School Lunch Cafeteria Noise is Associated with Fruit and Vegetable Consumption Among Elementary Students

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Disclosure

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• The speaker is currently employed by Chobani, LLC

• All other authors have no conflicts of interest to declare
Schools can help promote fruit and vegetable (FV) consumption

• Fewer than 1 in 10 meet federal recommendations for daily FV consumption¹

• With over 50% of calories consumed in schools, they offer an advantageous setting for interventions²

• The NSLP offers an opportunity to increase FV consumption

¹ 2015-2020 Dietary Guidelines for Americans
Factors associated with FV consumption at school lunch

- Updated HHFKA standards associated with increased FV consumption at school lunch\(^1\)
  - Unregulated factors may further constrain or enhance consumption\(^2\)

- Focus has been on physical and social environmental factors, such as recess placement, time for lunch, and access to salad bars

- Previous studies have generally only considered one factor in isolation\(^3\)

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\(^1\) Cullen & Daves. *J Acad Nutr Diet.* 2017
\(^2\) Dixon et al. *FASEB J.* 2015
\(^3\) Gorman et al. *Obesity.* 2007
Noise is a novel factor

- Exposure to noise associated with adverse health and cognitive effects\(^1\)

<table>
<thead>
<tr>
<th>Agency</th>
<th>Guideline</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nat’l Inst Occupational Safety &amp; Health (NIOSH)</td>
<td>Hearing loss likely at &gt;85 decibels; implement noise reduction</td>
</tr>
<tr>
<td>World Health Organization (WHO)</td>
<td>&gt;80 decibels for 160min/day may result in hearing loss</td>
</tr>
<tr>
<td>American Academy of Pediatrics (AAP)</td>
<td>Reduce noise exposure among children</td>
</tr>
</tbody>
</table>

- Cafeteria noise may influence FV consumption, but this has not been examined empirically\(^2\)

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\(^1\) Hammer et al. *J Am Pub Health*. 2014
\(^2\) Bryker et al. *JNEB*. 2014
Research question

• What is the association between the following *environmental factors* and consumption of FV at school lunch among 2nd and 3rd grade students participating in the NSLP?
  
  – Noise (decibels)
  
  – Presence of a salad bar (yes/no)
  
  – Lunch length (minutes)
  
  – Recess before lunch (yes/no)
  
  – Number of FV options at lunch (count)
Methods

• All data collected between May and June 2016

• 2nd and 3rd grade students from 20 schools participating in FoodCorps

• Stratified sampling methodology
  – School-level sociodemographic variables race/ethnicity, enrollment, and race/ethnicity
  – Healthy Schools Progress Report Score
Digital photography

- Cameras placed on tripods at 60-degree angle
- Before- and after-meal photo protocol ¹-²
- Interrater reliability: 99% for items on tray; 83% for amount consumed

¹. Swanson et al., 2008
². Taylor et al., 2014
Measurement of environmental factors

- Environmental factors measured via **observational checklist**
  - Recess relative to lunch
  - Time allocated for lunch
  - Presence of salad bar
  - Number of FV items offered

- **Noise** measured via sound level meter placed in cafeteria ~5ft from lunch tables
**Lunch tray observations (n=2,571)**  

<table>
<thead>
<tr>
<th>Grade</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>2nd grade</td>
<td>1,360</td>
<td>53</td>
</tr>
<tr>
<td>3rd grade</td>
<td>1,065</td>
<td>44</td>
</tr>
</tbody>
</table>

**Recess structure**

<table>
<thead>
<tr>
<th>Structure</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recess before lunch</td>
<td>695</td>
<td>27</td>
</tr>
<tr>
<td>Recess after lunch</td>
<td>1,876</td>
<td>73</td>
</tr>
</tbody>
</table>

**Salad bar access**

<table>
<thead>
<tr>
<th>Access</th>
<th>n</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>No salad bar</td>
<td>1,021</td>
<td>40</td>
</tr>
<tr>
<td>Salad bar</td>
<td>1,550</td>
<td>60</td>
</tr>
</tbody>
</table>

**Schools (n=20)**

<table>
<thead>
<tr>
<th>Ethnicity</th>
<th>Mean, range</th>
</tr>
</thead>
<tbody>
<tr>
<td>White (%)</td>
<td>29.4, 0 - 98</td>
</tr>
<tr>
<td>Black (%)</td>
<td>40.1, 0 - 90</td>
</tr>
<tr>
<td>Hispanic (%)</td>
<td>22.1, 0 - 76</td>
</tr>
<tr>
<td>Asian (%)</td>
<td>3.5, 0 - 36</td>
</tr>
</tbody>
</table>

**Healthy Schools Progress Report**

<table>
<thead>
<tr>
<th>FRPL eligible (%)</th>
<th>76.5, 32 - 100</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy Schools Progress Report</td>
<td>55, 28 - 97</td>
</tr>
<tr>
<td>FoodCorps participation (years)</td>
<td>2.2, 1 - 4</td>
</tr>
<tr>
<td>Time for lunch (min)</td>
<td>27.9, 21 - 39</td>
</tr>
<tr>
<td>FV items offered</td>
<td>7.4, 3 - 14</td>
</tr>
</tbody>
</table>

Graziose et al.  
*In Preparation.*
Sound (noise) levels of cafeterias are high

Rock concert: 100 decibels
Lawnmower: 90 decibels
Garbage disposal: 80 decibels
Vacuum cleaner: 75 decibels
Conversation: 70 decibels
A quiet room: 60 decibels

Graziose et al. In Preparation.
Noise is negatively associated with FV consumption

*Hierarchical linear models with FV consumption outcomes square-root transformed*

<table>
<thead>
<tr>
<th></th>
<th>Vegetable consumption (cups)</th>
<th>Fruit consumption (cups)</th>
<th>Fruit + vegetable consumption (cups)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B (S.E.)</td>
<td>B (S.E.)</td>
<td>B (S.E.)</td>
</tr>
<tr>
<td>Lunch length (min)</td>
<td>0.003 (0.003)</td>
<td>-0.001 (0.003)</td>
<td>0.003 (0.003)</td>
</tr>
<tr>
<td>Noise (decibels)</td>
<td>-0.004 (0.004)</td>
<td>-0.012** (0.004)</td>
<td>-0.017** (0.004)</td>
</tr>
<tr>
<td>FV items (count)</td>
<td>0.021** (0.006)</td>
<td>0.002 (0.007)</td>
<td>0.002 (0.006)</td>
</tr>
</tbody>
</table>

**Salad bar**

- No: ref ref ref ref ref ref ref
- Yes: -0.004 (0.103) 0.029 (0.084) 0.006 (0.107)

**Recess structure**

- After lunch: ref ref ref ref ref ref ref
- Before lunch: 0.003 (0.026) **0.100** (0.023) **0.096** (0.023)

Graziose et al. *In Preparation.*
Conclusions

• Environmental factors are associated with F/V consumption
  – Recess before lunch positive
  – Number of FV items positive
  – Noise negative
  – Time allocated for lunch null
  – Access to salad bar null

• Difference of about 0.15 cups per decibel between 25th and 75th percentile for noise
Implications for research and practice

• Noise and recess before lunch are potentially amenable to intervention

• Researchers should control for these potentially confounding effects in C-RCTs

• Future research is needed to manipulate noise levels and explore a mechanism
Thank you!

- **Co-authors:** Pam Koch, Randi Wolf, Isobel Contento, Heewon Gray
- **Collaborators:** Raynika Trent, Elizabeth Tipton, Ian Ang, Amanda Kelly, Kasey Wien, Colleen Topper, Erica Oliner, Camille Veri
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- **Data collection volunteers**
- **Schools, staff, parents, and students who participated in this study**