

ENVIRONMENTAL FACTORS THAT EXPLAIN VARIATION IN SERUM DIOXIN CONCENTRATIONS IN A COMMUNITY IN MICHIGAN, USA

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Study Design

- ❖ We measured the WHO 29 PCDD, PCDF, and PCB congeners in serum, house dust and soil.
- ❖ Today we are reporting the results for the TEQ and 7 specific dioxins that are the major contributors to the TEQ in people's blood in our study.

Congener	1998 WHO TEF Value
2,3,7,8-TCDD	1.0
1,2,3,7,8-PnCDD	1.0
1,2,3,6,7,8-HxCDD	0.1
2,3,4,7,8-PnCDF	0.5
PCB 126	0.1
PCB 118	0.0001
PCB 156	0.0005



Study Design

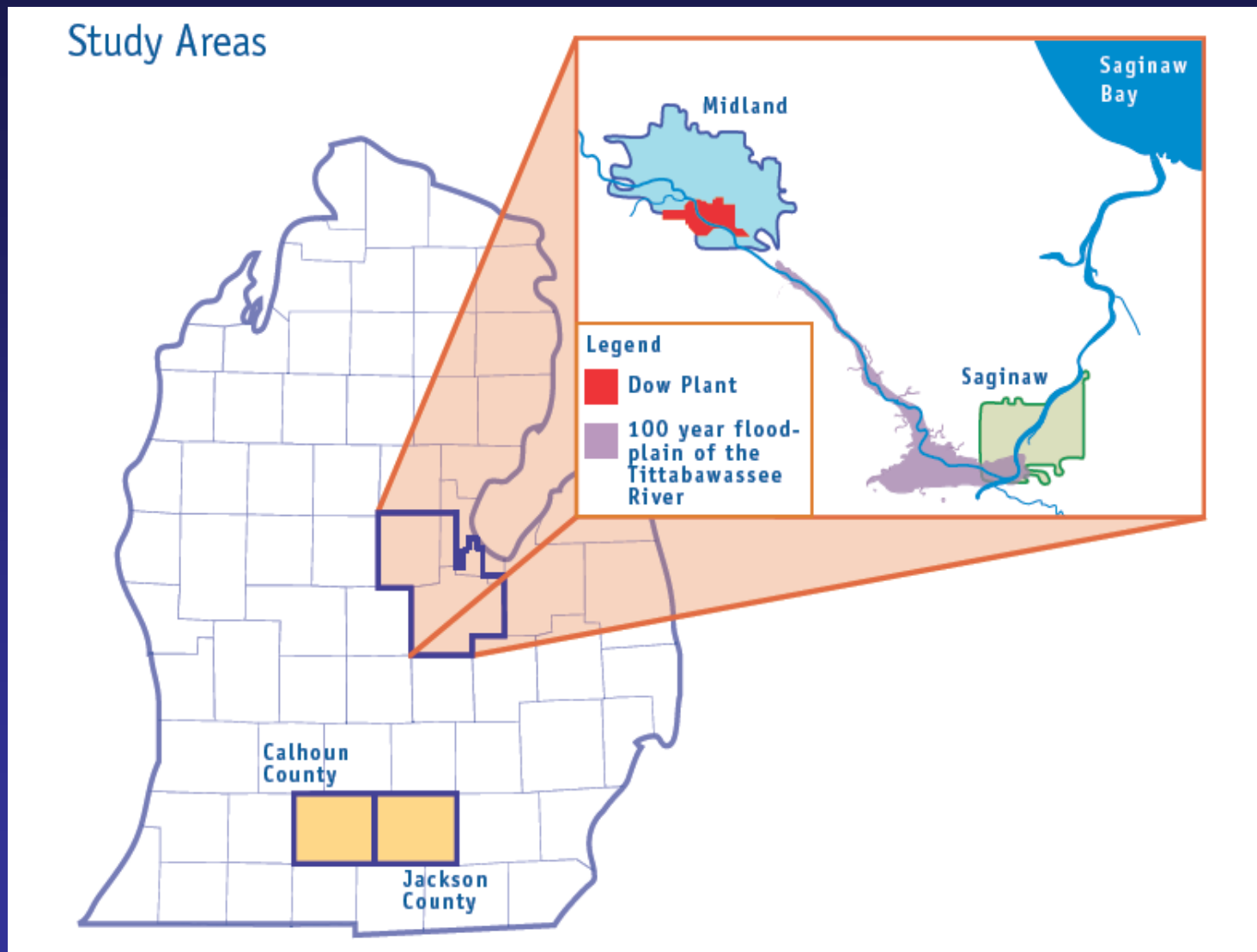
We studied people who live in five geographic areas:

- ❖ The Floodplain of the Tittabawassee River
- ❖ The Near Floodplain
- ❖ The Midland Plume
- ❖ Other Midland/Saginaw
- ❖ For comparison, Jackson/Calhoun Counties

Midland/Saginaw: Floodplain, Near Floodplain, Midland Plume and Other Midland/Saginaw combined into one geographic area.



Study Design





Number of study participants

Number of Participants

	Floodplain	Near Floodplain	Midland Plume	Other Midland/ Saginaw	Jackson/ Calhoun	Total Across All Areas
Interviews	314	276	66	309	359	1324
Blood Samples	243	205	43	204	251	946
Household Dust Samples	205	161	32	168	198	764
Soil Samples	203	164	32	173	194	766
Interviews, blood, dust and soil	195	156	30	167	183	731



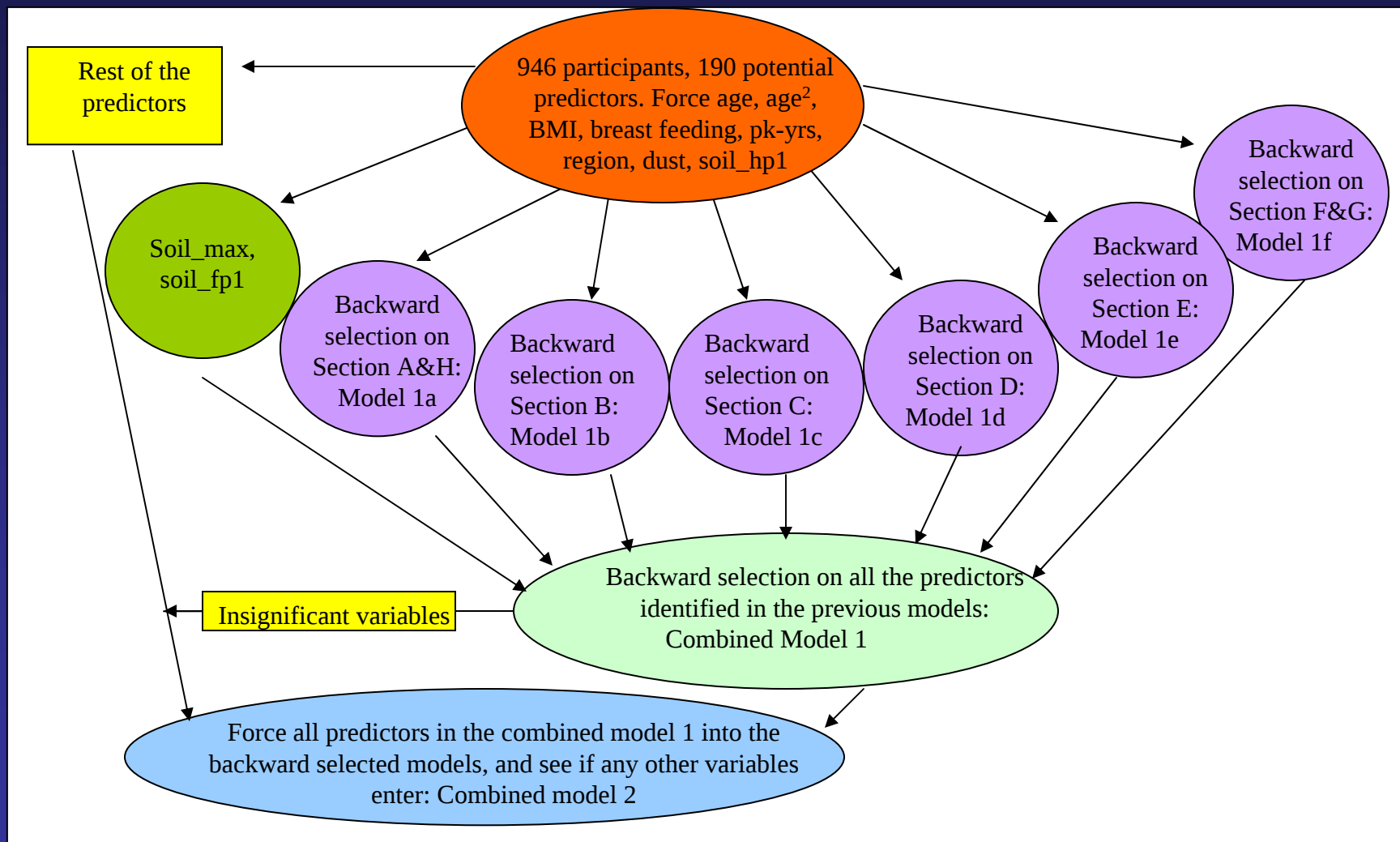
Modeling Strategy for Blood Dioxin Predictors

- Backwards selection from multiple imputed data sets
 - Identify potential explanatory factors for consideration in further models
- Linear regression models
 - $\text{Log}_{10}(\text{blood}) = \alpha + \beta_1(\text{factor}_1) + \dots + \beta_n(\text{factor}_n) + \text{error}$



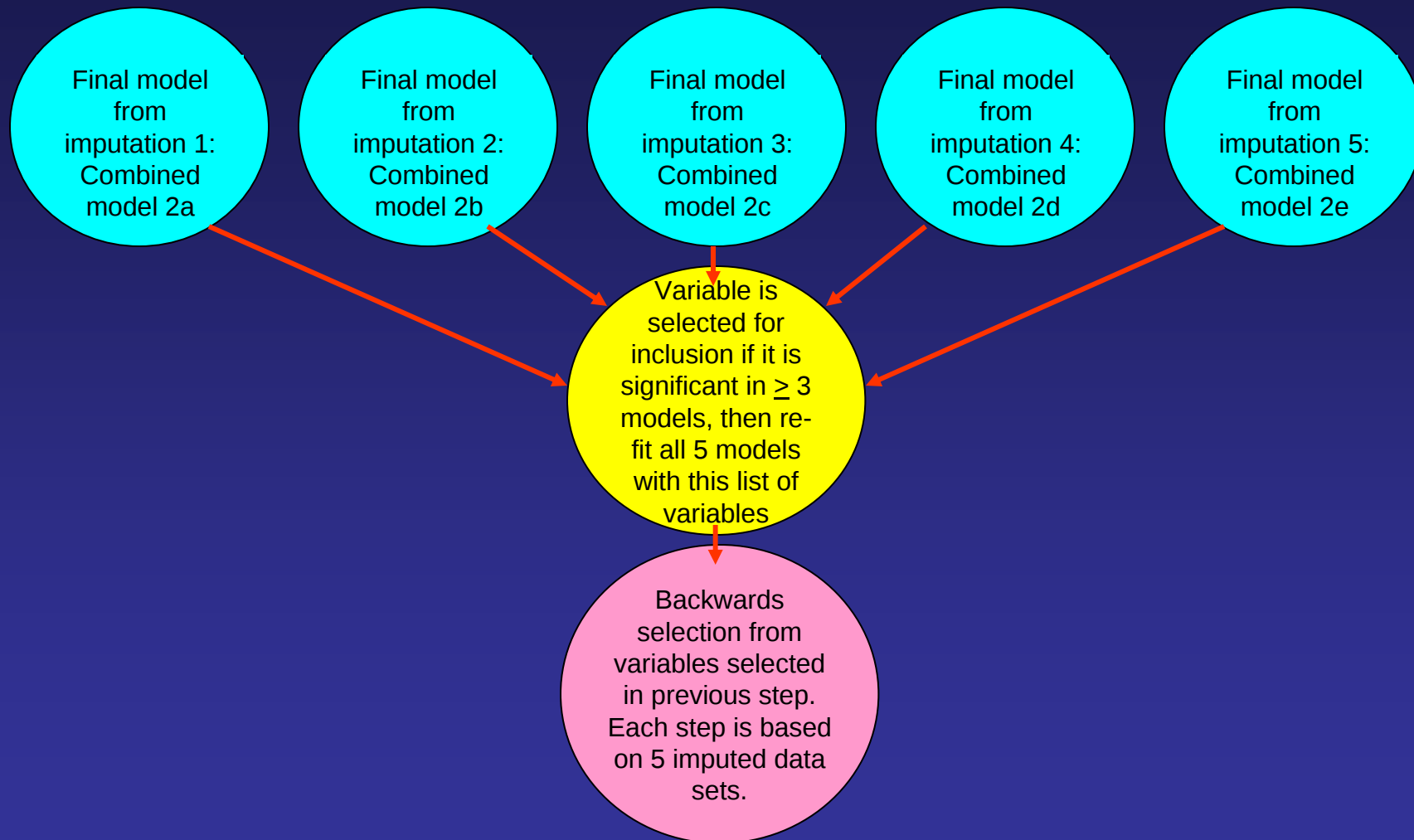
Modeling Strategy for Blood Dioxin Predictors

Backwards selection from multiple imputed data sets.





Modeling Strategy for Blood Dioxin Predictors





Issues about models

- Collinearity: many of the foods (and some other variables) were collinear.
 - Variables were removed from consideration when the variance inflation factor was 10 or greater.
 - Because some parameter estimates were unstable, we chose to estimate the contribution of variables in blocks (food, work, property use, etc.).
 - The contribution of a block of variables to a model is assessed by the difference in adjusted R^2 between the full model and the reduced model (without the block of variables).
- Choice of functional form of the variables
 - Both linear and categorical forms were modeled for ordinal variables. We chose categorical forms to avoid assuming any specific functional form for predictors.



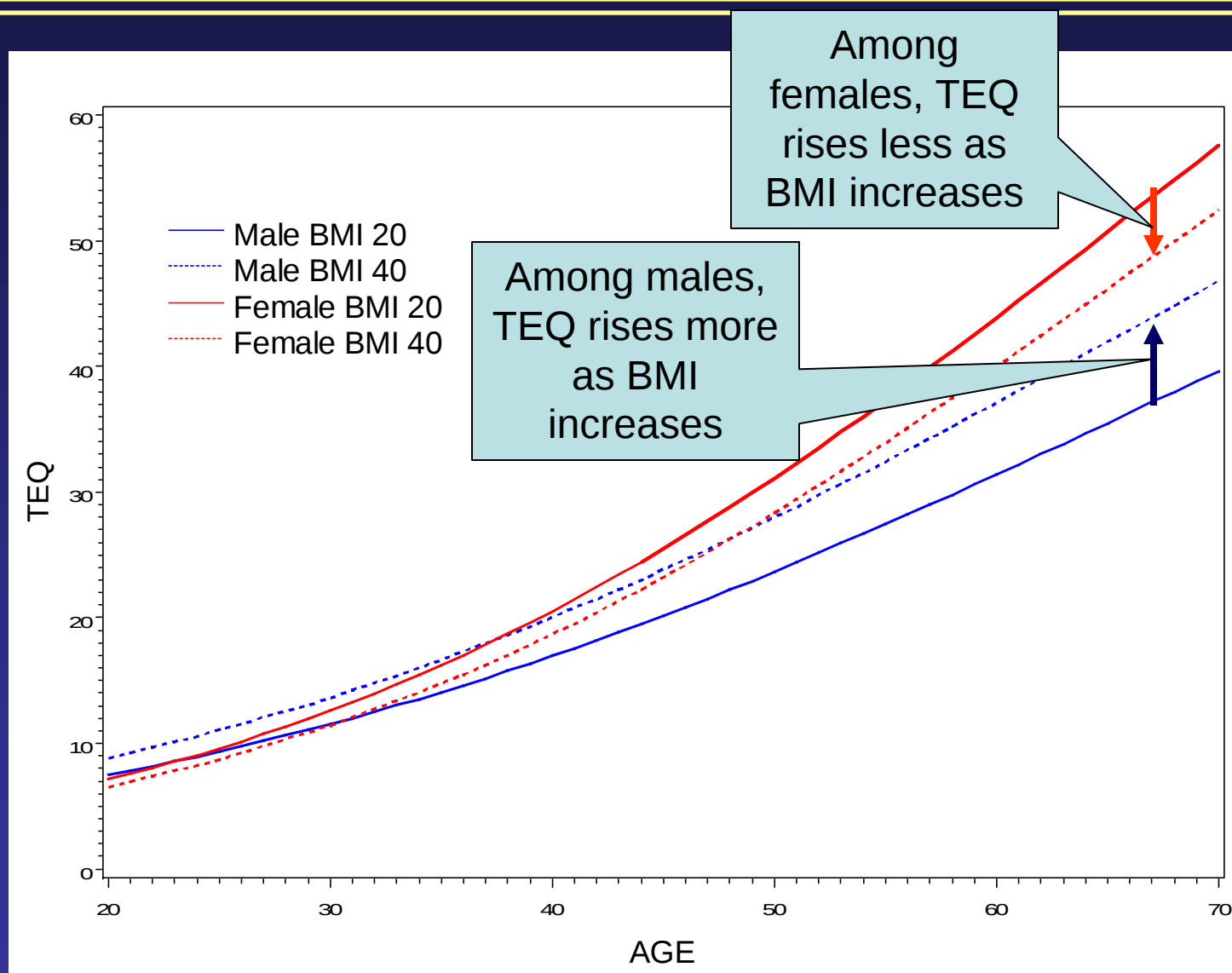
Results: Health / Demographic predictors of serum dioxin concentration

Parameter	TEQ		2378-TCDD		23478-PeCDF		12378-PeCDD		123678-HxCDD		PCB126		PCB118		PCB156	
Health/Demographic	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue
age	0.0244	0.000	0.0061	0.244	0.0188	0.000	0.0138	0.000	0.0254	0.000	0.0130	0.005	0.0240	0.003	0.0730	0.000
age_sq	-1.1E-04	0.000	-3.0E-05	0.420	-8.0E-05	0.003	-4.0E-05	0.056	-1.3E-04	0.000	4.0E-05	0.364	-9.0E-05	0.386	-5.3E-04	0.000
BMI	0.0036	0.079	-0.0082	0.192	0.0064	0.015	0.0042	0.037	0.0067	0.001	0.0157	0.000	0.0064	0.007	-0.0102	0.000
Female	0.0229	0.740	-0.2808	0.002	0.0277	0.758	-0.0115	0.888	0.2070	0.020	0.3942	0.001	0.1642	0.019	0.0218	0.735
packyrs	-0.0020	0.000	-0.0031	0.002	-8.2E-04	0.070	-0.0012	0.020	-0.0011	0.013	-0.0077	0.000	-0.0063	0.002	-0.0015	0.424
months_firstBreastFed	-0.0074	0.000	-0.0116	0.000	-0.0098	0.000	-0.0063	0.000	-0.0097	0.000	-0.0054	0.026	-0.0104	0.017	-0.0089	0.031
BMI_loss	0.0087	0.005	.	.	0.0126	0.002	.	.	.	.	0.0202	0.000	.	.	.	.
Race: White	.	.	-0.1124	0.033	.	.	.	.	.	.	.	.	-0.2347	0.000	-0.1348	0.003
education3	.	.	-0.1455	0.000	.	.	.	.	.	.	.	.	.	.	.	.
months_restBreastFed	-0.0026	0.000	.	.	.	.	-0.0030	0.000	.	.	.	.	.	.	-0.0068	0.000
preg_noChildren	0.0144	0.007	.	.	.	.	0.0180	0.001	0.0197	0.003	.	.	.	.	0.0233	0.048
current_smoke	.	.	.	.	.	.	.	.	.	.	0.0697	0.025	.	.	.	.
BMI x age	.	.	2.8E-04	0.012	.	.	.	.	.	.	.	.	.	.	.	.
BMI x female	-0.0055	0.021	.	.	-0.0088	0.002	-0.0053	0.037	-0.0104	0.000	-0.0139	0.000	.	.	.	.
female x age	0.0031	0.000	0.0079	0.000	0.0050	0.000	0.0040	0.000	0.0020	0.014	.	.	.	.	.	.

- Variables in blue are forced into models.
- Parameter estimates in pink are positive associations ($p < 0.05$)
- Parameter estimates in green are negative associations. ($p < 0.05$)
- Age and BMI are positively associated with most congeners.
- There are important interaction terms between age*BMI, age*sex, and BMI*sex.



Interaction between age, BMI and sex





Results: Region, soil, and house dust predictors of serum dioxin concentration

Parameter	TEQ		2378-TCDD		23478-PeCDF		12378-PeCDD		123678-HxCDD		PCB126		PCB118		PCB156	
	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue
Region, soil, house dust																
region_1 Flood Plain	0.0234	0.223	0.1145	0.002	0.0446	0.038	0.0455	0.034	-0.0168	0.423	0.0615	0.099	0.0899	0.182	-0.0322	0.578
region_2 Near Flood Plain	0.0551	0.007	0.1422	0.001	0.0624	0.015	0.0703	0.001	-0.0171	0.550	0.0930	0.013	0.1069	0.063	-0.0169	0.721
region_3 Other Midland/Saginaw	0.0243	0.089	0.0722	0.011	0.0270	0.073	0.0629	0.000	0.0157	0.393	0.0112	0.689	0.0361	0.596	0.0107	0.865
region_4 Midland Plume	0.0144	0.568	0.1713	0.038	-0.0378	0.221	0.0032	0.951	0.0582	0.189	-0.1040	0.225	-0.0907	0.091	-0.0543	0.148
region_5 Jackson/Calhoun	0.0000	.	0.0000	.	0.0000	.	0.0000	.	0.0000	.	0.0000	.	0.0000	.	0.0000	.
House perimeter top 1 inch soil	-8.0E-05	0.209	-0.0039	0.109	-4.0E-05	0.466	-2.2E-04	0.939	-0.0015	0.262	5.7E-04	0.000	7.7E-07	0.004	1.0E-06	0.193
Garden soil	2.8E-04	0.365	0.0084	0.001	7.0E-05	0.576	0.0044	0.215	-2.6E-06	0.998	2.8E-04	0.324	4.5E-06	0.029	3.3E-07	0.961
Household dust	-3.0E-05	0.514	1.0E-04	0.993	-1.5E-04	0.780	-0.0048	0.140	-1.0E-05	0.704	6.0E-05	0.220	5.3E-07	0.015	6.4E-07	0.209
Maximal soil concentration	1.0E-05	0.000	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Region: People who live in the

- Floodplain have higher levels of TCDD, 2,3,4,7,8-PeCDF, and 1,2,3,7,8-PeCDD
- Near Floodplain have higher levels of TEQ, TCDD, 2,3,4,7,8-PeCDF, 1,2,3,7,8-PeCDD, and PCB-126
- Other Midland/Saginaw have higher levels of TCDD and 1,2,3,7,8-PeCDD
- Midland Plume have higher levels of TCDD

than do people who live in Jackson/Calhoun.



Results: Region, soil, and house dust predictors of serum dioxin concentration

Parameter	TEQ		2378-TCDD		23478-PeCDF		12378-PeCDD		123678-HxCDD		PCB126		PCB118		PCB156	
	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue
Region, soil, house dust																
region_1 Flood Plain	0.0234	0.223	0.1145	0.002	0.0446	0.038	0.0455	0.034	-0.0168	0.423	0.0615	0.099	0.0899	0.182	-0.0322	0.578
region_2 Near Flood Plain	0.0551	0.007	0.1422	0.001	0.0624	0.015	0.0703	0.001	-0.0171	0.550	0.0930	0.013	0.1069	0.063	-0.0169	0.721
region_3 Other Midland/Saginaw	0.0243	0.089	0.0722	0.011	0.0270	0.073	0.0629	0.000	0.0157	0.393	0.0112	0.689	0.0361	0.596	0.0107	0.865
region_4 Midland Plume	0.0144	0.568	0.1713	0.038	-0.0378	0.221	0.0032	0.951	0.0582	0.189	-0.1040	0.225	-0.0907	0.091	-0.0543	0.148
region_5 Jackson/Calhoun	0.0000	.	0.0000	.	0.0000	.	0.0000	.	0.0000	.	0.0000	.	0.0000	.	0.0000	.
House perimeter top 1 inch soil	-8.0E-05	0.209	-0.0039	0.109	-4.0E-05	0.466	-2.2E-04	0.939	-0.0015	0.262	5.7E-04	0.000	7.7E-07	0.004	1.0E-06	0.193
Garden soil	2.8E-04	0.365	0.0084	0.001	7.0E-05	0.576	0.0044	0.215	-2.6E-06	0.998	2.8E-04	0.324	4.5E-06	0.029	3.3E-07	0.961
Household dust	-3.0E-05	0.514	1.0E-04	0.993	-1.5E-04	0.780	-0.0048	0.140	-1.0E-05	0.704	6.0E-05	0.220	5.3E-07	0.015	6.4E-07	0.209
Maximal soil concentration	1.0E-05	0.000	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Soil and House dust:

- **Living on property with a maximal soil concentration of 1,000 parts per trillion** TEQ of dioxins was associated with higher levels in blood of 0.7 parts per trillion (2%) for the TEQ. 4% of the properties tested had a soil TEQ at or above 1,000 parts per trillion (among all soil samples on the property).
- **Living on property with house perimeter top 1 inch soil containing 1,000 parts per trillion of PCB-118** was associated with higher levels in blood of 18 parts per trillion (less than 1%) for PCB-118.
- **Living on property with house perimeter top 1 inch soil containing 40 parts per trillion of PCB-126** was associated with higher levels in blood of 0.9 parts per trillion (5%) for PCB-126.
- **House dust** was not related to serum dioxin concentrations with the exception of a weak association for PCB-118.



Results: Milk and eggs predictors of serum dioxin concentration

Parameter	TEQ		2378-TCDD		23478-PeCDF		12378-PeCDD		123678-HxCDD		PCB126		PCB118		PCB156	
	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue
Food and corresponding activities																
eggs_else_c_1	0.0862	0.000	0.0628	0.076	0.0672	0.001	0.0763	0.004	.	.	0.1542	0.000	0.1298	0.004	0.1114	0.001
eggs_else_c_2	0.0255	0.099	0.0850	0.019	6.4E-04	0.965	0.0218	0.101	.	.	0.0961	0.020	-0.0872	0.592	-0.1452	0.363
eggs_else_c_3	0.0000	.	0.0000	.	0.0000	.	0.0000	.	.	.	0.0000	.	0.0000	.	0.0000	.
milk_bought_c_1	.	.	.	.	.	.	.	.	.	.	0.0868	0.073	.	.	.	.
milk_bought_c_2	.	.	.	.	.	.	.	.	.	.	0.2171	0.001	.	.	.	.
milk_bought_c_3	.	.	.	.	.	.	.	.	.	.	0.0000	.	.	.	.	.

Eggs and Milk:

- Positive association for eggs raised in other areas (not in the floodplain of the Tittabawassee River, Saginaw River, or Saginaw Bay) and most congeners.
- Positive association for store bought milk and PCB-126



Results: fruits and vegetable predictors of serum dioxin concentration

Parameter	TEQ		2378-TCDD		23478-PeCDF		12378-PeCDD		123678-HxCDD		PCB126		PCB118		PCB156	
	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue
Food and corresponding activities																
fruit_vege_SagRiver_c_1	.	.	.	.	.	.	-0.1661	0.008	.	.	.	.	.	.	.	.
fruit_vege_SagRiver_c_2	.	.	.	.	.	.	0.0724	0.046	.	.	.	.	.	.	.	.
fruit_vege_SagRiver_c_3	.	.	.	.	.	.	0.0000	.	.	.	.	.	.	.	.	.
fruit_vege_TittRiver_c_1	.	.	.	.	.	.	0.0597	0.034	.	.	.	.	.	.	.	.
fruit_vege_TittRiver_c_2	.	.	.	.	.	.	-0.0622	0.014	.	.	.	.	.	.	.	.
fruit_vege_TittRiver_c_3	.	.	.	.	.	.	0.0000	.	.	.	.	.	.	.	.	.
fruit_vege_bought_c_1	.	.	.	.	0.3240	0.000	.	.	.	.	.	.	.	.	.	.
fruit_vege_bought_c_2	.	.	.	.	0.3218	0.000	.	.	.	.	.	.	.	.	.	.
fruit_vege_bought_c_3	.	.	.	.	0.0000	.	.	.	.	.	.	.	.	.	.	.
fruit_vege_else_c_1	-0.0361	0.010	.	.	-0.0292	0.091	-0.0214	0.253	.	.	-0.0614	0.057	.	.	.	.
fruit_vege_else_c_2	-0.0573	0.000	.	.	-0.0479	0.003	-0.0528	0.002	.	.	-0.0934	0.001	.	.	.	.
fruit_vege_else_c_3	0.0000	.	.	.	0.0000	.	0.0000	.	.	.	0.0000	.	.	.	.	.
rootveg_SagRiver_c_1	.	.	.	.	.	.	.	.	-0.1479	0.000	.	.	.	.	.	.
rootveg_SagRiver_c_2	.	.	.	.	.	.	.	.	-0.1561	0.015	.	.	.	.	.	.
rootveg_SagRiver_c_3	.	.	.	.	.	.	.	.	0.0000	.	.	.	.	.	.	.
rootveg_TittRiver_c_1	.	.	-0.3021	0.000	-0.0352	0.317	.	.	0.1163	0.017	.	.	.	.	.	.
rootveg_TittRiver_c_2	.	.	-0.0772	0.168	-0.1819	0.002	.	.	-0.1364	0.003	.	.	.	.	.	.
rootveg_TittRiver_c_3	.	.	0.0000	.	0.0000	.	.	.	0.0000	.	.	.	.	.	.	.
rootveg_bought_c_1	-0.0460	0.074	-0.1756	0.033	.	.	.	.	0.1393	0.001	.	.	.	.	.	.
rootveg_bought_c_2	0.0031	0.929	-0.0603	0.522	.	.	.	.	0.1993	0.000	.	.	.	.	.	.
rootveg_bought_c_3	0.0000	.	0.0000	.	.	.	.	.	0.0000	.	.	.	.	.	.	.

Fruits and Vegetables:

- Generally negative associations for fruits, vegetables, and root vegetables, whether raised in the contaminated areas or raised elsewhere
- A few positive associations for store bought fruits, vegetables, and root vegetables.



Results: Meat, game meat, and hunting predictors of serum dioxin concentration

Parameter	TEQ		2378-TCDD		23478-PeCDF		12378-PeCDD		123678-HxCDD		PCB126		PCB118		PCB156	
	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue
Food and corresponding activities																
meat_bplv_else_c_1	.	.	.	.	.	.	.	.	.	.	0.1672	0.000	.	.	.	.
meat_bplv_else_c_2	.	.	.	.	.	.	.	.	.	.	0.0185	0.653	.	.	.	.
meat_bplv_else_c_3	.	.	.	.	.	.	.	.	.	.	0.0000	.	.	.	.	.
meat_ctdg_bought_c_1	.	.	.	.	0.0821	0.417	.	.	.	.	-0.1122	0.156	.	.	.	.
meat_ctdg_bought_c_2	.	.	.	.	0.0253	0.801	.	.	.	.	-0.1951	0.030	.	.	.	.
meat_ctdg_bought_c_3	.	.	.	.	0.0000	.	.	.	.	.	0.0000	.	.	.	.	.
gamemeat_deer_else_c_1	.	.	.	.	-0.0894	0.043	.	.	.	.	.	.	.	.	.	.
gamemeat_deer_else_c_2	.	.	.	.	-0.0527	0.007	.	.	.	.	.	.	.	.	.	.
gamemeat_deer_else_c_3	.	.	.	.	0.0000	.	.	.	.	.	.	.	.	.	.	.
gamemeat_deer_liver	.	.	.	.	.	.	.	.	.	.	0.2221	0.001	.	.	.	.
gamemeat_other_else_d	.	.	.	.	.	.	.	.	.	.	-0.1057	0.024	.	.	.	.
gamemeat_sr_TittRiver_d	.	.	.	.	.	.	.	.	0.2757	0.001	.	.	.	.	.	.
gamemeat_sr_else_d	.	.	0.1073	0.005	0.0559	0.044	.	.	0.0529	0.024	.	.	.	.	.	.
gamemeat_tpgqw_TittRiver_d	.	.	-0.1957	0.028	.	.	.	.	.	.	.	.	.	.	.	.
gamemeat_tpgqw_else_d	0.0610	0.018	.	.	0.0648	0.030	.	.	0.0542	0.010	.	.	.	.	.	.
ate game meat 1960_1979_yrs	.	.	.	.	-0.0032	0.023	.	.	.	.	.	.	.	.	.	.
ate game meat after 1980_yrs	.	.	.	.	0.0036	0.004	.	.	.	.	.	.	.	.	.	.
ate liver of game meat 1960_1979_yrs	.	.	-0.0094	0.001	.	.	.	.	.	.	.	.	.	.	.	.
lt_hunt_otherRiver_60_79_c_1	.	.	.	.	.	.	.	.	.	.	0.0820	0.300	.	.	.	.
lt_hunt_otherRiver_60_79_c_2	.	.	.	.	.	.	.	.	.	.	-0.1155	0.017	.	.	.	.
lt_hunt_otherRiver_60_79_c_3	.	.	.	.	.	.	.	.	.	.	0.0000	.	.	.	.	.
lt_hunt_sagRiver_60_79_d	.	.	.	.	.	.	0.1123	0.014	0.2244	0.001	.	.	.	.	.	.
lt_hunt_sagRiver_after80_d	.	.	.	.	.	.	-0.1291	0.007	-0.2263	0.000	.	.	.	.	.	.
lt_hunt_sagbay_60_79_d	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0.2856	0.001
lt_hunt_tittRiver_60_79_c_1	.	.	.	.	-0.1637	0.143	.	.	.	.	.	.	.	.	.	.
lt_hunt_tittRiver_60_79_c_2	.	.	.	.	0.0912	0.032	.	.	.	.	.	.	.	.	.	.
lt_hunt_tittRiver_60_79_c_3	.	.	.	.	0.0000	.	.	.	.	.	.	.	.	.	.	.

Meat, Game Meat, and Hunting:

- Findings suggest that meat (bplv= beef, pork, lamb, veal), poultry (ctdg=chicken, turkey, duck, goose), game meat (sr=squirrel, rabbit), and hunting are associated with higher dioxin levels in blood.
- Game meat and hunting in the contaminated areas not clearly different than in other areas.



Results: Fish consumption and fishing predictors of serum dioxin concentration

Parameter	TEQ		2378-TCDD		23478-PeCDF		12378-PeCDD		123678-HxCDD		PCB126		PCB118		PCB156	
	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue	est.	pvalue
Food and corresponding activities																
ate fish after1980_yrs	0.0024	0.005	.	.	.	.	0.0020	0.048	.	.	0.0052	0.000	.	.	.	.
Eating fish from TR/SR/SB after1980_yrs	0.0040	0.001	0.0086	0.000	.	.	0.0046	0.009	0.0037	0.004	.	.	.	.	.	.
Fishing in Saginaw River 1960-79_c_1	.	.	.	.	.	.	.	.	0.0742	0.013	.	.	.	.	.	.
Fishing in Saginaw River 1960-79_c_2	.	.	.	.	.	.	.	.	0.1088	0.030	.	.	.	.	.	.
Fishing in Saginaw River 1960-79_c_3	.	.	.	.	.	.	.	.	0.0000	.	.	.	.	.	.	.
Fishing in Saginaw River after 1980_c_1	.	.	.	.	.	.	.	.	.	.	.	.	0.1024	0.148	.	.
Fishing in Saginaw River after 1980_c_2	.	.	.	.	.	.	.	.	.	.	.	.	0.1600	0.001	.	.
Fishing in Saginaw River after 1980_c_3	.	.	.	.	.	.	.	.	.	.	.	.	0.0000	.	.	.
Fishing in Saginaw Bay 1960-79_c_1	.	.	.	.	0.0857	0.039	-0.0282	0.523	.	.	.	.	.	.	.	.
Fishing in Saginaw Bay 1960-79_c_2	.	.	.	.	0.0986	0.000	0.0745	0.025	.	.	.	.	.	.	.	.
Fishing in Saginaw Bay 1960-79_c_3	.	.	.	.	0.0000	.	0.0000	.	.	.	.	.	.	.	.	.
Fishing in Saginaw Bay after 1980_c_1	.	.	.	.	.	.	.	.	.	.	0.2572	0.000	.	.	.	.
Fishing in Saginaw Bay after 1980_c_2	.	.	.	.	.	.	.	.	.	.	0.0382	0.407	.	.	.	.
Fishing in Saginaw Bay after 1980_c_3	.	.	.	.	.	.	.	.	.	.	0.0000	.	.	.	.	.

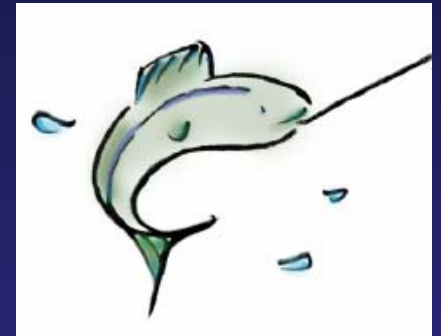
Fish and Fishing:

- Eating fish in general, eating fish from the contaminated areas, and fishing in Saginaw River and Saginaw Bay are associated with higher dioxin levels in blood.



Results: Fish consumption and fishing predictors of serum dioxin concentration

People who ate fish from the Tittabawassee River, Saginaw River, and Saginaw Bay between 1980 and the present have higher levels of some dioxins in their blood than people who did not eat fish from these areas.



For every one year of consumption the increase is:

- ❖ 0.23 parts per trillion (0.9%) for the TEQ
- ❖ 0.03 parts per trillion (2%) for TCDD
- ❖ 0.05 parts per trillion (1.1%) for 1,2,3,7,8 PentaCDD
- ❖ 0.34 parts per trillion (0.9%) for 1,2,3,6,7,8 HexaCDD
- ❖ No apparent effect on the other specific dioxins



Conclusions

Factors associated with higher levels of dioxins in people's blood

- Being older
- Eating fish, especially fish from the Tittabawassee River, Saginaw River, and Saginaw Bay
- Eating game, regardless of where it came from
- Eating meat, dairy, or eggs
- Living on property with soil contaminated by some dioxins
- Having household dust contaminated by PCB-118
- Living in the Floodplain, Near Floodplain, Midland Plume, and Other Midland/Saginaw, areas that are contaminated by some dioxins



Conclusions

Factors associated with lower levels of dioxins in people's blood

- Being younger
- Smoking
- Breastfeeding
- Eating fruit and vegetables



Results: Explained variation in serum dioxin concentration

Partial contribution to the adjusted R-square										
Model	Overall	Health	Food	Work	Residence	Property use	Water activities	Region	Soil contamination	House dust contamination
TEQ	77.85	51.30	3.74	1.62		1.47	0.32	0.06	0.05	-0.01
TCDD	68.82	29.23	5.53	2.68	1.45	1.20	0.50	0.43	0.59	-0.02
PeCDF	71.15	42.94	9.02	1.85		1.53	1.03	0.22	-0.05	-0.03
PeCDD	72.83	43.09	4.01	2.79		1.30	0.71	0.96	0.04	0.10
HxCDD	67.32	54.28	5.76	1.21		0.91		-0.01	0.02	-0.04
PCB126	61.10	36.76	11.20	3.59		4.53	1.51	0.15	0.73	0.03
PCB118	30.75	19.25	1.63	0.14		2.07	0.06	-0.06	0.14	0.80
PCB156	41.64	31.14	1.63			0.74		-0.20	-0.12	0.06

Note: the number in each cell is the mean of 5 imputation data sets

- The regression model explains 78% of the variation in serum TEQ.
- 51% of the variation in serum TEQ is explained by Health/Demographic variables: age, sex, BMI, smoking, breast feeding.
- Region, soil contamination, and house dust contamination explain only small fractions of the variation in TEQ or any specific congener.



Conclusions

- ❖ Age, sex, BMI, and demographic factors account for ~50% of the variation in the blood levels of dioxins (TEQ) among people. These are the most important factors related to levels in people's blood.
- ❖ Eating fish and game (especially from the contaminated areas), doing water-related activities and certain occupations combined to account for 1-6% of the variation in blood levels of dioxins among people.
- ❖ Living on contaminated soil, living in Midland/Saginaw, and contaminated household dust accounted for about 0.2-1.0% of the variation in the blood levels of dioxins among people.



END

