Updated Exposure Estimate for FD&C Color Additives for the U.S. Population D. Doell, D. Folmer, H. Lee, K. Butts, and S. Carberry U.S. Food and Drug Administration, College Park, MD 20740



Background

In the U.S., there are 7 synthetic organic color additives that are permitted for general use in food: FD&C Blue No. 1, FD&C Blue No. 2, FD&C Green No. 3, FD&C Red No. 3, FD&C Red No. 40, FD&C Yellow No. 5, and FD&C Yellow No. 6. These color additives are subject to batch certification by the Food and Drug Administration (FDA) and are permitted for use in foods at levels consistent with good manufacturing practice.

In 2011, FDA convened its Food Advisory Committee (FAC) to consider data on the possible association between children's consumption of these color additives in food and hyperactivity or other behavioral effects. The FAC concluded that a causal link between children's consumption of synthetic color additives and behavioral effects had not been established based on the available data. However, the FAC recommended further research, including a comprehensive exposure assessment for these color additives, especially for children.

Based on this recommendation, FDA previously conducted a robust exposure assessment of the FD&C color additives using data from the analysis of approximately 600 representative food products and 2-day food consumption data from the 2007-2010 National Health and Nutrition Examination Survey (NHANES). However, the use of 2-day food consumption data to assess chronic exposure can lead to an overestimation of exposure, especially for foods that are not commonly consumed. For this reason, data collected from a longer survey are considered to be more representative of actual consumption patterns in the U.S. The dietary exposure to FD&C color additives has been updated using 10-14 day food consumption data. Dietary exposure from the use of each FD&C color additive in food was estimated for the U.S. population aged 2 years or more, and several subpopulations, with a focus on children. This study summarizes the results of this exposure assessment.

Structures of the FD&C Color Additives Nat Nat FD&C Blue No.2 FD&C Blue No.1 FD&C Green No.3 FD&C Red No.40 035 FD&C Yellow No.6 FD&C Yellow No.5 FD&C Red No.3

These sources include:

• Product Label Survey: Data collected from the FoodEssentials LabelBase were verified by conducting a survey of over 7300 product labels at local grocery stores in the greater Washington D.C. area from June 2012 – December 2013. Product food categories known to currently or previously contain FD&C color additives were targeted. In addition, when available, information on the use of FD&C color additives from food manufacturers' websites and other publicly available websites were used.

• Analytical Data: Based on the label survey, approximately 600 representative products were chosen by FDA for analysis by a contract laboratory for FD&C color additives. A peer-reviewed high performance liquid chromatography (HPLC) method developed by FDA's Office of Cosmetics and Colors (OCAC) with a limit of detection of 1 mg/kg was used. Prior to analysis, all products were prepared as they would be consumed. The level of each FD&C color additive determined in a given food product was provided in mg/kg.

Dietary exposure estimates for FD&C color additives from their use in food were performed using two different sets of food consumption data: 1) the 2007-2010 NHANES 2-day dietary intake survey; and 2) the 2007-2010 NPD Group, Inc. National Eating Trends-Nutrient Intake Database (NPD NET-NID) 10-14 day data using the Foods Analysis and Residue Evaluation-National Eating Trends (FARE-NET) program. Three population groups were chosen for the exposure estimate: • U.S. population aged 2 years or more

The NPD NET-NID data consist of 10-14 day food diaries for over 5,000 respondents. The FARE-NET program provides food consumption data based on data combined from NPD NET-NID and NHANES. The food codes used by the NPD NET-NID data set were mapped to the corresponding NHANES food codes to obtain the mean amount consumed for a given food.

All dietary exposures were estimated on an "eaters-only" basis, meaning that the estimate represents the dietary exposure to FD&C color additives from the consumption of foods containing FD&C color additives by the individuals in the population who consumed one or more of those foods over the survey period. Dietary exposures were estimated at the mean and the 90th percentile, where the 90th percentile represents those individuals who are the "high intake" consumers of a given food.

The exposure estimate was performed as follows: • Foods that contain FD&C color additives were identified based on label information. These foods were then grouped into over 50 broad food categories.

- Low Exposure Scenario: The lowest analytical value for a given FD&C color additive was assigned to each food code. This represents the lowest exposure to a given FD&C color additive.
- Average Exposure Scenario: The analytical results were averaged for a given food code. High Exposure Scenario: The highest analytical value for a given FD&C color additive was assigned to each food code. This represents the highest exposure to a given FD&C color additive.

Exposure Assessment

Sources for Identifying Foods Containing FD&C Color Additives:

Two different sources were used to determine various food products labeled in the U.S as containing FD&C color additives.

• FoodEssentials LabelBase is a product label database providing access to information from greater than 250,000 food labels compiled from the Gladson and Mintel databases. This database was used to first identify the food products that list FD&C color additives as ingredients.

- Gladson Nutrition Database contains information from over 90% of products in most major consumer packaged goods categories. It includes information such as product images, ingredient information, nutrition information, and universal product codes (UPC).
- Mintel Global New Products Database (GNPD) monitors product innovation and retail success in the consumer packaged goods market. It contains data similar to that in the Gladson Database for 49 countries in 32 food categories from 1996 to the present.

Source of FD&C Color Additive Use Levels in Foods:

Methods for Estimating Exposure to FD&C Color Additives

• Children aged 2-5 years

• Teenage boys aged 13-18 years

Over 300 food codes from the NHANES survey were assigned across these food categories for each of the seven FD&C color additives.

For each NHANES food code identified as containing a particular FD&C color additive, a use level for that FD&C color additive, which was based on the results of the analytical data, was assigned to that food code. If a given FD&C color additive was not found to be present in food products represented by a given NHANES food code, then that food code was not included in the exposure estimate for that FD&C color additive.

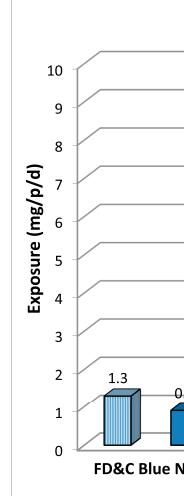
For the exposure estimate using NPD NET-NID data (10-14 day food consumption data), the NHANES food codes for each FD&C color additive were mapped to NPD NET-NID food codes.

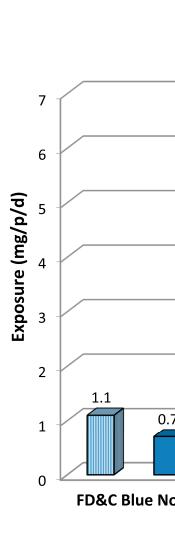
• For each FD&C color additive, three different exposure scenarios were performed:

- For those food codes where only one product was represented by a given food code, the same FD&C level was used for all three scenarios.

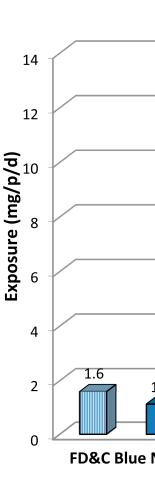
• For each population group, a cumulative exposure was estimated for all foods containing that FD&C color additive.

Results









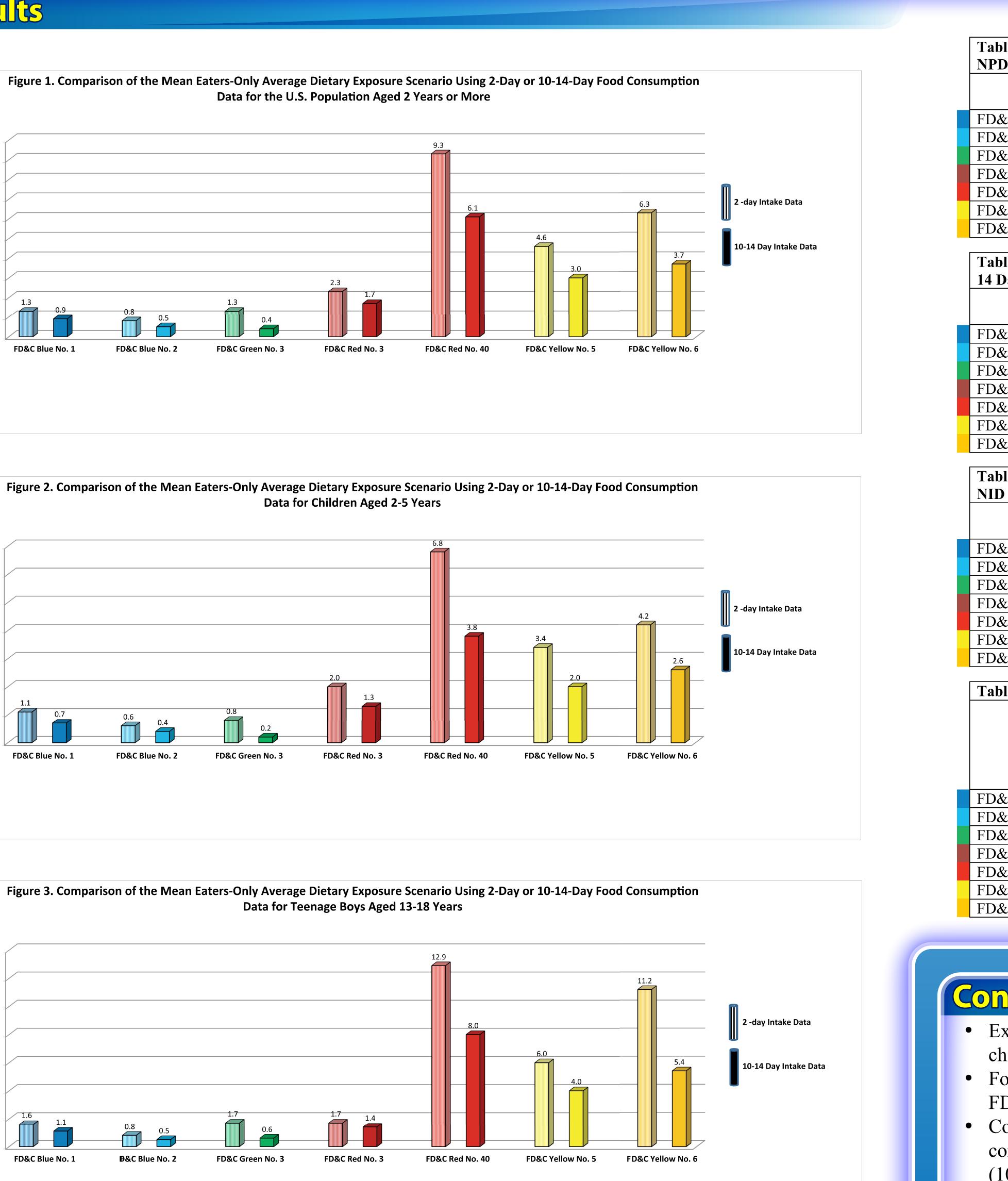




Table 1. Cumulative Exposure to FD&C Color Additives (mg/p/d) for the U.S. Population Aged 2+ Years or More Based on NPD NET-NID 10-14 Day Food Consumption Data

Color	% Eaters	Low Exposure Scenario		Average Exposure Scenario		High Exposure Scenario	
		Mean	90 th Percentile	Mean	90 th Percentile	Mean	90 th Percentile
D&C Blue No. 1	99	0.6	1.4	0.9	2.0	2.0	3.0
D&C Blue No. 2	93	0.4	0.9	0.5	1.2	0.9	2.1
D&C Green No. 3	51	0.4	0.9	0.4	0.9	0.4	0.9
D&C Red No. 3	84	0.7	2.1	1.7	3.0	3.2	3.2
D&C Red No. 40	100	2.7	6.2	6.1	13.1	16.3	36.6
D&C Yellow No. 5	100	1.7	3.4	3.0	5.9	5.4	11.1
D&C Yellow No. 6	99	2.3	5.1	3.7	8.2	5.3	11.0

Table 2. Cumulative Exposure to FD&C Color Additives (mg/p/d) for Children Aged 2-5 Years Based on NPD NET-NID 10-14 Day Food Consumption Data

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Color	% Eaters	Low Exposure Scenario		Average Exposure Scenario		High Exposure Scenario	
		Mean	90 th Percentile	Mean	90 th Percentile	Mean	90 th Percentile
D&C Blue No. 1	100	0.3	0.7	0.7	1.1	1.8	1.8
D&C Blue No. 2	96	0.3	0.7	0.4	1.0	0.8	2.2
D&C Green No. 3	47	0.2	0.5	0.2	0.5	0.2	0.5
D&C Red No. 3	87	0.3	0.6	1.3	1.4	3.1	1.7
D&C Red No. 40	100	1.6	3.6	3.8	7.7	9.9	21.9
D&C Yellow No. 5	100	1.3	2.6	2.0	3.8	3.3	6.4
D&C Yellow No. 6	100	1.6	3.2	2.6	5.2	4.2	7.1

Table 3. Cumulative Exposure to FD&C Color Additives (mg/p/d) for Teenage Boys Aged 13-18 Years Based on NPD NET-NID 10-14 Day Food Consumption Data

Color	% Eaters	Low Exposure Scenario		Average Exposure Scenario		High Exposure Scenario	
		Mean	90 th Percentile	Mean	90 th Percentile	Mean	90 th Percentile
D&C Blue No. 1	100	0.7	1.6	1.1	2.2	2.1	3.7
D&C Blue No. 2	91	0.3	0.8	0.5	1.3	1.2	3.2
D&C Green No. 3	48	0.6	1.3	0.6	1.3	0.6	1.3
D&C Red No. 3	85	0.7	2.1	1.4	2.6	2.3	2.7
D&C Red No. 40	100	3.6	7.8	8.0	16.3	21.7	49.0
D&C Yellow No. 5	100	2.3	4.6	4.0	8.2	7.4	14.8
D&C Yellow No. 6	100	3.6	8.0	5.4	11.5	7.3	14.7

Color	U.S. Popul	Eaters ation Aged 2+ or More	_	6 Eaters Aged 2-5 Years	% Eaters Teenage Boys Aged 13-18 Years	
	2-Day Data	10-14 Day Data	2-Day Data	10-14 Day Data	2-Day Data	10-14 Day Data
D&C Blue No. 1	92	99	96	100	93	100
D&C Blue No. 2	69	93	78	96	72	91
O&C Green No. 3	15	51	14	47	14	48
0&C Red No. 3	54	84	62	87	53	85
D &C Red No. 40	94	100	97	100	95	100
D &C Yellow No. 5	94	100	98	100	93	100
O&C Yellow No. 6	91	99	97	100	94	100

Conclusions and Future Work

• Exposure was estimated for each FD&C color additive for the U.S. Population aged 2 years or more, children aged 2-5 years, and teenage boys aged 13-18 years.

• For all populations considered and for all three exposure scenarios, the highest exposures were estimated for FD&C Red No. 40, FD&C Yellow No. 5, and FD&C Yellow No. 6.

• Comparing the exposure estimated using 2-day food consumption data to that using 10-14 day food consumption data, the percent eaters increased and the cumulative exposure decreased when the longer term (10-14 day) data were used.

• FDA is reassessing the safety studies conducted on FD&C color additives that are available in its files. Currently, all exposure estimates for these color additives are well below the acceptable intake levels that have been established by FDA.

• FDA will determine if additional safety studies are needed.