

Caffeine and Theobromine Intakes of Children: Results From CSFII 1994-96, 1998

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Caffeine and theobromine are naturally occurring purine alkaloids, which act as stimulants to the central nervous system. They are widely consumed through foods such as coffee, tea, cola, and chocolate. A variety of adverse health effects have been attributed to their consumption, including behavior abnormalities, hypertension, and hypercholesterolemia, though inconsistently. Existing data suggest that caffeine intake begins early in life, and that children are susceptible to caffeine and theobromine toxicity because their detoxifying mechanisms are not fully developed (4,5).

Food composition values for caffeine and theobromine were recently added to the United States Department of Agriculture's (USDA) Survey Nutrient Database; and data from the Continuing Survey of Food Intakes by Individuals (CSFII) 1994-96, 1998 (12), compiled by the Agricultural Research Service, have been used here to provide national probability estimates of caffeine and theobromine intakes for children through age 9.

Methods

Data presented are based on 24-hour recalls from 9,802 children compiled from the CSFII 1994-96, 1998 databases. Two nonconsecutive days of food intake data were collected during in-person interviews. The results are

weighted to adjust for differential rates of sample selection and nonresponse and to calibrate the sample to match population characteristics that are correlated with eating behavior. The design, methodology, and operation of the CSFII 1994-96 are detailed in a separate report (10). The CSFII 1998, a survey of children through 9 years of age, was designed to be combined with CSFII 1994-96. Similar approaches to sample selection, data collection, and weighting were used.

The caffeine and theobromine composition of foods was compiled from data supplied by the Nutrient Data Laboratory (Beltsville Human Nutrition Research Center, Agricultural Research Service, Beltsville, MD). Intake data were analyzed using SAS version 8.02 (SAS, Cary, NC) and SUDAAN (Research Triangle Institute, Research Triangle Park, NC). Mean and median intakes of caffeine and theobromine were estimated. The median may be a more meaningful statistic than the traditional mean for skewed distributions (9), such as the intakes of caffeine and theobromine. The Student *t* test was used to test differences in means between groups.

The food sources of caffeine and theobromine were also determined. Mean intakes are based on respondents' intakes on the first surveyed day, whereas sources of caffeine and theobromine are based on respondents' 2-day average intakes. This follows the

Table 1. Children's intakes of caffeine and theobromine, ¹ CSFII 1994-96, 1998, 1 day

Age	Sample size (unweighted)	Caffeine					Theobromine				
		All individuals			Consumers		All individuals			Consumers	
		Mean (mg)	Median (mg)	Percent consuming	Mean (mg)	Median (mg)	Mean (mg)	Median (mg)	Percent consuming	Mean (mg)	Median (mg)
Under 1	1,126	0.4 [†]	0	4.3	8.9 [†]	1.5 [#]	0.7	0	3.4	19.8 [†]	11.6 [#]
1-2	2,118	6.7	0	42.0	15.8	5.7	21.1	0	34.4	61.5	29.7
3-5	4,574	12.7	2.2	61.8	20.6	9.3	45.5	1.8	50.8	89.5	50.3
6-9	1,491	20.9	5.0	70.8	29.5	13.5	58.8	17.6	59.9	98.1	57.5
9 and under	9,309	13.9	1.4	57.2	24.2	10.0	42.5	0	47.6	89.3	57.4

¹Excludes breast-fed children.

[†]Coefficient of variation \geq 30 percent.

[#]Small sample size.

reporting practices of the Food Surveys Research Group at USDA. Mean intakes of food components are presented for the first surveyed day so that over time data users can compare day-1 intakes from surveys that include different numbers of days. The 2-day average is used for reporting foods consumed, since it better represents an individual's usual intake of any one food (10).

Results and Discussion

Mean caffeine and theobromine intakes for various age groups are presented in table 1. Data are presented for all children, and separately, for only those who consumed foods containing caffeine and theobromine. Breast-fed children were excluded from estimates in all tables. Unweighted counts of survey respondents on which estimates are based are also provided. In general, the sample sizes for each sex-age group provide a sufficient level of precision to ensure statistical reliability of the estimates. Data that are potentially unreliable because of a small sample size or large coefficient of variation are flagged, and should be used with caution. Data for males and females were combined because differences in mean intakes of caffeine and

theobromine based on gender were small for children 9 years of age and under.

The mean daily caffeine intake for all children through age 9 was 13.9 mg (table 1) or 8.3 mg/1,000 kcal (data not shown). Mean intakes ranged from 0.4 mg for children under 1 year to 20.9 mg for 6- to 9-year-olds. For comparison, mean caffeine intakes from the CSFII 1994-96, 1998 for ages 12-19 were 85.5 mg or 31.4 mg/1,000 kcal for males and 58.8 mg or 35.2 mg/1,000 kcal for females (11). The median caffeine intake for all children through age 9 was 1.4 mg, and the intake at the 90th percentile was 43.8 mg (data not shown).

A little more than half of the children (57 percent) consumed one or more foods containing caffeine. This percentage increased with age, from 4 percent for children under 1 year to 71 percent for 6- to 9-year-olds. For those children who consumed caffeine-containing foods, the mean daily intake was 24.2 mg, about the amount of caffeine in 8 ounces of cola. (See box for caffeine and theobromine content of selected foods. Additional values can be found on the Nutrient Data Laboratory Web site at www.nal.usda.gov/fnic/foodcomp/.) Mean caffeine intakes for consumers ranged from 8.9 mg for children under 1 year to 29.6 mg for 6- to 9-year-olds.

Caffeine and theobromine contents of selected foods

	Caffeine	Theobromine
	-----mg-----	
Candy, milk chocolate, 1.45 oz bar	11	69
Chocolate syrup, 1 tablespoon	3	89
Cocoa and sugar mix, milk added, 8 fl oz cup	7	250
Cola, regular, 12 fl oz can	37	0
Coffee, made from ground, 8 fl oz cup	137	0
Coffee, made from powdered instant, 8 fl oz cup	68	0
Cookie, chocolate sandwich, 1" - 1-1/2" diameter	1	47
Tea, made from leaves, 8 fl oz cup	47	5
Tea, made from powdered instant, 8 fl oz cup	25	2

Table 2. Comparison of children's intakes of caffeine and theobromine, ¹ by race, CSFII 1994-96, 1998, 1 day

Age	Sample size (unweighted)		Caffeine			Theobromine		
	White	Black	White	Black	Difference	White	Black	Difference
	----- Means -----							
Under 1	738	194	0.4 [†]	0.7 [†]	-0.3	0.8 [†]	0.4 [†]	0.4
1-2	1,459	332	7.3	5.5	1.8	22.7	15.1	7.6
3-5	3,181	695	14.3	8.5	5.8*	51.4	26.4	25.0*
6-9	1,059	231	23.2	14.8	8.5*	69.3	30.3	39.0*
9 and under	6,437	1,452	15.7	9.6	6.0*	49.6	23.4	26.2*

¹Excludes breast-fed children.

[†]Coefficient of variation \geq 30 percent.

*p value < 0.01.

A few earlier studies have reported caffeine intakes in children. In the Bogalusa Heart Study (1), caffeine intakes were examined for a biracial sample of 1,284 infants and children. Mean intakes ranged from 2.1 mg for 6-month-old black girls to 147 mg for 17-year-old white boys. They reported highest percentage of caffeine consumers among 2- and 3-year-olds, 91 and 93 percent, respectively. Morgan and colleagues (7) reported mean intakes of 37.4 mg using 7-day food records for a sample of 1,135 5- to 18-year-olds. Intakes for age groups comparable to our study population were 21.9 mg for 5- to 6-year-olds, and 19.3 mg for 7- to 8-year-olds.

Morgan reported that 98 percent of the sample consumed caffeine at least once during the 7-day period. Another group (3) reported mean daily intakes of 16 mg and a median intake of 15.2 mg/day for 96 6- to 10-year-olds participating in the Framingham Children Study in 1995. They reported that caffeine was consumed on 79 percent of the days that 3-day food diaries were collected. Differences in results among the studies may be due to several factors, including differences in methodology, age of sample, regional and socioeconomic

differences, variability in food caffeine values (2), increase in consumption of fruit drinks and noncitrus fruit juices among children (8), and greater availability of caffeine-free carbonated drinks.

The average theobromine intake among different age groups ranged from 0.7 mg for children under 1 year to 58.8 mg for 6- to 9-year-olds, with a mean intake of 42.5 mg or 23.8 mg/1,000 kcal for all children through age 9 (table 1). The median intake was 0 mg, and the intake at the 90th percentile was 126.5 mg (data not shown). The percentage of children who consumed theobromine-containing foods was even lower than that for caffeine: 48 percent versus 57 percent. The average theobromine intake among these consumers was 89.3 mg, about the amount of theobromine in 1 tablespoon of chocolate syrup. No existing data are available to compare theobromine intakes from our study with others.

Considerable differences were found when comparing mean caffeine and theobromine intakes of black and white children, as presented in table 2. White children consumed almost two-thirds more caffeine than black children (15.7 mg vs. 9.6 mg), and about twice as

much theobromine (49.6 mg vs. 23.4 mg). The differences are statistically significant at the 0.01 percent levels for age groups 3-5 and 6-9, as well as for all children through age 9. The racial differences persisted when income defined as percent of federal poverty guidelines was considered. These findings are in concurrence with the Bogalusa Heart Study (1).

The proportions of caffeine and theobromine contributed by different food groups are presented in table 3. These data represent population proportions as described by Krebs-Smith and colleagues (6). Carbonated beverages containing caffeine furnished more than half the total caffeine intake for all children, except for children under 1 year and 1- to 2-year-olds. For children under 1 year, most caffeine was obtained from tea; for 1- to 2-year-olds, the amounts from carbonated beverages and tea were about equal. For the other age groups, tea was the second largest contributor.

Chocolate-containing foods provided nearly one-fifth of total caffeine intake and almost all of the total theobromine intake; the top contributors were chocolate cookies, chocolate milk beverages, and chocolate syrup. While

Table 3. Contribution of food groups to caffeine and theobromine for children,¹ CSFII 1994-96, 1998, 2-day average

Age	Caffeine				Theobromine	
	Carbonated beverages	Tea	Chocolate-containing foods	Coffee	Tea	Chocolate-containing foods
	----- Percent -----					
Under 1	17.9 [†]	67.8	14.3 [†]	0	2.5 [†]	97.5 [†]
1-2	41.8	40.2	16.8	1.2 [†]	1.3 [†]	98.7 [†]
3-5	51.4	28.0	18.3	2.3	0.8	99.2
6-9	54.6	25.8	17.5	2.1	0.8 [†]	99.2 [†]
9 and under	52.1	28.2	17.6	2.1	0.9	99.1

¹Excludes breast-fed children.

[†]Indicates an estimate based on small sample size or coefficient of variation \geq 30 percent.

Note: Calculated using the population proportion method.

carbonated beverages contributed the most caffeine to the population, more children actually obtained caffeine from chocolate-containing foods than from carbonated beverages: forty-four percent of children consumed chocolate-containing foods compared with 20 percent of children who drank carbonated beverages containing caffeine.

Two groups (1,3) previously identified carbonated beverages as the major contributor of caffeine, followed by chocolate-containing foods, and tea. However, Morgan's group (7) reported tea as the major source, followed by carbonated beverages, coffee, and chocolate-containing foods. Increases in the consumption of carbonated beverages and method used to compute proportions (6), as well as other differences cited above, may explain the differences in our findings. No racial or gender differences were noted for sources of caffeine or theobromine.

Summary

Our study provides national probability estimates for caffeine and theobromine intakes for children 9 years old and under in the United States. The results suggest lower percent of caffeine use among children than previously reported. A little more than half of the children consumed caffeine-containing foods on a given day. The study is a first attempt to provide estimates of consumption of theobromine among children. Children's intake of theobromine is higher than that of caffeine and is mainly obtained from chocolate-containing foods. The consumption of caffeine and theobromine is higher among white children than their black counterparts.

References

1. Arbeit, M.L. 1988. Caffeine intakes of children from a biracial population: The Bogalusa Heart Study. *Journal of the American Dietetic Association* 88(4):466-471.
2. Barone, J.J. and Roberts, H.R. 1996. Caffeine consumption. *Food and Chemical Toxicology* 34(1):119-129.
3. Ellison, R.C., Singer, M.R., Moore, L.L., Nguyen, U.S., Garrahe, E.J., and Marmor, J.K. 1995. Current caffeine intakes of young children: Amount and sources. *Journal of the American Dietetic Association* 95(7):802-804.
4. Eteng, M.U. 1997. Recent advances in caffeine and theobromine toxicities: A review. *Plant Foods for Human Nutrition* 51:231-243. Kluwer Academic Publishers, Dordrecht, Netherlands.
5. Gilbert, R.M. 1980. *Caffeine: Overview and Anthology. Nutrition and Behavior* (pp. 145-166). Sandford A. Miller.
6. Krebs-Smith, S.M., Kott, P.S., and Guenther, P.M. 1989. Mean proportion and population proportion: Two answers to the same question? *Journal of the American Dietetic Association* 89(5):671-676.
7. Morgan, K.J., Stults, V.J., and Zabik, M.E. 1982. Amount and dietary sources of caffeine and saccharin intake by individuals ages 5 to 18 years. *Regulatory Toxicology Pharmacology* 2(4):296-307.
8. Research News, U.S. Department of Agriculture, Agricultural Research Service. What and Where Our Children Eat—1994 Nationwide Survey Results, April 18, 1996.
9. Sokal, R.R. and Rohlf, F.J. 1987. *Introduction to Biostatistics* (2nd ed., pp. 30-33). W. H. Freeman and Company, New York.
10. Tippet, K.S. and Cypel, Y.S. (Eds.). 1998. Design and Operation: Continuing Survey of Food Intakes by Individuals and Diet and Health Knowledge Survey, 1994-96. U.S. Department of Agriculture, Nationwide Food Surveys Report No. 96-1.
11. U.S. Department of Agriculture, Agricultural Research Service. 1999. Food and Nutrient Intakes by Children 1994-96, 1998. [On-line]. Available: <http://www.barc.usda.gov/bhnrc/foodsurvey/home.htm>
12. U.S. Department of Agriculture, Agricultural Research Service. 2000. Continuing Survey of Food Intakes by Individuals 1994-96, 1998. National Technical Information Service. CD-ROM. NTIS Accession no. PB2000-500027.