Consumption of Added Sugar and Lipids Profile Among US Adolescents: NHANES 2005-2010

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Disclaimer

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.

Conflicts of Interest Disclosures

None
Background

• Studies suggest that higher consumption of added sugar is associated with cardiovascular risk factors in adolescents.
• However, most of the studies have focused on sugar-sweetened beverage, rather than total added sugar.
• Moreover, none has taken into account measurement error in the association study.
Hypothesis

Higher usual percent of calories (%kcal) from added sugar is associated with dyslipidemia in adolescents.
Study Population / Sample

• National Health and Nutrition Examination Survey (NHANES) 2005-2010

• 4,536 participants aged 12-19 years with an initial, reliable 24-hour dietary recall
  - Exclusions: pregnant, underweight, restricted diet, total calorie intake <500 or >5000 kcal/d, and with missing covariate data
  - Final sample size: 3,322
Outcomes

- Total cholesterol
- High-density lipoprotein (HDL) cholesterol
- Non-HDL cholesterol
- Low-density lipoprotein (LDL) cholesterol
- Triglyceride
- Triglyceride to HDL cholesterol ratio
- Total cholesterol to HDL cholesterol ratio
Added Sugar Assessment

- Sugar and syrups that are added to foods during their preparation, processing, or at the table
- Up to two 24-hr dietary recalls (~90% for the 2\textsuperscript{nd} 24-hr dietary recall)
- Nutrient values
  - USDA Food and Nutrient Database for Dietary Studies (FNDDS)
  - USDA Food Patterns Equivalents Database (MPED/FPED)
Estimating Usual %Kcal from Added Sugar

• Single 24-hr dietary recall subject to measurement errors due to day-to-day variation

• NCI methods to estimate usual %Kcal from added sugar taking into account between- and within-person variation

  - adjusting for age, sex, race/ethnicity, 1st/2nd dietary recall, and day of week
Statistical Analyses

• Estimated mean and percent distribution ($\geq 10\%$ or $\geq 25\%$) of calorie from added sugar

• Multivariable linear regression to examine the association between %Kcal from added sugar and lipids profile
  Covariates: age, sex, race/ethnicity, BMI, parental educational attainment ($\leq 12$ vs. $>12$ years), smoker (active: serum cotinine $>10$ ng/mL), Health Eating Index, physical activity (active: $\geq 10$ minutes of moderate- and/or vigorous-intensity activity per week), and total calories
Results

Estimated usual intake

- Added sugar: 84.7 g/day
- Total calories: 2,115 kcal/day
- %Kcal from added sugar: 15.9%
- Proportion ≥10% or ≥25% calories from added sugar: 88.1% and 5.4%, respectively
<table>
<thead>
<tr>
<th></th>
<th>Male (n=1,760)</th>
<th>Female (n=1,562)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (yrs, se)</td>
<td>15.6 (0.08)</td>
<td>15.5 (0.10)</td>
<td>0.129</td>
</tr>
<tr>
<td>Race/ethnicity (%)</td>
<td></td>
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<tr>
<td>Non-Hispanic white</td>
<td>61.7 (2.51)</td>
<td>60.4 (2.60)</td>
<td>0.332</td>
</tr>
<tr>
<td>Non-Hispanic black</td>
<td>13.8 (1.16)</td>
<td>16.1 (1.70)</td>
<td></td>
</tr>
<tr>
<td>Mexican American</td>
<td>12.4 (1.34)</td>
<td>12.3 (1.50)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>12.1 (1.81)</td>
<td>11.3 (1.55)</td>
<td></td>
</tr>
<tr>
<td>Body mass index &lt;25 (%)</td>
<td>61.4 (2.13)</td>
<td>66.7 (1.96)</td>
<td>0.115</td>
</tr>
<tr>
<td>Parental educational attainment ≤12 years (%)</td>
<td>35.0 (1.77)</td>
<td>35.2 (2.37)</td>
<td>0.916</td>
</tr>
<tr>
<td>Physically active (%)</td>
<td>88.6 (1.15)</td>
<td>78.0 (1.49)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Active smoker (%)</td>
<td>18.2 (1.36)</td>
<td>9.4 (1.32)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Healthy Eating Index</td>
<td>49.5 (0.41)</td>
<td>50.9 (0.51)</td>
<td>0.035</td>
</tr>
<tr>
<td>Mean usual added sugar intake (g/d)</td>
<td>96.2 (3.11)</td>
<td>72.2 (2.21)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mean usual total calories (kcal/d)</td>
<td>2376 (46.7)</td>
<td>1831 (37.1)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Mean usual %Kcal from added sugar (%)</td>
<td>16.3 (0.46)</td>
<td>15.4 (0.37)</td>
<td>0.064</td>
</tr>
<tr>
<td></td>
<td>β-coefficient and 95% CI</td>
<td>P value</td>
<td></td>
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<td>------------------------</td>
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<tr>
<td><strong>High-density lipoprotein</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted for age, sex and race/ethnicity only</td>
<td>-0.29 (-0.46, -0.12)</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Fully-adjusted model</td>
<td>-0.24 (-0.42, -0.07)</td>
<td>0.006</td>
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<tr>
<td><strong>Triglycerides</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Adjusted for age, sex and race/ethnicity only</td>
<td>1.49 (0.49, 2.49)</td>
<td>0.003</td>
<td></td>
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<tr>
<td>Fully-adjusted model</td>
<td>1.27 (0.14, 2.40)</td>
<td>0.024</td>
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<tr>
<td><strong>Triglycerides to HDL ratio</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Adjusted for age, sex and race/ethnicity only</td>
<td>0.05 (0.02, 0.07)</td>
<td>&lt;0.001</td>
<td></td>
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<tr>
<td>Fully-adjusted model</td>
<td>0.04 (0.01, 0.07)</td>
<td>0.012</td>
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<tr>
<td><strong>Total cholesterol to HDL ratio</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adjusted for age, sex and race/ethnicity only</td>
<td>0.02 (0.00, 0.04)</td>
<td>0.018</td>
<td></td>
</tr>
<tr>
<td>Fully-adjusted model</td>
<td>0.02 (0.00, 0.04)</td>
<td>0.012</td>
<td></td>
</tr>
</tbody>
</table>
Results (cont.)

• The patterns of association consistent across sex, race/ethnicity, and BMI subgroups with one exception:
  - differed by sex for LDL (p for interaction: 0.023) every % ↑ in usual intake associated with 0.14 and 0.60 mg/dL ↑ in male and female adolescents, respectively.

• No association for total cholesterol, LDL, and non-HDL
Figure 1A. Adjusted HDL (95% CI) by mid-value of quintile of usual %Kcal from added sugar

P value for trend: 0.006

Mid-value of quintiles of usual percent of calories from added sugar

Adjusted HDL (mg/dL)

50 mg/dL

47 mg/dL
Figure 1B. Adjusted triglycerides (95% CI) by mid-value of quintile of usual %Kcal from added sugar

P value for trend: 0.024

Mid-value of quintiles of usual percent of calories from added sugar

84 mg/dL

100 mg/dL
Figure 1C. Adjusted triglyceride to HDL ratio (95% CI) by mid-value of quintile of usual %Kcal from added sugar

P value for trend: 0.012
Figure 1D. Adjusted total cholesterol to HDL ratio (95% CI) by mid-value of quintile of usual %Kcal from added sugar.

P value for trend: 0.012
Results (cont.)

• Sensitivity analysis

- When intake data from the 1\textsuperscript{st} 24-hour dietary recall was used, substantial attenuation occurred in the association between %Kcal from added sugar and lipids profile.
Strength

• The 1\textsuperscript{st} study to assess the association between usual %Kcal from added sugar and lipids profile in large nationally representative sample of US adolescents
• Estimated usual %Kcal from added sugar accounting for measurement error
• Able to control for several important confounding variables
Limitations

- 24-hour dietary recalls might under- or overestimate actual intake
- Physical activity questions differed between 2005-2006 and 2007-2010 cycles
- ≥10 minutes per week as physically active
- Cross-sectional study
- Effect of unmeasured confounding factors
Summary and Conclusion

• US adolescents aged 12-19 years consume ~16% of total calories from added sugar
• Overwhelming majority of US adolescents, ~88% consume ≥10%, and ~5.4% consume ≥25%
• Increased intake of added sugar is associated with several measures of lipids level.
• Reduction of added sugar consumption among adolescents might reduce the risk of developing cardiovascular disease in adults.