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CFSAN/Office of Plant & Dairy Foods

July 2004; Updated November 2004, June 2005, and June 2006

PCDD/PCDF Exposure Estimates from TDS Samples Collected in 2001-2004

Estimates of polychlorinated dibenzo-*p*-dioxin (PCDD) and polychlorinated dibenzofuran (PCDF) exposure were calculated from results of PCDD/PCDF analyses of Total Diet Study (TDS) samples collected in 2001, 2002, 2003, and 2004 and the most recent version of the [TDS diets](#), which is based on food consumption data collected in USDA's 1994-96, 1998 Continuing Survey of Food Intakes by Individuals (CSFII) (USDA 2000).

TDS foods were analyzed for PCDD/PCDF congeners for one market basket collected each year in 2001, 2002, 2003 and 2004. Collection year and site for each market basket analyzed are listed in Table 1.

Table 1.
Collection year and site for FDA Total Diet Study market baskets analyzed by the Dioxin Monitoring Program used for estimating PCDD/PCDF exposure

Collection Year	Collection Site
2001	Colorado Springs, Colorado; Oakland, California; Spokane, Washington
2002	Ventura County, California; San Jose, California; Yakima, Washington
2003	Albuquerque, New Mexico; Riverside-San Bernardino, California; Salem, Oregon
2004	Boston, Massachusetts; Syracuse, New York; Pittsburg, Pennsylvania

For estimating exposures, the average PCDD/PCDF concentration from TDS composite samples analyzed between 2001 and 2004 was determined for each TDS food. Results from TDS foods analyzed in 2000 were not used for estimating exposure due to elevated limit of detections (LODs) in these samples. For each TDS food, three sum TEQ values were generated from the 17 PCDD/PCDF congeners measured reflecting assignment of zero, half the LOD, or LOD values for congener non-detects.

There were some differences in the foods selected to be analyzed between 2001 and 2004. In addition, the TDS food list was updated in 2003, which resulted in a number of changes to the list (e.g., some foods were deleted, some foods were added). Overall, the majority of foods were analyzed in all four years and the four-year average concentrations were used in the exposure calculations. For TDS foods analyzed in only two or three years, the average of the two or three analytical results was used for calculating exposure. For TDS foods analyzed in only one year, a single analytical result was used for calculating exposure.

To calculate exposure, PCDD/PCDF concentration data from TDS samples were linked to consumption amounts for each TDS food, which are based on results of the USDA's 1994-1996, 1998 CSFII. In this survey, two days of consumption records were collected from approximately 20,000 individuals. Survey participants reported detailed information about the types and amounts of foods consumed; in all, approximately 6,000 different foods were reported in the survey. In estimating the consumption amounts for TDS foods, two-day average per-capita (total population) consumption amounts were calculated for each survey food for the total US population and 14 age/sex subgroups. Since there are many more foods reported in USDA's 1994-1996, 1998 CSFII than are analyzed in the TDS, the survey foods were grouped according to their similarity to TDS foods, and the consumption amounts of all foods in the group were then totaled to derive a consumption amount for each TDS food. These consumption amounts for each TDS food for each of the population groups are collectively referred to as the [TDS diets](#).

Exposures were calculated on a per-person basis per day then converted to a body-weight basis per day by dividing the per-person exposure by the average body-weights reported in the USDA's 1994-1996, 1998 CSFII. Daily exposures were then converted to a body-weight basis per month by multiplying daily exposure by 30. To obtain exposure estimates by food category, each TDS food was assigned to one of eight food categories (dairy, eggs, fats, fish, fruits/vegetables, meat, poultry, and other foods), and exposure was subtotaled for each category. Three possible exposure estimates were generated reflecting assignment of zero, half the LOD, or LOD values for congener non-detects, which is the approach commonly used when reporting results for dioxin-like compounds as well as other contaminants (Tables 2-4).⁽¹⁾ In our study, the majority of TDS foods analyzed were found to contain a large number of congener non-detects. Assignment of non-detects to zero, half the LOD or the LOD may have a large effect on estimates of PCDD/PCDF concentration in foods found to contain a large number of congener non-detects and a small effect on estimates of PCDD/PCDF concentration in foods found to contain a small number of congener non-detects. Moreover, assuming that non-detects equal half the LOD or the LOD may overestimate PCDD/PCDF concentration in foods thought to be low in PCDD/PCDFs (e.g., grains, legumes, fruits, vegetables). Since these foods are consumed in substantial quantities, such assumptions about non-detects may result in overestimates of PCDD/PCDF exposure.

Table 2.
 Dietary PCDD/PCDF Exposure Estimate (pg WHO-TEQ/kg body weight/month)
 by Food Category from TDS Foods Collected in 2001-2004 (Based on PCDD/PCDF
 Concentration Assuming ND = 0).^{1,2,3}

Food Category	Age-Sex Group							
	All Groups	Infants 6-11 months	Children 2 years	Children 6 years	Children 10 years	Girls 14-16 years	Boys 14-16 years	Women 25-30 years
Dairy foods and mixtures	1.5	6.0	7.4	5.0	3.4	1.2	1.9	1.0
Eggs and mixtures	0.1	0.3	0.5	0.2	0.2	0.1	0.1	0.1

Fats, oils and mixtures	0.2	0.1	0.3	0.3	0.1	0.1	0.1	0.1
Fish and mixtures	0.9	0.2	0.9	0.8	0.5	0.6	0.6	0.8
Fruits, vegetables and mixtures	0.5	1.5	1.3	0.7	0.5	0.3	0.3	0.3
Meat and mixtures	4.5	2.4	9.2	7.5	5.4	3.5	4.6	2.6
Poultry and mixtures	0.2	0.6	0.4	0.3	0.3	0.2	0.2	0.2
Other foods and mixtures⁴	1.8	1.7	3.5	3.6	2.7	1.9	2.9	1.5
Total	9.6	12.8	23.5	18.5	13.1	7.8	10.7	6.6

Table 2.
(Continued)

Food Category	Age-Sex Group						
	Men 25-30 years	Women 40-45 years	Men 40-45 years	Women 60-65 years	Men 60-65 years	Women >70 years	Men >70 years
Dairy foods and mixtures	1.0	0.8	1.1	0.7	0.8	0.8	1.1
Eggs and mixtures	0.2	0.1	0.1	0.1	0.2	0.1	0.1
Fats, oils and mixtures	0.1	0.1	0.1	0.1	0.2	0.1	0.2
Fish and mixtures	0.4	0.7	0.7	1.1	1.1	0.9	1.0
Fruits, vegetables and mixtures	0.3	0.4	0.4	0.4	0.4	0.5	0.5
Meat and	4.3	3.1	4.1	2.5	3.7	2.3	3.1

mixtures							
Poultry and mixtures	0.2	0.2	0.3	0.2	0.2	0.2	0.2
Other foods and mixtures⁴	1.9	1.2	1.2	0.7	0.9	0.7	0.8
Total	8.4	6.6	7.9	5.7	7.4	5.6	7.1

¹PCDD/PCDF concentrations from U.S. Food and Drug Administration Total Diet Study (2001, 2002, 2003, 2004).

²Food Consumption based on the USDA 1994-1996, 1998 Continuing Survey of Food Intake by Individuals.

³Abbreviations: PCDD, polychlorinated dibenzo-*p*-dioxin; PCDF, polychlorinated dibenzofuran; WHO, World Health Organization; TEQ, Toxicity Equivalents; ND, Non-detects

⁴Grains and mixtures, legumes and mixtures, beverages (other than milk and juice), candy.

Table 3.

Dietary PCDD/PCDF Exposure Estimate (pg WHO-TEQ/kg body weight/month) by Food Category from TDS Foods Collected in 2001-2004

(Based on PCDD/PCDF Concentration Assuming ND = Half the LOD).^{1,2,3}

Food Category	Age-Sex Group							
	All Groups	Infants 6-11 months	Children 2 years	Children 6 years	Children 10 years	Girls 14-16 years	Boys 14-16 years	Women 25-30 years
Dairy foods and mixtures	2.3	15.6	10.6	7.5	5.1	1.8	2.9	1.5
Eggs and mixtures	0.3	0.5	0.9	0.5	0.3	0.2	0.2	0.2
Fats, oils and mixtures	0.3	0.1	0.3	0.4	0.2	0.1	0.2	0.2
Fish and mixtures	1.1	0.3	1.1	0.9	0.7	0.7	0.7	0.9
Fruits, vegetables and mixtures	1.7	6.1	4.7	2.7	2.0	1.2	1.3	1.3

Meat and mixtures	4.5	2.8	10.5	8.7	6.2	4.1	5.3	3.1
Poultry and mixtures	0.5	1.6	0.9	0.7	0.6	0.4	0.4	0.4
Other foods and mixtures⁴	7.0	4.6	10.7	10.2	8.2	7.0	9.1	6.1
Total	18.2	31.6	39.6	31.5	23.2	15.5	20.0	13.6

Table 3.
(Continued)

Food Category	Age-Sex Group						
	Men 25-30 years	Women 40-45 years	Men 40-45 years	Women 60-65 years	Men 60-65 years	Women >70 years	Men >70 years
Dairy foods and mixtures	1.4	1.3	1.6	1.2	1.3	1.4	1.7
Eggs and mixtures	0.3	0.2	0.2	0.2	0.3	0.2	0.2
Fats, oils and mixtures	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Fish and mixtures	0.6	0.8	0.8	1.2	1.3	1.1	1.2
Fruits, vegetables and mixtures	1.2	1.4	1.3	1.5	1.5	1.7	1.9
Meat and mixtures	5.0	3.5	4.7	2.8	4.2	2.7	3.6
Poultry and mixtures	0.4	0.4	0.5	0.3	0.3	0.4	0.4
Other foods and mixtures⁴	7.2	5.5	5.6	3.8	3.8	3.4	3.7
Total	16.3	13.3	14.9	11.3	12.8	11.1	13.0

¹PCDD/PCDF concentrations from U.S. Food and Drug Administration Total Diet Study (2001, 2002, 2003, 2004).

²Food Consumption based on the USDA 1994-1996, 1998 Continuing Survey of Food Intake by Individuals.

³Abbreviations: PCDD, polychlorinated dibenzo-*p*-dioxin; PCDF, polychlorinated dibenzofuran; WHO, World Health Organization; TEQ, Toxicity Equivalents; ND, Non-detects; LOD, Limit of Detection

⁴Grains and mixtures, legumes and mixtures, beverages (other than milk and juice), candy.

Table 4.
Dietary PCDD/PCDF Exposure Estimate (pg WHO-TEQ/kg body weight/month)
by Food Category from TDS Foods Collected in 2001-2004
(Based on PCDD/PCDF Concentration Assuming ND = LOD). ^{1,2,3}

Food Category	Age-Sex Group							
	All Groups	Infants 6-11 months	Children 2 years	Children 6 years	Children 10 years	Girls 14-16 years	Boys 14-16 years	Women 25-30 years
Dairy foods and mixtures	3.1	25.3	13.7	9.9	6.8	2.4	3.8	2.0
Eggs and mixtures	0.4	0.7	1.3	0.7	0.5	0.2	0.3	0.3
Fats, oils and mixtures	0.3	0.1	0.4	0.5	0.3	0.2	0.2	0.2
Fish and mixtures	1.2	0.3	1.3	1.1	0.8	0.8	0.8	1.1
Fruits, vegetables and mixtures	3.0	10.7	8.0	4.7	3.4	2.2	2.3	2.2
Meat and mixtures	5.9	3.3	11.8	9.9	7.0	4.6	6.0	3.6
Poultry and mixtures	0.8	2.5	1.4	1.1	0.8	0.6	0.6	0.6
Other foods and mixtures ⁴	12.2	7.5	17.9	16.8	13.7	12.1	15.2	10.7
Total	26.8	50.4	55.8	44.6	33.3	23.2	29.3	20.7

Table 4.
(Continued)

Food Category	Age-Sex Group						
	Men 25-30 years	Women 40-45 years	Men 40-45 years	Women 60-65 years	Men 60-65 years	Women > 70 years	Men > 70 years
Dairy foods and mixtures	1.9	1.8	2.1	1.6	1.7	2.0	2.4
Eggs and mixtures	0.4	0.2	0.3	0.3	0.4	0.3	0.3
Fats, oils and mixtures	0.2	0.3	0.3	0.2	0.3	0.2	0.3
Fish and mixtures	0.7	1.0	0.9	1.4	1.4	1.2	1.5
Fruits, vegetables and mixtures	2.1	2.4	2.2	2.7	2.6	3.0	3.2
Meat and mixtures	5.8	4.0	5.4	3.2	4.8	3.0	4.1
Poultry and mixtures	0.7	0.7	0.8	0.5	0.5	0.6	0.6
Other foods and mixtures ⁴	12.4	9.8	10.0	7.0	6.8	6.1	6.5
Total	24.2	20.0	22.0	16.9	18.5	16.5	18.8

¹PCDD/PCDF concentrations from U.S. Food and Drug Administration Total Diet Study (2001, 2002, 2003, 2004).

²Food Consumption based on the USDA 1994-1996, 1998 Continuing Survey of Food Intake by Individuals.

³Abbreviations: PCDD, polychlorinated dibenzo-*p*-dioxin; PCDF, polychlorinated dibenzofuran; WHO, World Health Organization; TEQ, Toxicity Equivalents; ND, Non-detects; LOD, Limit of Detection

⁴Grains and mixtures, legumes and mixtures, beverages (other than milk and juice), candy.

To obtain more general information on dioxin, see [Questions and Answers about Dioxin](#). The Interagency Working Group on Dioxin (IWG) prepared the questions and answers. The

Dioxin IWG is composed of U.S. federal agencies that address health, food, the environment and are working together to ensure a coordinated federal approach to issues related to dioxin-like compounds.

References

(USDA 2000) United States Department of Agriculture, Agricultural Research Service. Continuing Survey of Food Intakes by Individuals 1994-96, 1998 [CD-ROM]. NTIS No. PB2000-50027. 2000.

(JECFA 2001) Joint FAO/WHO Expert Committee on Food Additives. *Summary and Conclusions of the Fifty-seventh Meeting*. 2001.

Notes

⁽¹⁾ In 2001, the Joint FAO/WHO Expert Committee on Food additives (JECFA) established a Provisional Tolerable Monthly Intake (PTMI) of 70 pg WHO-TEQ/kg body weight/month for PCDDs/PCDFs and dioxin-like polychlorinated biphenyls (DL-PCBs) (JECFA 2001). Dietary exposure estimates found in Tables 2-4 include PCDDs and PCDFs but not DL-PCBs.

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