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Associations of sweetened beverage intake with energy, sugar and cardiometabolic markers in UK children: a cross-sectional analysis of the National Diet and Nutrition Survey Rolling Programme

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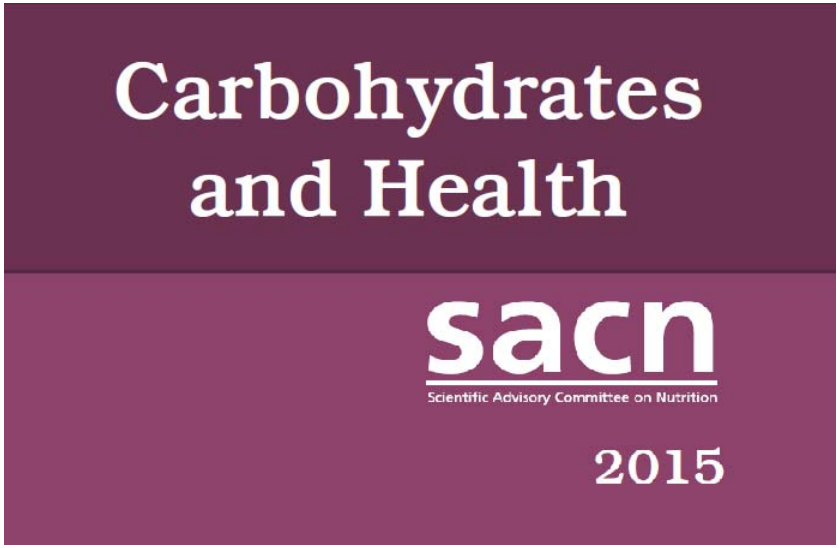
Current guidelines for sugar consumption

Average intake of free sugars should not exceed **5%** of total dietary energy



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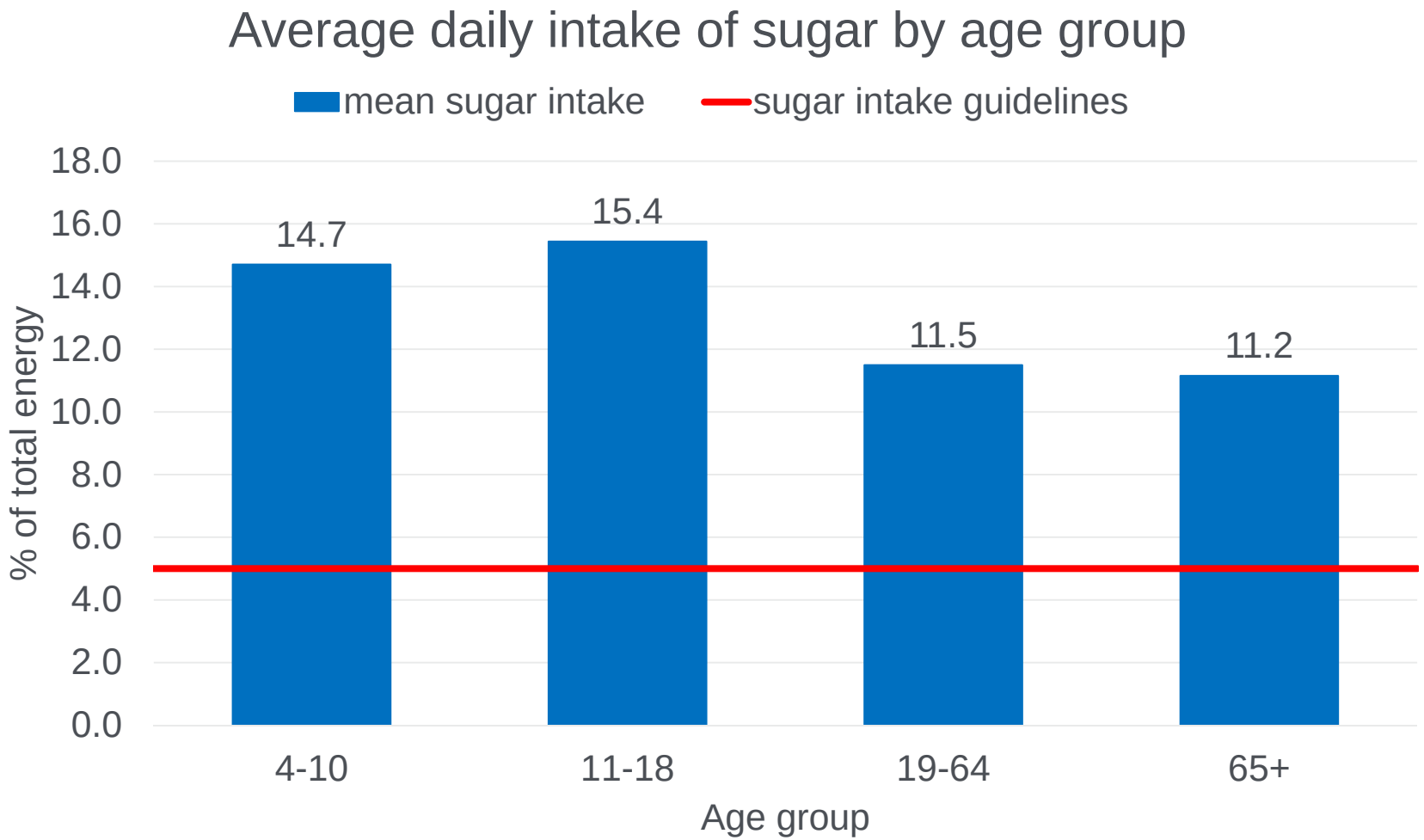
Sugar intake: where are we now?



Source: NDNS: Results from Years 1, 2, 3 and 4 (combined) of the RP

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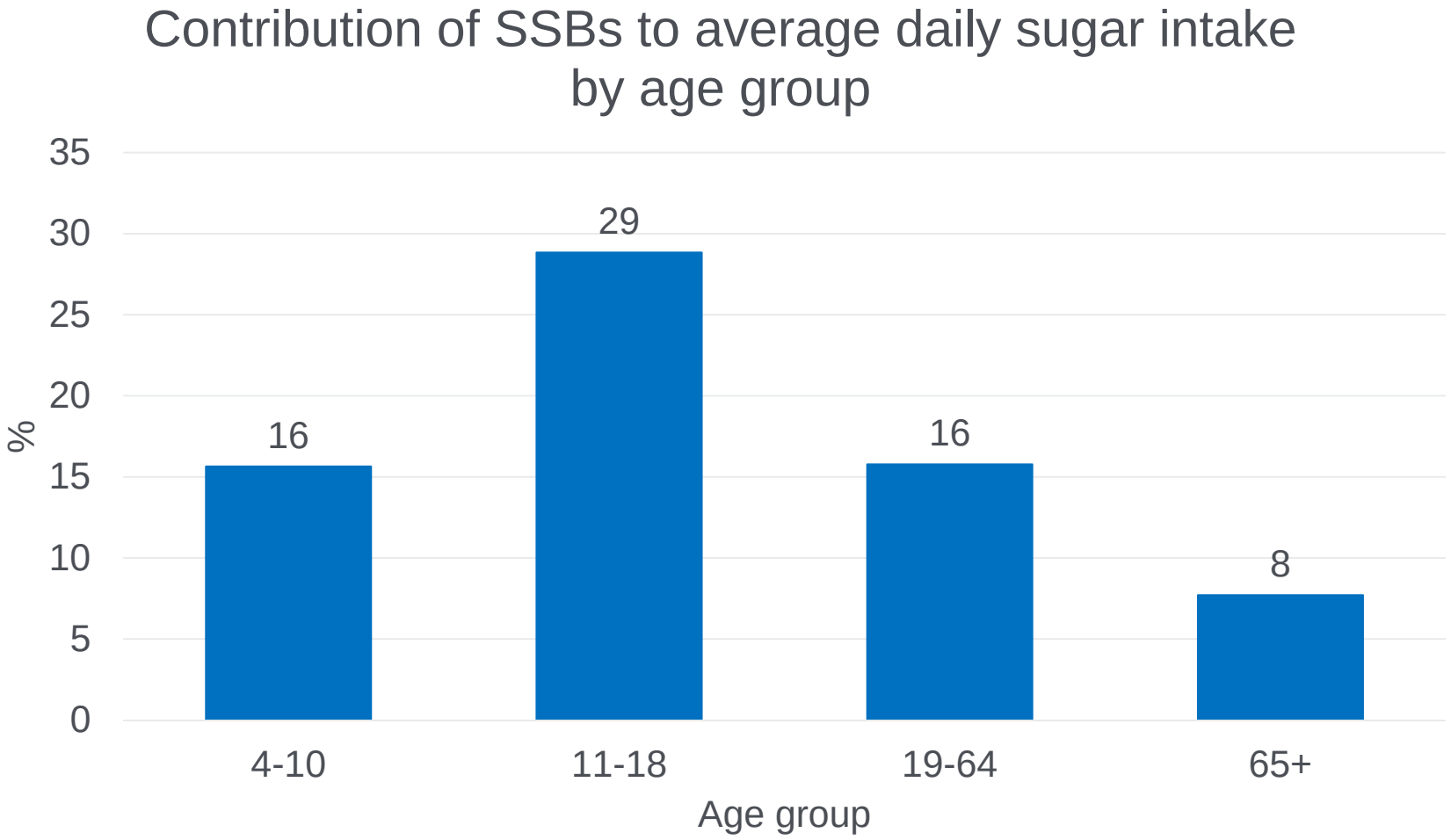
Sugar-sweetened beverages (SSBs)



Source: NDNS: Results from Years 1, 2, 3 and 4 (combined) of the RP

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Sugar-sweetened beverages (SSBs)

Main sugar contributor in UK children

Associated with obesity, diabetes, and metabolic syndrome

Main priority for policymakers

→ e.g. sugar tax

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Artificially-sweetened beverages (ASBs)

Sales increasing rapidly

Uncertainty among dietary guidelines

Caloric compensation → mixed results

Association with glucose intolerance → mixed results

No previous studies on a nationally representative sample of children

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Research questions

1. What are the associations between SSB/ASB consumption and **energy** and **sugar** intake, **overall** and from **solid foods** and **beverages**, and

2. What are the associations between SSB/ASB consumption and cardio-metabolic markers, including **BMI**, **blood glucose** and **blood lipids** in a nationally representative sample of UK children and adolescents?

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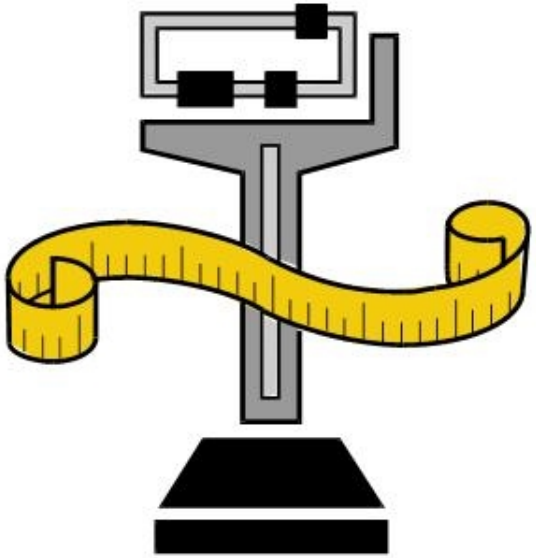
National Diet and Nutrition Survey Rolling Program 2008/12 (NDNS)

Cross-sectional study of a representative UK sample

1,648 children **4-18 years old**;

- *Stage 1*
  - Computer Assisted Personal Interview
  - 4-day food diary
  - Physical activity data
  - Weight and height
- *Stage 2 - Nurse visit*
  - Physical measurements
  - Blood sample
  - 24-h urine sample



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Sweetened beverage intake

1. Neither SSB nor ASB consumption (ref.)
2. Only SSB consumption
3. Only ASB consumption
4. Both SSB and ASB consumption

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Dietary intake – 4-day food diary

Energy and sugar

- **total**
- from **solid foods**
- from **beverages**

Dietary intake

- **Between-person** – mean of 4-days intake
- **Within-person** – each day as a separate observation

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Models

1. **Between-person** associations with **energy and sugar** intake

2. **Within-person** associations with **energy and sugar** intake → fixed-effects linear regression

3. Associations with **cardio-metabolic markers**

Sensitivity analyses:
Age and sex stratification
Excluding children on a weight loss diet and/or being obese

All analyses used survey weights for sampling and non-response

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Descriptive characteristics: Demographic characteristics per beverage consumption

Characteristic	Neither	SSBs	ASBs	Both
N (%)	164 (9.7)	501 (29.7)	298 (17.7)	724 (42.9)
Age* (years)	10.7 (0.4)	11.7 (0.2)	9.7 (0.2)	10.9 (0.2)
Male (%)	75 (45.7)	265 (52.9)	149 (50.0)	370 (51.1)
BMI (kg/m^2)	19.4 (4.3)	19.7 (4.3)	19.3 (4.5)	19.8 (0.4)
SSBs (g/day)	0	311.9 (268.0)	0	250.5 (237.1)
ASBs (g/day)	0	0	351.4 (300.8)	286.3 (248.5)
Total energy (kcal)*	1499 (499)	1699 (485)	1511 (372)	1729 (440)
Total sugar (% TE)*	11.7 (5.4)	16.4 (6.1)	12.1 (5.1)	16.2 (5.6)

**p<0.05*

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Sweetened beverages and energy/sugar intake – between person associations

Beverage consumed	Neither	SSBs	ASBs	Both
	(ref)	Coeff. (95% CI)	Coeff. (95% CI)	Coeff. (95% CI)
Total Energy (kcal)		106 (-38, 250)	27 (-120, 174)	**162 (21, 303)**
Energy from solid foods (kcal)		15 (-118, 148)	37 (-99, 174)	108 (-22, 239)
Energy from beverages (kcal)		**91 (54, 129)**	-11 (-48, 27)	**54 (20, 88)**
Total sugar (% TE)		**6.2 (4.2, 8.1)**	1.4 (-0.4, 3.3)	**4.9 (3.1, 6.8)**
Sugar from solid foods (% TE)		0.8 (-0.5, 2.0)	**1.7 (0.5, 2.9)**	**1.2 (0.0, 2.3)**
Sugar from beverages (% TE)		**5.4 (3.8, 6.9)**	-0.2 (-1.6, 1.1)	**3.8 (2.4, 5.2)**

adjusted for: age, sex, BMI, ethnic group, equivalised household income, frequency of eating takeaway and physical activity

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Sweetened beverages and energy/sugar intake – within person associations

Beverage consumed	Neither	SSBs	ASBs	Both
	(ref)	Coeff. (95% CI)	Coeff. (95% CI)	Coeff. (95% CI)
Total Energy (kcal)		**216 (163, 269)**	17 (-45, 79)	**217 (135, 299)**
Energy from solid foods (kcal)		**89 (41, 138)**	50 (-7, 106)	**154 (81, 226)**
Energy from beverages (kcal)		**127 (107, 146)**	**-33 (-54, -12)**	**64 (35, 92)**
Total sugar (% TE)		**7.0 (6.2, 7.8)**	**-1.0 (-1.8, -0.1)**	**4.5 (3.4, 5.5)**
Sugar from solid foods (% TE)		-0.4 (-1.0, 0.2)	0.0 (-0.6, 0.7)	-0.1 (-0.9, 0.6)
Sugar from beverages (% TE)		**7.4 (6.8, 8.1)**	**-1.0 (-1.7, -0.3)**	**4.6 (3.8, 5.4)**

adjusted for: diary being collected on a Friday, Saturday, or Sunday

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Sweetened beverages and metabolic markers

Beverage consumed	Neither	SSBs	ASBs	Both
	(ref)	Coeff. (95% CI)	Coeff. (95% CI)	Coeff. (95% CI)
BMI (Kg/m^2)		-0.72 (-1.91, 0.48)	0.79 (-0.43, 2.00)	0.38 (-0.83, 1.60)
Glucose (mmol/L)		**0.30 (0.11, 0.49)**	**0.24 (0.06, 0.43)**	**0.28 (0.08, 0.47)**
HbA1c (%)		-0.08 (-0.24, 0.08)	-0.16 (-0.33, 0.01)	-0.09 (-0.25, 0.07)
Triglycerides (mmol/L)		**0.29 (0.13, 0.46)**	0.15 (0.00, 0.31)	**0.29 (0.12, 0.47)**
Total chol (mmol/L)		0.38 (-0.06, 0.81)	0.31 (-0.13, 0.76)	0.30 (-0.13, 0.72)
HDL (mmol/L)		0.08 (-0.12, 0.28)	0.12 (-0.08, 0.32)	0.07 (-0.13, 0.26)

adjusted for: age, sex, ethnic group, equivalised household income, frequency of eating takeaway, physical activity, energy, food groups (g/1000 kcal): fruits and vegetables, meat, confectionery, juices, and tea-coffee-water, and BMI (only for the blood measurements)

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Recap

- SSBs: ↑ total **sugar** intake
- SSBs: ↑ **glucose** and **triglycerides**
- SSB days: ↑ total **energy** and **sugar** intake

- ASBs: ↑ sugar from **solid** foods
- ASBs: ↑ **glucose**
- ASB days: ↓ total **sugar**

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Strengths and limitations

Strengths	Limitations
✓National representative sample	✗Cross-sectional design
✓High quality dietary data	✗Missing values

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Policy implications

SSB → priority

We need effective measures

•fiscal measures

•product reformulation

•warning labels

ASB → closely monitored

•Child-focused advertising

•Availability

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Many thanks to the researchers and participants of the study!