

Sweet enough already?

Artificial sweeteners in the diets
of young children in the UK

November 2019



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children in the UK**

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Acronyms

ADI	Acceptable Daily Intake
BMI	Body Mass Index
DNSIYC	Diet and Nutrition Survey of Infants and Young Children
EFSA	European Food Safety Authority
FSMP	Foods for Special Medical Purposes
FSA	UK Food Standards Agency
MPL	Maximum Permitted Level
NDNS	National Diet and Nutrition Survey
NOAEL	No Observed Adverse Effect Level
PKU	Phenylketonuria
RCT	Randomised Controlled Trial
SDIL	Soft Drinks Industry Levy
FDA	US Food and Drug Administration

Executive summary and recommendations

Sweeteners such as acesulfame-potassium (acesulfame-K), aspartame, saccharin and sucralose are used in thousands of food and drink products in the UK, many of which are labelled as 'diet' or low/reduced sugar. Current regulations prohibit their addition to foods specifically marketed for babies and toddlers. While data on sweetener exposures and intakes among infants and young children in the UK are lacking, available data suggests that many infants and young children are consuming sweeteners. Artificially sweetened drinks are likely to be a key dietary source.

Mechanisms to safeguard against any health risks of excessive consumption of artificial sweeteners include the setting of Acceptable Daily Intakes. However, these have been calculated in the absence of data on intake from infants and with limited data on intakes of toddlers, generalising from the data available from European countries not including the UK. Exposure data is also outdated; the most recent food consumption data used to inform the Acceptable Daily Intakes was collected in 2009 and the oldest was collected over two decades ago.

In the meantime, sweetener consumption is likely to have increased in all population groups as public health efforts to reduce sugar intakes have intensified and consumer preferences increasingly favour low/reduced sugar options. The soft drinks industry levy ("sugar tax") has led to a rapid increase in the amounts of sweeteners used in soft drinks marketed in the UK. Post-Brexit trade deals may put infants and young children at risk of greater sweetener exposure if current regulations preventing the addition of

sweeteners to foods marketed for infants and young children are changed, or if higher amounts of sweeteners are allowed in a larger range of food and drink products. The absence of clear and consistent public health messaging which advises families to avoid giving young children artificially sweetened foods and drinks exacerbates this risk.

There remains a lack of evidence about the possible impacts of sweetener consumption prenatally and in the early years on long term health. The existence of documented negative effects, including but not limited to increased calorie consumption and weight gain among pre-pubertal children, and a potential impact on the microbiota, are a cause for serious concern. For this reason, we make the following eight recommendations which promote a precautionary approach to limit the intake of artificial sweeteners by pregnant and breastfeeding women and by infants and young children.

Recommendations

1. Public health groups backing sugar reduction initiatives should have a clear statement recommending that reduction strategies should not increase the intake of artificial sweeteners, particularly among pregnant women, infants and young children.
2. Public Health England should explicitly discourage the addition of sweeteners as a part of product reformulation under the Government's Childhood Obesity Action Plan, and sweetener use should be monitored and reported.
3. Public health messages should not promote artificially sweetened foods and drinks as 'healthy' options. Messages should actively encourage minimal consumption of all sweet products, particularly among young children, to avoid creating a sweet palate.
4. Future national surveys should include comprehensive assessment of intakes of sweeteners and their dietary sources among infants and young children, beyond low-calorie soft drinks.
5. The Food Standards Agency and regulators in Government Health and Health and Social Care departments should safeguard current sweetener safety standards in the event of new trade deals and revisit these standards when up to date consumption data is available.
6. The Government should explore the opportunity leaving the European Union presents for food labelling to include statements that artificially sweetened products are not suitable for children under 5 years of age.
7. Relevant stakeholders should set an appropriate research agenda and undertake more robust experimental studies (free of conflicts of interest) to assess the short, medium and longer-term effects of dietary sweeteners in pregnancy and the early years, as well as additional high-quality systematic reviews of data collected from children.
8. Further research is needed on the impact of artificially sweetened beverages on the oral health of infants and young children. Oral health guidance should be explicit that many low-calorie soft drinks are acidic and can cause tooth erosion.

1 What sweeteners are young children exposed to in the UK?

Sweeteners are additives used instead of sugar to sweeten foods, drinks, medicines and oral hygiene products. There are 19 approved for use by the European Food Safety Authority (EFSA) and therefore by the UK Food Standards Agency (FSA), as listed in Table 1. Eleven of these are non-sugar or non-nutritive and intense or high potency sweeteners, so called because very small amounts are required to achieve sweetness. Some normative bodies classify all of these as 'artificial' whilst others distinguish the few that are derived from naturally occurring sources. In this report we consider them all as artificial sweeteners. The remaining eight approved sweeteners are low-calorie polyols, which are low-digestible carbohydrates, derived from the hydrogenation of a sugar, e.g. lactitol is derived from lactose. These are also referred to as bulk sweeteners as larger volumes are needed to achieve sweetness

Sweeteners are often used in combination to achieve the required taste within exposure limits. The artificial sweeteners most commonly found in foods and drinks available in Ireland have been reported to include acesulfame-K, aspartame, saccharin and sucralose, and it is likely this is similar in the UK (Martyn et al. 2016).

As well as being used as 'table top sweeteners', sweeteners are found in thousands of food and drink products, many, but not all, labelled as 'diet', or low/reduced sugar, as well as in toothpastes and mouthwashes, medicines and alcohol. Sweeteners are commonly found in soft drinks, hot beverage

powders, desserts including ice creams, cakes and other baked goods, confectionery, ready meals, jams, yoghurts and other dairy products (e.g. flavoured milks), breakfast cereals, salad dressings, sauces (e.g. ketchup) and chewing gum. European and therefore UK legislation currently holds that foods specifically marketed for babies and children under three years of age should not include sweeteners (see more on regulation of sweeteners on page 12).

Recent market research in the UK highlights that parents do not only offer young children food products specifically targeted for children (Mintel Group Ltd., 2016). Half of parents with children aged 4 and under said they like their child to eat the same foods as the rest of the family, and one in five said that they buy child-friendly versions of regular food, such as low-salt baked-beans and full-fat yogurt, instead of manufactured baby or toddler food.

Given the likely increase in the use of sweeteners in foods and drinks, and the lack of any explicit public health messaging to avoid giving sweeteners to young children (see page 16), it is likely that even the youngest children are being exposed to sweeteners. Their exposure is also likely to be comparatively higher than for the general population on a body weight basis. Some examples of widely available, artificially sweetened food products which may be given to young children are provided in Table 2.

Table 1: EFSA/FSA approved sweeteners and their Acceptable Daily Intakes (ADI)

Sweetener name	E number	ADI (mg/kg/day) ^a	Sweetness compared to sucrose	Selected information on sources, metabolism and data underpinning ADI derivation for more commonly used sweeteners
Artificial sweeteners				
Acesulfame-potassium	950	9	200	<ul style="list-style-type: none"> Absorbed and excreted by the body unchanged ADI based on animal data (Scientific Committee on Food, 2000b)
Advantame	969	5	37,000	<ul style="list-style-type: none"> Derived by chemical synthesis from isovanillin and aspartame Metabolised and excreted in urine and faeces ADI based on estimated dietary exposure using European Comprehensive Database, not including infants Main food sources for toddlers (from European but not UK data): flavoured, fermented milk products; edible ices; processed fruits and vegetables; cocoa/chocolate products; desserts; fruit and vegetable nectars; flavoured drinks; potato/cereal/flour/starch-based snacks (Aguilar et al., 2013b)
Aspartame	951	40 ^b		<ul style="list-style-type: none"> Derived by chemical or enzymatic synthesis Metabolised and excreted in urine or converted to carbon dioxide and water ADI based on estimated dietary exposure using European Comprehensive Database, not including infants Main food sources for toddlers as for advantame (Aguilar et al., 2013a)
Salt of aspartame acesulfame	962	See aspartame and acesulfame-K	350	<ul style="list-style-type: none"> Dissociates into aspartame and acesulfame; aspartame digested and metabolised, acesulfame is not metabolised and is excreted by kidneys
Cyclamic acid (and sodium/calcium salts)	952	7	30	
Neohesperidine DC	959	5	1900	
Neotame	961	2	8000	
Saccharin (and sodium, potassium and calcium salts)	954	5	300-500	<ul style="list-style-type: none"> Made by chemical processes Absorbed and excreted unchanged by the kidneys ADI included consideration of dietary consumption in adults but not children (Scientific Committee on Food, 1997)
Steviol Glycoside	960	4	200-300	<ul style="list-style-type: none"> Produced from purified extracts of stevia plant leaves Absorbed and excreted in faeces and urine ADI based on estimated dietary exposure using European Comprehensive Database, not including infants Most important contributors to total mean exposure for toddlers (from European but not UK data): flavoured fermented milk products, edible ices, fruit and vegetable nectars and breakfast cereals (EFSA, 2014)

Table 1 continued

Sweetener name	E number	ADI (mg/kg/day) ^a	Sweetness compared to sucrose	Selected information on sources, metabolism and data underpinning ADI derivation for more commonly used sweeteners
Sucralose	955	15	600	<ul style="list-style-type: none"> Chemically derived from sucrose Excreted in urine ADI based on animal data (Scientific Committee on Food, 2000)
Thaumatococin	957	NA	2000-3000	
Polyols^c				
Sorbitol/sorbitol syrup	420	NA	0.5-1	<ul style="list-style-type: none"> Chemically extracted from glucose Slowly and partially absorbed and converted into fructose. Unabsorbed sorbitol broken down into carbon dioxide and excreted
Mannitol	421	NA	0.7	
Poly glycolic syrup	964	NA	0.25-0.50	
Malitol/malitol syrup	965	NA	1	
Lactitol	966	NA	0.50	
Xylitol	967	NA	1	<ul style="list-style-type: none"> Obtained from a variety of plants Slowly and partially absorbed and converted into glucose. Unabsorbed xylitol broken down into carbon dioxide and excreted
Isomalt	953	NA	0.50	
Erythritol	968	NA	0.60-0.8	

- ADIs are not applicable to certain sweeteners, including bulk sweeteners, as expected exposure to the substance, arising from its use or uses in food at the level necessary to achieve the desired effect does not represent a hazard to health (Mortensen, 2006).
- Except for those with Phenylketonuria (PKU) who should not consume this additive.
- While ADIs are not applicable, large intakes can have a laxative effect.

Table 2: Examples of artificially sweetened food products which may be given to young children.












Type of food	Product name		Sweeteners listed among ingredients	'Change 4 Life' sugar swap ^a
Drinks	Ribena 'really light' no added sugar blackcurrant squash		Aspartame and acesulfame-K	
	Robinsons no added sugar orange squash		Aspartame and saccharin	
	Diet Coke		Aspartame and acesulfame-K	
	Fanta Zero Sugar		Acesulfame-K and aspartame	
	Irn Bru sugar free ^b		Acesulfame-K and aspartame	
	Crusha Banana Milkshake mix		Aspartame and acesulfame-K	

Table 2 continued

Type of food	Product name		Sweeteners listed among ingredients	'Change 4 Life' sugar swap ^a
Puddings	Hartley's Jelly, raspberry flavour, no added sugar		Aspartame and acesulfame-K	
	Halo Top peanut butter cup ice cream		Steviol glycosides	
	ASDA no added sugar instant custard powder		Sucralose	
Sweets	Haribo Fruitilicious 30% reduced sugar		Sorbitol syrup	
	Chupa chups sugar free lolly		Isomalt, maltitol syrup, sucralose and acesulfame-K	
	ASDA sugar free fruit drops		Isomalt and sucralose	

Table 2 continued

Type of food	Product name		Sweeteners listed among ingredients	'Change 4 Life' sugar swap ^a
Yogurt	Muller Light Greek Style sublime strawberry yogurt		Aspartame	
Sauce	Heinz 50% less sugar and salt tomato ketchup		Sucralose	
	Napolina smooth bolognese pasta sauce, no added sugar		Steviol glycosides	
Pasta/beans in sauce	Heinz no added sugar beans		Steviol glycosides	
	Heinz no added sugar spaghetti hoops		Steviol glycosides	

^a'Change 4 Life' recommended 'sugar swaps' for children aged 4 years and older (NHS, 2019a) (see page17).

^bThis product also contains the artificial colours Sunset Yellow (E110) and Ponceau 4R (E124) which may have an adverse effect on activity and attention in children.

2 Regulation of sweeteners

2.1 Regulation overview

Sweeteners are regulated and are subject to safety evaluation prior to market authorisation. In the EU, the European Commission, Parliament and Council regulate the use of all food additives, including sweeteners, and the Commission and Member States determine which additives can be used in which foods and at what levels (EFSA, 2018). More specifically, the regulations stipulate that sweeteners can only be added to certain foods and drinks if they replace sugars; either for the production of energy-reduced food, non-cariogenic food or food with no added sugars; or to increase the shelf-life; or to produce a food intended for particular nutritional use (Council Regulation (EC) No. 1333/2008).

The EFSA Panel on Food Additives and Flavourings carries out risk assessments and provides scientific advice on food additives used as sweeteners (EFSA, 2018). Risk assessments are ad hoc at the request of the EC and on a rolling basis. EFSA is currently re-evaluating all sweeteners permitted for use in the EU since before 20 January 2009 with a deadline to finish by 2020. The EFSA Panel on Nutrition, Novel Foods and Food Allergens is responsible for verifying the scientific substantiation of health claims.

2.2 Risk assessment

As part of its safety evaluations, when sufficient information is available, and it is applicable, EFSA establishes an Acceptable Daily Intake (ADI) for each food additive, see Table 1. This is a measure of the amount of the substance in foods/drinks that can be ingested orally, each day, over a lifetime, without an appreciable health risk. ADIs

are based on a scientific review of all toxicological data available at the time, including long-term tests on animals to determine the No Observed Adverse Effect Level (the NOAEL, i.e. the greatest concentration or amount of a substance, found by observation or experiment, which causes no detectable adverse effect in the exposed population). The NOAEL is scaled by a safety factor of 100, to account for the differences between test animals and humans (factor of 10) and possible differences in sensitivity between humans (another factor of 10).

To set the ADIs, EFSA uses data from the Comprehensive European Food Consumption Database which is comprised of existing national data from Member States' national dietary surveys (EFSA, 2011a). Data were collected between 1997 and 2009. The database only includes data concerning infants (under 12 months of age) from two surveys in two Member States (Italy and Bulgaria) and from toddlers (aged one to three years of age) from eight surveys in eight Member States (Belgium, Bulgaria, Finland, Germany, Italy, The Netherlands, Poland and Spain). Whereas data from older children come from 16 surveys in 14 Member States and data for adults come from more than 20 surveys in 20 Member States. The contributing UK data was collected in 2000/2001 and covered only adults aged 19-64 years old.

The data used to calculate each sweetener's ADI differs depending on what is available; see some examples in Table 1. The EC approach to estimating exposure involves a 'tier two' and/or 'tier three' approach, using individual-based consumption data from national dietary surveys combined with the Maximum Permitted Level (MPL) for the respective sweeteners (tier two)

and/or chemical concentration data from the food industry (tier three) (Martyn et al., 2018). Additionally, specific consumption scenarios may be modelled, e.g. based on the proposed use of sucralose and acesulfame-K in foods for special medical purposes by young children (see below).

Concerns have been raised about the appropriateness of EFSA's risk assessment process in relation to aspartame (Millstone and Dawson, 2019). This review of the toxicological assessment concluded that EFSA did not even-handedly try to identify possible unreliable positives and unreliable negatives. The authors outline how in their opinion, the assessment of evidence of safety and risks was biased towards the former, disregarding evidence of harm. By applying 'lax and forgiving' criteria to judge studies showing potential harmful effects, they view the current assessment as insufficient to allow the safety of aspartame to be assured.

2.2.1 Risk in infants and young children

Sweeteners are generally considered safe to consume up to the ADI in the general population, which includes pregnant women, infants and young children, and there are studies which support this generally and globally (Martyn et al., 2018). In Ireland, exposure assessment models (drawing on consumption data, sweetener presence data and analytical data on sweetener occurrence in foods) have been used to ascertain realistic estimates of exposure among children aged one to four years old, and suggested that even among high consumers, intakes of acesulfame-K, aspartame, saccharin and sucralose were below the respective ADIs (at between 17 and 31%) (Martyn et al., 2016).

However, and despite being declared safe for consumption at levels below the respective ADIs, less is known regarding potential benefits and harms of non-sugar sweeteners within this range of intake because evidence from studies and reviews is often limited and conflicting (Toews et al., 2019). In addition, there are concerns that ADIs may be exceeded by specific groups of young children (Martyn et al., 2018), including those with phenylketonuria (O'Sullivan et al., 2017) or type 1 diabetes (Dewinter et al., 2016) and children consuming certain foods for special medical purposes (FSMPs) (EFSA, 2016a). FSMPs are foods that are designed to meet the needs of those with special dietary requirements, for example those requiring diets that exclude a certain component (such as gluten or a particular amino-acid), those who need artificial feeds or supplements higher in energy and other nutrients, and include specialist breastmilk substitutes for infants.

2.2.2 Regulation affecting infants and young children

Additives including sweeteners are not permitted in any foods specifically intended for infants or young children (Council Regulation (EC) No. 1333/2008). This is to safeguard the specific and high nutritional needs of children in these age groups for optimal developmental growth, specifically, for energy. There are, however, exceptions to this rule. In 2015/2016 the EU approved the use of sucralose and acesulfame-K up to their ADIs in foods marketed as FSMPs for children aged between one and three years of age (EFSA, 2016a; EFSA, 2016b).

3 Food sources of sweeteners and their dietary intakes among young children

We know surprisingly little about the sweetener intakes of the youngest children in the UK.

To set safety standards, EFSA models sweetener intakes using knowledge about their legislated food sources and generalises from available EU-wide consumption data, which as outlined above, is sparse for infants and young children.

Although there is no data from the UK, and limited data for young children, the prevailing opinion is that drinks are the main dietary source of sweeteners. Two recent studies support this assumption. Research examining food composition in Australia, Mexico, New Zealand and the US found that 5% of all food and drink products were found to contain at least one sweetener, and the highest prevalence was among beverages (Dunford et al., 2018). In a study of sweetener intake among pre-school aged children in Ireland, while the most commonly consumed artificially sweetened foods were sauces (69%) and potato/cereal/flour-based snacks (50%) followed by flavoured drinks (49%), the mean intake from drinks was by far the highest among these products (Martyn et al., 2016). On the contrary, however, and as shown in Table 1, the highest reported contributions of aspartame and advantame in the diets of toddlers in two unspecified European countries came from flavoured fermented milk products (including yoghurt and cheese), fruit/vegetable nectars, ice cream and flavoured sweetened drinks (Aguilar et al., 2013a; Aguilar et al., 2013b). Drinks provided an estimated 6% and 25% of the total aspartame and advantame consumed.

The only two publically available sources of data on dietary sweetener intake among children in the UK both focus exclusively on low-calorie soft drinks. One is the rolling National Diet and Nutrition Survey (NDNS) which started in 2008 and includes small samples of children from 18 months to 3 years of age (Public Health England, 2019), and the other is the one off 2011 Diet and Nutrition Survey of Infants and Young Children (DNSIYC) which focused on 4-18 month olds (Lennox et al., 2013).

In the 2011 DNSIYC, frequency of consumption of low-calorie soft drinks (LCSD) rose from less than 1 in 10 (7%) of babies aged 4-6 months to nearly half (46%) of 12-18 month old children. The percentage of infants and young children consuming low-calorie soft drinks and sugar sweetened soft drinks is shown in figure 1. The number consuming low-calorie soft drinks compared to sugar sweetened drinks is higher for each age group, with over 45% of children aged 12-18 months consuming low-calorie soft drinks.

Among infants and young children (12-18 months) who consumed low-calorie soft drinks, the mean consumption ranged from 57g to 189g per day (see figure 2). Young children who consumed low-calorie soft drinks had between a fifth and a half of a 330ml can of soft drink each day.

Figure 1: Percentage of infants and young children consuming sugar sweetened soft drinks and low-calorie soft drinks in the UK in 2011.

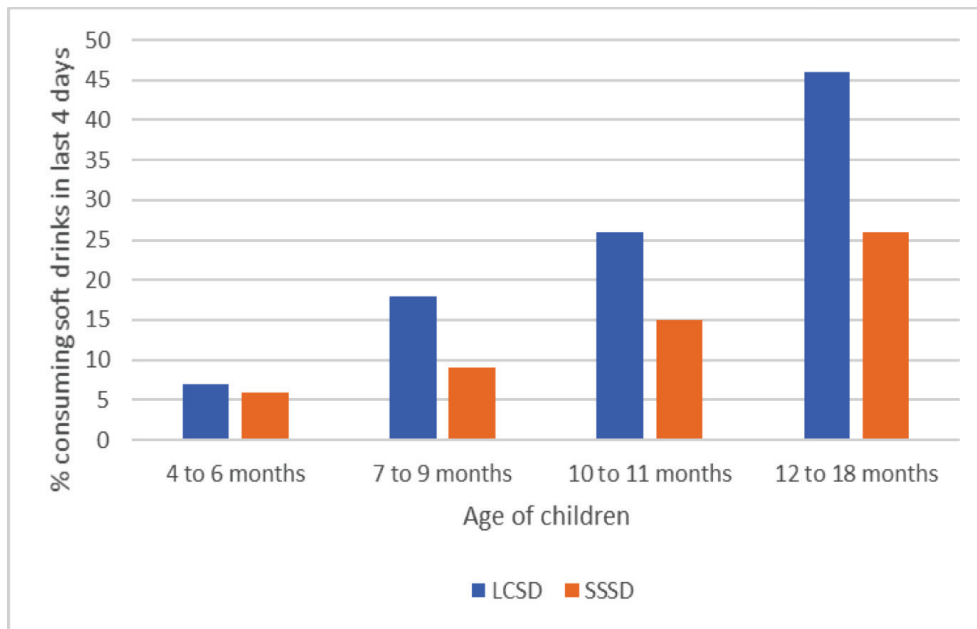
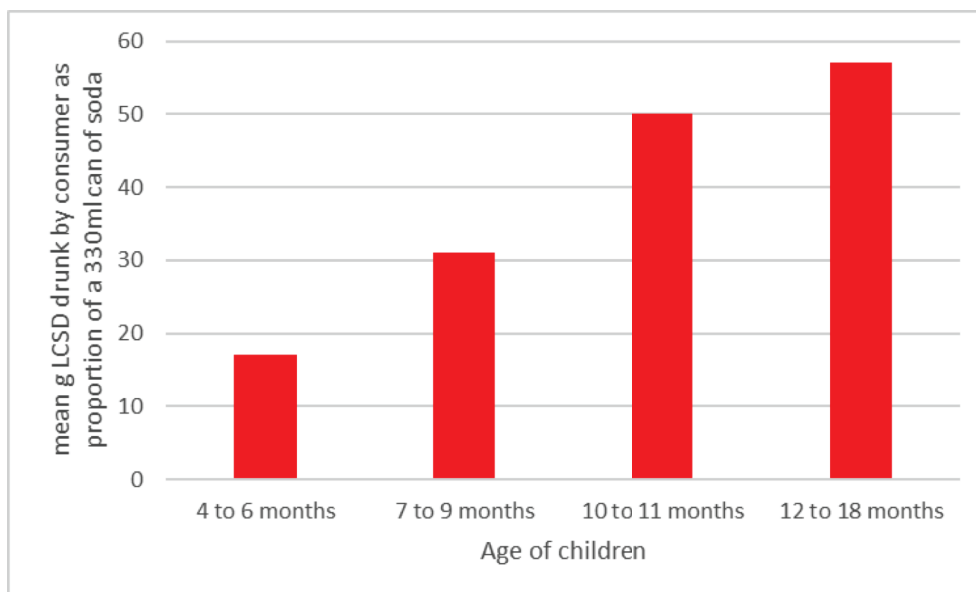


Figure 2: Mean intake of low-calorie soft drinks among young consumers in the UK in 2011 as a proportion of a 330ml can of soft drink.



The most recent data from the National Diet and Nutrition Survey (Public Health England, 2019) indicated that:

- The average volumes of sugar sweetened soft drinks consumed were lower than the volumes of low-calorie soft drinks consumed among all age groups in all reporting periods. For example between 2014/15 and 2016/7 children aged 1.5-3 years had a mean intake of 45g/day (+/-114g) of sugar sweetened soft drinks compared to 215g/day (+/-298g) low-calorie soft drinks
 - The proportion of children aged between 18 months and 3 years of age drinking low-calorie soft drinks was higher than the proportion of teenagers, and the median volume these toddlers consumed was also higher than for teenagers
 - Among the 65% of children aged 18 months to 3 years old who drank a low-calorie soft drink during the four-day recall period, median consumption was 330g/day; one whole can of soft drink
-

4 Consumption guidance

Consistent with measures influencing the availability of reduced sugar goods on the market, consumption guidance recommends that low-sugar varieties of dairy or dairy alternative foods are chosen and that sugary drinks are swapped for no added sugar drinks as well as those labelled 'diet' or sugar-free (Public Health England, 2018a). Public Health England's social marketing campaigns, which include 'Change4Life', aim to raise awareness of the sugar levels in foods and encourage consumers to switch to lower sugar alternatives (NHS 2019a). Unfortunately, the campaign does not provide any explicit guidance on sweetener consumption.



Change4Life also has a 'good choice' logo which it allows manufacturers to use on certain products (some examples are given in Table 2) and the majority of products that carry this logo are artificially sweetened soft drinks. The logo is even permitted on a product that contains artificial

colours that may have an adverse effect on activity and attention in children. Products which contain any of the artificial colours that may have this effect have to carry a warning on the label under EU law. It seems perverse that Public Health England would actively promote a product that contains these artificial colours.

The Start4Life webpage on safe weaning advice aimed at parents of babies and toddlers (shown below) says that diet or reduced sugar drinks are not recommended for babies or toddlers but does not mention avoiding artificial sweeteners here or in subsequent sections on foods to avoid.

Start4Life: Safe weaning advice (NHS, 2019b)

The screenshot shows the Start4Life website interface. At the top, there is a navigation bar with "start 4 life" logo, dropdown menus for "Pregnancy", "Baby", and "Toddler", a search bar, and the NHS logo. Below this is a section titled "Drinks to avoid" with a red cup icon. A red oval highlights the following text in the list:

- **fruit juice or smoothies** - avoid before 12 months as babies don't need them. If you do choose to offer them, dilute with water (one part juice to 10 parts water) and offer with a meal in an open cup/free-flow beaker to avoid tooth decay
- **squash, fizzy drinks, flavoured milk** - even when diluted, these drinks contain lots of sugar and can cause tooth decay. Diet or reduced-sugar drinks are not recommended for babies and toddlers either. For older babies and toddlers, these drinks can fill your child up so they're not hungry for healthier food. Instead, offer sips of water from a cup with meals

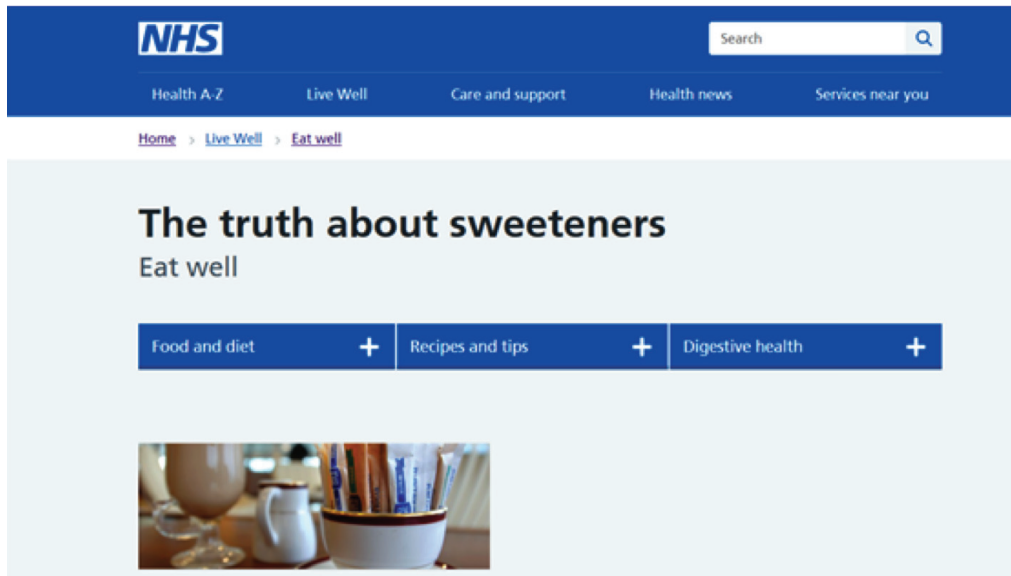
Change4Life: Full list of sugar swaps (NHS, 2019a).

Those circled commonly contain sweeteners

The screenshot shows the Change4Life website's 'Sugar swap Ideas' page. It features a navigation bar with 'change 4 life', 'Food facts', 'Recipes', 'Activities', 'Your child's weight', and a 'Join Change4Life' button. Below the navigation bar is a header section with the title 'Sugar swap Ideas' and a sub-header 'All of these swaps are a great way to cut down on sugar, but always check the label or use the Change4Life Food Scanner to help pick the product with the lowest amount. And remember, the more swaps you make, the more sugar you save!'. The main content is organized into four categories: Cereal swaps, Drink swaps, Yoghurt swaps, and Pudding swaps. Each category has a 'Swap from' and a 'Swap to' list. In the 'Drink swaps' section, 'sugar-free drinks' is circled in red. In the 'Yoghurt swaps' section, 'lower-sugar yoghurts' is circled in red. In the 'Pudding swaps' section, 'lower-sugar yoghurt' is circled in red.

Category	Swap from	Swap to
Cereal swaps	<ul style="list-style-type: none">frosted flakeshoney crunch cerealchocolate cereal	<ul style="list-style-type: none">wheat biscuit cerealshredded wholegrain cerealporridgeno added sugar museli
Drink swaps	<ul style="list-style-type: none">colajuice drinksmilkshakesfizzy drinks	<ul style="list-style-type: none">waterlower-fat milkssugar-free drinksno added sugar drinks
Yoghurt swaps	<ul style="list-style-type: none">split pot yoghurtshigher-sugar yoghurts	<ul style="list-style-type: none">fromage frais potslower-sugar yoghurtsplain natural yoghurt
Pudding swaps	<ul style="list-style-type: none">cake barschocolate pudding potsdoughnutsmuffins	<ul style="list-style-type: none">sugar-free jellylower-sugar yoghurtfresh or tinned fruit (in juice)lower-sugar rice puddinglower-sugar custard

There is some information provided on the NHS website in a section called 'The truth about sweeteners' (NHS, 2019c). The information does not make any reference to different age groups or life stages.



"You do not need to keep track of how much sweetener you consume each day, as our eating habits are factored in when specifying where sweeteners can be used".

"Food manufacturers claim sweeteners help prevent tooth decay, control blood sugar levels and reduce our calorie intake. EFSA has approved the health claims made about xylitol, sorbitol and sucralose, among others, in relation to oral health and controlling blood sugar levels".

"Research into sweeteners shows they're perfectly safe to eat or drink on a daily basis as part of a healthy diet."

"It's been suggested that the use of artificial sweeteners may have a stimulating effect on appetite and, therefore, may play a role in weight gain and obesity. But research into sweeteners and appetite stimulation is inconsistent. Also, there's little evidence from longer term studies to show that sweeteners cause weight gain".

5 Benefits and risks associated with children's consumption of sweeteners

5.1 Health claims for sweeteners

Health claims made by the sweetener industry include sustainable weight loss or weight loss maintenance, improved glycaemic control among individuals with diabetes and improved dental health (International Sweeteners Association,

2018). However, EFSA has only verified the claims related to glycaemic control and dental health (EFSA, 2011) (see Table 3). Claims are not authorised where there is an inconclusive evidence base.

Table 3: Status of health claims submitted to EFSA relating to sweeteners (EFSA, 2011)

Health outcome	Claim status
1 Reduction of post-prandial glycaemic responses.	Authorised
2* Maintenance of tooth mineralisation by decreasing tooth demineralisation.	Authorised
3 Contribution to the maintenance or achievement of a normal body weight.	Non-authorised
4 Maintenance of normal blood glucose concentrations.	Non-authorised

* Whilst a claim related to tooth mineralisation has been allowed by EFSA it is important to remember that if drinks are artificially sweetened and have a low pH or are highly acidic (either from carbonation and/or a fruit component or an acidic component such as phosphoric acid or citric acid), these drinks can lead to tooth erosion (von Fraunhofer and Rogers, 2004). Diet drinks have been reported to have a lower pH than their sugary equivalents and whilst the degree of erosion that can be caused is linked to both the amount of drink consumed and the length of contact time with the teeth (for example taking sips over a longer period of time leads to greater contact time) erosion causes significant damage to children's dental enamel.

5.2 Sweetener use and weight management in children

Claims relating to the association between artificial sweetener intakes and body weight remain contentious and there is evidence of benefit (i.e. association with weight loss among overweight individuals) and of harm (i.e. association with weight gain) from the consumption of sweeteners.

In 2019 the BMJ published a systematic review and meta-analysis examining the association between non-sugar sweeteners and health outcomes in adults and children, which included 56 studies (Toews et al., 2019). While the authors reported a smaller increase in body mass index (BMI) Z-score among children consuming non-sugar sweeteners than those consuming sugar, there were no significant differences in body weight and the data came from only two randomised clinical trials, so confidence in the reported results is limited.

A recent narrative review focused on studies among pre-pubertal children (Archibald et al., 2018) and reported a positive association between artificially sweetened food/drink consumption and BMI from 14 observational studies (i.e. cross sectional and cohort studies), but a mixed picture of cause and effect from five trials. Young et al recently highlighted that the majority of available intervention studies (some blinding children to the contents of the drinks being tested), reported benefits of sweeteners over sugar for reducing excessive child weight gain (Young et al., 2019). Several earlier reviews including observational and trial data reported mixed findings (Brown et al., 2010; Reid et al., 2016; Sylvetsky et al., 2011).

Observational studies cannot establish that the consumption of artificially sweetened products causes weight gain and there are likely to be many differences between families that do, and those that do not, offer their children artificially

sweetened foods and drinks (Sylvetsky et al., 2011). It could be that the children who consume sweeteners may be those at greater risk of weight gain, indicating reverse causality. On the other hand, the varied results of experimental studies will be partly due to heterogeneity among the studied populations (including age and baseline bodyweight of the children), heterogeneity among the studied populations (including age and baseline bodyweight of the children) and the heterogeneity of measured outcomes. For example, which sweeteners are used amounts consumed, frequency of intake, length of study follow-up and mode of delivery. In addition there are differences in whether comparison groups were used (e.g. with those consuming sugar sweetened beverages) or whether other variables were noted such as physical activity.

Three recent additional studies among children highlight the potential for harmful effects of sweeteners on children's energy intakes and/or weight. Sylvetsky et al undertook a study of the association between low-calorie soft drinks consumption and dietary intakes among children aged 2-17 years old in the US between 2011 and 2016 (Sylvetsky et al., 2019). They found that drinking low-calorie soft drinks, or sugar sweetened soft drinks, or low-calorie soft drinks and sugar sweetened soft drinks, were all associated with an increase in total calorie and sugar consumption compared to drinking water. These findings suggest drinking low-calorie soft drinks may promote general overconsumption and challenge the wisdom of promoting the replacement of sugar sweetened soft drinks for low-calorie soft drinks over water. A cross-sectional survey in Sweden revealed a positive association between low-calorie soft drinks consumption among seven to nine-year olds and measures of overweight/obesity (Nilsen et al., 2017). A longitudinal study among Scottish

children enrolled at four or five years of age and followed up at seven and eight years old also reported a positive association between artificially sweetened beverage consumption and obesity (Macintyre et al., 2018).

Several potential mechanisms have been proposed to explain harmful effects of sweeteners on body weight, including:

- Sweetener-induced promotion of appetite and energy intake
- Promotion of sweet preferences
- Disruption of the gut microbiota

However, all hypotheses currently lack consistent supporting data (Sylvetsky et al., 2011). Studies assessing effects of low-calorie soft drinks compared with sugarsweetened soft drinks on child appetite report mixed findings (Young et al., 2019). There is also conflicting evidence that exposure to sweeteners may influence psychological processes promoting sweet preferences in a way which may encourage calorie intake (Swithers, 2015; Piernas et al., 2013a).

Nevertheless, while the evidence base is inconclusive and the mechanisms of action unclear, the existence of some studies which indicate that sweetener consumption by young children could cause increasing energy intake and thereby body weight, should be a concern. In addition, there is also a need to acknowledge numerous other potentially negative outcomes, including cardiometabolic effects (Seferidi et al., 2018) and effects on the gut microbiota.

Whilst a recent systematic review suggested artificial sweeteners do not have any adverse effect on the gut microbiota (Lobach, Roberts and Rowland, 2018), this review has also been

criticised as having overlooked literature that shows that some specific sweeteners do have a significant impact (Schiffman and Nagle, 2019). Schiffman and Nagle argue that artificial sweeteners are structurally diverse and vary widely in pharmacokinetics, and that it is therefore inappropriate to draw generalised conclusions regarding effects on gut microbiota and safety for this diverse group of chemicals. They provide evidence from animal studies looking at sucralose which they report unequivocally and irrefutably disrupts the gut microbiome at levels approved by regulatory agencies and associated with human use. There remains a paucity of human studies in this area (Ruiz-Ojeda et al., 2019), and while potential negative effects on the microbes of the digestive tract have been reported (Roca-Saavedra et al., 2018) further research is urgently needed (Lohner et al., 2017).

5.3 Maternal exposure to sweeteners

A limited number of studies have evaluated pre-natal sweetener exposure and obesity-related outcomes in children, the results of which are inconclusive (Archibald et al., 2018). However, there is some evidence that potential effects on infant outcomes may include preterm birth risk and offspring preference for sweet foods (Goran, Plows and Ventura, 2018). A recent study exposing pregnant mice to sucralose and acesulfame-K at doses relevant for human consumption reported significant metabolic changes in the pups with changes to the microbiota that have been associated with metabolic diseases and obesity. More research is urgently needed to consider potential impacts of consumption of artificial sweeteners in pregnant women and their babies.

5.4 Sweetener consumption and lactation

A recent review of sweetener use and impacts on breastmilk composition concluded that, for those sweeteners where there is evidence, excretion into breastmilk appears to be below conventional toxic thresholds (Anderson, 2019). One small study of twenty breastfeeding women in the US reported that saccharin, sucralose, and acesulfame-K were present in 65% of participants' milk samples (Sylvetsky et al, 2015). Animal studies have demonstrated that animals exhibit heightened preferences for both caloric sweeteners (sucrose) and acesulfame-K in adulthood, when they were exposed to acesulfame-K either in utero or through breastfeeding (Zhang et al., 2011). Such studies have prompted other investigators to suggest that sweetener exposure during lactation may promote development of metabolic abnormalities (von Poser Toigo et al., 2015) and obesity (Araujo et al., 2014), but similar studies do not exist among humans.

6 What does the future hold for sweeteners in the diets of infants and young children?

6.1 Consumption trends

In the absence of data from the UK little can be said about consumption trends relating to artificially sweetened foods. However, given the global evidence (Sylvetsky & Rother, 2016) and what is known about UK consumption and preferences, it is clear that there is a trend for increasing consumption of artificially sweetened drinks among young children nationally.

The British Soft Drinks Association recently reported that in 2018 65% of total soft drinks purchased were no/low-calorie, and 88% of all dilutable drink sales were no/low-calorie (British Soft Drinks Association, 2019). There was a fall in the average amounts of sugar sweetened soft drinks drunk by children 18 months to 3 years old between 2008/2009 and 2016/2017, while at the same time, both the proportions of children in this age group consuming low-calorie soft drinks and the volumes of low-calorie soft drinks they consume have risen (Public Health England, 2019). On average between 2012 and 2017, 33% of children aged 18 months to 3 years drank sugar sweetened soft drinks whilst twice as many (65%) consumed low-calorie soft drinks, and these children consumed 134g a day of sugar sweetened soft drinks compared to 330g a day of low-calorie soft drinks.

Recent market research highlights that parents remain increasingly sugar aware and 'anti-sugar' and this suggests a persistent if not increasing preference of parents to give their young children reduced sugar products (Mintel Group Ltd., 2018). Similar purchase preference trends have been recorded in the US for the decade 2000 to 2010, particularly in households with children (Piernas et al., 2013b).

6.2 Factors behind consumption trends

Any increase in consumption of sweeteners among young children is likely to be, at least in part, a result of efforts to tackle childhood obesity (Archibald et al., 2018). These efforts include a focus on reducing sugar intake and promotion of low sugar foods and drinks (which may contain sweeteners) as a healthier alternative.

The UK government launched a childhood obesity plan of action in 2016 (HM Government, 2016). A key 'challenge' within this was for the food/drinks industry to reduce the sugar content across a range of products in the categories of food that contribute most to the sugar intakes of children up to the age of 18 years, by at least 20% by 2020 (Public Health England, 2017). The target was for a 5% reduction in the first year of the programme, although in fact the actual achievement was 2% (excluding cakes and 'morning goods') (Public Health England, 2018b). The government provided technical guidelines on the reduction of sugar levels in products, of portion sizes, and of how to shift purchasing towards lower sugar alternatives (Public Health England, 2017). They state explicitly:

"Sweeteners that have been approved through European Food Safety Authority's processes are a safe and acceptable alternative to using sugar" (page 20).

Although this is then followed by:

"There may be advantages in businesses not adding sweeteners to their products and gradually reducing the overall sweetness of their products because this allows for people's palates to gradually adjust to less sweet foods" (page 20).

PHE have stated that they will not be monitoring the consumption of artificial sweeteners as a part of their annual sugar reformulation progress reports, and instead encourage industry to submit case studies where sweeteners have been used (Public Health England, 2018b).

As soft drinks have been found to be the single largest food contributor to sugar in children's diets, a relevant regulatory measure introduced in April 2018 was the Soft Drinks Industry Levy (SDIL) (Department of Health and Social Care, 2018). This is intended to encourage reformulation, reduction of portion sizes and changing consumer behaviours away from high sugar drinks. Even in 2016, prior to the policy enactment, there was an increase in advertising of low/no-calorie alternatives of 70% (British Soft Drinks Association, 2016). It seems highly likely that the levy is accelerating the existing consumer preference for artificially sweetened no/low-calorie alternatives to sugar sweetened drinks.

The recent government Prevention Green Paper (Advancing our health: prevention in the 2020's, The Cabinet Office and DHSC, 2019) confirmed that the next phase may also subject sugary milk drinks to the levy and this could have additional important implications for younger children whose diets typically contain more milk than other age groups (Cabinet Office & Department of Health and Social Care, 2019).

Consumer preference

Not surprisingly given the changing policy context and public health messaging, consumer research suggests that concerns about sugar are increasing. In the May 2018 Food Standards Agency Biannual Public Attitudes Tracker, over half (55%) of respondents reported concern about the amount of sugar in food when prompted, compared to 4 out of 10 in November 2010, whereas less than a third (29%) of respondents reported they were concerned about the use

of additives, which includes sweeteners (Food Standards Agency, 2018). Spontaneously reported concerns on additives were even lower (9%). Recent market research also shows that sugar remains a particular concern for consumers with babies and young children; half of parents of 0-4 year olds said that no added sugar was an important factor when choosing which food to buy for their babies or toddlers (Mintel Group Ltd., 2019).

6.3 Changing guidelines

In anticipation of the increased use of sweeteners, the WHO, through the work of the Nutrition Guidance Expert Advisory Group (NUGAG) Subgroup on Diet and Health, is currently developing new guidelines on the intake of sweeteners. It remains to be seen what affect these guidelines may have on global artificial sweetener policy. The conclusions of the systematic review and meta-analysis by Toews et al (2019) which was commissioned to inform this guidance suggests however that changes will be conservative.

Given the UK government's plan to review the scope for reformulation of product ranges aimed exclusively at babies and young children as part of the next phase of the sugar reduction programme, (Department of Health and Social Care, 2018) it is important that there is consistent support to uphold the current rule forbidding the use of sweeteners as additives in foods marketed for infants and young children.

6.4 The UK's departure from the European Union

BREXIT could result in new trade deals, including one with the US. The US government's Food and Drug Administration only approve six sweeteners, but four of these have safety levels which are higher than the current European ADIs used in

the UK (see Table 4). In addition, the US permits the addition of sweeteners to many more foods and drinks than the EU (FAO/WHO 2019). The potential for the import of a wider range of food and drink products with higher concentrations of

these sweeteners is a concern given the examples in which estimated exposures among some children are already higher than European ADIs (see section 2.2.1).

Table 4: US FDA approved sweeteners and their comparative ADIs

Sweetener name	E number	UK/EU ADI (mg/kg/day)	US ADI (mg/kg/day)
Acesulfame-K	950	9	15
Aspartame	951	40	50
Saccharin (and Na, K and Ca salts)	954	5	15
Sucralose	955	15	5
Neotame	961	2	0.3
Advantame	969	5	32.8

7 Conclusion

Sweeteners are used in thousands of foods and drinks in the UK, especially in ‘diet’ and ‘low sugar’ or ‘reduced sugar’ options. A key dietary source of sweeteners for babies and young children is artificially sweetened drinks. Data indicate that consumption of sweeteners is on the rise, including among the youngest children. The National Diet and Nutrition Survey data from 2012/13-2016/17 indicates that more toddlers (between 1.5 and 3 years old) consume artificially sweetened soft drinks than teenagers, and the median consumption among consumers is equivalent to a whole can of soft drink each day.

A key driver of this positive consumption trend is the public health promotion of lower sugar foods and drinks in an environment where more artificially sweetened alternatives are available and promoted as healthy options. There is, however, a lack of evidence on the health impacts of sweetener consumption during pregnancy and the early years and acceptable daily intakes are based on old or limited population intake data. For this reason, a precautionary approach to the intake of artificial sweeteners by pregnant and lactating women, infants and young children is recommended.

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