Cariogenicity of soft drinks, milk, and fruit juice in low-income African-American children: a longitudinal study

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Background
- Beverage intake in US children has become more diverse and extensive over the last several decades
  - The increased intakes of sugared drinks may increase the risk of dental caries
  - Cariogenic bacteria can produce the organic acids that initiate the carious process in enamel with simple carbohydrates
- Two components to determine effective cariogenicity
  - Cariogenic potential: the ability of foods or beverages to cause a significant drop in plaque pH, demineralization of enamel, or more caries in animals under controlled experimental conditions
  - The frequency or manner of consumption should be considered along with cariogenic potential

Objectives
- Research questions
  - What are the intake patterns of soft drinks (= soda + fruit drinks), milk, and 100% fruit juice over a 2-year period?
  - Are children with a high consumption of soft drinks over two years, relative to milk and 100% fruit juice, at a higher risk of developing new carious lesions?

Methods
Sample
- Detroit Dental Health Project
  - A longitudinal study to investigate oral health disparities within African American community living in urban Detroit
  - From a stratified two-stage sampling design, 1386 eligible families were identified
    - Wave 1 (2001-03): 1021 pairs of child and caregiver
    - Wave 2 (2004-05): 790 pairs of child and caregiver
- Samples: preschool African-American children (n = 369)
  - Children who participated in Wave 1 and Wave 2 were selected
  - Children aged 0 to 2 years were omitted because beverage consumption data were not collected
  - Further 34 children were excluded due to the implausible dietary intakes

Study variables
- Increments of dental caries
  - Caries status of primary tooth surfaces was assessed using the International Caries Detection and Assessment System
  - Outcomes: increments of $d_1$, $d_2$, filled, missing, $d_{mfs} (=d_2+filled+missing)$, $d_{mfs} (=d_1+d_2+filled+missing)$
- Dietary information
  - The kids FFQ was used to collect intake frequencies and the usual amount consumed in 1 day
  - The collected dietary data were quantified to the gram

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**Beverage intake patterns**

- Three major sources of sugared drinks were soft drinks, milk, and 100% fruit juice.
- Cluster analysis was used to evaluate the best grouping of children based on similarities in consumption of 3 beverages.
- Based on the largest contributing beverage to the total beverage consumption, 3 groups in Wave 1 and 2 groups in Wave 2 were identified.

**Results**

- Zero-inflated negative binomial models were used to control for the large number of zero counts.
- Children with a low-high soft drinks pattern had a 1.8 times greater risk of developing new DMF surfaces, and a 2.7 times greater risk of developing new filled surfaces compared with those in the reference group.
- Children with a high-high soft drinks pattern had a 2.7 times greater risk for developing new filled surface.

<table>
<thead>
<tr>
<th>Intake pattern</th>
<th>Description</th>
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<tbody>
<tr>
<td>High intake of milk or 100% fruit juice in both Waves 1 and 2.</td>
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<tr>
<td>Low-high soft drinks (n = 114, 44.8%)</td>
<td>High intake of soft drinks changed from low to high in both Waves 1 and 2.</td>
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<tr>
<td>High-low soft drinks (n = 31; 12.6%)</td>
<td>Intake of soft drinks changed from high in Wave 1 to low in Wave 2.</td>
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<tr>
<td>High-high soft drinks (n = 70, 29.3%)</td>
<td>High intake of soft drinks in both Waves 1 and 2.</td>
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</tbody>
</table>

**Implications**

- Given that a majority of children (59%) had visited a dentist during 2 years, we interpret the significant increase in filled surfaces in the low-high soft drinks children as rapid progression of caries to a stage where restorative care is necessary.
- Caries progresses rapidly under conditions of high sugar exposure. Symptoms of sensitivity and pain may thus have lead the caregivers to seek dental care for these children.

**Limitations**

- The Kids FFQ did not collect detailed eating patterns (e.g., between meals) and intake of water.
- Further analysis of detailed frequency of consumption and fluoride exposure was prevented.
- The dietary information was collected from the interview with caregivers.
- Reporting error could occur when children grew up and spent more time outside of home.
Conclusion

- Children with a high consumption of soft drinks over time, or those who increase their consumption of soft drinks relative to milk and 100% fruit juice, are at a higher risk of developing dental caries.

- Soft drinks are potentially cariogenic
  - Soft drinks can still be safely consumed by young children if the exposure is reduced and dental plaque is regularly removed with a fluoridated dentifrice.

- It is important to emphasize in health promotion programs the need to maintain the balance between exposure to soft drinks and preventive oral hygiene behaviors.