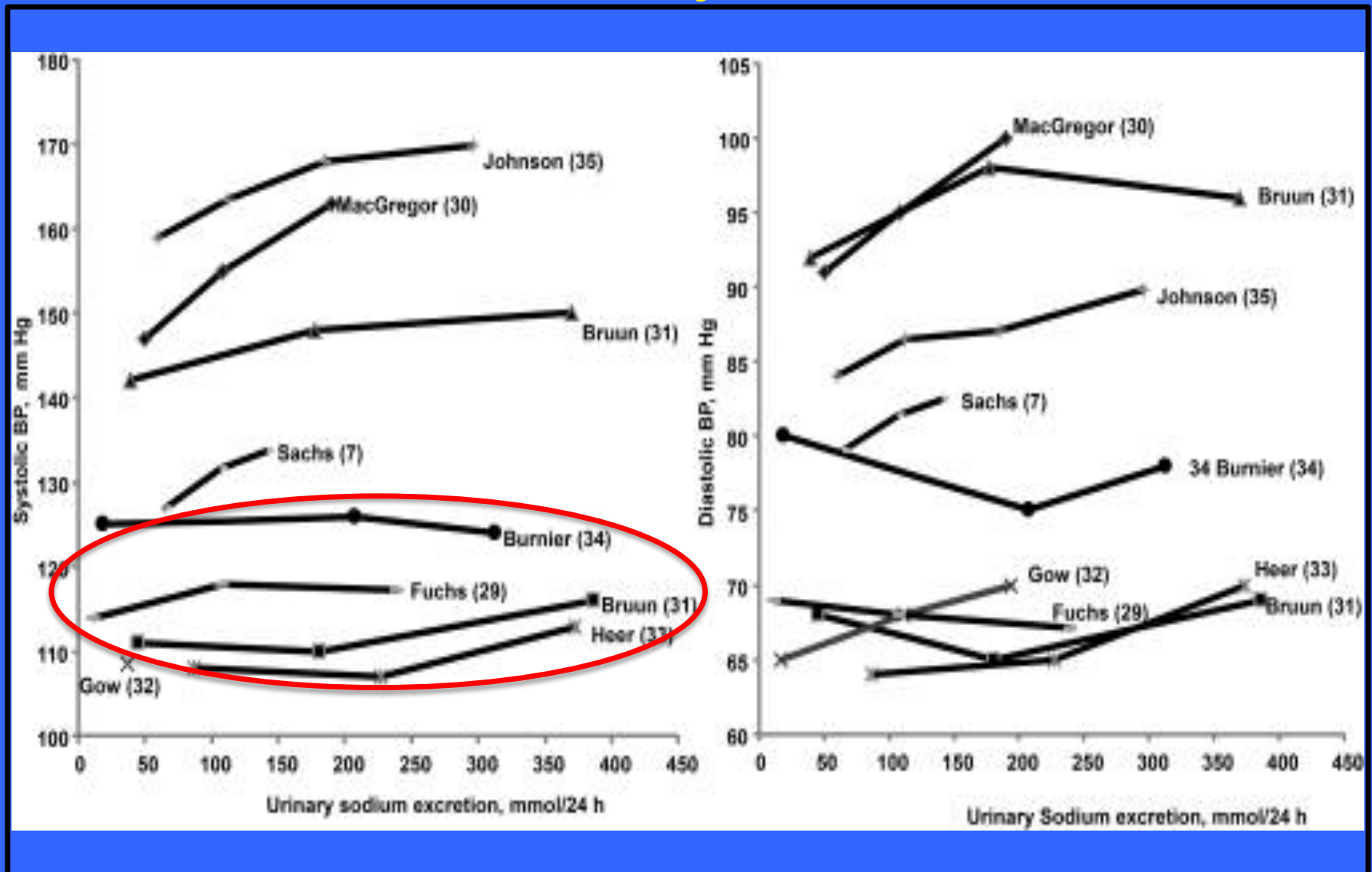


Figure 1. Relation of Noon Plasma Renin Activity and the Corresponding Daily Aldosterone Excretion to the Concurrent Daily Rate of Sodium Excretion in 52 Normal Subjects.

# CVD mortality rates adjusted for age-sex by tertiles of Framingham and PRA.



# ↓ Na<sup>+</sup> does not lower BP in Normotensive subjects

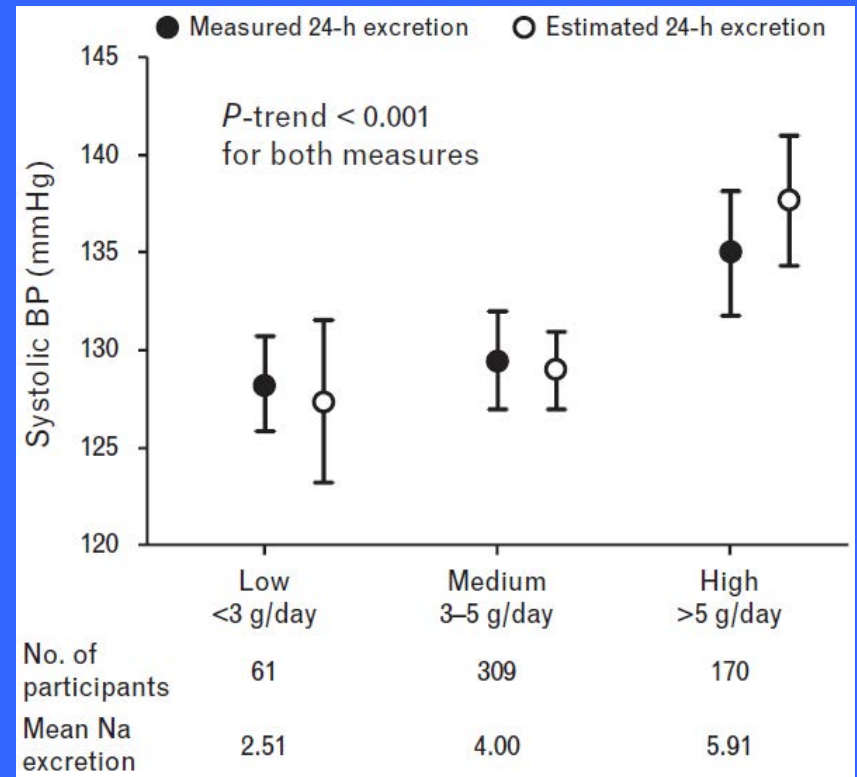
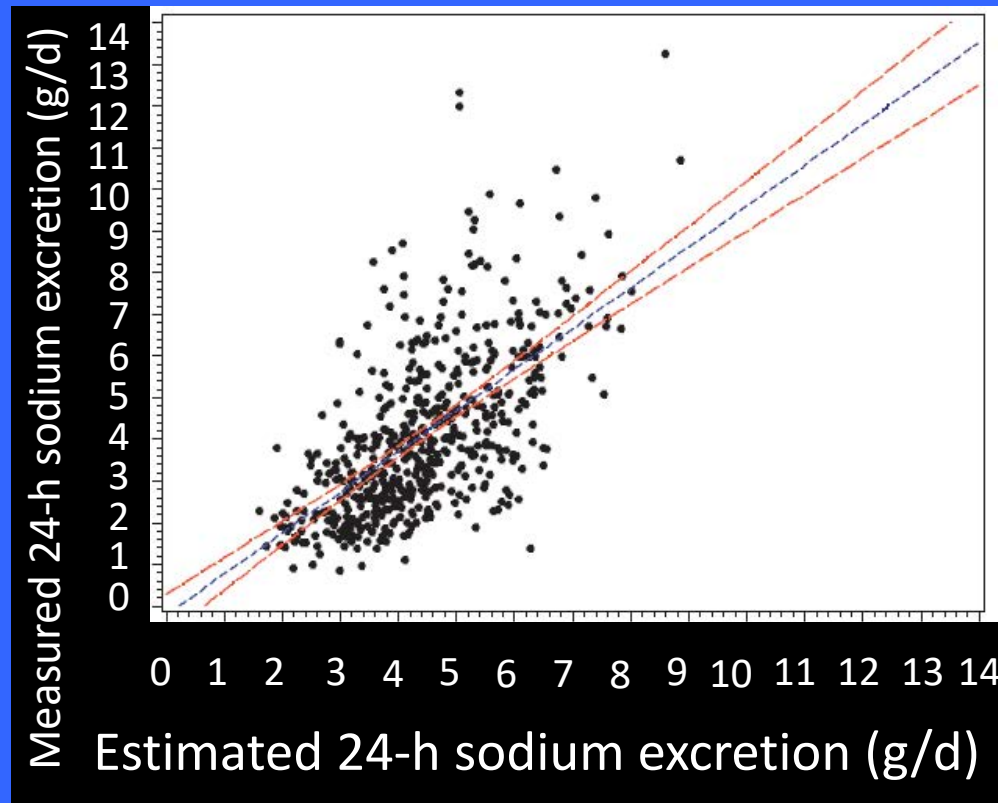


# Estimated vs. measured 24-hr excr.

(n=1083; 11 countries)

Measured vs. estimated Na excr.  
ICC = 0.71,  $P < 0.001$

## Na excr. vs Systolic BP



Similar results for K

Similar results for diastolic BP



# RCT confirmed Physiological consequences of Reduced Na<sup>+</sup>

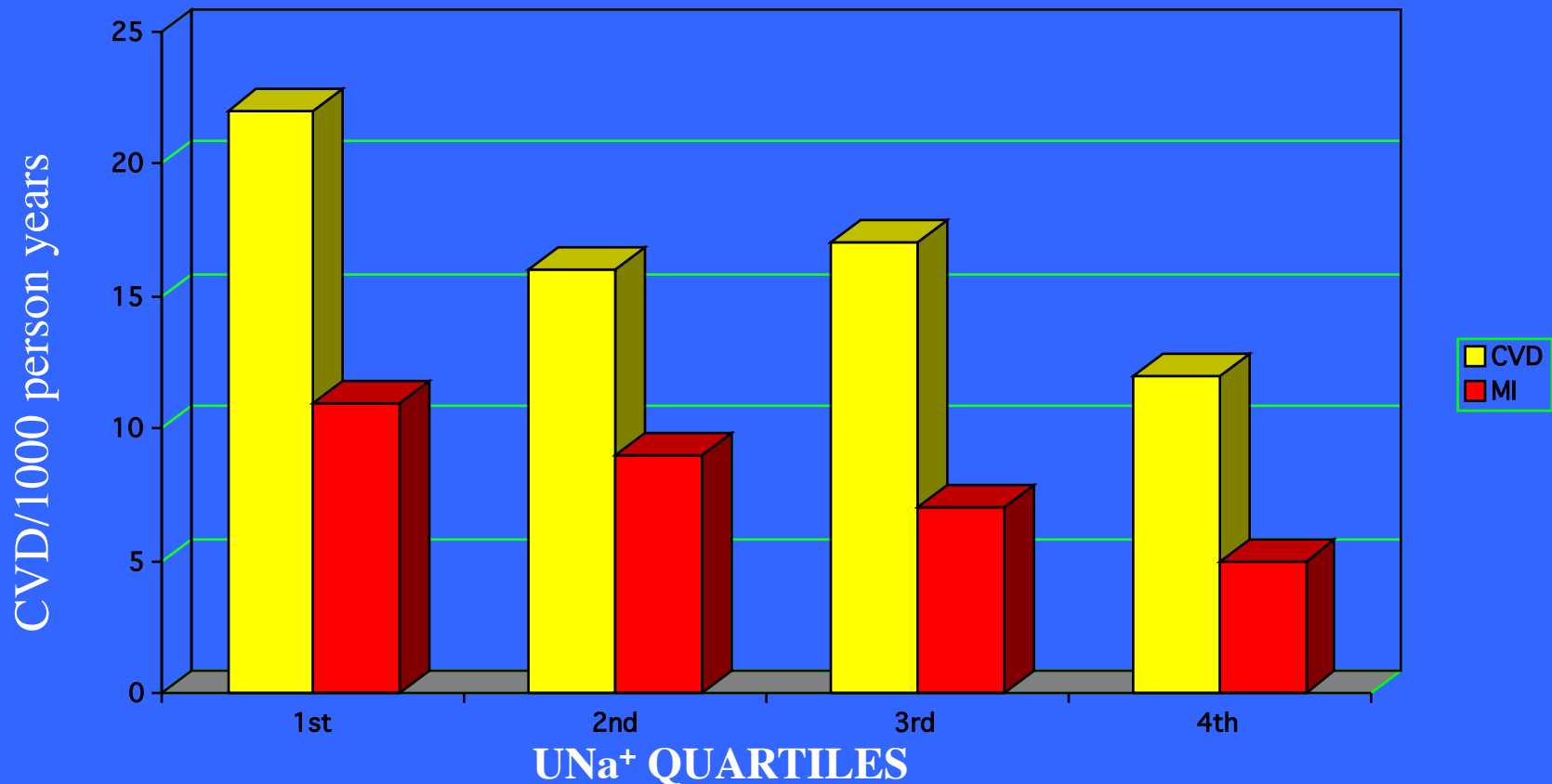
- Renin
- Aldosterone
- Adrenaline
- Blood pressure
- Cholesterol
- HDL
- Noradrenaline
- Triglycerides

# Observational studies

- 36+ with >400,000 participants.
- Regardless of method, the mean and range of these studies is the same –average 160, all match population surveys
- Because sodium is required to sustain human life, like all other essential nutrients a “J” or “U” shaped relation to mortality is expected.
- Observational studies tell us the outcomes of those who choose a particular diet.
- But, nothing about what might happened if sodium intake were modified.

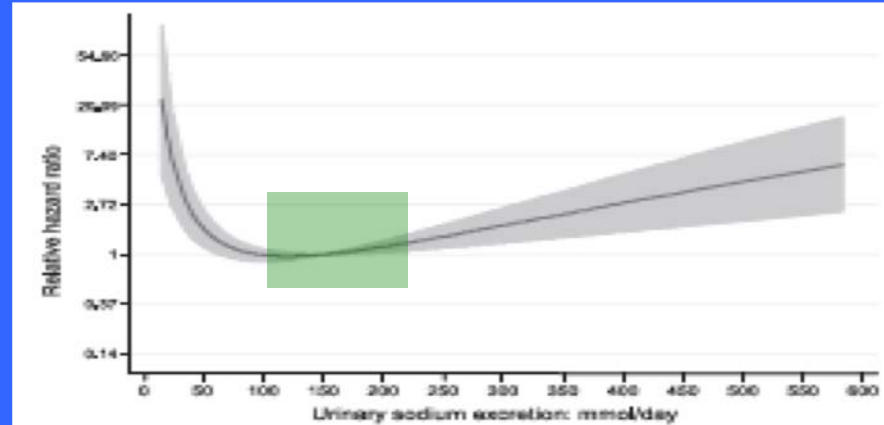
# WORKSITE HYPERTENSION STUDY

## CARDIOVASCULAR EVENTS BY $\text{UNa}^+$

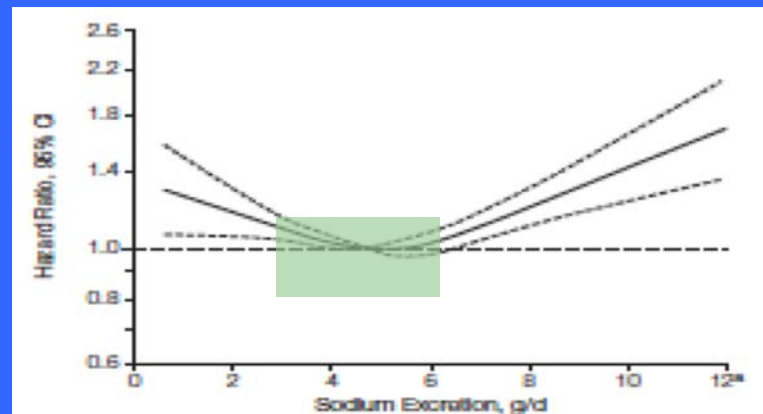


# Lower UNaV and Increased CVD Risk

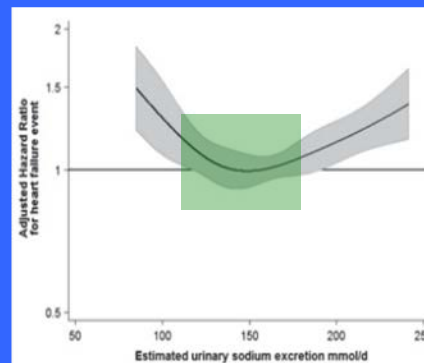
DM I – Na<sup>+</sup> Intake  
All-Cause Mortality  
*Diabetes Care* 2011



Na<sup>+</sup> Intake & CVD  
Events  
Death, MI, CHF, Stroke  
*JAMA* 2011



Na<sup>+</sup> Intake & Risk of  
CHF  
*Euro J Ht* 2014

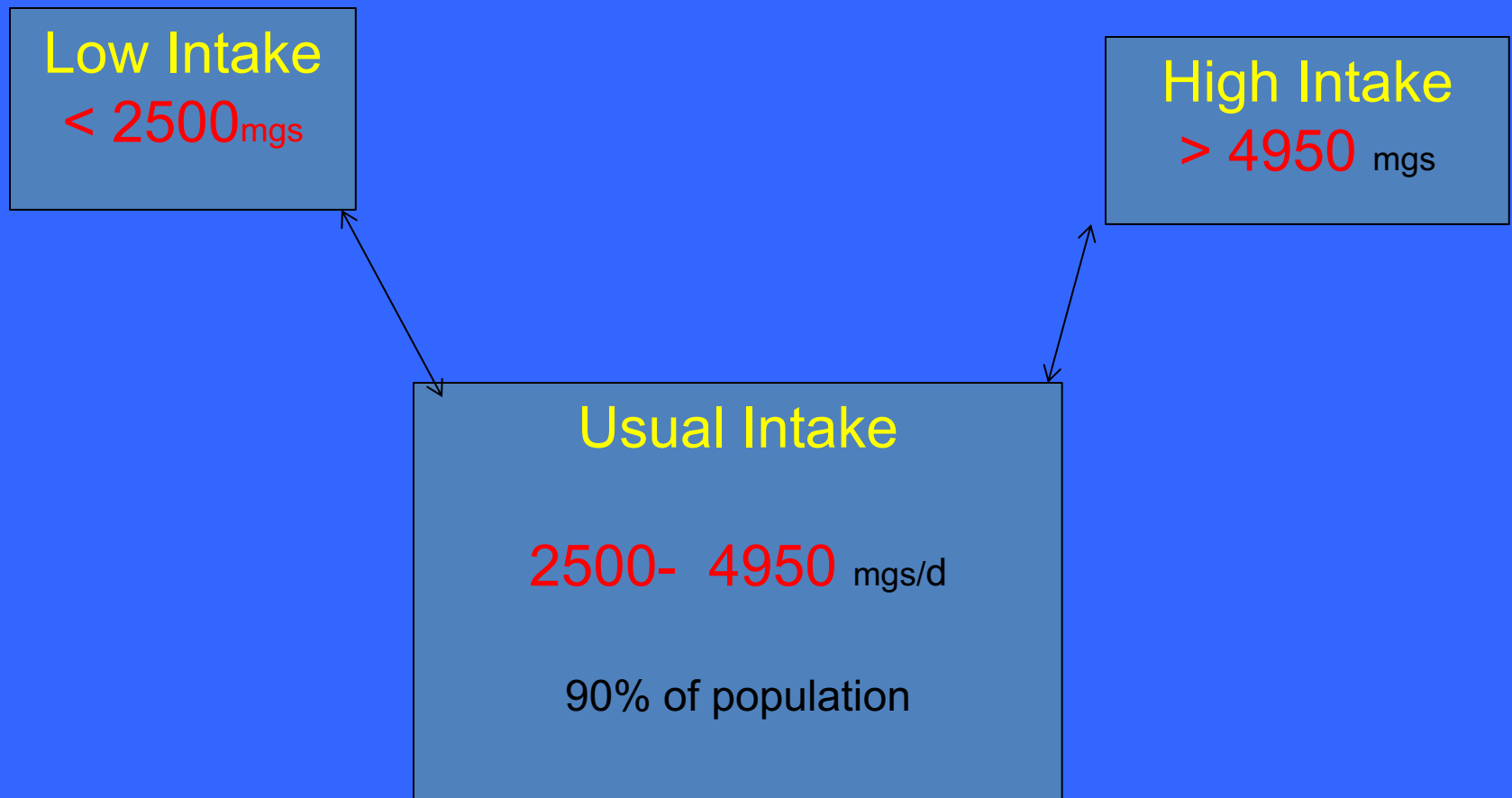


< 1500 mg/d

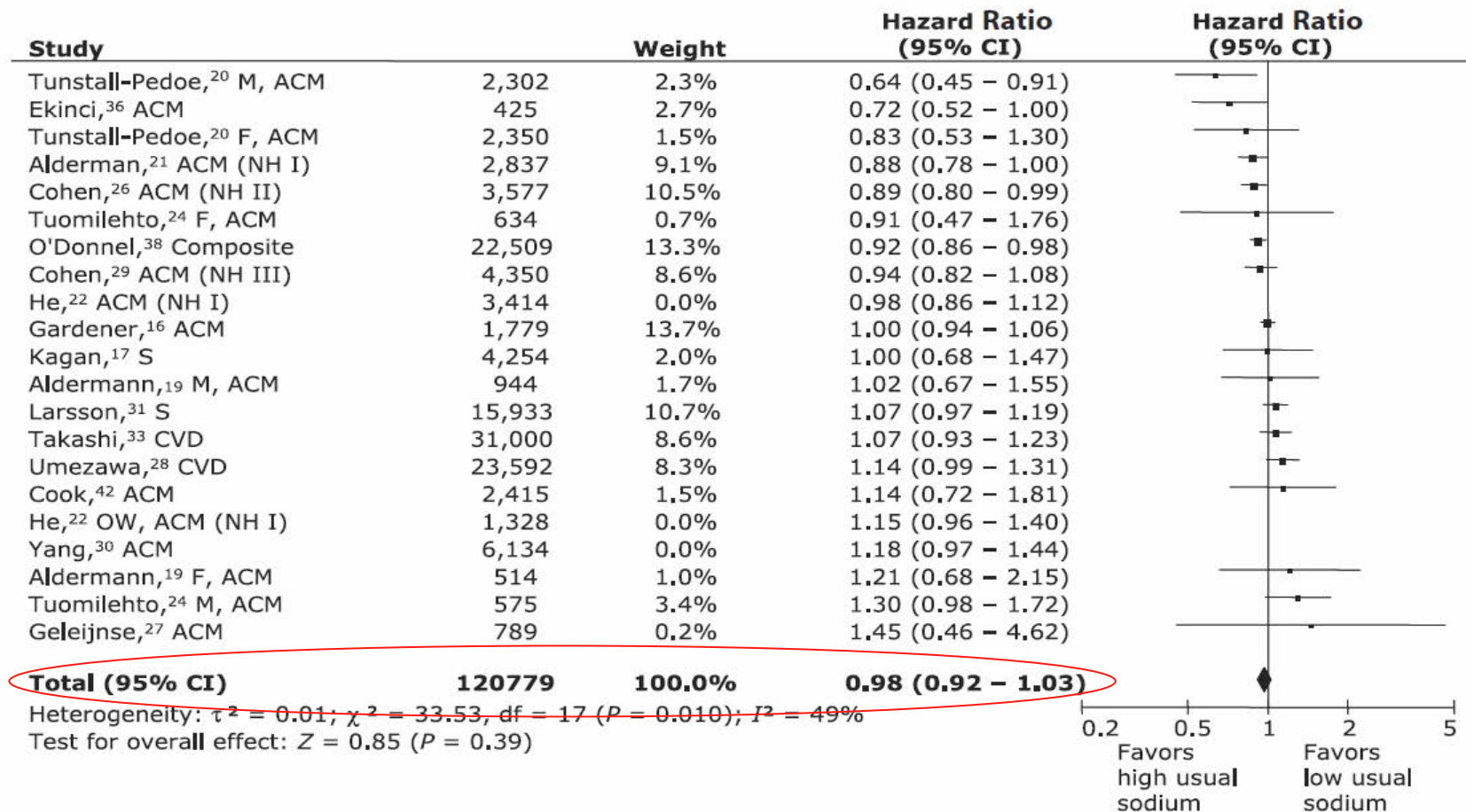
< 2300 mg/d

>2800-5000<  
mg/d

# Mortality of Usual compared to Higher and Lower Sodium intakes

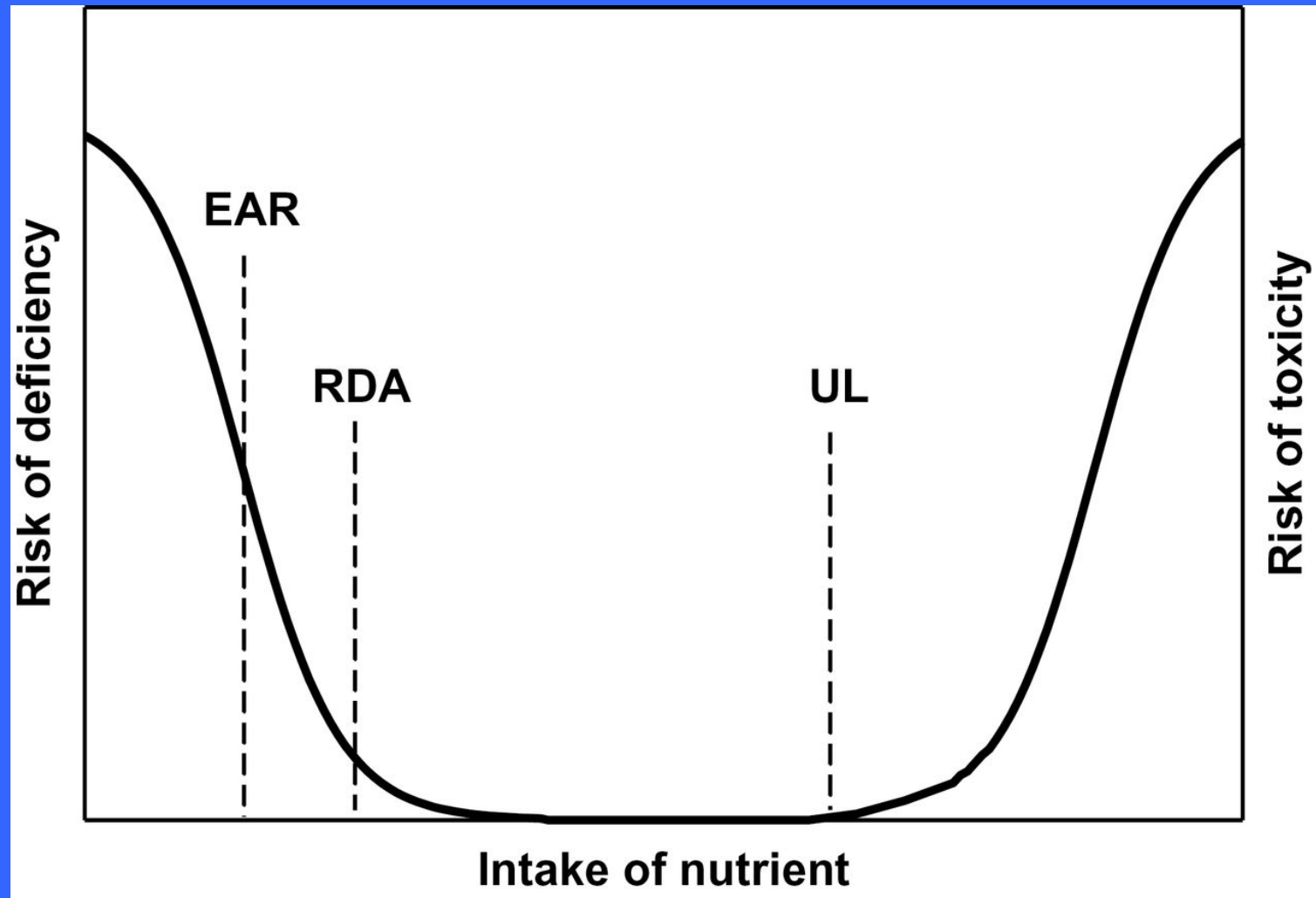


# Composite Endpoint: High v. Low within Usual Sodium 25 studies, 120,000 persons



**Figure 2.** Composite outcome (most frequent events combined), high usual sodium vs. low usual sodium. Exchanging the first NHANES analyses<sup>21,29</sup> with the reanalyses<sup>22,30</sup> (hazard ratio = 1.01; 95% confidence interval = 0.95–1.07;  $P = 0.79$ ). ACM, all-cause mortality; CVD, cardiovascular disease; F, female; M, male; NH, NHANES; S, stroke.

## Relationship of risk and nutrient intake, and the 3 principal Dietary Reference Intakes.



# Evidence that altering sodium intake effects health outcomes

- Requires Randomized clinical Trials.
- There is only one prospectively designed study comparing outcomes in two groups randomly assigned to high and low sodium intakes



# 20 year mortality Post-TOHP Follow-up of 1987-95 RCT

DEATHS/# (%) TOHP I & II	HAZARD RATIO	CONFIDENCE INTERVAL	P VALUE
Low v. High Na <sup>+</sup>			
115/1518 v. 136/1608 (7.6) (8.5)	0.85	0.66 – 1.10	0.21*

\* No significant difference

# Conclusions

- The Na<sup>+</sup> intake of most (85%) in America and worldwide appears optimal.
- Unlikely that sodium intake can be changed in free living persons
- About 15% have intakes that may be either deficient or excessive.
- ? Would they benefit from remediation?

# Implications

- No scientific justification for universal Na<sup>+</sup> reduction.
- If observational studies accurately predict health outcome, then population wide reduction would produce some winners and some losers – but most would not be affected.
- Clinical studies should focus on the 15% or so whose intakes are “deficient” or “excessive”.