Balancing the Sugar-Fat Seesaw: Understanding the relatives roles played in obesity

Dr Carlos Celis-Morales
Institute of Cardiovascular and Medical Sciences
University of Glasgow
Is sugar the new tobacco?
OBESITY IS NOW A GLOBAL EPIDEMIC!
Sugar is apparently the enemy. More so than fat or calories themselves, sugar is considered the most dangerous thing you can consume and has been compared, even by scientists, to heroin.
Executive Summary

1975

BMI: $21.7 \text{ kg.m}^2$

$=\quad$

62.7 kg

(1.7 m height
(5.6 foot)

Observational data from 19.2 millions participants worldwide

Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19·2 million participants, The Lancet, April 2016
Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19.2 million participants, The Lancet, April 2016
1975
BMI: 21.7 kg.m⁻²
= 62.7 kg
(1.7 m height
(5.6 foot)

2014
BMI: 24.2 kg.m⁻²
= 70.1 kg
(1.7 m height
(5.6 foot)

Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19·2 million participants, The Lancet, April 2016
Executive Summary

Trends in adult body-mass index in 200 countries from 1975 to 2014: a pooled analysis of 1698 population-based measurement studies with 19·2 million participants, The Lancet, April 2016

Obesity (%)

1975

Men
3.2 to 10.8

Women
6.4 to 14.9

2014
Prevalence in the UK from 1980 to 2014
Prevalence in the UK from 1980 to 2014
Prevalence in the UK from 1980 to 2014

BMI (kg/m²)

- < 18.5
- 18.5-20
- 20-25
- 25-30
- 30-35
- 35-40
- ≥ 40

100% 50% 0%

1980 1990
Prevalence in the UK from 1980 to 2014
Prevalence in the UK from 1980 to 2014
Prevalence in the UK from 1980 to 2014

More than 50% of the UK population was overweight or obese by 2010
Prevalence in the UK

% adults obese\(^*\)

- <20
- 21-23
- 24-26
- 27-29
- No data

EU average: 14%

\(^*\) % of population age 16+ with BMI 30kg/m² or greater

Source: NHS Choices – Your Health, Your Choices
Sugar has been targeted as Public Enemy No. 1 in the fight against obesity. But is it really where we should be placing all the blame?
GUIDELINES
Headlines based on evidence reviewed in SACN report:

• higher consumption of sugars and sugars containing food is associated with a greater risk of tooth decay;

• increasing or decreasing total energy (calorie) intake from sugars leads to a corresponding increase or decrease in energy intake;
Headlines based on evidence reviewed in SACN report:

- Consumption of sugars-sweetened drinks* results in greater weight gain and increases in BMI in children and adolescents;

- Greater consumption of sugars-sweetened drinks is associated with increased risk of type 2 diabetes.
This led to the following recommendations from SACN:

- Average intake across the UK population of free sugars should not exceed 5% of total dietary energy intake for age groups from 2 years upwards.

- The consumption of sugars-sweetened drinks should be minimised in children and adults.
<table>
<thead>
<tr>
<th>Age</th>
<th>Recommended maximum free sugars(^a) intake, g per day(^b)</th>
<th>Sugar cubes(^c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4-6 years</td>
<td>No more than 19g/day</td>
<td></td>
</tr>
<tr>
<td>7-10 years</td>
<td>No more than 24g/day</td>
<td></td>
</tr>
<tr>
<td>From 11 years, including adults</td>
<td>No more than 30g/day</td>
<td></td>
</tr>
</tbody>
</table>
What are free sugars?

• All sugars added to foods by the manufacturer, cook or consumer, plus sugars naturally present in honey, syrups and unsweetened fruit juice.

What sugars do not count as free sugar?

• Lactose (the sugar in milk) when naturally present in milk and milk products and the sugars contained within the cellular structure of foods (e.g. fruit and vegetables).
Current estimates of UK sugar intakes from the National Diet and Nutrition Survey programme (NDNS) show that mean intakes are three times higher than the new 5% maximum recommended level in school-aged children and teenagers (14.7% to 15.6% of energy intake) and around twice the maximum recommended level in adults (12.1% of energy intake).
Contributors to sugar intake in the UK – children aged 4 to 18 years

Soft drinks (excluding fruit juice) are the largest single source of sugar for children
Contributors to sugar intake in the UK – children aged 4 to 18 years

- Soft drinks provide 29% of daily sugar intake, on average, for this age group as a whole.
Contributors to sugar intake in the UK – children aged 4 to 18 years

For younger children the major sources of sugar intake are:

1. soft drinks
2. biscuits
3. buns
4. cakes
5. Pastries and puddings
6. breakfast cereals
7. confectionery
8. fruit juice

Soft drinks provide 29% of daily sugar intake, on average, for this age group as a whole.
Contributors to sugar intake in the UK – Adults aged 19-64 years
Contributors to sugar intake in the UK – Adults aged 19-64 years

For adults the major sources of sugar intake are:
1. table sugar
2. Biscuits
3. Buns
4. Cakes
5. pastries and puddings
6. soft drinks

Alcoholic drinks also contribute to sugar intake in adults
A review of total & added sugar intakes and dietary sources in Europe

Véronique Azaïs-Braesco¹, Diewertje Sluik², Matthieu Maillot³, Frans Kok² and Luis A. Moreno⁴
In all countries and at all ages, women/girls had a lower intake in sugars than men, when expressed in g/day.
In all countries and at all ages, women/girls had a lower intake in sugars than men, when expressed in g/day, but this difference disappeared when the sugar contribution to the total energy intake was considered, likely reflecting the higher energy intake of males.
Contributors to total sugars among adults.

Sweet products were major contributors to the intake of total sugars in all countries and across genders and ages.
Contributors to total sugars among adults.

F&V were major contributors (more than 20% of total sugar intakes) in Southern European adults (Spain, Italy and France),
Contributors to total sugars among Children.

Sweet products were major contributors to the intake of total sugars in all countries and across genders and ages.
Contributors to intake of added sugars in adults

Sweets products provide between 47% and 61% of the total energy from added sugars.

Beverages contribute to 12% to 31% of total energy.
In the UK sweets & beverages contribute to 73% of TE in women and 81% in men.
Sweets products provide between 40-50% of total energy from added sugars.

Beverages contribute to 20-37% of total energy.
Total sugars contribute to 15 to 25% of energy supply in several European countries, among which 7.5 to 17% are added sugars or NMES, the highest figure always being for children or teens.

From the available data, a large proportion of the European population, especially, but not only children, appears to exceed the 10% WHO threshold.
Children in England are exposed to a high volume of marketing and advertising in many different forms both old (eg TV advertising, radio, cinema, press and billboards) and new (eg advergames, social media, online advertising), as well as through sponsorship by food and drinks companies of TV programmes, public amenities and events.

Available research evidence shows that all forms of marketing consistently influence food preference, choice and purchasing in children and adults.
Food retail price promotions are more widespread in Britain than anywhere else in Europe. Foods on promotion account for around 40% of all expenditure on food and drinks consumed at home.

Higher sugar products are promoted more than other foods.

Price promotions increase the amount of food and drink people buy by around one-fifth.
Potential cost savings of achieving SACN’s sugar recommendation

The majority of the cost savings are realised from reductions in excess body weight and associated ill health.

Table 1. Economic model outputs per year by each scenario

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Years to achieve target</th>
<th>Deaths averted&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Caries cases avoided&lt;sup&gt;b&lt;/sup&gt;</th>
<th>Total NHS cost saving (£m)&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Achieving 5% energy intake for sugar</td>
<td>5</td>
<td>4,700</td>
<td>242,000</td>
<td>576</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>4,100</td>
<td>204,000</td>
<td>484</td>
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<tr>
<td></td>
<td>15</td>
<td>3,500</td>
<td>173,000</td>
<td>396</td>
</tr>
</tbody>
</table>
Supreme Court backs minimum alcohol price

Scotland is set to be the first country in the world to establish a minimum price per unit of alcohol.

3 hours ago | Scotland | 736
Sugar has been targeted as Public Enemy No. 1 in the fight against obesity. But is it really where we should be placing all the blame?
Sugar has been targeted as Public Enemy No. 1 in the fight against obesity. But is it really where we should be placing all the blame?
Executive Summary

Observational data from Epidemiological studies
Is Sugar to Blame for Obesity? The Numbers Don’t Add Up

Since 1999: U.S. Obesity Rates Up, Per Capita Caloric Sweetener Consumption Down

1999=100%

Obesity Data — Centers for Disease Control and Prevention/HHS.
Note: Official obesity data available only for years shown.
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Since 1999: U.S. Obesity Rates Up, Per Capita Caloric Sweetener Consumption Down

1999=100%

Adult Obesity (% of population)

Obesity Data — Centers for Disease Control and Prevention/HHS.
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Is Sugar to Blame for Obesity?
The Numbers Don’t Add Up

Since 1999: U.S. Obesity Rates Up, Per Capita Caloric Sweetener Consumption Down

1999 = 100%

Adult Obesity (% of population)

Caloric Sweetener Consumption (lbs/person)

15% Decline

Obesity Data — Centers for Disease Control and Prevention/HHS.
Note: Official obesity data available only for years shown.
Declining consumption of added sugars and sugar-sweetened beverages in Australia: a challenge for obesity prevention\(^1,2\)

Jennie C Brand-Miller\(^3,4\) and Alan W Barclay\(^4\)

Abstract

**Background:** Reduced intakes of added sugars and sugar-sweetened beverages (SSBs) have been the main focus of efforts to stall obesity. Although obesity has risen steeply in Australia, some evidence suggests that added-sugars and SSB intakes have declined over the same time frame.

**Objective:** We investigated recent trends in the availability of sugars and sweeteners and changes in intakes of total sugars, added sugars, and SSBs in Australia by using multiple, independent data sources.

**Design:** The study was designed to compare relevant data published by the Food
Is Sugar to Blame for Obesity? The Numbers Don’t Add Up

**FIGURE 8** Age-standardized trends in obesity in Australian adults aged ≥20 y between 1980 and 2013 (1) compared with trends in the availability of sugars and sweeteners between 1980 and 2011 according to the FAO Statistics Division Database (18). Am J Clin Nutr 2017, March 8th
Mean changes in intakes of added sugars from all sources in children according to national dietary surveys in 1995 and 2011–2012.

Mean changes in intakes of added sugars from all sources, including discretionary sugars and sugars that were added to processed foods, in Australian children (aged 2–18 y) according to national dietary surveys in 1995 and 2011–2012.
Mean changes in intakes of added sugars from all sources, including discretionary sugars and sugars that were added to processed foods, in Australian children (aged 2–18 y) according to national dietary surveys in 1995 and 2011–2012.

Added–sugars intake fell 34% in boys (from 96 to 63 g/d) and 26% in girls (from 72 to 53 g/d).
From this data, it is clear that over the last 30 or more years, the intake of sugars, however defined, has not shown any concerted global trend to increase. The above data are for males and the female data is pretty similar. Some countries have data on both sexes combined and again they show no upward trend:

Evidence from Prospective studies
Evidence from observational studies: obesity and sugar intake

ORIGINAL ARTICLE
Changes in Diet and Lifestyle and Long-Term Weight Gain in Women and Men

Dariush Mozaffarian, M.D., Dr.P.H., Tao Hao, M.P.H., Eric B. Rimm, Sc.D., Walter C. Willett, M.D., Dr.P.H., and Frank B. Hu, M.D., Ph.D.

Comments open through June 29, 2011
Evidence from observational studies: obesity and sugar intake

- **Prospective** investigations involving **three separate cohorts** (Nurse Healthy Study, Nurse Health Study II and Health Professional study)

- **120,877** U.S. women and men

- **Free of chronic diseases** and not obese at baseline

- Follow-up periods from 12 to 20 years
Weight gain associated with increased consumption of refined grains (0.39 lb per serving per day) was similar to that for sweets and desserts (0.41 lb per serving per day).
Weight gain associated with increased consumption of SSBs (0.98 lb per serving per day) and 100%-Fruit Juice (0.36 lb per serving per day).
Adiposity among 132,479 UK Biobank participants; contribution of sugar intake vs other macronutrients

JJ Anderson, CA Celis-Morales, DF Mackay, S Iliodromiti, DM Lyall, N Sattar, JMR Gill, JP Pell

Published: 12 July 2016  
Article history ▼

Abstract

Published by Oxford University Press on behalf of the International Epidemiology Association.
Body mass index by quintile of percentage of total energy obtained from sugar

Adjusted for age, sex, ethnicity
Body mass index by quintile of percentage of total energy obtained from sugar

Adjusted for age, sex, ethnicity
Body mass index by quintile of percentage of total energy obtained from total sugar

Adjusted for age, sex, ethnicity

Adjusted for age, sex, ethnicity and physical activity
Fizzy drinks and obesity – evidence from the UK Biobank
Fizzy drinks and visceral fat – evidence from the UK Biobank
Evidence from Randomised Controlled Trials
A Randomized Trial of Sugar-Sweetened Beverages and Adolescent Body Weight

Cara B. Ebbeling, Ph.D., Henry A. Foidman, Ph.D., Virginia R. Chomitz, Ph.D., Tracy A. Antonelli, M.P.H., Steven L. Gortmaker, Ph.D., Stavroula K. Osganian, M.D., Sc.D., and David S. Ludwig, M.D., Ph.D.


The consumption of sugar-sweetened beverages among adolescents has increased in tandem with the prevalence of pediatric obesity in the United States, suggesting a causal relationship. At present, a substantial proportion of high-school students habitually consume sugar-sweetened beverages, including carbonated soda, sports drinks, energy drinks, and highly sweetened coffees and teas. Sugar-sweetened beverages are the leading source of added sugar in the diet of a wide range of racial and ethnic groups. According to nationally representative data, overweight and obese adolescents obtain more than 300 kcal per day from these products, amounting to an average of 15% of their total daily energy intake.

Short-term feeding studies show greater energy intake and weight gain with the consumption of sugar-sweetened beverages than with beverages containing artificial sweeteners, and prospective observational studies show positive associations with the risk of obesity and related complications. However, the findings from the relatively few randomized, controlled trials designed to examine the...
• **224 adolescents** (124 boys and 100 girls) who reported consuming at least one serving (12 oz) per day of sugar-sweetened beverages or 100% fruit juice.

• A multicomponent intervention was designed to **reduce the consumption of sugar-sweetened beverages in the experimental group**. The emphasis was on displacing sugar-sweetened beverages with noncaloric beverages in the home as a strategy to decrease consumption.

• The **1-year intervention** consisted of home delivery of noncaloric beverages (e.g., bottled water and “diet” beverages) every 2 weeks.

• **Monthly motivational telephone calls** with parents (30 minutes per call), and three check-in visits with participants (20 minutes per visit).
• RESULTS

At 1 year
• there were significant between-group differences for changes in BMI (−0.57, P=0.045) and weight (−1.9 kg, P=0.04).

At 2 years of follow up
• After an additional 1 year of follow-up without active intervention, the intervention group still had less weight gain than the control group, although the between-group difference was not statistically significant

• As was expected, the consumption of SSBs in both groups rebounded somewhat after the intervention ceased, suggesting that to achieve long-term benefits, the intervention needs to be sustained over time.
A Trial of Sugar-free or Sugar-Sweetened Beverages and Body Weight in Children

Janne C. de Ruyter, M.Sc., Margreet R. Olthof, Ph.D., Jacob C. Seidell, Ph.D., and Martijn B. Katan, Ph.D.


BACKGROUND
The consumption of beverages that contain sugar is associated with overweight, possibly because liquid sugars do not lead to a sense of satiety, so the consumption of other foods is not reduced. However, data are lacking to show that the replacement of sugar-containing beverages with noncaloric beverages diminishes weight gain.
A double-blinded placebo-controlled trial

Randomized 641 normal-weight Dutch children to receive:

- 250 mL (8 oz) per day of a sugar-free, artificially sweetened beverage (sugar-free group) or,
- a similar sugar-containing beverage that provided 104 kcal per serving (sugar group).

- 18 months of the intervention
After 18 months of the intervention, compared with the sugar group, the sugar-free group had **significant reductions in BMI z-score weight gain and body fat change**. A major advantage of this study is the double-blind design, which avoids potential biases because of psychological cues and social desirability.
Is sugar the only evil?
Is sugar the only evil?
The historically inverse relationship between fat and “added sugars” intake

Published studies* have documented and consumption data** confirms the historically inverse relationship between fat and “added sugars” intake when expressed as percent of energy in both the United States and the European Union.
Obesity prevalence in US adults and daily per capita total calories and calories consumed from added fats and sugars, 1970 - 2010.
Americans are consuming more than 450 additional calories each day than they were 40 years ago, with these calories coming mostly from refined grains, added fats and oils. That’s equivalent to adding a double cheeseburger on to your total calories every day!

Comparatively, added sugars contribute only 8 percent (40 calories) to the daily increase in consumption.
SACN’s analysis reveals that free sugars intake is a dietary factor that increases energy intake in situations where food intake is unrestricted.
SACN’s analysis reveals that free sugars intake is a dietary factor that increases energy intake in situations where food intake is unrestricted.

Decreasing the population intake of free sugars is one step that could be taken to help reduce the current UK overconsumption of energy in relation to energy requirements.
Adiposity among 132 479 UK Biobank participants; contribution of sugar intake vs other macronutrients

JJ Anderson, CA Celis-Morales, DF Mackay, S Iliodromiti, DM Lyall, N Sattar, JMR Gill, JP Pell

International Journal of Epidemiology, Volume 46, Issue 2, 1 April 2017, Pages 492-501,
https://doi.org/10.1093/ije/dyw173
Published: 12 July 2016  Article history ▼
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Body mass index by quintile of percentage of total energy obtained from total sugar

Adjusted for age, sex, ethnicity

Adjusted for age, sex, ethnicity and physical activity
Body mass index by quintile of percentage of total energy obtained from total sugar

Adjusted for age, sex, ethnicity

Adjusted for age, sex, ethnicity and physical activity

Adjusted for age, sex, ethnicity, physical activity and total energy intake
Body mass index by quintile of percentage of total energy obtained from total fat intake

Adjusted for age, sex, ethnicity

Adjusted for age, sex, ethnicity and physical activity
Body mass index by quintile of percentage of total energy obtained from total sugar

Adjusted for age, sex, ethnicity

Adjusted for age, sex, ethnicity and physical activity

Adjusted for age, sex, ethnicity, physical activity and total energy intake
Association between added sugars intake and BMI

Percent Energy from Added Sugars

*data from USDA’s What We Eat in America (2003-2006) (n=15,189)  
Source: Marriott et al., Crit Rev Food Sci, 2010
A U-shaped relationship exists between added sugars intake and BMI. BMIs are highest when added sugars intake is less than 10% and greater than 35%.
Association between added sugars intake and BMI

A U-shaped relationship exists between added sugars intake and BMI. BMIs are highest when added sugars intake is less than 10% and greater than 35%.

Mean intakes:
- U.S. - 13.4%
- Canada - 13%
- Mexico - 17%

Source: Marriott et al., Crit Rev Food Sci, 2010

*data from USDA’s What We Eat in America (2003-2006) (n=15,189)
Data has shown the seesaw effect of restricting individual nutrients only leads to caloric overcompensation with another, whether sugar for fat, or vice-versa.
Changes in Diet and Lifestyle and Long-Term Weight Gain in Women and Men

Dariush Mozaffarian, M.D., Dr.P.H., Tao Hao, M.P.H., Eric B. Rimm, Sc.D., Walter C. Willett, M.D., Dr.P.H., and Frank B. Hu, M.D., Ph.D.


Comments open through June 29, 2011
Weight gain associated with increased consumption refined grains +0.39 lb sweets and desserts +0.41 lb per serving per day.

Relationships between Changes in Food and Beverage Consumption and Weight Changes Every 4 Years, According to Study Cohort.
Weight gain associated with increased consumption of high fat foods

Potato chips +1.6 lb
Fries +1.2 lb
Processed meat +1 lb
Is it possible to design a better, healthier and more individual diet?
EU FP7 project:
- Funded for 5 years (2011 to 2015)
- Led by Mike Gibney (University College Dublin)
- 25 partners from 12 countries

What make us fat – evidence from a Pan-European study

Food4me Team

**University partners**
1. University College Dublin
2. University of Ulster
3. Maastricht University
4. Newcastle University
5. University of Oslo
6. University of Navarra
7. Lund University
8. University of Reading
9. National Food and Nutrition Institute Warsaw
10. Harokopio University Athens
11. University of Wageningen
12. LEI-Wageningen University Research
13. Technische Universität München
14. Jönköping University
15. Universidade do Porto

**Industrial partners**
1. Bio-Sense
2. Crème Software Ltd.
3. European Food Information Council
4. TNO Quality of Life
5. DSM Nutritional Products Ltd.
6. Philips Netherlands
7. NuGO-A Association
8. Keller & Heckman
9. Philips UK
10. Vitas

food4me.org
Led by Prof John Mathers, HNRC, Newcastle University

9 partners from 8 countries
1. Newcastle University (UK)
2. University College Dublin (Ireland)
3. Maastricht University (The Netherlands)
4. University of Oslo (Norway)
5. University of Navarra (Spain)
6. University of Reading (UK)
7. National Food and Nutrition Institute Warsaw (Poland)
8. Harokopio University Athens (Athens)
9. Technische Universitaet Muenchen (Germany)
What make us fat – evidence from a Pan-European study

<table>
<thead>
<tr>
<th></th>
<th>Odds ratio</th>
<th>Lower limit</th>
<th>Upper limit</th>
<th>p-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total fat (% of TE)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Higher (Ref.)</td>
<td>0.666</td>
<td>0.478</td>
<td>0.927</td>
<td>0.016</td>
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<tr>
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<td>0.426</td>
<td>0.264</td>
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<td><strong>Saturated fat (% of TE)</strong></td>
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<td>0.615</td>
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<td><strong>Monounsaturated fat (% of TE)</strong></td>
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<td><strong>Polyunsaturated fat (% of TE)</strong></td>
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<td>2.013</td>
<td>0.010</td>
</tr>
<tr>
<td>Lower</td>
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</tbody>
</table>

44% and 58% less likely to had a BMI >25.0

Celis-Morales, Mathers J., (Food4Me), et al., (2016) In progress
What make us fat – evidence from a Pan-European study

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<th>Upper limit</th>
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<tr>
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<td>1.851</td>
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<td>1.581</td>
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<td>Fizzy drinks</td>
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<td>0.607</td>
<td>0.424</td>
<td>0.866</td>
<td>0.006</td>
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<td>0.561</td>
<td>0.969</td>
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<td>0.561</td>
<td>0.969</td>
<td>0.029</td>
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<td>0.552</td>
<td>0.978</td>
<td>0.035</td>
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<tr>
<td>Middle</td>
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<td>0.445</td>
<td>0.813</td>
<td>0.001</td>
</tr>
<tr>
<td>Lower</td>
<td>0.601</td>
<td>0.445</td>
<td>0.813</td>
<td>0.001</td>
</tr>
</tbody>
</table>

40% and 27% less likely to had a BMI >25.0

Celis-Morales, Mathers J., (Food4Me), et al., (2016) In progress
There is an inverse relationship between the percentage of calories people consume from fat and those consumed from added sugars.

In other words, people with diets that are low in fat tend to consume more sugar. The reverse is also true – those with diets high in fat are likely to have low sugar intakes.
For overweight individuals, SACN advises that reducing the amount of energy consumed as free sugars, without increasing energy intake from other sources, could contribute to a reduction in total energy intake and result in weight loss.
Focusing public health messages too strongly on reducing sugar consumption may mislead the public on the need to also reduce intake of fat and calories overall.