IMPACT OF THE CHANGES IN WHO TEF VALUES FROM 1998 TO 2005 ON THE TOTAL TEQ VALUES IN SERUM, HOUSEHOLD DUST AND SOIL

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The University of Michigan Dioxin Exposure Study

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Introduction

- The UMDES previously calculated the toxic equivalency (TEQ) values based on WHO 1998 toxicity equivalency factors (TEFs) in blood, household dust, and soil from a sample of adults in Michigan, USA.

- In June 2005, the TEFs for the 29 dioxin-like compounds were reevaluated in a WHO expert meeting in Geneva, Switzerland and new WHO 2005 TEFs were presented.
  - TEFs for 14 of the 29 congeners were changed (details in next slide) causing an expected 10-25% decrease in calculated blood TEQ for the general population.

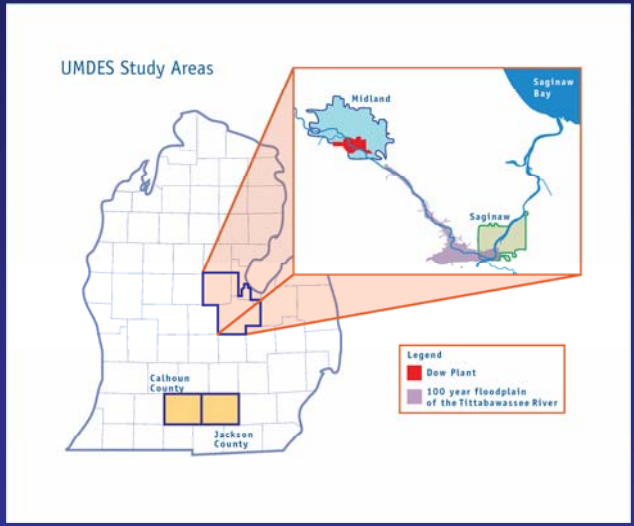
- All TEQ values in our study have been recalculated based on the WHO 2005 TEFs. The objective of this presentation is to discuss the changes in TEQ values, after implementation of 2005 TEFs.

Changes in WHO TEF

Compound	WHO 1998 TEF	WHO 2005 TEF	Change
OCDD	0.0001	0.0003	↑
1,2,3,7,8-PeCDF	0.05	0.03	↓
2,3,4,7,8-PeCDF	0.5	0.3	↓
OCDF	0.0001	0.0003	↑
PCB 81	0.0001	0.0003	↑
PCB 169	0.01	0.03	↑
PCB 105	0.0001	0.00003	↓
PCB 114	0.0005	0.00003	↓
PCB 118	0.0001	0.00003	↓
PCB 123	0.0001	0.00003	↓
PCB 156	0.0005	0.00003	↓
PCB 157	0.0005	0.00003	↓
PCB 167	0.00001	0.00003	↑
PCB 189	0.0001	0.00003	↓

UMDES Study Populations

- A total of 946 blood samples, 764 household dust samples and 766 soil house perimeter 0-1 inch samples were collected from 5 populations in Michigan:
  - **Midland/Saginaw Floodplain:**
    Within the 100-year floodplain of the Tittabawassee River
  - **Midland/Saginaw Near Floodplain:**
    Within the census block of the Floodplain, but outside the Floodplain
  - **Other Midland/Saginaw:**
    The other Midland/Saginaw areas
  - **Midland/Saginaw Plume:**
    Down wind of Dow Chemical
  - **Jackson/Calhoun Counties (referent population):**
    Located about 100 miles south of Dow Chemical



Comparison of TEQs

- TEQ_{DFP29_1998} = 1998 TEFs, using 29 congeners (dioxins, furans, and PCBs)
- TEQ_{DFP29_2005} = 2005 TEFs, using 29 congeners (dioxins, furans, and PCBs)

Blood Median TEQs (ppt)

Population	N	TEQ_{DFP29_1998}	TEQ_{DFP29_2005}	% Change
M/S Floodplain	243	31.5	23.3	-26%
M/S Near Floodplain	205	29.0	21.9	-24%
Other M/S	204	28.0	20.7	-26%
M/S Plume	43	24.0	18.7	-22%
Jackson/Calhoun	251	24.8	18.5	-25%
Overall	946	26.4	19.6	**-26%**

Note: All the results accounted for sample weights that reflect selection and non-response probabilities.

Household Dust Median TEQs (ppt)

Population	N	TEQ_{DFP29_1998}	TEQ_{DFP29_2005}	% Change
M/S Floodplain	205	17.1	16.4	-4%
M/S Near Floodplain	161	12.3	11.6	-6%
Other M/S	168	18.7	17.6	-6%
M/S Plume	32	35.2	34.2	-3%
Jackson/Calhoun	198	14.4	13.8	-4%
Overall	764	17.3	16.2	**-6%**

Note: All the results accounted for sample weights that reflect selection and non-response probabilities.

Soil Median TEQs, House Perimeter 0-1 Inch (ppt)

Population	N	TEQ_{DFP29_1998}	TEQ_{DFP29_2005}	% Change
M/S Floodplain	203	12.6	11.4	-10%
M/S Near Floodplain	164	4.3	3.9	-9%
Other M/S	173	5.7	5.3	-7%
M/S Plume	32	59.2	58.2	-2%
Jackson/Calhoun	194	3.6	3.6	0%
Overall	766	4.8	4.5	**-6%**

Note: All the results accounted for sample weights that reflect selection and non-response probabilities.

Percent Contribution to TEQs for PCDDs, PCDFs, and PCBs

Percent Contribution to the TEQ (%)		WHO 1998 TEF	WHO 2005 TEF	Changes
Blood	PCDDs	48.65	64.72	+16.07
	PCDFs	16.83	16.43	-0.4
	PCBs	34.53	18.85	-15.68
Dust	PCDDs	59.51	66.79	+7.28
	PCDFs	16.95	15.62	-1.33
	PCBs	23.54	17.59	-5.95
Soil HP1*	PCDDs	49.44	54.35	+4.91
	PCDFs	36.2	32.07	-4.13
	PCBs	14.36	13.58	-0.78

Due to the down-weighting of the majority of mono-*ortho* substituted PCBs.

Due to the down-weighting of 23478-PeCDF (1998 TEF=0.5; 2005 TEF=0.3), which accounted for 18% to the total TEQ_{DFP29_1998}.

Soil HP1* - Soil House Perimeter 0-1 inch.

Conclusions

Percent Contribution to Blood TEQ

Percent contribution to the TEQ (%)	WHO 1998 TEF	WHO 2005 TEF
2378_TCDD	7.25	9.58
12378_PeCDD	20.59	27.29
123478_HxCDD	1.98	2.61
123678_HxCDD	14.63	19.49
123789_HxCDD	2.47	3.23
1234678_HpCDD	1.62	2.1
OCDD	0.11	0.42
2378_TCDF	0.23	0.3
12378_PeCDF	0.11	0.09
23478_PeCDF	10.86	8.69
123478_HxCDF	2.19	2.88
123678_HxCDF	2.11	2.77
123789_HxCDF	0.42	0.54
234678_HxCDF	0.5	0.64
1234678_HpCDF	0.37	0.47
1234789_HpCDF	0.04	0.05
OCDF	<0.005	<0.005
PCB_77	<0.005	<0.005
PCB_81	<0.005	<0.005
PCB_126	8.6	11.41
PCB_169	0.81	3.32
PCB_105	0.85	0.35
PCB_114	2.04	0.17
PCB_118	4.2	1.73
PCB_123	0.06	0.03
PCB_156	14.42	1.23
PCB_157	3.26	0.28
PCB_167	0.06	0.24
PCB_189	0.21	0.09

The yellow-shaded values indicate the 7 congeners that had the highest contribution to the total TEQ.

For TEQ based on 1998 TEFs, the top 7 congeners together contributed 81%.

PCB 118 and PCB 156 together contributed only 3% to the total TEQ based on new TEFs, while they contributed about 19% based on 1998 TEFs.

Percent Contribution to Household Dust TEQ

Percent contribution to the TEQ (%)	WHO 1998 TEF	WHO 2005 TEF
2378_TCDD	4.19	4.49
12378_PeCDD	9.16	9.75
123478_HxCDD	1.49	1.58
123678_HxCDD	9.31	9.84
123789_HxCDD	3.59	3.8
1234678_HpCDD	29.65	30.74
OCDD	2.11	6.59
2378_TCDF	1.3	1.43
12378_PeCDF	0.46	0.31
23478_PeCDF	6.39	4.24
123478_HxCDF	1.87	2.07
123678_HxCDF	1.92	2.07
123789_HxCDF	0.44	0.48
234678_HxCDF	1.82	1.96
1234678_HpCDF	2.59	2.74
1234789_HpCDF	0.11	0.11
OCDF	0.07	0.22
PCB_77	0.17	0.19
PCB_81	0.01	0.03
PCB_126	12.07	14.07
PCB_169	0.1	0.34
PCB_105	2	0.75
PCB_114	0.6	0.05
PCB_118	4.68	1.75
PCB_123	0.09	0.03
PCB_156	3.09	0.24
PCB_157	0.67	0.05
PCB_167	0.02	0.08
PCB_189	0.04	0.01

Percent Contribution to Soil TEQ, House Perimeter 0-1 Inch

Percent contribution to the TEQ (%)	WHO 1998 TEF	WHO 2005 TEF
2378_TCDD	14.56	15.4
12378_PeCDD	14.37	15.37
123478_HxCDD	1.78	1.9
123678_HxCDD	4.53	4.83
123789_HxCDD	3.79	4.04
1234678_HpCDD	9.59	10.19
OCDD	0.82	2.61
2378_TCDF	3.44	3.99
12378_PeCDF	1.12	0.77
23478_PeCDF	18.02	12.28
123478_HxCDF	3.14	3.49
123678_HxCDF	3.49	3.81
123789_HxCDF	0.74	0.82
234678_HxCDF	2.68	2.93
1234678_HpCDF	3.34	3.59
1234789_HpCDF	0.16	0.17
OCDF	0.07	0.21
PCB_77	0.04	0.05
PCB_81	<0.005	0.01
PCB_126	10.93	12.24
PCB_169	0.16	0.53
PCB_105	0.58	0.21
PCB_114	0.11	0.01
PCB_118	1.11	0.4
PCB_123	0.03	0.01
PCB_156	1.1	0.08
PCB_157	0.28	0.02
PCB_167	0.01	0.03
PCB_189	0.02	0.01

23478-PeCDF contributed 6% less to the total TEQ after implementation of new TEFs.

Conclusions

- $TEQ_{DFP29\text{-}2005}$ were recalculated
  - Compare to $TEQ_{DFP29\text{-}1998}$
    - For blood, overall median TEQ decreased by 26%.
    - For dust, overall median TEQ decreased by 6%.
    - For soil, overall median TEQ decreased by 6%.
- The percent contribution to $TEQ_{DFP29\text{-}2005}$ for PCDDs, PCDFs and PCBs were recalculated
  - Compare to $TEQ_{DFP29\text{-}1998}$
    - The contribution of PCDDs increased 16% for blood, 7% for dust and 5% for soil.
    - The contribution of PCDFs decreased a small percent (less than or around 1%) for blood and dust, but 4% for soil.
    - The contribution of PCBs decreased 16% for blood, 6% for dust and 1% for soil.

Conclusions

- Among the 7 congeners that had the highest contribution to the blood TEQ using 1998 TEFs, PCB 118 and PCB 156 together contributed only 3% and were not among the top 7 contributed congeners to TEQ using 2005 TEFs.

7 congeners are:

2378-TCDD,
12378-PeCDD,
123678-HxCDD,
23478-PeCDF,
PCB126,
PCB118,
PCB156.

Related Posters

Related posters will be displayed on Session B on Wednesday 12:00 – 13:00 and Thursday 13:00 – 14:00.

- Poster P-287:

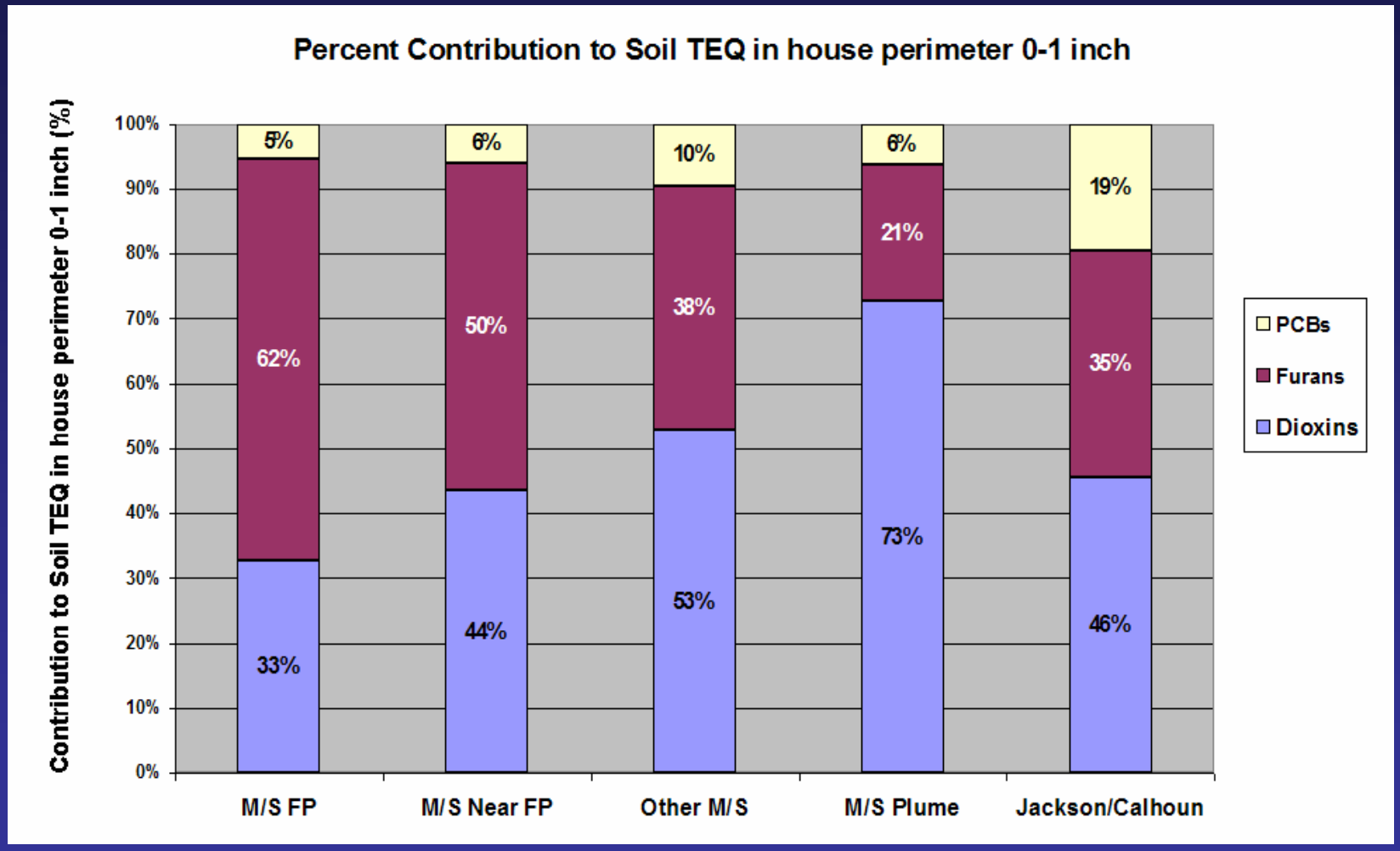
  CHANGE IN BACKGROUND SERUM LEVELS WITH THE NEW 2005 TEFS

- Poster P-292:

  IMPACT OF CHANGES IN WHO TEF VALUES FROM 1998 TO 2005 ON MEASUREMENTS OF SOIL CONCENTRATIONS OF PCDDS, PCDFS AND PCBS IN A COMMUNITY IN MICHIGAN, USA

Thank You !

Percent Contribution to soil TEQ for PCDDs, PCDFs, and PCBs by region



TEFs for 29 congeners

Summary of WHO 1998 and WHO 2005 TEF values

Compound	WHO 1998 TEF	WHO 2005 TEF*
chlorinated dibenzo-p-dioxins		
2,3,7,8-TCDD	1	1
1,2,3,7,8-PeCDD	1	1
1,2,3,4,7,8-HxCDD	0.1	0.1
1,2,3,6,7,8-HxCDD	0.1	0.1
1,2,3,7,8,9-HxCDD	0.1	0.1
1,2,3,4,6,7,8-HpCDD	0.01	0.01
OCDD	0.0001	**0.0003**
chlorinated dibenzofurans		
2,3,7,8-TCDF	0.1	0.1
1,2,3,7,8-PeCDF	0.05	**0.03**
2,3,4,7,8-PeCDF	0.5	**0.3**
1,2,3,4,7,8-HxCDF	0.1	0.1
1,2,3,6,7,8-HxCDF	0.1	0.1
1,2,3,7,8,9-HxCDF	0.1	0.1
2,3,4,6,7,8-HxCDF	0.1	0.1
1,2,3,4,6,7,8-HpCDF	0.01	0.01
1,2,3,6,7,8,9-HpCDF	0.01	0.01
OCDF	0.0001	**0.0003**
non-ortho substituted PCBs		
PCB 77	0.0001	0.0001
PCB 81	0.0001	**0.0003**
PCB 126	0.1	0.1
PCB 169	0.01	**0.03**
mono-*ortho substituted PCBs*		
PCB 105	0.0001	**0.00003**
PCB 114	0.0005	**0.00003**
PCB 118	0.0001	**0.00003**
PCB 123	0.0001	**0.00003**
PCB 156	0.0005	**0.00003**
PCB 157	0.0005	**0.00003**
PCB 167	0.00001	**0.00003**
PCB 189	0.0001	**0.00003**

* numbers in bold indicate a change in TEF

How to calculate TEQ and percent contribution?

- $TEQ = \sum TEF \times Congener\ Concentration$

- Percent contribution to the total TEQ of congener i
  $= (TEF_i \times Congener_i\text{'s Concentration}) / TEQ$