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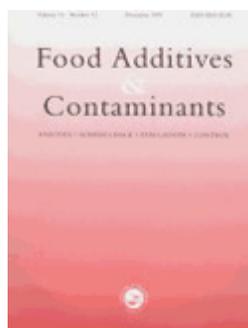
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1 Pattern of intake of food additives associated with 2 hyperactivity in Irish children and teenagers

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12 Abstract

13 A double-blind randomised intervention study has previously shown that a significant
14 relationship exists between the consumption of various mixes of seven target additives by
15 children and the onset of hyperactive behaviour. The present study set out to ascertain the
16 pattern of intake of two mixes (A and B) of these seven target additives in Irish children and
17 teenagers using the Irish national food consumption databases for children (n = 594) and
18 teenagers (n = 441) and the National Food Ingredient Database. The majority of additive-
19 containing foods consumed by both the children and teenagers contained 1 of the target
20 additives. No food consumed by either the children or teenagers contained all 7 of the target
21 food additives. For each additive intake, estimates for every individual were made assuming
22 that the additive was present at the maximum legal permitted level in those foods identified
23 as containing it. For both groups, mean intakes of the food additives among consumers only
24 were far below the doses used in the previous study on hyperactivity. Intakes at the 97.5th
25 percentile of all food colours fell below the doses used in Mix B, while intakes for 4 of the 6
26 food colours were also below the doses used in Mix A. However, in the case of the
27 preservative Sodium benzoate, it exceeded the previously used dose in both children and
28 teenagers. No child or teenager achieved the overall intakes used in the study linking food
29 additives with hyperactivity.

30 **Keywords:** *Food additives, hyperactivity, children, teenagers, consumption*

1 Introduction

2 In 2008, the EU introduced new legislation with regards to the use of food additives
3 (Regulation (EC) N^o 1333/2008). This new legislation stipulates that any food on sale in the
4 EU which contains particular food additives (Sunset yellow, Carmoisine, Tartrazine, Ponceau
5 4R, Allura Red, and Quinoline yellow) be labelled with the words to indicate that these
6 additives “may have an adverse effect on activity and attention in children” (EC Regulation
7 2008). This change in legislation was adopted on 16th October 2008, published on 31st
8 October 2008 and entered into force on 20th January 2009. It will apply from the 20th January
9 2010. Foods entering the market or labelled before this date which do not comply may be
10 marketed until their date of minimum durability or the use-by-date. This development arose
11 from a study based in Southampton, UK, which showed that either of two mixes of food
12 additives administered to children daily over one week increased the risk of developing
13 hyperactive behaviour (McCann et al. 2007). The study was a double-blind, randomised-
14 controlled study and was subsequently analysed by two independent committees of experts,
15 the UK Committee on Toxicology (Committee on Toxicity 2007) and the European Food
16 Safety Authority (European Food Safety Authority 2007) and both fully accepted the validity
17 of the study. The present paper does not attempt to negate or contest the findings of that
18 study which clearly showed that a given hazard (either of two mixes of five food additives)
19 elicited an adverse effect (hyperactive behaviour) in a given population (children). What the
20 present study is attempting to do is to add to risk assessment data by examining the
21 probability that the hazard in question actually occurs in a nationally representative sample
22 of Irish children and teenagers. The Irish food consumption databases are particularly suited
23 to this purpose since all food intake data are collected at brand level. The collection of
24 branded data is to allow the maintenance of the Irish National Food Ingredient Database
25 (INFID) which records all ingredients of branded foods consumed in the various food
26 consumption surveys (Gilsenan et al. 2002).

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3 1 INFID has many uses such as identifying which foods contain specific ingredients
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5 2 and thus was used to establish human exposure to dioxin in the recent Irish pork dioxin
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7 3 incident. In the case of food additive intake estimates, the great strength of INFID is its use
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9
10 4 to accurately assign the true presence or absence of a target food additive in a given food.
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12 5 Normally, in the absence of such data, the estimation of food additive intake must
13
14 6 necessarily assume that if an additive can legally be present in a food it will always be
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16 7 present. INFID also allows for the exploration of the simultaneous ingestion of given food
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18 8 additives whether from one food or from several foods. Thus the present paper is intended to
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20 9 inform the risk assessment process on the pattern and level of usage of the food additives
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22
23 10 used in the Southampton study.

24 25 26 11 **Methods**

27 28 29 12 ***The Irish National Food & Ingredient Database (INFID)***

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32 13 Patterns of additive intake by Irish children and teenagers were assessed using The Irish
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34 14 National Food & Ingredient Database (INFID). INFID is a multi-faceted database developed
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36 15 in Microsoft Access which stores information on the ingredients of 1859 foods eaten in the
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38 16 Irish diet. This information was obtained alongside two national dietary surveys: The National
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40 17 Children's Food Survey (NCFS), (2003 - 2004) and the National Teen Food Survey (NTFS),
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42 18 (2005 - 2006). The NCFS surveyed 594 children aged between 5-12 years and the NTFS
43
44 19 surveyed 441 teenagers aged between 13-17 years. Both surveys collected quantitative food
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46 20 intake data using 7-day food diaries along with physical activity measurements, lifestyle and
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48 21 attitude information. A detailed account of the methodology used in both surveys is available
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50 22 elsewhere (Irish Universities Nutrition Alliance 2009). INFID is updated on a regular basis,
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52 23 having been updated in 2004 (during the NCFS), 2007 (during the NTFS) and is currently
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54 24 being updated as part of a new national food survey. However, when analysing the usage
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56 25 patterns for the present study, ingredient data was used from INFID that related to the time
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58 26 frame of the Southampton study (2007).
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1 All packaging belonging to foods consumed during the survey period were collected
2 by the participants and given to the field workers conducting the surveys. This packaging
3 was then forwarded to the coordinating centre in University College Dublin. Using this
4 packaging, general information about the food was recorded in INFID, such as the brand
5 name, product description, product weight, and country of origin of the food. Ingredient lists
6 for every product were also recorded from the package label, as well as the nutritional
7 information of each product. A composite food & ingredient table also recorded information
8 on the composite ingredients in the products e.g. ingredients for the jam of a biscuit.

9 All food intake data in the surveys were collected at brand level, and unique brand
10 identification codes were assigned to separate branded food items and these differed per
11 flavour per product type. This resulted in 5551 different brand codes for the children and
12 4921 brand codes for the teenagers. Details of all ingredients per food item consumed were
13 entered into INFID and coded using unique brand id codes to link with the food consumption
14 databases. Ingredients were also identified by unique ingredient id codes, which allowed
15 INFID to be searched for a specific ingredient. For example, when INFID was explored to
16 ascertain the occurrence of Sunset Yellow (E 110) in foods consumed by the children and
17 teenagers, the ingredient table was searched for its unique ingredient code. This produced a
18 list of all the products and brand id codes that contained this food colour.

20 **Food consumption data**

21 Food consumption data from the NCFS and the NTFS were exported from the dietary
22 analysis software WISP[®] (Tinuviel Software, Anglesey, UK) and exported as food files into
23 SPSS (SPSS v.12). Each row in the food files corresponded to the weight and the nutrient
24 breakdown of each food consumed per each eating occasion per day per subject. All foods
25 consumed were also coded at brand level, thus each food was linked to a brand id code as

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3 1 per INFID. Information on the day of the week and on the type of meal, i.e. breakfast, was
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5 2 recorded. The NCFS food file contained 72024 rows and the NTFS food file contained 46473
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7 3 rows of data.
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10 4 11 12 13 5 **Assessing additive intake** 14

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16 6 Based on the assigned brand id codes per food in the food files, it was possible to establish
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18 7 the food ingredients associated with each food eating occasion, such as food additives,
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20 8 based on the ingredient lists in INFID. More than one additive may have been present per
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22 9 branded food product consumed.
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26 10 INFID was then explored to determine the probability of the intakes of different
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28 11 combinations of seven additives in the diets of Irish children (NCFS) and teenagers (NTFS).
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30 12 The present study focused on the seven food additives used in the Southampton study:
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32 13 Sunset yellow (E 110), Carmoisine (E 122), Tartrazine (E 102), Ponceau 4R (E 124), Allura
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34 14 Red (E 129), Quinoline yellow (E 104) and Sodium benzoate (E 211).
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38 15 39 40 16 **Categorisation of Foods** 41

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44 17 For the purpose of exposure assessment, all foods consumed by the survey participants
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46 18 were categorized into food groups in which these seven additives are legally permitted, as
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48 19 outlined in EU legislation (EU Directive No. 94/36/EC (EU Directive 1994) and EU Directive
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50 20 No. 95/2/EC (EU Directive 1995)). These EU Directive food groups detail the Maximum
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52 21 Permitted Level (MPL) of each additive per food group (in mg/kg food). These groups were
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54 22 developed by categorizing foods consumed in the SPSS food files according to the
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56 23 appropriate food group outlined in the legislation. If a food comprised of more than one
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58 24 component that may contain the additives (i.e. composite foods), the separate components
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3 1 were put into separate food groups. For example, an iced doughnut would be categorised
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5 2 into both the 'Fine Bakery Wares' group (doughnut) and the 'Decorations and Coatings'
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7 3 group (icing). This resulted in 36 food groups for food colours and 34 groups for Sodium
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9 4 benzoate.

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12 5 The additive intake for each participant was then estimated by multiplying the
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14 6 consumption level of each food group where the target additives were present (identified
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16 7 from INFID) by the additive concentration based on the MPL. When the additive was absent
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18 8 from a food the exposure was always zero. Creme software was used to handle all of the
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20 9 datasets and to conduct the exposure assessments. (Creme Software Ltd. 2009) These
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22 10 assessments were run by uploading information from the NCFS and the NTFS into Creme
23
24 11 software. This information included the raw food intake data from the survey diaries (on all
25
26 12 eating occasions), EU Directive food-groups and the true occurrence of the target additives
27
28 13 in those food groups.

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33 14 The mean daily intake of each food additive for children and teenagers was used to
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35 15 construct a distribution from which the mean and the 97.5th percentiles of additive intakes
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37 16 were computed. Considering each food additive separately, participants who did not
38
39 17 consume the target additive in the course of the 7-day study were excluded so that all intake
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41 18 estimates presented are for consumers only. Analysing 'consumer only' data ensured that
42
43 19 the worst case exposure was computed, as this prevents the reduction of intake estimates
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45 20 by the otherwise inclusion of individuals with no intake of the additive.

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49 21 The average age of the children in this study was 8.5 years which allowed their
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51 22 intakes to be compared to the doses given to the 7/8-year olds in the Southampton study. In
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53 23 that study, the additive dose used for this age group was partly based on a multiple of a
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55 24 younger group (3 years of age) because of their higher energy requirements. In the present
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57 25 study, the average intake of energy among the teenagers (mean age = 15.4 years) was 1.2
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59 26 times that of the children, and thus, in the present study the Southampton doses could have

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3 1 been adjusted upwards *pro rata*. However, by keeping with the lower dose applicable to 8-9
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5 2 year olds with lower energy intakes, this allowed a conservative approach to be adopted for
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7 3 the exposure assessments to the target additives in the adolescent sample.
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5 **Results**

6 ***Probability of Occurrence (in foods and meals)***

7 By availing of the data recorded in INFID at brand level, frequencies of the target additive
8 consumption for the children and teenagers were calculated. With 594 children and 441
9 teenagers surveyed over 7 days, this resulted in 4158 child-days and 3087 teen-days.
10 Arising from these, 72024 eating occasions were consumed by the children and 46473 by
11 the teenagers. These are known as *food-eating occasions*. Further to this, 19795 eating
12 occasions (meals and snacks) were recorded for the children and 13541 for the teenagers.
13 These are referred to as *meal-eating occasions* in the present study.

14 Table 1 lists the frequency of foods eaten by Irish children and teenagers containing
15 1 or more of the target food additives. The majority of additive-containing food eating
16 occasions for both children and teenagers only contained a maximum of one of the target
17 additives (3.8% for the children, 3.1% for the teenagers). There were a total of 5551 unique
18 brand codes in the children's database and 4921 in the teenagers. Of these, the vast
19 majority did not contain any of the target additives i.e. 94.8% for the children and 96.2% for
20 the teenagers. Of those brands that contained the target additives, 279 (5%) of the children's
21 branded foods contained at least 1 of the target additives, with 194 (3.9%) for the teenagers
22 (data not shown). In the case of children, no food-eating occasion ever contained 5 or more
23 of the target additives, and in the case of teenagers no food contained any 6 of the target
24 additives.

1 A similar trend is followed when looking at additive consumption in terms of meals.
2 Table 2 presents the frequency of meal-eating occasions by Irish children and teenagers that
3 contained at least 1 of the target additives. Again, the majority of meals for both populations
4 contained at least 1 of the target additives. As the number of foods per meal eating occasion
5 decreased, the presence of an additive-containing food increased, reflecting the high
6 occurrence of additives in snack-foods eaten alone.

8 ***Occurrence per food group***

9 To gain insight into the distribution of the target food additives per food group, the presence
10 of the target additives was investigated per brand per food group according to the EU
11 Directives (Table 3a, 3b and 4). Regarding food colours (Tables 3a and 3b), 'Fine Bakery
12 Wares' and 'Non-Alcoholic Flavoured Drinks' were the food groups that contained the most
13 branded products consumed by both the teenagers and children. However, the food group
14 'Confectionary' recorded the most brands containing the target food colours for both the
15 teenagers and children. A number of food groups consumed by the children and teenagers
16 did not contain any of the 7 target additives. Also, not all of the EU Directive food groups
17 were consumed in the NCFS or in the NTFS. The children consumed a total of 19 food
18 groups out of the 36 compiled where the 6 target food colours were legally permitted. Of
19 these 20 food groups, 13 did not contain any of the 6 target colours. The teenagers
20 consumed 23 food groups out of the possible 36 food groups. Of these 23 food groups, 15
21 did not contain any of the 6 target food colours. Food groups, such as 'Jams, jellies,
22 marmalade', 'Sauces and seasonings' and 'Soups (dehydrated, canned, stick cubes)' are
23 examples of food groups regularly consumed by the children and teenagers, yet which did
24 not contain any of the 6 target colours.

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3 1 A similar trend emerges when analysing the intake of Sodium benzoate (E 211)
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5 2 (Table 4). The children consumed a total of 16 food groups out of a possible 34 food groups
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7 3 in which Sodium benzoate is legally permitted. Of these 16 food groups, 13 did not contain
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9 4 Sodium benzoate. The teenagers also consumed 16 food groups out of a possible 34. Of
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11 5 these, 12 food groups did not contain Sodium benzoate. 'Non-alcoholic flavoured drinks' and
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13 6 'non-heat treated desserts' were the food groups that contained the most brands consumed
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15 7 by both the children and teenagers. However, while a considerable amount of the brands in
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17 8 the 'Non-alcoholic flavoured drinks' group contained Sodium benzoate (42% of brands
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19 9 consumed by teenagers and 40% consumed by children), no brand consumed by the
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21 10 children in the 'Non-heat treated desserts' contained the additive. Food groups, such as
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23 11 'Low sugar jams, jellies', 'Emulsified sauces with fat content of >60%' and 'Liquid soups and
24
25 12 broths' were regularly consumed by the children and teenagers, yet did not contain Sodium
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27 13 benzoate. Therefore, the primary source of Sodium benzoate for both children and
28
29 14 teenagers was through the 'non-alcoholic flavoured drinks' food group.
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34 ***Exposure to the 7 target food additives***

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37 16 Estimated mean daily and 97.5th percentile intakes of the target additives and comparison
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39 17 with the doses used in the Southampton study (additives in Mix A and B) are presented in
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41 18 Table 5. In general, apart from Tartrazine, a higher proportion of children consumed the
42
43 19 target food additives compared to teenagers. This may reflect a higher preference for
44
45 20 coloured sweet confectionery in the younger age group. However, apart from Carmoisine,
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47 21 intake of the target additives was generally higher in teenagers, which partly reflects the
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49 22 difference in energy intakes between the two groups (8.3 MJ/d for teenagers versus 7.0
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51 23 MJ/d for children). Among consumers of any food colour, estimated mean intakes fell below
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53 24 the doses used in both Mixes. Also, when higher intakes were examined (i.e. at the 97.5th
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55 25 percentile of food additive intake), values for both children and teenagers were less than
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57 26 those used in Mix B. In the case of Mix A, estimated intakes at the 97.5th percentile were
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3 1 lower for 4 food colours: Tartrazine, Ponceau 4R, Allura Red and Quinoline Yellow. In the
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5 2 case of the preservative Sodium benzoate, the estimated 97.5th percentile of intake for both
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7 3 children and teenagers exceeded the dose used in both Mixes.
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10 4 In some cases of food additive intake, it was possible that certain individual children
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12 5 or teenagers may have had intakes greater than the doses used in either mix. For Mix B, no
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14 6 individual child or teenager had an estimated daily intake that reached the doses used for
15
16 7 any additive except for Quinoline Yellow (n=4) and Sodium benzoate (n=53). In the case of
17
18 8 Mix A, the total number of individuals with estimated intakes exceeding the dose used were
19
20 9 15 for Sunset Yellow, 22 for Carmoisine and 53 for Sodium benzoate (Table 5). In all cases,
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22 10 there was no child or teenager who ever achieved an intake, even at the 97.5th percentile, on
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24 11 all seven days at the level used in the Southampton study.
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35 14 **Discussion**

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38 15 The results of the present study show that these conservative estimates of intake of food
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40 16 additives in Irish teenagers and children are below those used in the Southampton study
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42 17 which demonstrated a relationship between food additive intake and hyperactivity in UK
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44 18 children. The estimated upper intakes for a very small proportion of Irish teenagers and
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46 19 children exceeded the intake levels used in the Southampton study on individual days but
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48 20 never on seven consecutive days. The estimated intakes of additives were made assuming
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50 21 that the additive was present at the maximum permitted level in those foods identified as
51
52 22 containing them. It is a conservative assumption which is likely to result in significant
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54 23 overestimation of intakes. This is borne out by a recent study in Australia which found that
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56 24 the measured concentrations of added colours in foods are mostly less than 25% of the
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58 25 maximum permitted levels (Food Standards Australia, New Zealand 2008).
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3 1 When analysing the food groups permitted to contain the target food additives, it is
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5 2 clear that even though the food additives were permitted in a number of food groups, the
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7 3 children and teenagers only consumed a small proportion of these food groups
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10 4 (approximately half). Further to this, although the additives were permitted in these food
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12 5 groups, the majority of the brands consumed did not contain any of the target additives. This
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14 6 was also a contributory factor to the low exposure of the children and teenagers to the 7
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16 7 target additives.
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19 8 The basis for selection of the intake levels of food additives in the Southampton study
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21 9 is not well established. The authors of that study state that the levels of additives used in Mix
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23 10 A were based on a previous study, while those of Mix B were “selected to indicate the
24
25 11 current average daily consumption of food additives by 3-year old and 8/9-year old children
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27 12 in the UK”. The reference cited to support this statement refers to a national survey of food
28
29 13 intake in UK children (Gregory et al. 1995). This report gives details of the intake of intense
30
31 14 sweeteners but gives no data on the intake of any of the additives used in Mix A or B.
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33 15 Moreover, there are no published data available in the literature on the intakes of these
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35 16 additives by UK children. The authors also state that the challenge in their study was “with
36
37 17 quantities of additives equal to typical dietary intakes”. The results of the present study show
38
39 18 that these doses are higher than even the highest exposures of Irish children and teenagers
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41 19 to the target additives. The intakes of food additives in Irish children are likely to be
42
43 20 representative of those of children in the UK since food consumption patterns for Irish
44
45 21 children are comparable to those reported in the UK (Gregory et al. 200). For example, the
46
47 22 pattern of food intake for four food categories associated with the use of food colours
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49 23 (biscuits, chocolate confectionary, non-chocolate confectionary and savoury snacks) is
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51 24 comparable between British and Irish children (respectively, 70 and 66 g/d for intake of the
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53 25 four food groups combined). Furthermore, although the food ingredient database used in the
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55 26 present study is regularly updated, the usage pattern adopted for the present study was that
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57 27 which prevailed in the retail market at the time of the Southampton study.
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3 1 The published paper of the Southampton study refers to the two doses of additives
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5 2 used in terms of the intakes that would be expected from the consumption of multiple bags
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7 3 of 56g sweets. In the case of Mix B, which was stated to equal normal exposure to the target
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9 4 food additives in UK children; this translates into two 56g bags of sweets per day for the 3-
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11 5 year olds and 4 such bags for the 8/9-year olds. In the case of the latter, based on the
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13 6 energy value of an international brand of coloured sweets, this is equivalent to approximately
14
15 7 900 kcal per day, and this corresponds to 53% of the average daily energy intake of UK
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17 8 children aged 7/10 years of age. However, published data on the dietary habits of British
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19 9 children (Gregory et al. 2000) reveals that the average contribution of all sources of sugar
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21 10 confectionary to energy intake was just 7-9%.
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26 11 In the present study, even more conservative deterministic estimates of food additive
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28 12 intake were also computed (i.e. assuming that if an additive can legally be present in a food
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30 13 category, it will always be present (data not shown)). The estimated mean intakes of all of
31
32 14 the food colours used were found to be also below those purported to be typical among
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34 15 British children. This approach of conservatively calculating food additive intake was open to
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36 16 the regulatory agencies which reviewed that paper of McCann *et al* (McCann et al. 2007)
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38 17 based on publicly available data but was evidently not pursued.
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45 **Conclusion**

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48 20 In Irish children and teenagers, levels of exposure to food additives rarely, if ever, reach the
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50 21 levels used in the Southampton study. In addition, the concurrent consumption of the
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52 22 combination of additives in either of the cocktails used in that study, in single foods or in
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54 23 eating occasions of multiple foods, hardly ever occurs. These data would suggest that the
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56 24 risk assessment process which followed from the Southampton study should be re-
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58 25 considered.
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Table 1: Frequency of food-eating occasions containing 1 or more of the target additives in 594 children (5-12 yrs.) and 441 teenagers (13-17 yrs.)

No. of target additives	Teenagers* (total no. of food-eating occasions = 46,473)	Children** (total no. of food-eating occasions = 72,024)
1	1,439 (3.1%)	2,745 (3.8%)
2	1,139 (2.5%)	312 (0.4%)
3	186 (0.4%)	254 (0.35%)
4	97 (0.2%)	83 (0.12%)
5	8 (0.02%)	56 (0.08%)
6	9 (0.02%)	0 (0%)
7	0 (0%)	0 (0%)

*National Teenagers Food Survey (NTFS), 2005 – 2006, 13 – 17 years (n = 441).

**National Childrens Food Survey (NCFS), 2003 - 2004, 5 – 12 years (n = 594).

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Table 2: Frequency of meal-eating occasions containing 1 or more target additives in 594 children (5-12 yrs.) and 441 teenagers (13-17 yrs.)

Additive containing foods within a meal		Total meal-eating occasions	1 Additive	2 Additives	3 Additives	4 Additives	5 Additives	6 Additives	7 Additives
1 food*	Teenagers	1307	2340	162	83	8	9	0	0
	Children	2867	1248	248	192	58	38	0	0
2 foods*	Teenagers	59	4	29	10	15	1	0	0
	Children	249	46	92	45	38	18	10	0
3 foods*	Teenagers	4	2	1	0	0	1	0	0
	Children	30	4	4	11	3	5	2	1
<3 foods*	Teenagers	1	1	0	0	0	0	0	0
	Children	5	1	0	0	3	1	0	0
Total meals with >1 additive-containing food	Teenagers	1371	1052	192	93	23	11	0	0
	Children	3160	2391	344	248	102	62	12	1

* indicates the number of foods within a given meal

Table 3 (a): Brands per food-groups and the occurrence of the target colours within these branded food items. (Teenagers)

Food Group Name	Intake (g/d)	N (Brands)	E110		E122		E102		E124		E1
			n	%	n	%	n	%	n	%	
Americano	0	0	-	-	-	-	-	-	-	-	-
Bitter Soda	0	0	-	-	-	-	-	-	-	-	-
Jams, Jellies, Marmalade	2.18	73	-	-	-	-	-	-	-	-	-
Luncheon Meat	0.33	10	-	-	-	-	-	-	-	-	1
Chorizo Sausage	0	0	-	-	-	-	-	-	-	-	-
Breakfast Sausage	9.52	88	-	-	-	-	-	-	-	-	-
Sobrasda	0	0	-	-	-	-	-	-	-	-	-
Non-Alcoholic Flavoured Drinks	228.27	253	-	-	4	1.58	2	0.7	-	-	2
Candied fruit & veg	0	0	-	-	-	-	-	-	-	-	-
Preserves of red fruit	0	0	-	-	-	-	-	-	-	-	-
Confectionary (sugar confectionary)	7.3	166	18	10.8	12	7.2	1	0.6	19	11.4	24
Decorations & Coatings	5.93	122	1	0.8	2	1.6	-	-	4	3.2	6
Fine Bakery Wares	18.16	264	-	-	-	-	-	-	3	1.1	1
Edible Ices	1.61	28	-	-	-	-	-	-	-	-	-
Flavoured Processed Cheese	0.005	1	-	-	-	-	-	-	-	-	-
Desserts incl. flavoured milk products	16.5	207	1	0.4	2	0.9	-	-	-	-	1
Sauces & seasonings	14.18	204	-	-	-	-	-	-	-	-	-
Mustard	0.03	9	-	-	-	-	-	-	-	-	-
Fish Paste	0	0	-	-	-	-	-	-	-	-	-
Pre Cooked Crustaceans	0.34	9	-	-	-	-	-	-	-	-	-
Salmon Substitutes	0	0	-	-	-	-	-	-	-	-	-
Surimi	0	0	-	-	-	-	-	-	-	-	-
Fish Roe	0	0	-	-	-	-	-	-	-	-	-
Smoked Fish	0.29	7	-	-	-	-	-	-	-	-	-
Snacks	12.43	189	-	-	-	-	-	-	-	-	-
Edible Cheese Rind & Casings	0	0	-	-	-	-	-	-	-	-	-
Weight Control Formulae	0	0	-	-	-	-	-	-	-	-	-
Complete Nutritional Supplements	0.32	1	-	-	-	-	-	-	-	-	-
Liquid Food Supplements,Dietary Integrators	1.38	14	-	-	-	-	-	-	-	-	-
Solid Food Supplements,Dietary Integrators	1.12	68	1	1.4	-	-	-	-	-	-	1
Soups(dehydrated,canned,stock cubes)	18.99	73	-	-	-	-	-	-	-	-	-
Meat & Fish analogues based on veg protein	0.43	6	-	-	-	-	-	-	-	-	-

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4	Spiritous Beverages	3.6	2	-	-	-	-	-	-	-	-	-
5	Aromatized Wines	0	0	-	-	-	-	-	-	-	-	-
6	Fruit Wines(cider,perry aromatized fruit wines,cider,perry)	3.37	1	-	-	-	-	-	-	-	-	-
7	Processed mushy and garden peas,canned	5.73	28	-	-	-	-	12	42.8	-	-	-
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10 **E110** = Sunset Yellow, **E122** = Carmosine, **E102** = Tartrazine, **E124** = Ponceau 4R, **E129** = Allura Red, **E104** = Quinoline Yellow

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Table 3 (b): Brands per food-groups and the occurrence of the target colours within these branded food items. (Children)

Food Group Name	Intake (g/d)	N (Brands)	E110		E122		E102		E124		E129	
			n	%	n	%	n	%	n	%	n	%
Americano	0	0	-	-	-	-	-	-	-	-	-	-
Bitter Soda	0	0	-	-	-	-	-	-	-	-	-	-
Jams, Jellies, Marmalade	1.34	90	-	-	-	-	-	-	-	-	-	-
Luncheon Meat	1.25	25	-	-	-	-	-	-	-	-	-	-
Chorizo Sausage	0	0	-	-	-	-	-	-	-	-	-	-
Breakfast Sausage	0	0	-	-	-	-	-	-	-	-	-	-
Sobrasda	0	0	-	-	-	-	-	-	-	-	-	-
Non-Alcoholic Flavoured Drinks	187.46	339	6	1.7	3	0.8	-	-	2	0.5	2	0.5
Candied fruit & veg	0	0	-	-	-	-	-	-	-	-	-	-
Preserves of red fruit	0	0	-	-	-	-	-	-	-	-	-	-
Confectionary (sugar confectionary)	10.65	247	38	15.3	21	8.5	2	0.8	57	23	32	12.9
Decorations & Coatings	3.75	16	-	-	-	-	-	-	-	-	-	-
Fine Bakery Wares	21.06	362	1	0.2	-	-	-	-	-	-	4	1.1
Edible Ices	3.55	38	7	18.4	-	-	-	-	1	2.6	-	-
Flavoured Processed Cheese	0.07	3	-	-	-	-	-	-	-	-	-	-
Desserts incl. flavoured milk products	29.05	228	1	0.4	2	0.8	-	-	1	0.4	2	0.8
Sauces & seasonings	4.95	148	-	-	-	-	-	-	-	-	-	-
Mustard	0.01	5	-	-	-	-	-	-	-	-	-	-
Fish Paste	0	0	-	-	-	-	-	-	-	-	-	-
Pre Cooked Crustaceans	0.26	8	-	-	-	-	-	-	-	-	-	-
Salmon Substitutes	0	0	-	-	-	-	-	-	-	-	-	-
Surimi	0	0	-	-	-	-	-	-	-	-	-	-
Fish Roe	0	0	-	-	-	-	-	-	-	-	-	-
Smoked Fish	0.22	11	-	-	-	-	-	-	-	-	-	-
Snacks	12.47	203	1	0.4	-	-	-	-	-	-	-	-
Edible Cheese Rind & Casings	0	0	-	-	-	-	-	-	-	-	-	-
Weight Control Formulae	0	0	-	-	-	-	-	-	-	-	-	-
Complete Nutritional Supplements	0.15	1	-	-	-	-	-	-	-	-	-	-
Liquid Food Supplements,Dietary Integrators	1	15	-	-	-	-	-	-	-	-	-	-
Solid Food Supplements,Dietary Integrators	17.46	51	-	-	-	-	-	-	-	-	-	-
Soups(dehydrated,canned,stock cubes)	12.22	108	-	-	-	-	-	-	-	-	-	-
Meat & Fish analogues based on veg protein	0.33	7	-	-	-	-	-	-	-	-	-	-

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3	Spiritous Beverages	0	0	-	-	-	-	-	-	-	-	-	-
4	Aromatized Wines	0	0	-	-	-	-	-	-	-	-	-	-
5	Fruit Wines(cider,perry aromatized fruit wines,cider,perry)	0	0	-	-	-	-	-	-	-	-	-	-
6	Processed mushy and garden peas,canned	3.84	44	-	-	-	-	17	38.6	-	-	-	-
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8 **E110** = Sunset Yellow, **E122** = Carmosine, **E102** = Tartrazine, **E124** = Ponceau 4R, **E129** = Allura Red, **E104** = Quinoline Yellow

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Table 4: Brands per food-groups and the occurrence of sodium benzoate within these branded food items.

	Teenagers			Children		
	Intake (g/d)	N (Total)	n(E211)	Intake (g/d)	N (Total)	n (E211)
Non Alcoholic Flavoured Drinks	231.51	232	97	184.37	332	130
Liquid Tea Conc. and Liquid Fruit Infusion Conc.	0	0	-	0	0	-
Grape Juice	0	0	-	0	0	-
Soft	0	0	-	0	0	-
Alcohol-free Beer in Keg	0	0	-	0	0	-
Spirits with less than 15 alcohol	3.59	4	2	0	0	-
Low Sugar Jams,Jellies	0	0	-	0.12	7	-
Candies,glace fruit and veg	0	0	-	0	0	-
Frugtgrod	0	0	-	0	0	-
Veg in vinegar,brine,oil	0.09	4	-	0.17	5	-
Olives and Preparations	0.2	4	-	0.002	2	-
Fish roe,etc	0	0	-	0	0	-
Salted,dried fish	0	0	-	0.02	2	-
Crangon	0	0	-	0	0	-
Non Heated Dairy Based Desserts	26.12	359	2	39.6	304	-
Liquid Egg	0	0	-	0	0	-
Emulsified sauces fat content of 60	2.99	61	-	0.68	36	-
Emulsified sauces less 60 fat	0	0	-	0.001	1	-
Non emulsified sauces	26.35	191	1	7.38	219	1
Prepared Salad	2.4	2	-	0.19	8	-
Mustard	0.03	9	-	0.01	5	-
Seasoning and Condiments	0.36	1	-	0.02	11	-
Liquid Soups,broths	6.84	13	-	3.02	15	1
Aspic	0	0	-	0	0	-
Dietary Food Medical Purpose	0.32	1	-	0	0	-
Mehu and Makeutettu	0	0	-	0	0	-
Dulce de Membrillo	0	0	-	0	0	-
Marmelada	0	0	-	0	0	-
Cooked Red Beet	0	0	-	0	0	-
Flavourings	0	0	-	0	0	-
Crustaceans and molluscs cooked	0.35	8	-	0.23	7	-
Food supplements supplied in liquid form	1.38	13	-	1	14	-
Chewing Gum	0.64	21	-	0.27	28	-

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Confectionary (non choc)	6.72	157	-	9.69	293	-
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E211 = Sodium Benzoate

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Table 5: Mean daily and 97.5th percentile intakes of the target food additives in consumers only for children and teenagers in all foods consumed compared to the doses present in Mix A and B used in the McCann et al., (2007) study, plus an indication of the number of children and teenagers who had intakes that exceeded these doses

Food additive	Population	Intake among consumers only (mg/d)				Daily doses in the Mixes used in the McCann et al study and the number of subjects exceeding the			
		% consumers	Mean (SD)	Percentile		Mix A (mg/d)	Mix B (mg/d)	Mix A n >dose	Mix B n >dose
				5th	97.5th				
Sunset yellow (E110)	Children [^]	34.9	1.29 (2.1)	0.06	6.96	6.25	15.6	6	0
	Teenagers*	22.0	2.42 (2.9)	0.11	10.40			9	0
Carmosine (E122)	Children	31.7	0.98 (1.7)	0.07	5.87	3.12	15.6	18	0
	Teenagers	14.3	0.59 (1.0)	0.11	3.57			4	0
Tartrazine (E102)	Children	13.3	1.28 (1.0)	0.24	3.81	9.36	0	0	0
	Teenagers	13.4	1.78 (1.5)	0.57	6.38			0	0
Ponceau 4R (E124)	Children	34.0	0.39 (0.5)	0.04	1.54	6.25	0	0	n/a
	Teenagers	19.7	0.61 (0.9)	0.03	3.57			0	n/a
Allura red (E129)	Children	24.1	2.26 (2.0)	0.3	7.21	0	15.6	n/a	0
	Teenagers	20.2	2.17 (2.1)	0.03	8.22			n/a	0
Quinoline yellow (E104)	Children	35.0	2.77 (3.3)	0.37	10.39	0	15.6	n/a	3
	Teenagers	20.4	2.65 (3.0)	0.2	11.18			n/a	1
Sodium Benzoate (E211)	Children	74.1	14.89 (15.8)	0.66	56.22	45	45	21	21
	Teenagers	64.4	22.14 (23.2)	2.83	76.79			32	32

n/a = non applicable as additive not present in Mix in McCann et al., 2007 study

[^]Children: n=594; *Teenagers: n=441