Review of the Science on Sodium and Health Outcomes and Sodium Reduction Progress in the Food Industry

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Sodium Intake and Health Outcomes

Interest in Sodium Reduction

41 Million — *Deaths due to noncommunicable diseases (NCD) (71% of all deaths)*

17.9 Million — *Deaths due to cardiovascular disease (44% of NCD)*

1 Billion — *Affected by high blood pressure (hypertension)*

2.5 Million — *Preventable deaths if individuals consume recommended sodium intake of 2000 mg/day (5 g salt)*

Source: WHO, 2018, http://apps.who.int/iris/bitstream/handle/10665/272596/9789241565585-eng.pdf?ua=1

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Global Sodium and Potassium Intake

- Sodium – an essential nutrient that help regulate blood volume (impacts blood pressure)
- Consuming high levels of sodium (>2 g/d) and low levels of potassium (<3.5 g/day) contribute to high blood pressure[1,2]
- WHO recommends <2 g/d sodium and ≥ 3.51 g/d potassium

Research	Mean Sodium Intake (g/d)	Sodium Intake Range (g/d)	Mean Potassium Intake (g/d)	Potassium intake Range (g/d)
Powles et al.[3]	3.95	2.18 – 5.51		
McCarron et al.[4]	3.67	2.62 – 4.83		
Mente et al.[5]	4.93	3.78 – 5.59	2.12	1.7 – 2.46

[1] http://www.who.int/mediacentre/factsheets/fs393/en/

[2] http://apps.who.int/iris/bitstream/handle/10665/77986/9789241504829_eng.pdf?sequence=1

[3]Powles et al. 2013. *Brit Med J*. 3(12) 3:e003733. doi:10.1136/bmjopen-2013-003733

[4]Mccarron et al. 2013. *Am J Hyper.* 26(10):1218-1223

[5]Mente et al. 2014. *N Engl J Med*. 371(7):601-611

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Randomized Clinical Trial

> 50 dose-response trials

McGregor et al., 1989[1]

- n=20, 42-72 years of age with mild hypertension (164/101 mmHg)
- Sodium intake range of 50-200 mmol/d
- Linear dose response to decrease in sodium intake and blood pressure
- Average reduction 16/9 mmHg

Johnson et al., 2001[2]

- n=46, >60 years of age, hypertensive and normotensive
- Sodium intake range of 50-300 mmol/d
- Linear dose response to decrease in sodium intake and BP over regardless of hypertensive state
- More pronounced for ISH than SDH and ISH than normotensive

Sack set al., 2001[3]

- n=412, > 22 years of age systolic of 120-159 mmHg, diastolic of 80-95 mmHg
- Controlled vs. DASH diet at sodium intake of 50, 100 and 150 mmol /day
- Control and DASH diets lowered blood pressure
- Observed effect for those with and without hypertension, all ethnicities, women and men
- DASH diet had lower BP than control at all sodium levels, greater difference at higher sodium levels

He & McGregor, 2002[4]

- Meta-analysis randomized trials (>4 weeks duration), modest sodium reductions
- n=734 hypertension, n=2220 normotensive
- Dose-response effect sodium intake and blood pressure. Pooled estimate drop of 4.96/2.73mmHg (hypertension) and 2.03/0.97 mmHg (normotensive)
- Weighted linear regression: drop of 7.11/3.88 mmHg (hypertensive) and 3.57/1.66 mmHg (normotensive) per 100 mmol/day (6g salt)

[1]McGregor et al. 1989. *Lancet*. 2:1244-1247

[2]Johnson et al. 2001. *J Hyperten*. 19:1053-1060

[3]Sacks et al. 2001. *N Engl J Med*. 344:3-10

[4]He & McGregor. 2017. *J Hum Hypertens*. 16:761–770.

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Studies Challenging Conventional Wisdom

of Sodium Intake and Health Outcomes

Mente et al. 2014[1]

- Epidemiological study (PURE, 102,216 adults, 18 countries)
- Non-linear relationship between sodium excretion and blood pressure
- Greater impact at higher sodium intakes and for those with hypertension, increased age and obesity
- Inverse relationship between potassium excretion and blood pressure
- Greater impact for those with hypertension and increased age

O'Donnell et al. 2014[2]

- Epidemiological study (PURE, 156,424 individuals, 17 countries)
- Mean SBP/DBP higher with est. sodium intake
- J-shape association between est. sodium intake and cardiovascular events and mortality for hypertensive
- Increased risk at lower sodium intake (3 g/d) for normotensive

Mente et al. 2016[3]

- Pooled analysis from 4 large prospective studies (133118 individuals)
- Association between sodium intake (excretion) and mortality and cardiovascular events
- For hypertensive individuals, increased risk at ≥7 and <3 g/d sodium excretion
- For individuals without hypertension, increased risk at < 3 g/s sodium excretion.

Graudal et al. 2017[4]

- Meta-analysis of 185 intervention studies (12,210 individuals)
- Normotensive and hypertensive
- Mean sodium reduction 11.5 to 3.8 g/day
- BP reduction greater for hypertensive (5.5/2.9 mmHg) vs. normotensive (1/0 mmHg)
- Hormones (salt conserving and stress) and lipids (cholesterol, triglycerides) increased as sodium intake decreased for hypertensive and normotensive).

[1]Mente et al. 2014. *N Engl J Med*. 371(7):601-611

[2]O'Donnell et al. 2014. *N Engl J Med*. 371(7) 612-623

[3]Mente et al. 2016. *Lancet*. 388:465-475

[4]Graudal et al. 2017. Cochrane Database of Systematic Reviews, Issue 4. Art. No.: CD004022. DOI: 10.1002/14651858.CD004022.pub4.

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Reports and Activities in the United States

- Institute of Medicine[1] (2013)[2]
  - Review of latest scientific evidence on dietary sodium intake and health outcomes
  - Concluded a positive relationship between sodium intake >2.3 g/d and risk of cardiovascular disease
  - Evidence inconsistent for lowering sodium intake to 1.5g/day for the general public
- Agency for Healthcare Research Quality (2018)[3]
  - Effect of dietary sodium reduction and increased potassium intake on high blood pressure and cardiovascular diseases and renal disease.
  - Results suggests a benefit for reduced sodium and increased dietary potassium on reducing blood pressure, especially for those with hypertension
- Review of the Dietary Reference Intake for Sodium and Potassium currently underway[4]

[1]Currently the National Academy of Medicine
[2]Institute of Medicine (currently the National Academy of Medicine). 2013. https://doi.org/10.17226/18311
[3]RAND Southern California Evidence-Based Practice Center. 2018. https://effectivehealthcare.ahrq.gov/sites/default/files/pdf/cer-206-prepub-final-sodium-potassium.pdf
[4]National Academies of Science. http://nationalacademies.org/hmd/Activities/Nutrition/ReviewDRIforSodiumandPotassium.aspx

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Global Sodium Reduction Initiatives

- WHO member states adopt global target of 30% reduction sodium intake by 2025[1]
- In 2015, 75 countries had national salt reduction strategies[2]
- Strategies include food reformulation, consumer education, front of package labelling, interventions in public settings and taxation[3]
- Strategy considers source of sodium
  - At home, focus on consumer education
  - Processed foods, collaborations with government and food industry

Global Initiatives (2015)[2]	Number of Countries
Voluntary sodium target	36
Mandated maximum sodium content limits	9
Consumer education	71
Front of package labelling	31
Intervention initiatives	43
Sodium specific or general tax	3

[1]WHO. 2013. http://apps.who.int/iris/bitstream/handle/10665/94384/9789241506236_eng.pdf;jsessionid=43319843D576972100D863DD60BB17BD?sequence=1
[2]Trieu K et al. 2015. *PLoS One*. 10(7). e0130247
[3]Webster et al. 2014. *Nutrients*. 6:3274-3287

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Sodium Reduction in the Food Supply

Brazil[1]

- Voluntary
- Survey >3000 foods, 2011-2017
- Grains, dairy, condiments, etc.
- >50% met PAHO's 2017 sodium targets, exclude 1 category, 85% met targets
- 8-34% reduction in sodium

[1]Nilson et al. 2017. *Nutrients.* 9:742-755

Canada[2]

- Voluntary, step-wise approach
- Targeted 94 food categories
- 52% products made progress towards 2016 targets: Phase I (28%), Phase II (10%), Phase III (14%)

[2]Health Canada. 2018. https://www.canada.ca/content/dam/hc-sc/documents/services/food-nutrition/legislation-guidelines/guidance-documents/guidance-food-industry-reducing-sodium-processed-foods-progress-report-2017/pub1-eng.pdf

Ireland[3]

- Voluntary
- Targeted 10 food categories
- Monitored years 2003-2018
- Significant progress for cereals
- Meats lag expectations

[3]Food Safety Authority of Ireland. 2015. https://www.fsai.ie/uploadedFiles/Science_and_Health/Salt_and_Health/Salt_Surveys_2003_onwards.pdf

South Africa[4]

- Mandatory for certain foods
- Analyzed 110 foods from 13 categories
- 72% met 2016 target
- 46% met 2019 target

Swanepoel et al. 2017. *J Food Comp Anal*. 62:73-78

United Kingdom[5]

- Voluntary, stepwise
- >18,000 foods, 2006-2011
- Mean sodium reduction 7%
- Sales-weighted reduction of 6%, greatest in dairy (27%)
- Same products in 2006 and 2011, 9% reduction

[5]Eyles et al. 2013. *Preventative Medicine*. 57:555-560

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Impact of Sodium Reduction Initiatives on Population Dietary Intake

Summary of Systematic Review (2015)[1]	Number of Countries
Reported decrease in population sodium intake	12 countries
Reported range of sodium intake decrease	4.9 – 36%
Analytical method: 24-hour urinary	3 countries
Analytical method: 24-hour urinary and dietary survey combination	1 country
Analytical method: Dietary survey	27 countries
Analytical method: Spot urine	1 country
Sodium specific or general tax	3 countries

- Finland
  - In 1993, mandatory warning labels on high salt foods[1]
  - 36% reduction in sodium intake
- United Kingdom Salt Intake*
  - UK, 9.5 g/d (2001)[2]
  - England), 8.0 g/d (2014)[3]
  - Northern Ireland, 8.6 g/d (2015)[4]
  - Scotland (2014), 7.1 g/d[5]

*1 g salt = 0.4 g sodium

[1]Trieu K et al. 2015. *PLoS One*. 10(7). E0130247
[2]Henderson et al. 2003. http://webarchive.nationalarchives.gov.uk/20100410000326/http://www.food.gov.uk/multimedia/pdfs/ndnsv3.pdf
[3]Public Health of England. 2016 https://www.gov.uk/government/statistics/national-diet-and-nutrition-survey-assessment-of-dietary-sodium-in-adults-in-england-2014
[4]Food Standard Agency. 2016 . https://www.gov.uk/government/statistics/national-diet-and-nutrition-survey-assessment-of-dietary-sodium-adults-19-to-64-years-in-northern-ireland-2015
[5]Food Standards Scotland. 2016 . http://www.foodstandards.gov.scot/downloads/Monitoring_the_Scottish_Diet-_Sodium_Survey_2014_SCOTLAND_FINAL_PDF.pdf

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Conclusions

- Sodium is an essential mineral required to maintain health
- Random controlled trials suggests a linear dose-response to a decrease sodium intake and reduced blood pressure
- Epidemiological studies suggest lower sodium intake may increase cardiovascular events and mortality
- In addition to blood pressure, identification of other suitable cardiovascular disease biomarkers may be beneficial for understanding overall effect of sodium intake and health outcomes
- Continued improvement on monitoring surveys will ensure accuracy of sodium reduction effects by the food industry on population sodium intakes

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Questions

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