



Predictors of 8 Furan 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 furan 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 furan exposure and elimination.
- Blood concentrations of 8 furan congeners were measured in three U.S. samples presumably only exposed to background furan 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 furan 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).

	TCDF		1,2,3,7,8 PeCDF			2,3,4,7,8 PeCDF			1,2,3,4,7,8 HxCDF			1,2,3,6,7,8 HxCDF			2,3,4,6,7,8 HxCDF			1,2,3,4,6,7,8 HpCDF			OoCDF	
Median (75 th , 90 th)	<0.1 (0.6, 1.3)	<0.1 (0.5, 1.1)	5.5 (7.7, 11.6)	5.3 (10, 15.8)	3.6 (6.5, 10.0)	5.5 (7.5, 10.4)	5.4 (8.2, 12.9)	3.1 (5.0, 7.5)	5.6 (7.4, 10.4)	4.5 (7.2, 11.2)	2.3 (4.4, 6.8)	<0.2 (1.0, 2.0)	<0.7 (<0.7, 2.2)	<0.6 (<0.6, <0.6)	7.0 (9.7, 13.5)	10.1 (14.5, 21.4)	7.7 (11.0, 15.7)	<0.7 (<0.7, <0.7)	<0.6 (<0.6, 6.6)			
% below LOD (median LOD)†	66.5% (0.4)	75.7% (0.4)	1.2% (2.5)	34.5% (2.0)	34.8% (1.8)	5.2% (2.7)	18.0% (2.4)	39.4% (2.0)	4.8% (2.0)	30.7% (2.2)	50.5% (2.1)	74.5% (0.9)	89.2% (2.0)	95.1% (1.9)	9.2% (1.8)	10.5% (2.4)	10.7% (2.3)	94.8% (2.6)	72.6% (2.6)			
Half-life in human body	2.1 yrs	3.5 yrs	7.0 yrs			6.4 yrs			7.2 yrs			2.8 yrs			3.1 yrs			1.4 yrs				
	UM	UM	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 03-04			
	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	0.009 (.022)	0.006 (.042)	0.012 (<.001)	0.013 (<.001)	0.011 (<.001)	0.009 (<.001)	0.008 (<.001)	0.009 (<.001)	0.009 (<.001)	0.009 (<.001)	0.008 (<.001)	0.007 (.100)	0.007 (<.001)	0.005 (.001)	-0.009 (.380)	0.001 (.262)	0.004 (.601)	-0.001 (.262)	-0.008 (.254)			
Age ^{2a}	-0.0003 (.087)	-0.0003 (.053)	-0.0001 (.005)	-0.00008 (.218)	-0.00003 (.084)	-0.00008 (.179)	-0.00004 (.377)	-0.00002 (.531)	-0.00007 (.091)	-0.00006 (.364)	-0.00005 (.041)	-0.0002 (.374)	-0.00008 (.398)	-0.0001 (.014)	-0.00003 (.552)	-0.00002 (.618)	0.000002 (.911)	0.00007 (.874)	0.00006 (.224)			
Sex (female)	-0.299 (<.001)	-0.289 (.002)	-0.003 (.916)	-0.003 (.729)	0.011 (.263)	-0.019 (.449)	-0.012 (.658)	-0.012 (.245)	0.031 (.279)	0.013 (.672)	-0.027 (.068)	-0.059 (.674)	-0.101 (.018)	-0.065 (.191)	0.057 (.143)	-0.047 (.121)	-0.054 (.009)	0.126 (.576)	-0.039 (.493)			
BMI	0.012 (.159)	0.014 (.024)	0.002 (0.405)	-0.004 (.079)	-0.003 (.005)	0.006 (.002)	0.003 (.021)	0.004 (<.001)	0.006 (.037)	-0.002 (.196)	0.003 (.037)	0.010 (.267)	-0.003 (.293)	0.007 (.830)	0.005 (.134)	-0.002 (.222)	-0.004 (.808)	0.027 (.085)	-0.00009 (.968)			
Breastfeeding ^b	0.009 (.080)	0.005 (.389)	-0.003 (.083)	-0.009 (.288)	-0.008 (.411)	-0.003 (.036)	-0.015 (.082)	-0.015 (.025)	-0.005 (.072)	-0.019 (.020)	-0.009 (.308)	0.004 (.453)	-0.008 (.669)	0.019 (.233)	0.008 (.569)	-0.005 (.527)	0.00006 (.996)	0.011 (.140)	-0.011 (.548)			
Pack Years	-0.006 (.089)	-0.009 (.004)	-0.001 (.193)	-0.008 (.285)	-0.002 (.530)	-0.001 (.179)	-0.001 (.059)	-0.009 (.160)	-0.006 (.446)	-0.001 (.096)	-0.008 (.133)	-0.022 (<.001)	-0.006 (.002)	-0.002 (.155)	-0.007 (.604)	-0.006 (.375)	0.0001 (.836)	0.002 (.715)	-0.001 (.862)			
Race ^c (NH only)																						
Mex. American				-0.151 (.015)	-0.073 (.005)		-0.114 (<.001)	-0.077 (<.001)		-0.145 (<.001)	-0.099 (.012)		-0.137 (.039)	-0.081 (.260)		-0.091 (.016)	-0.071 (.042)		-0.124 (.012)			
Non-Hisp. Black				-0.006 (.877)	-0.008 (.730)		0.060 (.026)	0.028 (.174)		0.046 (.101)	-0.038 (.174)		-0.004 (.946)	-0.029 (.671)		0.117 (.001)	0.071 (.002)		-0.024 (0.627)			
BMI loss / gain																						
BMI loss (past yr)	0.015 (.661)	0.025 (.463)	0.011 (.014)	0.009 (.356)	0.013 (.051)	0.013 (.010)	0.017 (.005)	0.020 (<.001)	0.016 (.003)	0.016 (.006)	0.021 (.001)	0.003 (.911)	0.027 (.082)	0.016 (.044)	0.012 (.166)	0.008 (.250)	0.017 (.001)	-0.006 (.891)	0.006 (.638)			
BMI gain (past yr)	-0.116 (<.001)	-0.041 (.224)	-0.025 (<.001)	-0.018 (.037)	-0.019 (.002)	-0.010 (.217)	-0.010 (.011)	-0.010 (.064)	-0.016 (.035)	-0.016 (.010)	-0.016 (.004)	-0.074 (.034)	-0.022 (.195)	-0.036 (.075)	-0.019 (.089)	-0.018 (.019)	-0.011 (.240)	-0.036 (.597)	-0.016 (.163)			

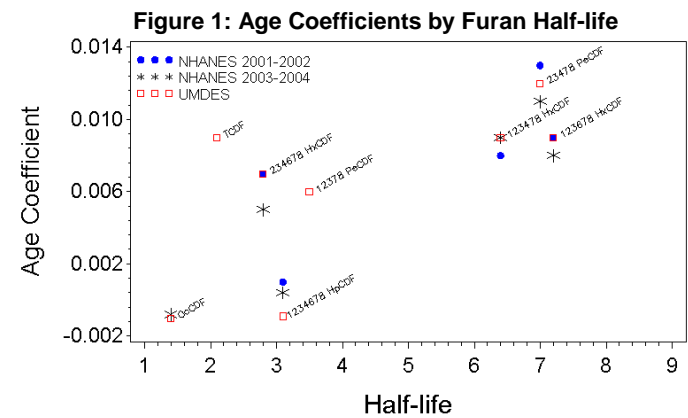
†Median of LOD values among observations below the LOD ^a Age centered at 50 for all three samples.
^b Breastfeeding measured as UM - the total number of months breastfed after 1980; NH - the total number of children breastfed at least one month.
^c The reference category for race is Caucasian.
^d Furans and population results not shown were not modeled due to the high proportion of censored data.

Results

- The strongest predictor of higher furan levels for 6 of the 8 congeners was older age. Age effects tend to be stronger in congeners with longer half-lives (see Figure).
- Gender effects were weaker and in the opposite direction (women had lower furan levels than men) compared to those seen for dioxins.
- Hispanics had lower furan levels than other races in all congeners measured. Blacks had higher furan levels for 2 of the congeners.
- Higher furan levels were significantly associated with greater BMI and recent weight loss.
- Lower furan levels were associated with recent weight gain, breastfeeding and smoking.

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 of gender, race, BMI, breastfeeding, and smoking are fairly consistent across congeners and samples.



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