Sodium and Potassium Intake: NHANES and Other Data

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Objectives

- **Inform**
  - Review of the *Dietary Reference Intakes (DRI)* for Sodium and Potassium

- **Describe**
  - Canadian and US sodium and potassium intakes

- **Understand**
  - Strengths and limitations of population intake estimates
Data Sources - Overview

- **Canadian Community Health Survey (CCHS)**
  - 24-hour dietary recalls

- **US National Health and Nutrition Examination Survey (NHANES)**
  - 24-hour dietary recalls
  - 24-hour urine collection

- **Salt Sources Study**
  - 24-hour dietary recalls
  - Duplicate salt sample collection
  - Supplements/antacids
  - Home tap water
Canadian Community Health Survey

- **Sample - 2004**
  - Nationally-representative, non-institutionalized persons
  - All ages (diet data 1+ years, n=32,776)

- **Two 24-hour dietary recalls**
  - Interviewer administered
  - Day 1: in-person at home
  - Day 2: ~1/3 random sample by telephone (3-10 days later)
  - Bilingual dietary interviewers – English\French
  - Conducted all days of week

- **Based on USDA’s Automated Multiple-Pass Method**
  - Computerized instrument
  - 5-step multiple pass approach

- **Nutrient values**
  - Canadian Nutrient File, 2001b

- **Population estimates**
  - Excluded salt added at the table, supplements/antacids
  - Account for survey design, non-response
  - Percentiles of usual intake, C-SIDE
What We Eat in America, NHANES

- **Sample – continuous**
  - Nationally-representative, non-institutionalized persons
  - All ages (dietary data 2009-2014, n=26,446)

- **Two 24-hour dietary recalls**
  - Interviewer-administered
  - Day 1: in-person
  - Day 2: telephone (3-10 days later)
  - Bilingual dietary interviewers – English\Spanish
  - Conducted all days of week

- **USDA Automated Multiple-Pass Method**
  - Computerized instrument
  - 5-step multiple pass approach

- **Nutrient values**
  - Food and Nutrient Database for Dietary Studies

- **Population estimates**
  - Exclude salt added at the table, supplements/antacids
  - Account for survey design and non-response
  - Usual intake estimation, NCI Method, 2009-2014
  - Population proportions by WWEIA food categories, 2013-2014

NHANES – 24-Hour Urine Collection

- **Sample - 2014**
  - Nationally-representative, non-institutionalized persons
  - Random-half sample
  - Non-pregnant adults aged 20-69 years

- **Two 24-hour urine collections**
  - In-person start / stop (most)
  - First collection: post-examination
  - Second collection,~ ½ sample: 3-10 days later
  - Verbal, written, pictorial instructions – English/Spanish
  - Conducted all days of the week

- **Laboratory analysis**
  - “Complete” specimens
  - Roche Ion-Selective Electrode technique

- **Population estimates**
  - First 24-hour urine collection
  - Account for complex survey design and non-response

Flow Chart – First 24-h Urine
Results – Sodium
Mean Daily Sodium Intake by DRI Age-Sex Group, Canada, 2004

Source: Statistics Canada, Canadian Community Health Survey, 2004, n=32,776
Mean Daily Sodium Intake by DRI Age-Sex Group, United States, 2009-2014

Source: CDC, unpublished analyses, What We Eat in America, NHANES 2009-2014, n=26,446
Cogswell ME, Loria CM, Terry AL, et al.

Estimated 24-Hour Urinary Sodium and Potassium Excretion in US Adults

Published online March 7, 2018

Available at jama.com and on The JAMA Network Reader at mobile.jamanetwork.com
Mean 24-Hour Urinary Sodium Excretion, Adults 20-69 years, United States, 2014

Mean Estimated Daily Sodium Intake by Method, United States

Sodium Intake Distributions, Adults 19+ Years by Sex, United States, 2009-2014

Source: CDC, unpublished analyses, What We Eat in America, NHANES 2009-2014, n=15,678
Sodium Density Distributions, Adults 19+ Years by Sex, United States, 2009-2014

Source: CDC, unpublished analyses, What We Eat in America, NHANES 2009-2014, n=15,678
Results – Sodium
Salt Sources Study

• **Sample**
  - Convenience sample, Dec 2013-Dec 2014
  - 450 Non-pregnant adults, aged 18-74 years
  - 4 race/ethnic groups, 3 geographic locations (MN, CA, AL)

• **Baseline clinic visit**

• **Four record-assisted 24-h dietary recalls**
  - Interviewer-administration by telephone
  - Non-consecutive over 11 days
    - 1 weekend day, 3 weekdays
  - Bilingual dietary interviews – English\Spanish

• **Other sodium sources**
  - Duplicate salt samples
  - Dietary supplements/non-prescription antacids
  - Home tap water

• **Data collection and nutrient values**
  - UMN Nutrition Data System for Research (NDSR)
  - Automated data collection and nutrient coding

• **Estimates**
  - Mean proportions (4 days per person)
  - Various sources, e.g., inherent, salt added at the table, supplements/antacids
Mean Proportions of Sodium Intake from Various Sources (n=450)

Mean total sodium intake: 3501 mg per day

- Added outside the home, 71%
- Inherent to food, 14%
- Added at table, 5%
- Added in home preparation, 6%
- Dietary supplements/antacids and tap water, <1%

### Top 10 Food Types Contributing to Sodium Intake
#### United States, 2013-2014

<table>
<thead>
<tr>
<th>Rank</th>
<th>Food Type</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Yeast breads</td>
<td>6.2</td>
</tr>
<tr>
<td>2</td>
<td>Pizza</td>
<td>5.9</td>
</tr>
<tr>
<td>3</td>
<td>Single code sandwiches</td>
<td>5.7</td>
</tr>
<tr>
<td>4</td>
<td>Cold cuts and cured meats</td>
<td>5.4</td>
</tr>
<tr>
<td>5</td>
<td>Soups</td>
<td>3.8</td>
</tr>
<tr>
<td>6</td>
<td>Burritos and Tacos</td>
<td>3.8</td>
</tr>
<tr>
<td>7</td>
<td>Savory snacks</td>
<td>3.7</td>
</tr>
<tr>
<td>8</td>
<td>Chicken, whole pieces</td>
<td>3.8</td>
</tr>
<tr>
<td>9</td>
<td>Cheese</td>
<td>3.5</td>
</tr>
<tr>
<td>10</td>
<td>Eggs and Omelets</td>
<td>3.1</td>
</tr>
</tbody>
</table>

Source: Quader et al., MMWR. 2017;66(12):324-328. NHANES 2013-2014, US persons 2 years and older, n=8,067
Results – Potassium

Canadian Community Health Survey

Nutrient Intakes from Food
Provincial, Regional and National Summary Data Tables
Volume 2
Revised February 2003

Sources

What We Eat in America
NHANES

NHANES
Mean Daily Potassium Intake by DRI Age-Sex Group, Canada, 2004

Source: Statistics Canada, Canadian Community Health Survey, 2004, n=32,776
Mean Daily Potassium Intake by DRI Age-Sex Group, United States, 2009-2014

Source: CDC, unpublished analyses, What We Eat in America, NHANES 2009-2014, n=26,446
Mean 24-Hour Urinary Potassium Excretion
Adults 20-69 years, United States, 2014

Mean Estimated Daily Potassium Intake by Method, United States

Potassium Intake Distributions, Adults 19+ years by Sex, United States, 2009-2014

Source: CDC, unpublished analyses, What We Eat in America, NHANES 2009-2014, n=15,678
### Top 10 Food Types Contributing to Potassium Intake
**United States, 2005-2006**

<table>
<thead>
<tr>
<th>Rank</th>
<th>Food Type</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Reduced fat milk</td>
<td>5.9</td>
</tr>
<tr>
<td>2</td>
<td>Coffee</td>
<td>5.2</td>
</tr>
<tr>
<td>3</td>
<td>Chicken and chicken mixed dishes</td>
<td>4.5</td>
</tr>
<tr>
<td>4</td>
<td>Beef and beef mixed dishes</td>
<td>3.6</td>
</tr>
<tr>
<td>5</td>
<td>100% Orange/grapefruit juice</td>
<td>3.4</td>
</tr>
<tr>
<td>6</td>
<td>Fried white potatoes</td>
<td>3.3</td>
</tr>
<tr>
<td>7</td>
<td>Potato/corn/other chips</td>
<td>3.2</td>
</tr>
<tr>
<td>8</td>
<td>Whole milk</td>
<td>2.9</td>
</tr>
<tr>
<td>9</td>
<td>Other white potatoes</td>
<td>2.9</td>
</tr>
<tr>
<td>10</td>
<td>Pasta and pasta dishes</td>
<td>2.7</td>
</tr>
</tbody>
</table>


For foods ranked by the amount of potassium per standard food portions see 2015-2020 Dietary Guidelines for Americans, Appendix 10.
Results – Sodium:Potassium Ratio
Mean Sodium:Potassium Ratio, by DRI Age-Sex Group, United States, 2009-2014

Source: CDC, unpublished analyses, What We Eat in America, NHANES 2009-2014, n=26,446
Mean 24-Hour Urinary Sodium:Potassium Excretion, Adults 20-69 years, United States, 2014

<table>
<thead>
<tr>
<th>Molar Ratio Sodium:Potassium</th>
<th>Overall (827)</th>
<th>Men (421)</th>
<th>Women (406)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>3.17</td>
<td>3.32</td>
<td>3.03</td>
</tr>
</tbody>
</table>

Mean Estimated Sodium:Potassium Ratio by Method, United States

Sodium:Potassium Distributions, Adults 19+ years by Sex, United States, 2009-2014

Source: CDC, unpublished analyses, What We Eat in America, NHANES 2009-2014, n=15,678
Strengths and Limitations
NHANES / CCHS Dietary Recalls

- **Strengths**
  - Short-term recall
  - Low reactivity
  - Automated interview
  - All seasons / days of the week

- **Limitations**
  - Random error – within-person variability
  - Under-reporting
  - Excludes salt / salt substitutes* added at the table
  - Relies on accurate nutrient composition

NHANES/CCHS Nutrient Composition

- **Strengths**
  - Up-to-date, select laboratory values
    - National sampling
    - Brands represent ~70%-80% market
  - Standard recipe files
  - Brand-specific values (increasing)

- **Limitations**
  - Variability by brand, location, time
  - Laboratory / label values can differ
  - Limited label values for potassium
NHANES - 24-Hour Urine

**Strengths**
- In person start and stop
- Captures
  - All seasons / days of the week
  - All sources of intake

**Limitations**
- Selection bias
- Sample size
- Random error
  - Within-individual
  - Inaccurate timing
- Underestimation
  - Incomplete collection
  - % excreted, ~90% sodium, 50%-90% potassium

<table>
<thead>
<tr>
<th>Participant characteristic</th>
<th>Asked to Participate (n=1103), No.</th>
<th>Completed (n=827), No. (%)</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>542</td>
<td>421 (77.7)</td>
<td>0.04</td>
</tr>
<tr>
<td>Female</td>
<td>561</td>
<td>406 (72.4)</td>
<td></td>
</tr>
<tr>
<td><strong>Age range, years</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20-44</td>
<td>584</td>
<td>432 (74.0)</td>
<td>0.41</td>
</tr>
<tr>
<td>45-69</td>
<td>519</td>
<td>395 (76.1)</td>
<td></td>
</tr>
<tr>
<td><strong>Race and Hispanic origin</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic white</td>
<td>448</td>
<td>339 (75.7)</td>
<td>0.001</td>
</tr>
<tr>
<td>Non-Hispanic black</td>
<td>281</td>
<td>225 (80.1)</td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic Asian</td>
<td>160</td>
<td>100 (62.5)</td>
<td></td>
</tr>
<tr>
<td>Hispanic</td>
<td>178</td>
<td>137 (77.0)</td>
<td></td>
</tr>
</tbody>
</table>
Conclusions

- **Intake**
  - Sodium and potassium intake vary by age and sex
  - Usual sodium intake varied widely within population subgroups.
  - Dietary and urinary sodium assessment are similar & underestimate intake
  - 24-hour urinary potassium excretion significantly lower than dietary estimates

- **Sources**
  - Commonly consumed foods contribute to sodium and potassium intake
  - Most sodium consumed is not naturally occurring
Thank You

- CDC – *Draft Tables*
  - Lixia Zhao
  - Zefeng Zhang
  - Katherine Overwyk
  - Kirsten Herrick
- NIH
  - Janet De Jesus
  - Catherine Loria
- USDA
  - Alanna Moshfegh
  - Jaspreet Ahuja
  - Pamela Pehrsson
- Health Canada
  - Amanda MacFarlane
The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.
Mean Daily Sodium Density by DRI Age-Sex Group, United States, 2009-2014

Data Source: What We Eat in America, NHANES 2009-2014
Mean Daily Sodium Density by Age-Sex Group, United States, 2013-2014

Mean Daily Potassium Density by Age-Sex Group, United States, 2013-2014