



Predictors of 7 Dioxin Congeners in Background U.S. Populations: Data from 2 Michigan Counties and the U.S. National Health and Nutrition Examination Survey (NHANES) 2001-2002 & 2003-2004

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Introduction & Objectives

- Modeling blood dioxin concentrations as a function of demographic and lifestyle variables in background populations
 - allows prediction of background values in new populations.
 - aids in understanding the routes of dioxin exposure and elimination.
- Blood concentrations of 7 dioxin congeners were measured in three U.S. samples presumably only exposed to background dioxin levels:
 - University of Michigan Dioxin Exposure Study (UMDES), and
 - National Health and Nutrition Examination Survey, (NHANES) 2001-2002 and 2003-2004 samples.

Methods

- Population-based samples were drawn from a 2-county area of Michigan, U.S. (UMDES), and the entire U.S. (NHANES).
- Serum concentration percentiles for each congener were estimated using Turnbull's estimator.
- Predictors of dioxin concentration were examined in each sample using lognormal regression models for left-censored data to handle values below the limit of detection (LOD). All models incorporated survey sampling weights.
- Covariates included age, age², gender, body mass index (BMI), breastfeeding, pack years, race, BMI loss and gain.
- Analyses were performed using STATA 10 (Intreg procedure) and SAS 9.1 (Lifereg procedure).

	2,3,7,8 TCDD			1,2,3,7,8 PeCDD			1,2,3,4,7,8 HxCDD			1,2,3,6,7,8 HxCDD			1,2,3,7,8,9 HxCDD			1,2,3,4,6,7,8 HpCDD			1,2,3,4,6,7,8,9 OxCDD					
	Median (75 th , 90 th)	% below LOD (median LOD) †	Half-life in human body	UM	NH 01-02	NH 03-04	UM	NH 01-02	NH 03-04	UM	NH 01-02	NH 03-04	UM	NH 01-02	NH 03-04	UM	NH 01-02	NH 03-04	UM	NH 01-02	NH 03-04	UM	NH 01-02	NH 03-04
Median (75 th , 90 th)	1.4 (2.4, 3.9)	<0.3 (<0.3, 4.0)	<0.3 (2.4, 4.3)	5.1 (7.1, 10.0)	<0.7 (6.4, 13.7)	2.5 (6.2, 9.5)	5.1 (7.0, 9.9)	<0.9 (6.3, 12.7)	<0.1 (3.3, 7.5)	40.7 (54.5, 75.4)	40.2 (66.8, 110)	16.5 (36.1, 56.6)	6.4 (8.4, 12.4)	<0.9 (8.1, 14.6)	<1.0 (4.0, 8.0)	33.5 (54.2, 74.0)	43.0 (76, 128)	23.4 (42, 71.6)	247 (404, 569)	365 (630, 1040)	178 (330, 592)			
% below LOD (median LOD) †	20.7% (0.5)	87.3% (1.9)	62.4% (0.8)	1.6% (1.6)	66.4% (2.0)	46.8% (0.9)	11.6% (2.6)	65.9% (3.0)	74.9% (2.9)	0.8% (2.6)	7.1% (3.5)	19.5% (3.3)	10.0% (3.2)	58.6% (3.2)	72.6% (2.9)	0.4% (2.1)	1.4% (4.3)	3.0% (3.6)	0.0% (0.0)	18.3% (143.1)	16.0% (88.4)			
Half-life in human body	7.2 yrs			11.2 yrs			9.76 yrs			13.1 yrs			5.1 yrs			4.92 yrs			6.73 yrs					
	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)	β (p)
Age ^a	0.018 (<.001)	0.015 (<.001)	0.017 (<.001)	0.012 (<.001)	0.020 (<.001)	0.019 (<.001)	0.014 (<.001)	0.018 (<.001)	0.015 (<.001)	0.014 (<.001)	0.014 (<.001)	0.016 (<.001)	0.010 (<.001)	0.011 (<.001)	0.010 (<.001)	0.008 (<.001)	0.011 (<.001)	0.010 (<.001)	0.010 (<.001)	0.010 (<.001)	0.010 (<.001)	0.011 (<.001)	0.010 (<.001)	0.011 (<.001)
Age ^{2a}	-0.0001 (.229)	0.0002 (.056)	-0.00003 (<.001)	-0.00006 (.026)	-0.00003 (.791)	-0.0001 (.002)	-0.0002 (.017)	-0.0001 (.134)	-0.00008 (.013)	-0.0001 (<.001)	-0.0002 (.008)	-0.00009 (<.001)	-0.00006 (.289)	0.00008 (.249)	-0.0000009 (.985)	-0.000007 (.895)	0.00002 (.687)	0.00002 (.365)	-0.0001 (.005)	-0.00004 (.322)	-0.00006 (.037)			
Sex (female)	0.084 (.022)	0.237 (.009)	0.124 (<.001)	0.018 (.500)	0.068 (.282)	0.013 (.743)	0.043 (.224)	0.031 (.482)	-0.003 (.893)	0.032 (.136)	0.035 (.288)	-0.012 (.680)	0.083 (.011)	0.125 (.023)	0.056 (.068)	0.042 (.259)	0.019 (.625)	0.015 (.524)	0.168 (<.001)	0.169 (<.001)	0.145 (<.001)			
BMI	0.008 (.026)	0.007 (.268)	0.004 (.032)	0.001 (.530)	-0.008 (.205)	-0.003 (.021)	0.004 (.068)	0.005 (.131)	0.006 (.004)	0.009 (.660)	-0.001 (.349)	0.0003 (.888)	0.008 (<.001)	0.005 (.071)	0.010 (<.001)	0.012 (<.001)	0.007 (.003)	0.010 (<.001)	0.009 (<.001)	0.004 (.100)	0.006 (<.001)			
Breastfeeding ^b	-0.006 (.109)	-0.028 (.257)	-0.024 (.111)	-0.004 (.002)	-0.011 (.629)	-0.038 (.019)	-0.003 (.022)	-0.005 (.667)	-0.021 (.125)	-0.005 (.0004)	-0.029 (.026)	-0.025 (.073)	-0.004 (.580)	-0.007 (.628)	-0.007 (.729)	0.0003 (.848)	0.003 (.729)	-0.007 (.470)	-0.001 (.378)	0.010 (.189)	-0.016 (.029)			
Pack Years	-0.003 (.006)	0.0004 (.768)	-0.003 (<.001)	-0.0008 (.246)	-0.0006 (.542)	-0.001 (.259)	-0.004 (<.001)	-0.003 (<.001)	-0.002 (<.001)	-0.0004 (.540)	-0.006 (.361)	-0.001 (.144)	-0.003 (.003)	-0.001 (.176)	-0.002 (<.001)	-0.007 (<.001)	-0.005 (<.001)	-0.005 (<.001)	-0.002 (.099)	-0.001 (.084)	-0.002 (<.001)			
Race ^c (NH only)																								
Mex. American		-0.188 (.188)	-0.115 (.112)		-0.149 (.051)	-0.095 (.150)		-0.051 (.494)	0.026 (.664)		-0.180 (<.001)	-0.076 (.064)		-0.022 (.636)	0.025 (.622)		0.053 (.077)	0.082 (.003)		0.022 (.593)	0.049 (.143)			
Non-Hisp. Black		0.172 (.037)	0.122 (.002)		0.206 (.005)	0.086 (.015)		0.144 (.020)	0.070 (.048)		0.092 (.015)	0.027 (.467)		0.151 (.011)	-0.017 (.588)		0.080 (.035)	0.020 (.368)		0.133 (.001)	0.045 (.036)			
BMI loss/gain																								
BMI loss (past yr)	0.020 (.003)	0.032 (.231)	0.022 (.018)	0.010 (.056)	0.030 (.111)	0.027 (.006)	0.002 (.706)	0.018 (.173)	0.018 (.046)	0.005 (.470)	0.011 (.226)	0.028 (<.001)	0.010 (.168)	0.037 (.001)	0.030 (<.001)	-0.0006 (.948)	0.021 (.019)	0.018 (.002)	0.008 (.260)	0.011 (.086)	0.021 (<.001)			
BMI gain (past yr)	0.004 (.0828)	-0.010 (.543)	0.004 (.507)	-0.009 (.150)	-0.012 (.431)	-0.002 (.835)	-0.015 (.17)	-0.006 (.527)	-0.005 (.464)	-0.002 (.779)	-0.010 (.124)	-0.011 (.347)	-0.002 (.823)	-0.011 (.323)	-0.011 (.404)	-0.009 (.530)	-0.015 (.047)	-0.026 (.026)	-0.015 (.084)	-0.016 (.047)	-0.006 (.323)			

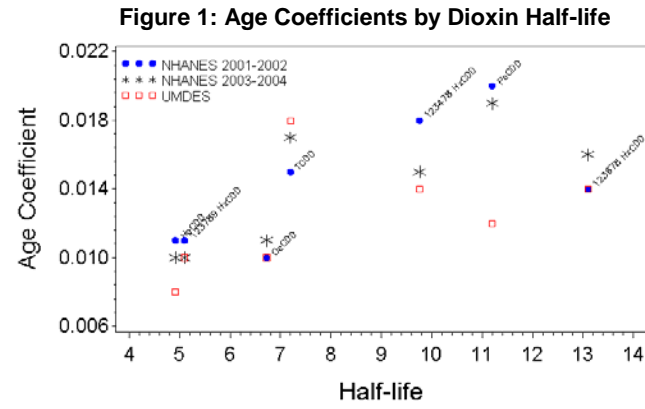
†Median of LOD values among observations below the LOD
^aAge centered at 50 for all three samples.
^bBreastfeeding measured as UM - the total number of months breastfed after 1980; NH - the total number of children breastfed at least one month.
^cThe reference category for race is Caucasian.

Results

- The strongest predictors of higher dioxin blood levels were older age (for all 7 congeners) and female gender (for 3 congeners). Age effects tend to be stronger in congeners with longer half-lives (see Figure).
- Blacks had significantly higher levels of serum dioxin for all 7 congeners in 2001-2002, and for 4 of the 7 congeners in 2003-2004.
- Higher blood levels were significantly associated with greater BMI and recent weight loss, particularly in congeners with shorter half-lives.
- Lower blood levels were significantly associated with recent weight gain, breastfeeding and smoking.
 - Breastfeeding was significant for the two congeners with the longest half-lives.
 - Smoking was significant for the 5 congeners with shorter half-lives.

Conclusions

- These results show strong age effects that increase with longer congener half-life. This can be explained by longer exposure time with older age and high exposures prior to ~1980.
- Effects for gender, race, BMI, breastfeeding, and smoking show fairly consistent patterns across congeners and samples.



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