27ο Πανελλήνιο Συνέδριο Νεφρολογίας

Astir-Egnatia Palace

20–23 Μαΐου 2026
Αλεξανδρούπολη

ΥΠΕΡΤΑΣΗ

Προεδρείο: **Π. Σαραφίδης, Δ. Βλαχάκος**

13.35–13.55	Η πρόσληψη άλατος προκαλεί Αρτηριακή Υπέρταση; **Μ. Κωστοπούλου**

DOI: None for this lecture

Αλάτι και εξέλιξη

500,000 χρόνια

Ο τροφοσυλλέκτης

- Φρούτα, φυτά, κρέας
- **NaCl : <1 g / day.**
- Περιεκτικότητα σε K 16x υψηλότερη του Na

10,000 χρόνια

Ο καλλιεργητής

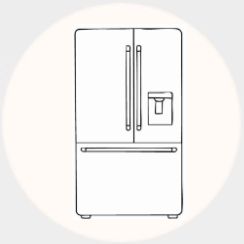
- Εγκατάλειψη νομαδικής ζωής
- Αύξηση πληθυσμού
- Φυτικές τροφές 90%

4,000 χρόνια

Ο τεχνίτης

- Το αλάτι για συντήρηση τροφής
- Τροφές με μεγάλη περιεκτικότητα σε NaCl
- **NaCl 18 g / day**
- Πρώτη λέξη για το αλάτι

Σήμερα



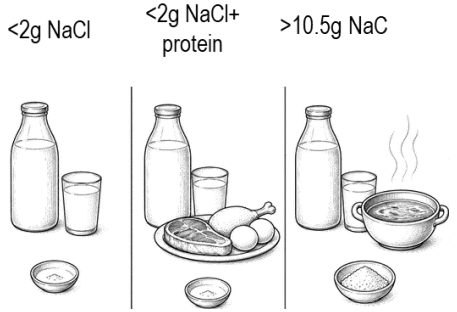
Σύγχρονη εποχή

- Άλλοι μέθοδοι συντήρησης
- **NaCl ~10 g / day**
- Χαμηλή πρόσληψη K

Αλάτι και Αρτηριακή Πίεση (take it with a grain of salt…)

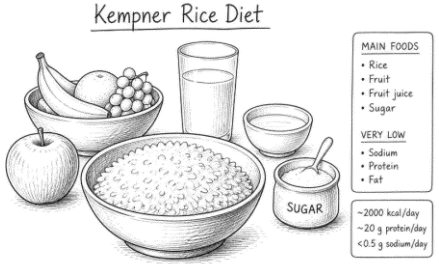
"Therefore, if large amounts of salt are taken, the pulse will stiffen or harden."
The Yellow Emperor's Classic of Internal Medicine, ***1700 BC***

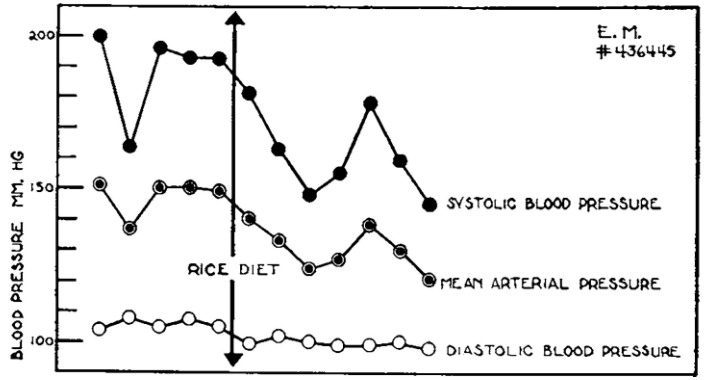
1904: Ambard and Beaujard



a. Αρνητικό ισοζύγιο και ↓ΑΠ
b. Αρνητικό ισοζύγιο και ↓ΑΠ
c. Θετικό ισοζύγιο και ↑ΑΠ

1948: Kempner's rice diet





NEJM Volume 244 • Number 16 • April 19, 1951 Pages: 577-581

Guyton’s autoregulation and pressure natriuresis

sodium

↓

ECFV expansion

↓

Increased cardiac output

↓

Increased peripheral flow

↓

Increased PVR

Kidney’s filtration capacity 25,000 mEq Na

Kidney’s excretion capacity 99%

Impaired renal function to excrete sodium in the urine

↓

ECFV expansion

↓

Increased cardiac output

↓

Increased peripheral flow

↓

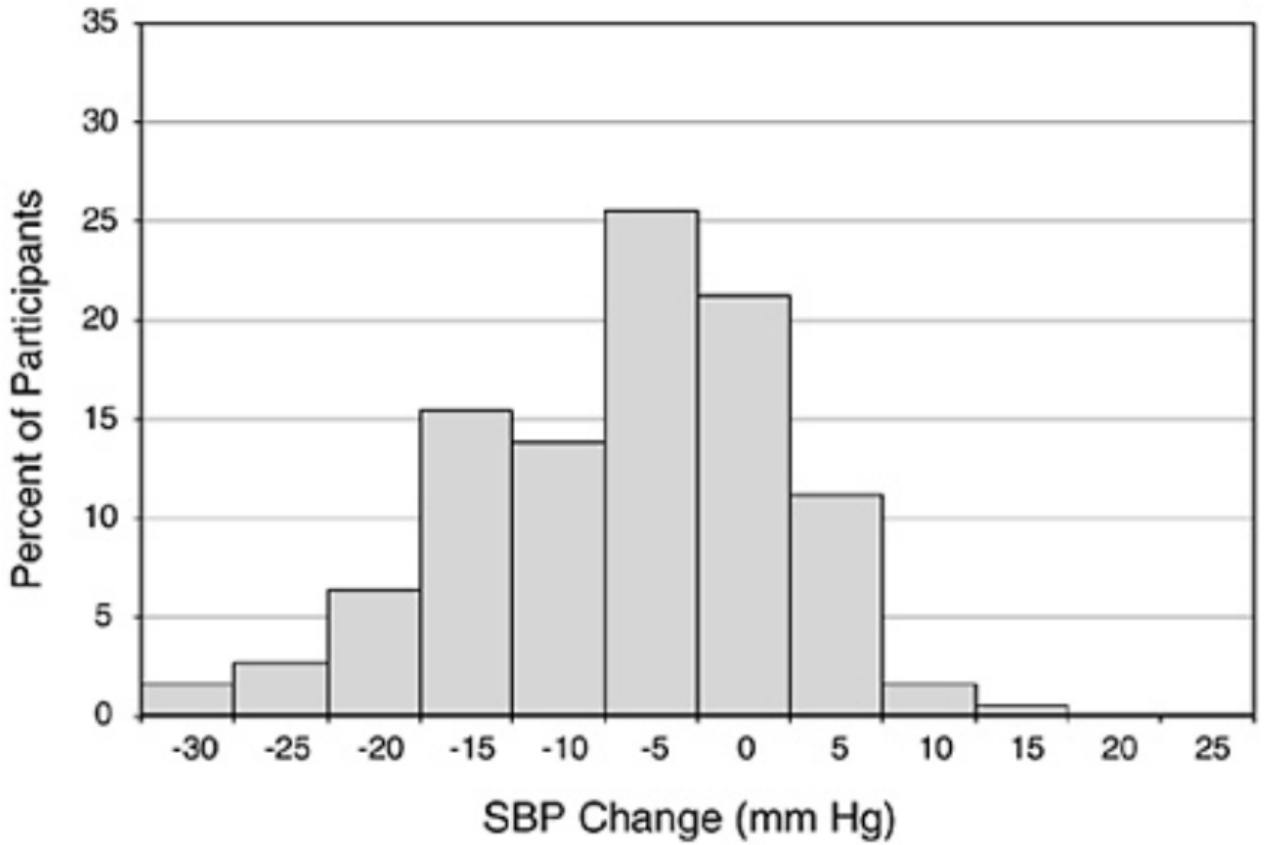
Increased PVR

↓

Chronic BP elevation

Hypertensive individuals respond with variation in high salt intake

BP differences between **two points in time** when sodium intake **decreased by 1.8 g/d (77 mmol/d)**.



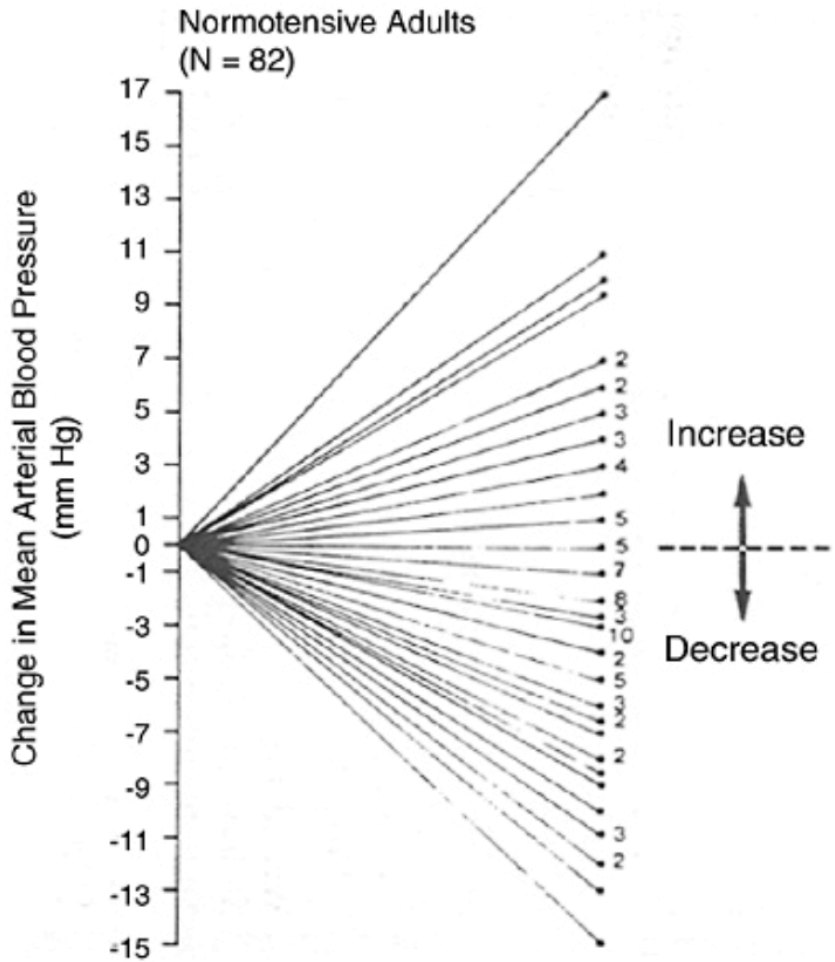
2 Phenotypes after a Sodium load:

Salt sensitive: Marked BP increase
Salt resistant: No or very small BP increase

SS test: 460 mmol for the day of salt loading (300 mmol in the saline infusion and 160-mmol diet) and 10-mmol diet plus furosemide (three 40 mg doses over 8 hours) the following day.

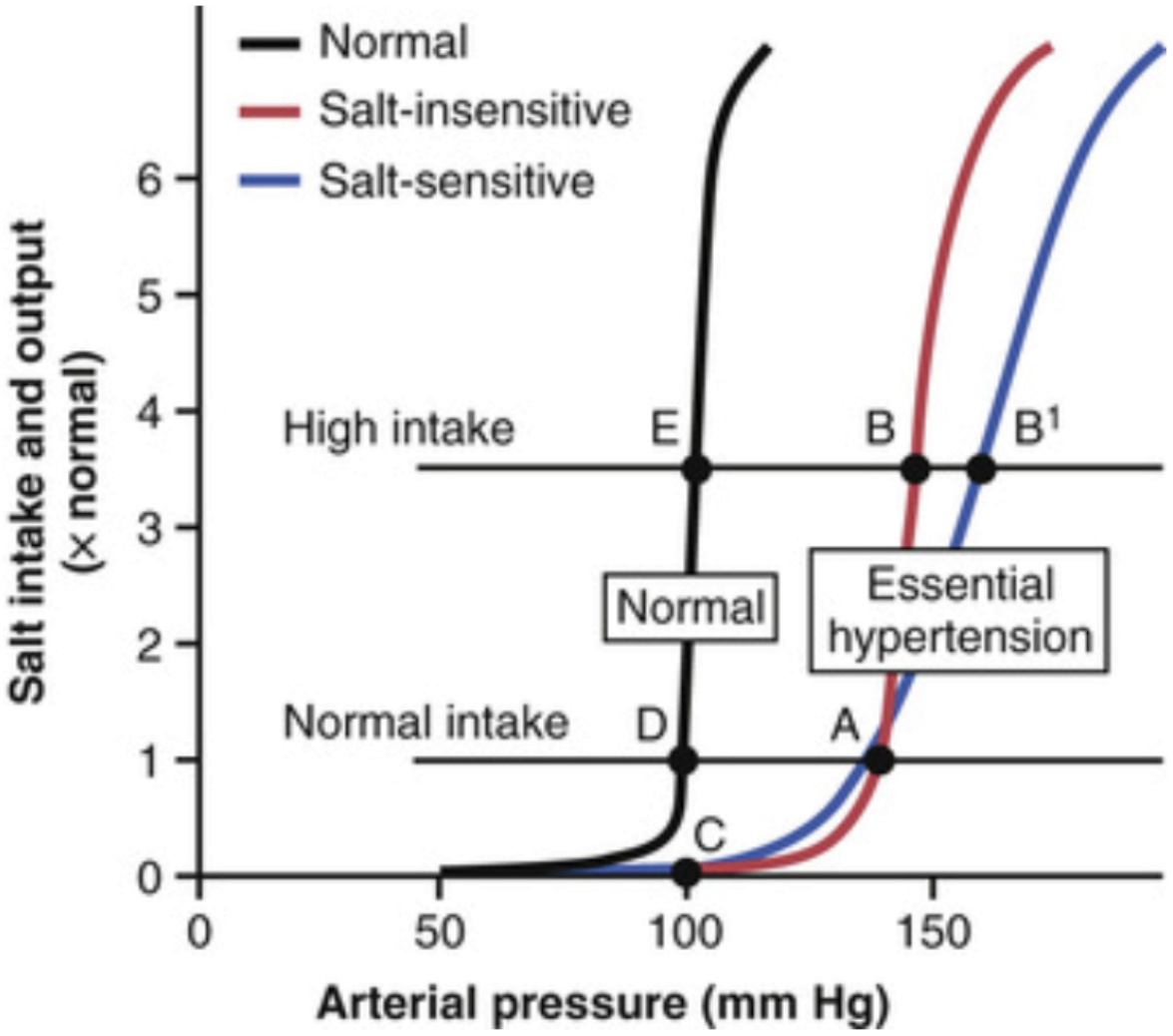
Salt Sensitivity of Blood Pressure: A Scientific Statement From the American Heart Association. https://doi.org/10.1161/HYP.0000000000000047
National Academies of Sciences, Engineering, and Medicine. 2005. Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate. Washington, DC: The National Academies Press. https://doi.org/10.17226/10925.

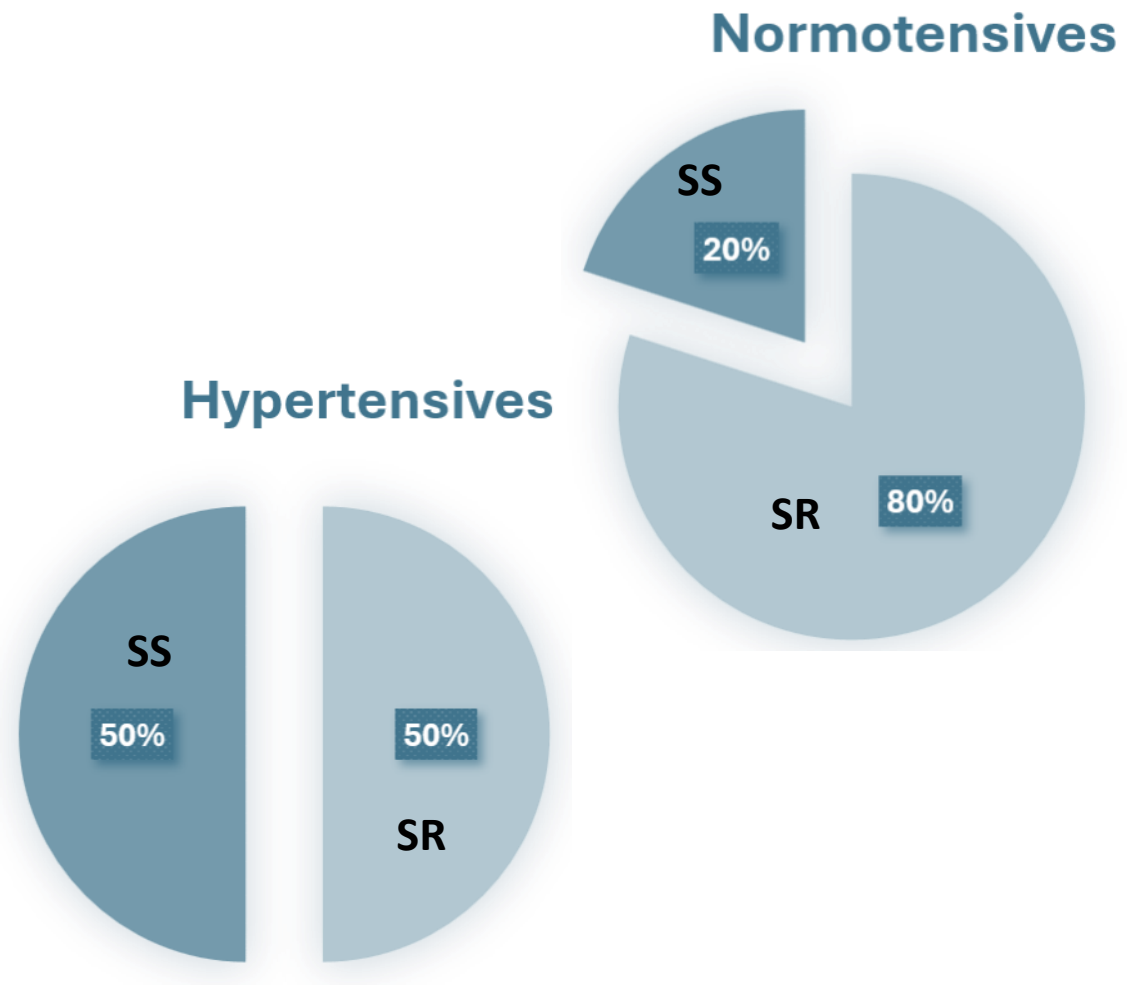
Normotensive individuals respond with variation in high salt intake



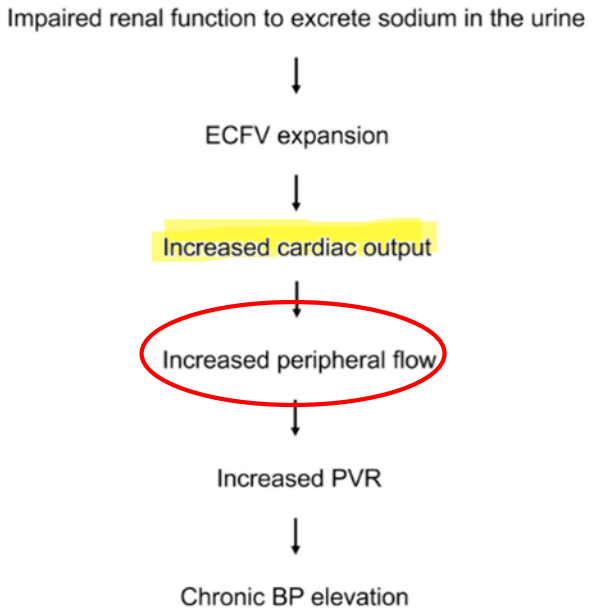
National Academies of Sciences, Engineering, and Medicine. 2005. Dietary Reference Intakes for Water, Potassium, Sodium, Chloride, and Sulfate. Washington, DC: The National Academies Press. https://doi.org/10.17226/10925.

Guyton: The Renal-Centric View





https://elsevier-elibrary.com/contents/fullcontent/83273/epubcontent_v2/OPS/xhtml/chp00019.xhtml



Kurtz and Morris : The Vascular-Centric View

ECV and total body mass have non-linear responses to increased salt:

Significant from low to moderate Na diet
None from moderate to high Na diet

1. high-salt diet
2. normal (compared to salt resistant) sodium accumulation,
3. normal volume expansion
4. normal cardiac output adjustments
5. subnormal vasodilatory response to increased salt **in the absence of abnormal salt retention and before systemic vascular resistance increases above baseline**

N Engl J Med 2021;385:1981-93. DOI: 10.1056/NEJMra2030212

Bie: The RAS-humoral centred View

In **slow rates** of iv NaCl there is an increased Na excretion but no measurable change in BP

So is BP elevation necessary to get rid of Na?

Salt

⇩

ECFV (Sensed by low-pressure stretch receptors)

⇩

↓PRA

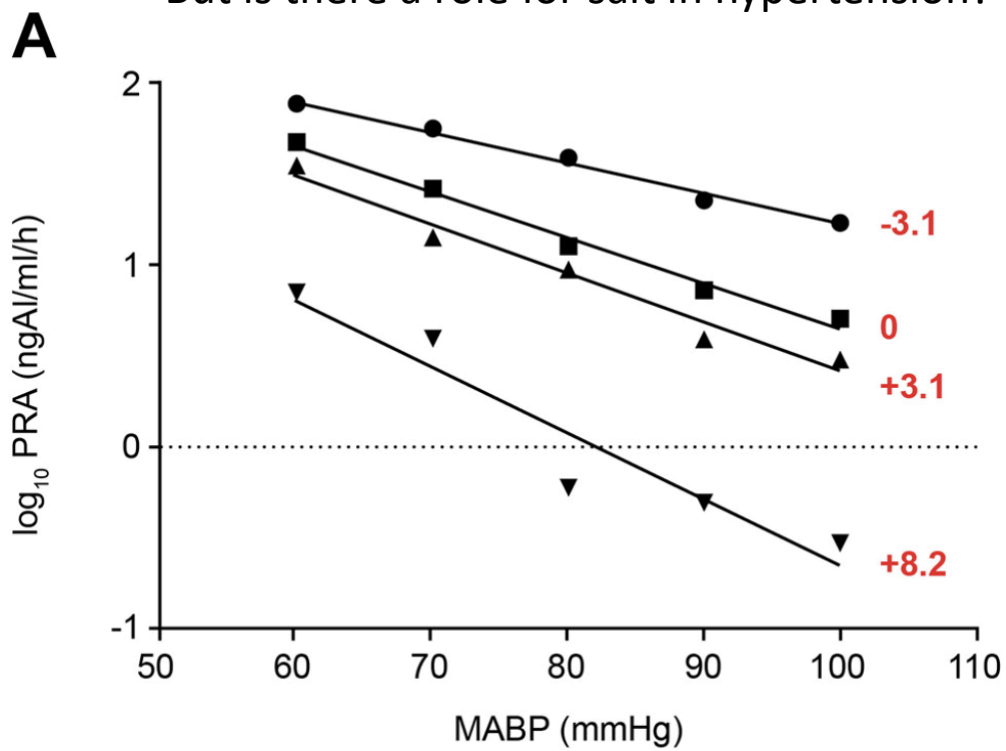
⇩

↓ Sodium Reabsorbing

⇩

Natriuresis

But is there a role for salt in hypertension?

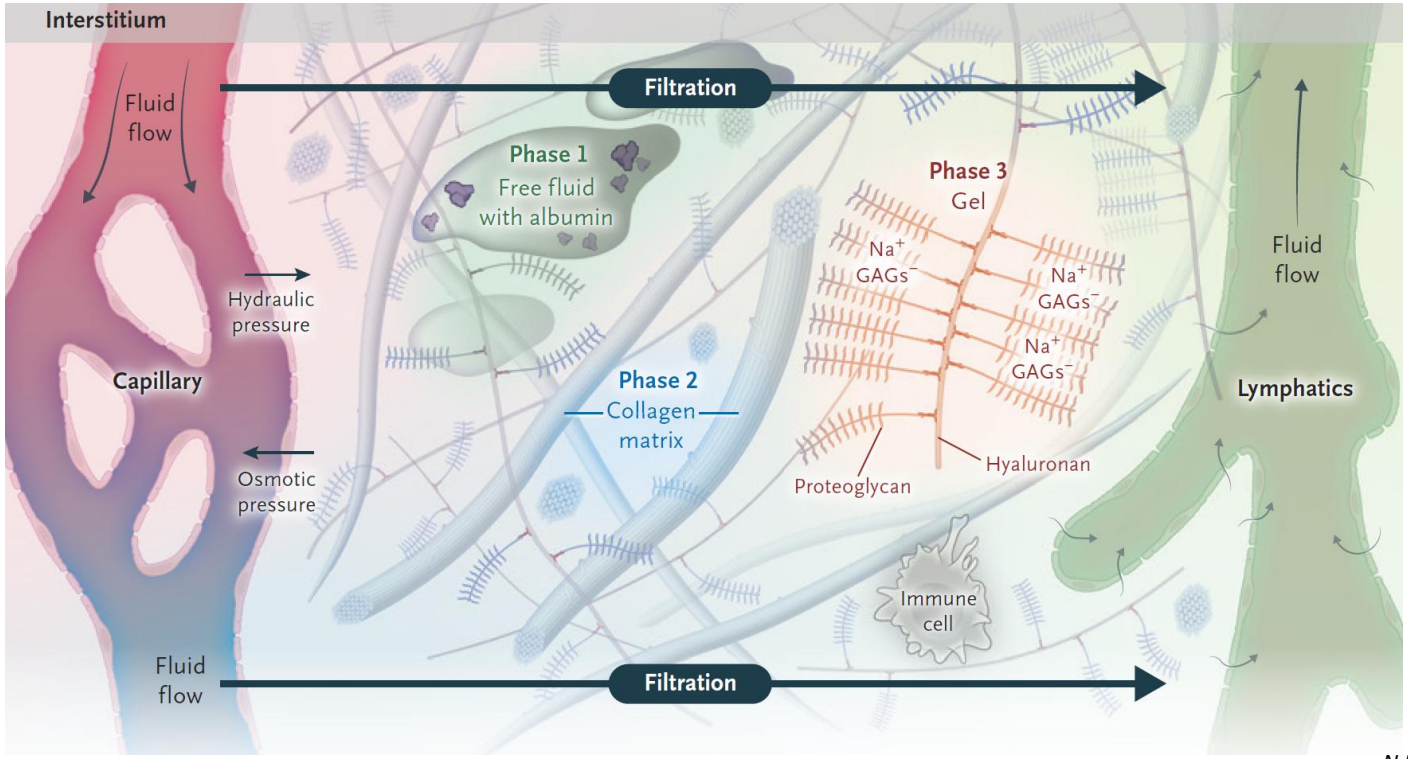


Bie Am J Physiol Regul Integr Comp Physiol 315: R945–R962, 2018.First published August 15, 2018; doi:10.1152/ajpregu.00363.2017

Titze: The osmotic vs non-osmotic Sodium

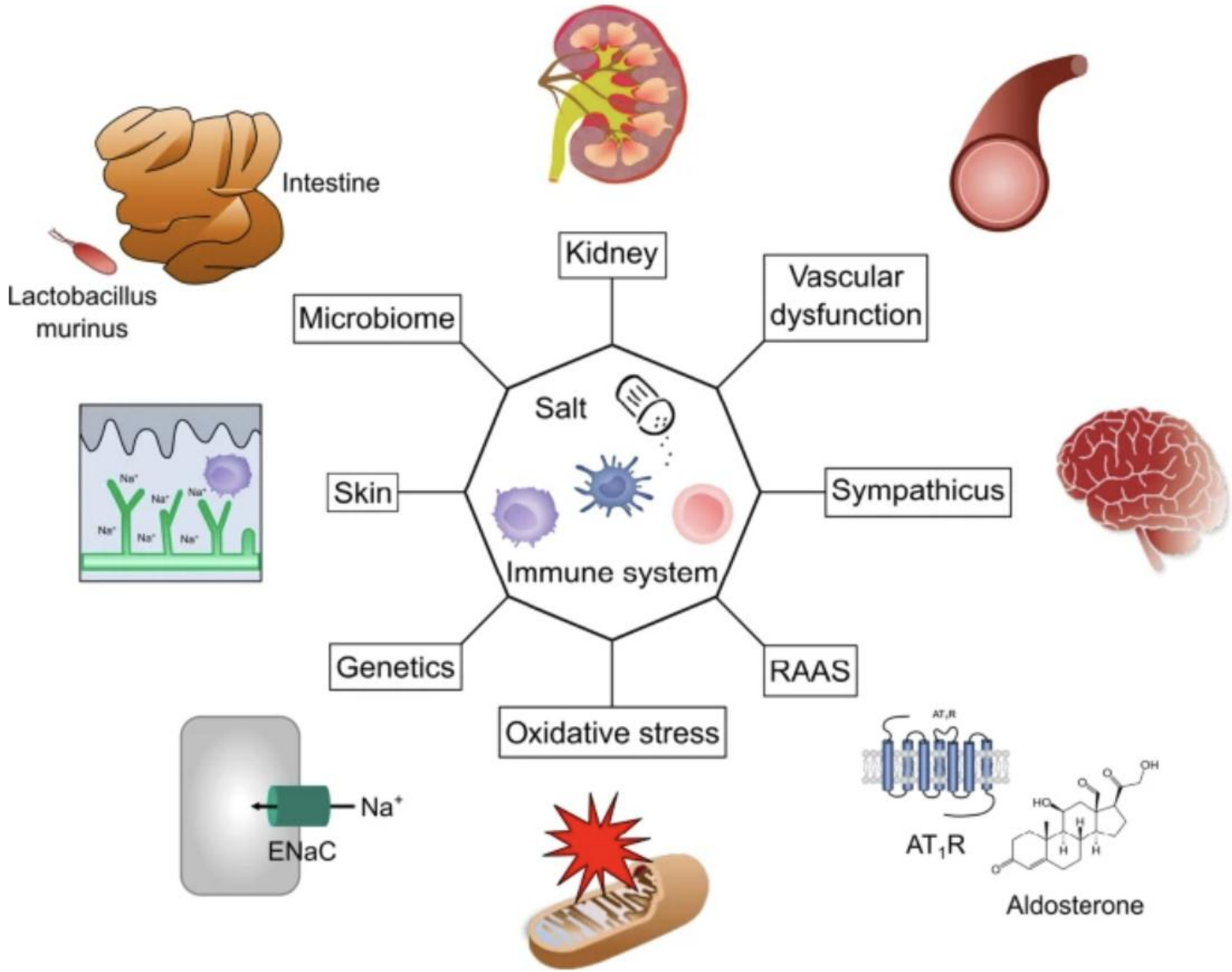
Is salt in – salt out a true story?

After a salty meal 40% of the increase in TBS cannot be accounted for by the body mass increase and thus represents the fraction of the TBS increase which is osmotically buffered



N Engl J Med 2021;385:1981-93. DOI: 10.1056/NEJMra2030212

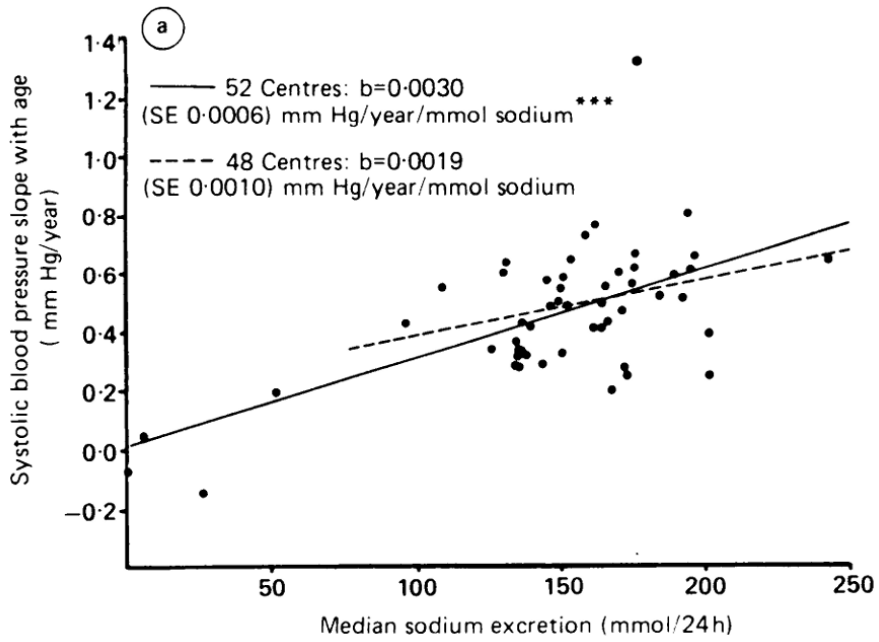
The revised mosaic theory: Salt and inflammation

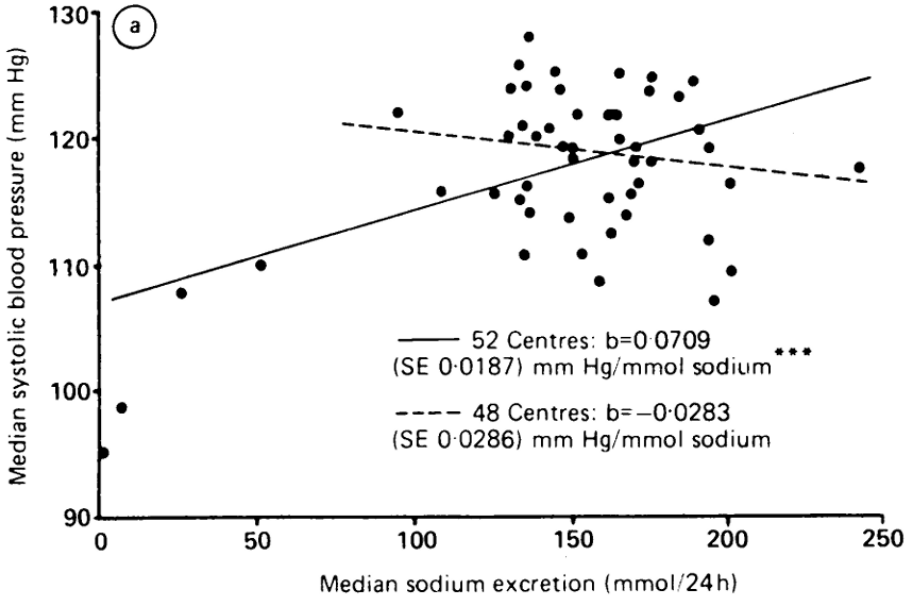


Cell Mol Immunol. 2022 May;19(5):561-576. doi: 10.1038/s41423-022-00851-8. Epub 2022 Mar 30. PMID: 35354938; PMCID: PMC9061754.

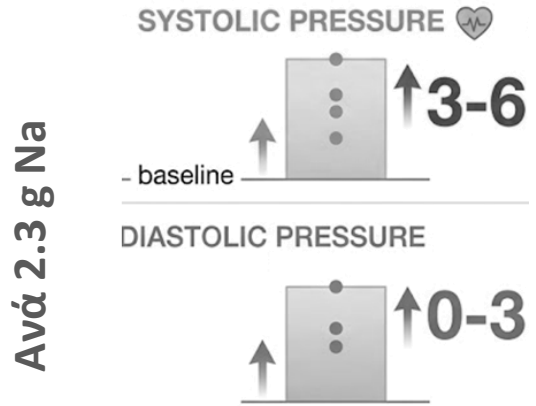
Αλάτι και Αρτηριακή Πίεση (take it with a grain of salt…)

1988: **Intersalt**

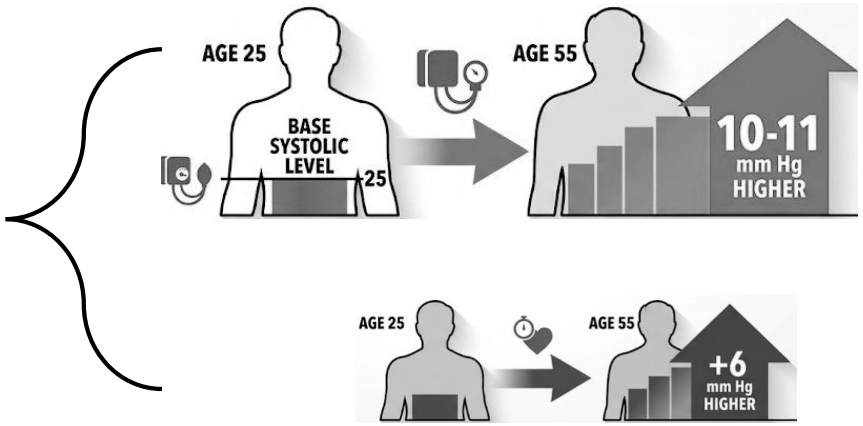




1996: **Intersalt revisited**



> 2.3 g Na



British Medical Journal 1988; 297 :319 doi:10.1136/bmj.297.6644.319
BMJ 1996; 312 :1249 doi:10.1136/bmj.312.7041.1249

Epidemiological Studies on Sodium or Salt Intake and Blood Pressure

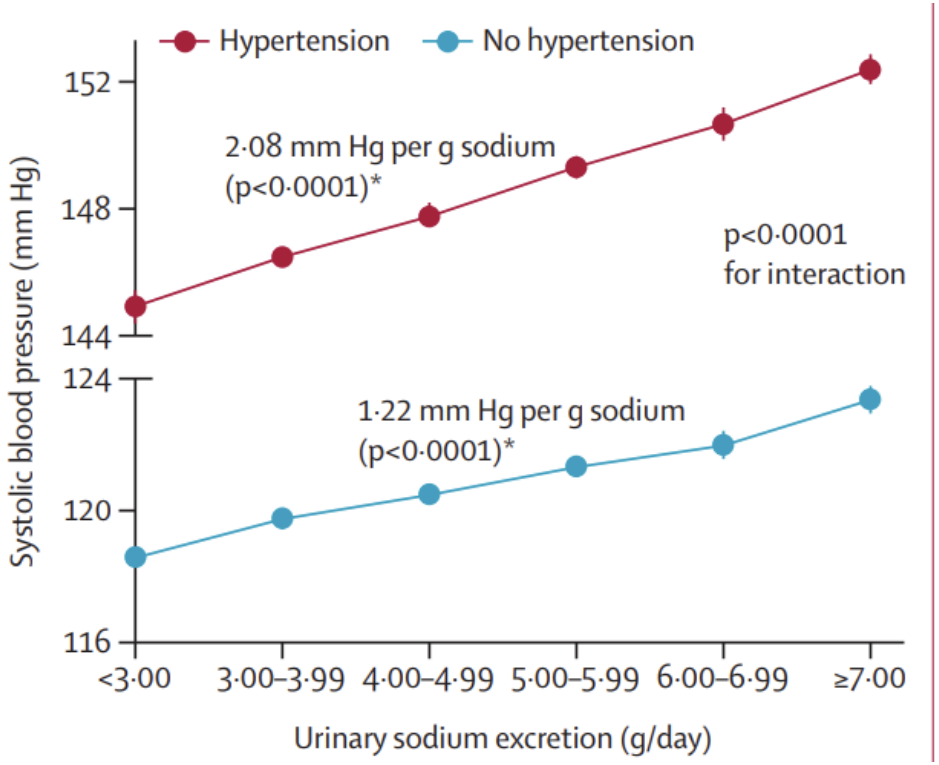
References	Study Design	Results[a]
Rose et al., 1988; Stamler et al., 1989	Intersalt Study, 10,079 men and women, cross-sectional in 32 countries	Significant positive correlation with urinary Na and slope of blood pressure with age, but not median BP or prevalence of elevated BP In 4 remote locations where sodium intake was very low, BP was low for all ages
Frost et al., 1991	12,773 men and women, cross-sectional data from 14 published studies	Significant association between blood pressure and sodium intake ($p < 0.001$)
Ascherio et al., 1992	Health Professional Followup Study, 30,681 US men, prospective cohort, 4-yr follow-up, 1,248 incident cases of hypertension, multivariate analysis	No significant association between hypertension and dietary intake of sodium as assessed by food-frequency questionnaire
Elliott et al., 1996	Intersalt Study, 10,074 men and women, cross-sectional	SBP of individuals was positively associated with sodium excretion
Rastenyte et al., 1997	3,326 Finnish men and women, cross-sectional	No association between urinary sodium and BP in either men or in women
Tunstall-Pedoe, 1999	Scottish Heart Health Study, cross-sectional, *n* = 11,629 men and women	Weak association between urinary sodium and blood pressure
Liu et al., 2000	WHO-CARDIAC Study, 1,151 Chinese and 1,681 Japanese men and women, cross-sectional	SBP was positively associated with sodium excretion in Japanese, while both SBP and DBP was associated with sodium excretion in Chinese

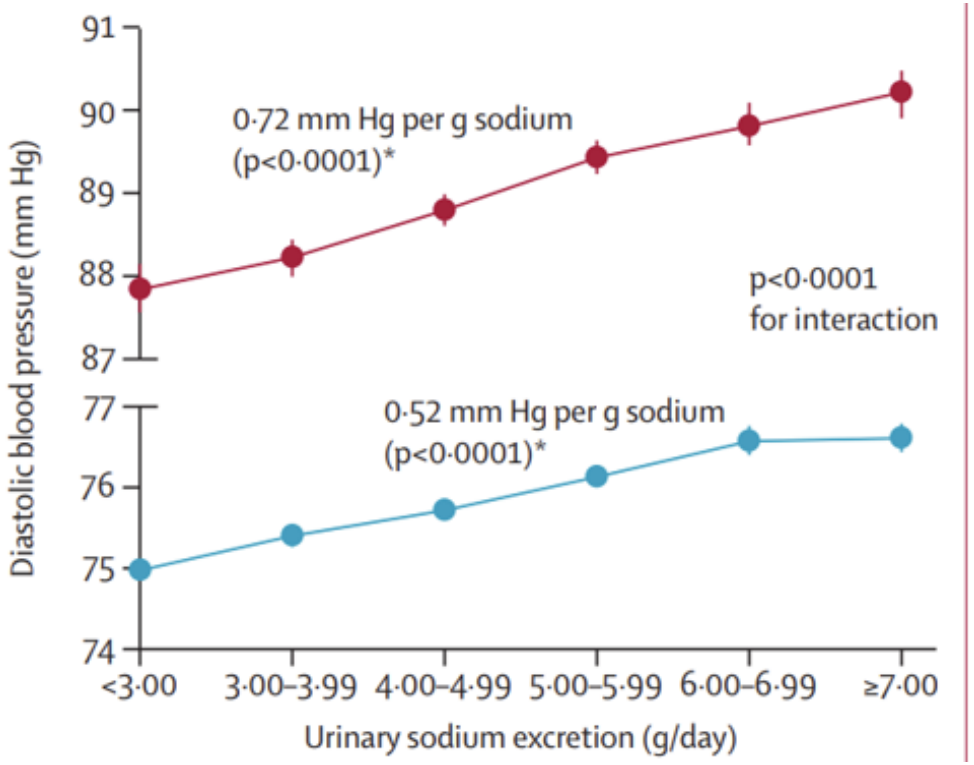
[a] Na = Sodium, BP = blood pressure, DBP = diastolic blood pressure, SBP = systolic blood pressure.

https://www.nationalacademies.org/read/10925/chapter/8#326

Αλάτι και Αρτηριακή Πίεση (take it with a grain of salt…)

The provocative Lancet paper (2016) 133,118 individuals



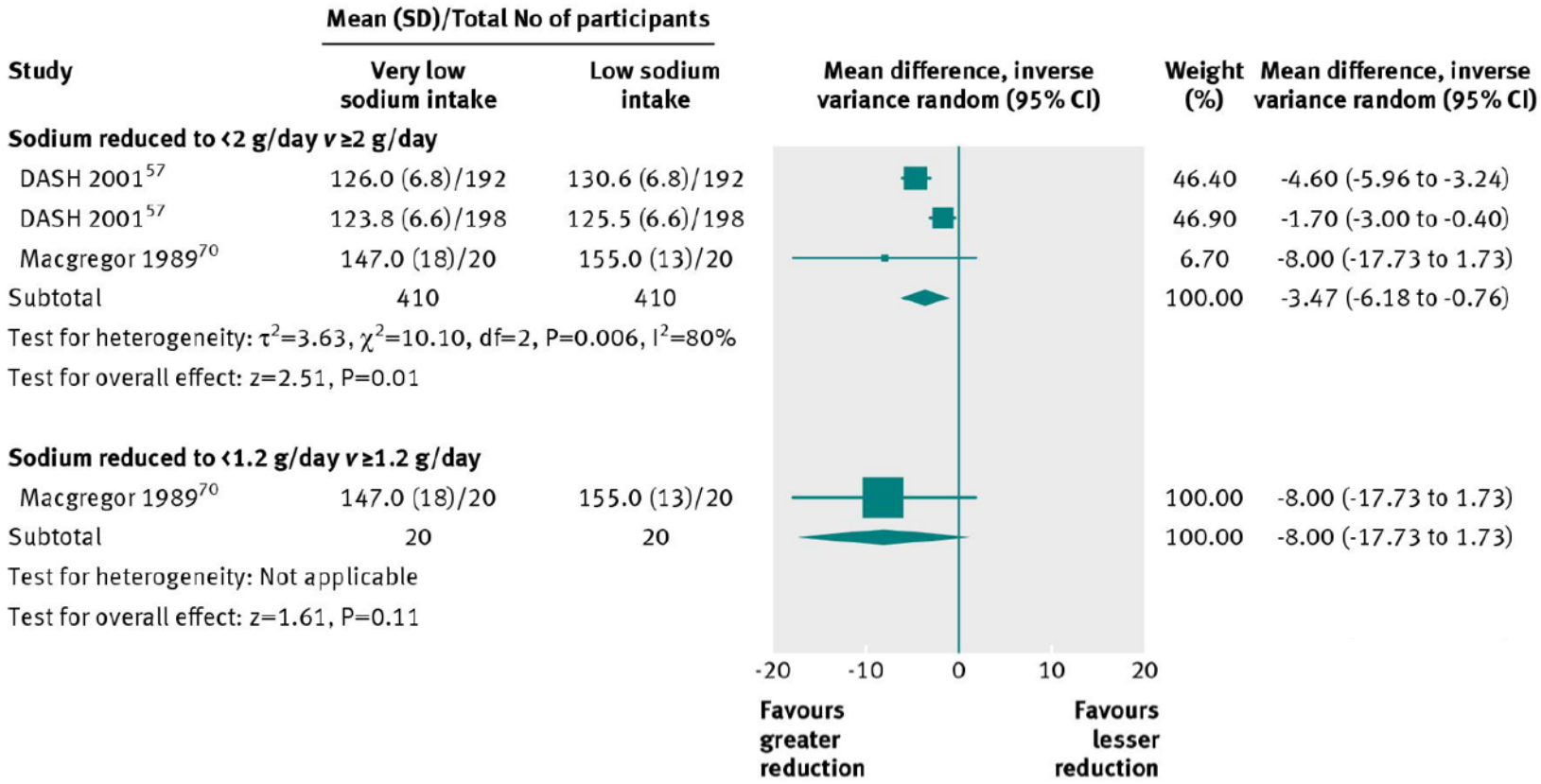


Associations of urinary sodium excretion with cardiovascular events in individuals with and without hypertension: a pooled analysis of data from four studies
The Lancet, 2016; 388, 465-475

Αλάτι και Αρτηριακή Πίεση (take it with a grain of salt…)

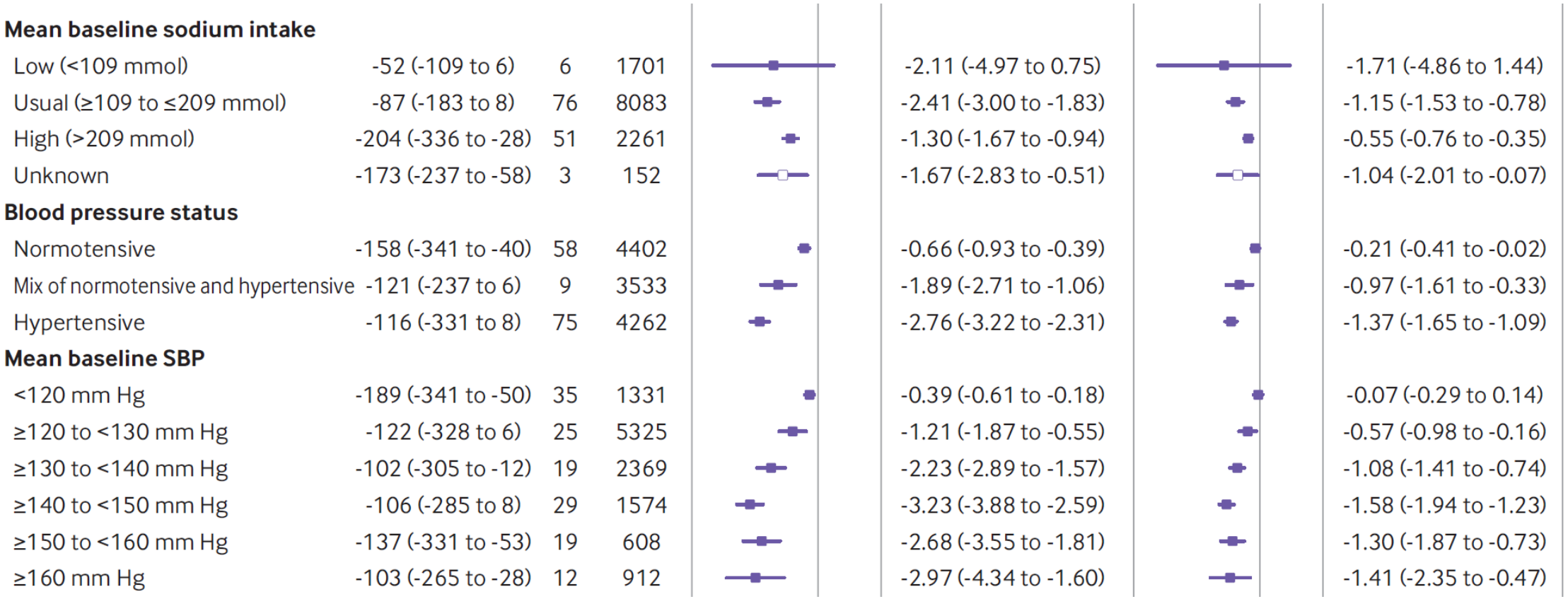
The WHO meta-analysis (2013) or more robust evidence (RCT) suggest…

Effects on Systolic BP



The totality of evidence suggests that most people will likely benefit from reducing sodium intake.

BMJ 2013;346:f1326 doi: 10.1136/bmj.f1326 (Published 5 April 2013)



BMJ 2020;368:m315 http://dx.doi.org/10.1136/bmj.m315

Study design — Systematic review with meta-analysis | Excluded pregnant women and patients with chronic kidney disease or heart failure

Data sources — 133 trials | 12 197 participants aged ≥18 years

Comparison

Outcomes

Outcomes	Data points		Change of systolic blood pressure[1] (95% CI)	Evidence quality (GRADE score)
All studies	135	12 173		★★★★ High
Studies ≤14 days	77	2977		★★★★ High
Studies >14 days	58	9196		★★★★ High
Studies >14 days and salt reduction ≤100 mmol	48	7410		★★★★ High

BMJ 2020;368:m315 http://dx.doi.org/10.1136/bmj.m315

Cochrane Library

Cochrane Database of Systematic Reviews

Effects of low sodium diet versus high sodium diet on blood pressure, renin, aldosterone, catecholamines, cholesterol, and triglyceride (Review)

Graudal NA, Hubeck-Graudal T, Jurgens G

Cochrane Database of Systematic Reviews 2020, Issue 12. Art. No.: CD004022.
DOI: 10.1002/14651858.CD004022.pub5.

Cochrane Library

Outcomes	Mean Difference (95% CI)	No of Participants (studies)
White population, normotensive, SBP mmHg	-1.14 [-1.65 to -0.63] *-1.38 [-1.87, -0.89]**	5982 (95)
White population, normotensive, DBP mmHg	0.01 [-0.37 to 0.39] *-0.37 [-0.78, 0.04]**	6276 (96)
White population, hypertensive, SBP mmHg	-5.71 [-6.67 to -4.74] *-5.32 [-6.36, -4.28]**	3998 (88)
White population, hypertensive, DBP mmHg	-2.87 [-3.41 to -2.32] *-2.76 [-3.38, -2.13]**	4032 (89)

Outcomes	Mean difference (95% CI)	No of Participants (studies)
Black population, normotensive, SBP mmHg	-4.02 (-7.37 to -0.68)	253 (7)
Black population, normotensive, DBP mmHg	-2.01 (-4.37 to 0.35)	253 (7)
Black population, hypertensive, SBP mmHg	-6.64 (-9.00 to -4.27)	398 (8)
Black population, hypertensive, DBP mmHg	-2.91 (-4.52 to -1.30)	398 (8)

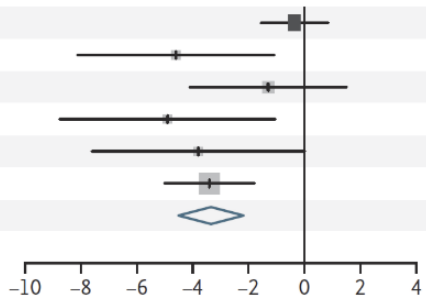
* Outcome of studies with duration of at least 7 days and high sodium intake of maximum 250 mmol

Cochrane Database of Systematic Reviews 2020, Issue 12. Art. No.: CD004022.
DOI: 10.1002/14651858.CD004022.pub5.

The Na-K Exchange Saves Lives

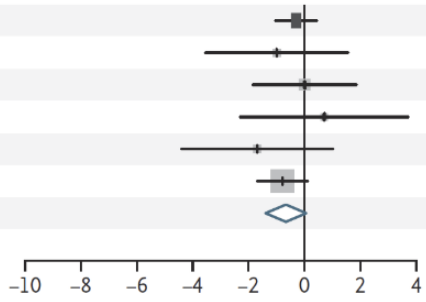
A Systolic Blood Pressure (mm Hg)

Time Point	Salt Substitute	Regular Salt	Mean Difference (95% CI)
	no. of participants		
Baseline	10,504	10,491	−0.40 (−2.50 to 1.70)
12 Mo	768	658	−4.60 (−8.10 to −1.10)
24 Mo	1,412	1,374	−1.30 (−4.10 to 1.50)
36 Mo	584	584	−4.90 (−8.75 to −1.05)
48 Mo	587	559	−3.80 (−7.60 to 0.00)
60 Mo	7,436	7,081	−3.40 (−5.00 to −1.80)
Fixed-Effects Model			**−3.34 (−4.51 to −2.18)**
Heterogeneity: I^2=0%; P=0.52			



B Diastolic Blood Pressure (mm Hg)

Time Point	Salt Substitute	Regular Salt	Mean Difference (95% CI)
	no. of participants		
Baseline	10,504	10,491	−0.30 (−1.55 to 0.95)
12 Mo	768	658	−1.00 (−3.55 to 1.55)
24 Mo	1,412	1,374	0.00 (−1.85 to 1.85)
36 Mo	584	584	0.70 (−2.30 to 3.70)
48 Mo	587	559	−1.70 (−4.40 to 1.00)
60 Mo	7,436	7,081	−0.80 (−1.70 to 0.10)
Fixed-Effects Model			**−0.67 (−1.39 to 0.05)**
Heterogeneity: I^2=0%; P=0.73			



The potassium switch!!!

Neal et al, NEJM 2021

Σας ευχαριστώ για την προσοχή σας