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Environmental Toxins and Depression in an American Indian Community

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Environmental Toxins and Depression in an American Indian Community

Polychlorinated biphenyls (PCBs) are man-made toxic chemicals formerly used in industry. Despite being banned since the 1970's, they continue to persist in the environment and affect people living near contaminated sites [1]. PCBs are linked to a wide range of health problems including cancer, [2, 3], diabetes, heart disease [4-6], memory problems, impact on intelligence, and problem solving [7, 8]. Despite the known physical health effects of PCBs, their impact on mental health and illnesses such as depression is not well understood.

Depression is a serious mental illness associated with decreased work productivity, greater risk of suicide, and physical health conditions such as heart disease and low thyroid functioning[9, 10]. Five to nine percent of the general U.S. population reports depression [11-13] . Among American Indians and Alaska Natives (AIANs), the rate of depression range from 5 to 20% [14, 15].

Emerging research examined exposure to toxic chemicals such as PCBs as another risk factor for depression [16]. This research has special relevance for AIAN populations, who suffer from both high rates of depression and exposure to environmental toxins [17]. Furthermore, many Indian reservations are located near rivers and lands contaminated by toxic chemicals, including PCBs [18]. Only one study has investigated possible relationships between PCB exposure and mental health in an AIAN population [17]. Although the study found no relationship between PCB exposure and depression, this may be because of how PCBs were measured. Specifically, the exposure measure was defined as the total amount of measured PCBs, whereas more recent work suggests that PCBs should be categorized based on level of chlorine and the toxic compound, dioxin [17].

The Mohawk Indian community of Akwesasne is an ideal location to study relationships between PCB exposure and depressive symptoms among AIANs. The St. Lawrence River runs through Akwesasne, carrying environmental toxins such as PCBs from three industrial plants built during World

War II. Fish from this river have long been among these tribes' principle foods and their sale has provided a main source of income. Thus, potential negative impacts of exposure to environmental toxins could impact multiple life domains, including physical, economic, and mental health status. Only one long-term study conducted at Akwesasne from 1995 to 2001 examined effects of toxic chemicals on the environment and reservation residents [17].

This project re-examines the association between depressive symptoms and level of PCBs using data from the same study. Our analysis looked at a more detailed categorization of PCBs based on the amount of chlorine and presence of a dioxin-like structure. We hypothesized that highly chlorinated dioxin-like PCBs and highly chlorinated non-dioxin-like PCBs would be associated with increased depressive symptoms, while low chlorinated non-dioxin-like PCBs would not.

Method

Participants- Data were from a population-based sample of 353 Mohawk respondents in the Akwesasne Environment, Health and Well-Being study [17].

Procedures-Four hundred-six households were randomly sampled from across the reservation. Mohawk staff visited homes to explain the study to potential participants and family members. Next, Mohawk staff administered surveys and drew blood from enrolled participants. The project was approved by the University at Albany Institutional Review Board and the Akwesasne Task Force on the Environment [17]

Measures

PCB exposure-Serum blood PCB levels were measured using state-of-the-art technology at the State University of New York, University at Albany School of Public Health Analytical Laboratory [19]. Researchers measured all types of PCBs present in blood samples. We separated PCBs based on the amount of chlorine and dioxin type to create 3 categories: highly chlorinated, dioxin-like PCBs; highly chlorinated, non-dioxin-like PCBs; and low chlorinated, non-dioxin-like PCBs. We created 3 variables that measured the total PCB level within each category.

Depressive symptoms and mental health conditions-Depressive symptoms were measured with the Center for Epidemiology Studies of Depression (CES-D). The CES-D is a widely used and reliable self-report measure that assesses frequency of 20 depressive symptoms [20]. We computed an overall depressive symptom score with a possible range between 0 to 60, higher scores indicating more depressive symptoms.

Though limited, research has suggested that having two or more mental health issues may confuse associations between PCB exposure and depressive symptoms [1, 9, 10, 21]. We created a mental health index equal to the total number of mental health disorders other than depression that study participants endorsed in responses to the University of Michigan Composite International Diagnostic Interview (UM-CIDI) [22]. The mental health index included lifetime diagnoses for generalized anxiety disorder, phobic anxiety, social anxiety, post traumatic stress disorder, substance dependence, and substance abuse. The index ranged from 0 to 6, with higher values indicating more co-morbid disorders.

Demographics and health characteristics-We included age, gender, education, smoking status, and body mass index as covariates in our model because they have been linked to PCBs and health problems [1, 3, 5, 16].

Data Analysis-We computed descriptive statistics for demographic and health characteristics, depressive symptom score, and PCB exposure. We used linear regression to examine the relationship between PCB exposure and depressive symptom score. Our results are presented as mean depressive symptom score according to level of PCB exposure for each category of PCBs. Ninety-five percent confidence intervals show the precision of mean estimates. Adjusted models control for the effects of the mental health index, demographic, and health characteristics.

Results

Descriptive statistics-The final sample included 306 participants (87%) from the original sample, with 47 exclusions due to missing data. Demographic, health, and PCB exposure characteristics of the sample appear in Table 1. On average, participants were 38 years of age (range 18 – 79). Most were female and had completed a high school education; slightly less than half the sample had ever smoked. Mean body mass index was 29.6 kg/m^2 (SD = 5.7); mean depressive symptom score was 10.9 (SD = 9.6); and mean mental health index was 1.1 conditions (SD = 1.2). Participants' exposure to the PCB categories varied considerably, with lowest levels found for low chlorinated, non-dioxin-like PCBs and the highly chlorinated, non-dioxin-like group exhibiting the highest levels.

PCBs and depression symptom score- Table 2 shows mean depressive symptom score according to level of PCB exposure for each category of PCBs. Mean depressive symptom score increased by level of PCB exposure in the two highly chlorinated PCB categories after adjusting for covariates; however, none of the differences were statistically significant (all $p>0.05$).

Discussion

We found no relationship between depressive symptoms and exposure level for any PCB category examined. Results are consistent with a previous study [23] that also failed to find an association between depression and total body burden of PCBs in the same AIAN community. Although not significant, in the highly chlorinated, dioxin-like and highly chlorinated, non-dioxin-like PCB categories, mean depressive symptom scores increased with greater PCB exposure. The trend is noticeable despite low levels of highly chlorinated PCBs and relatively low depressive symptom scores; it is possible that a sample including individuals with higher and more variable levels of highly chlorinated PCBs and depression scores might yield different results.

The strengths of this study lie in the random sampling methods, reliability and validity of measures used [19, 20, 24], and their well-established appropriateness for this special population. This study also has limitations. Specifically, participants' low average scores for both depressive symptoms and PCB levels may have affected our ability to identify associations.

Our analyses confirm lack of a relationship between depressive symptoms and PCB exposure in a large AIAN sample. Although serious health effects of PCBs are well documented, our ongoing line of inquiry supports the interpretation that depression is not among them.

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Table 1. Demographic, health, and exposure measures in a sample of 306 Mohawk Indians living on the Akwesasne Reservation.

Characteristic	***Mean or %***	***Standard Deviation***	***Range***
Demographic			
Age (years)	38.3	13.2	18.0 – 79.0
Gender (female)	68%	–	–
≥ high school education	73%	–	–
Health			
Ever smoked, (yes)	46%	–	–
Body mass index (kg/m^2)	29.6	5.7	14.6 – 53.0
Depressive symptom score[a]	10.9	9.6	0.0 – 58.0
Mental Health Index[b]	1.1	1.2	0.0 – 6.0
Exposure			
Polychlorinated biphenyls (ppb)			
Low Chlorinated, Non- Dioxin Like	0.1	0.2	0.0 – 1.1
Highly Chlorinated, Non-Dioxin Like	5.1	5.4	0.3 – 33.8
Highly Chlorinated, Dioxin Like	0.4	0.6	<0.1 – 4.8

[a] Center for Epidemiologic Studies Depression Scale; [b] Mental Health Index equals total number of reported mental health conditions including posttraumatic stress disorder, generalized anxiety disorder,

panic disorder, agoraphobia, substance abuse and substance dependence; ppb = parts per billion.

Table 2. Mean depressive symptom score and 95% confidence interval according to polychlorinated biphenyl (PCB) category.

	Low chlorine non-dioxin like			***High chlorine non-dioxin like***			***High chlorine dioxin like***		
Level of PCB exposure	**Mean**	**(95% CI)**	p_{trend}	**Mean**	**(95% CI)**	p_{trend}	**Mean**	**(95% CI)**	p_{trend}
Unadjusted model			0.54			0.54			0.84
Lowest PCB tercile	11.0	(9.2 – 12.8)		10.7	(8.9 – 12.6)		10.8	(9.0 – 12.6)	
Middle PCB tercile	11.3	(9.5 – 13.2)		11.9	(10.1 – 13.8)		11.2	(9.3 – 13.1)	
Highest PCB tercile	10.1	(8.2 – 12.1)		9.9	(8.1 – 11.7)		10.5	(8.7 – 12.4)	
Adjusted[a] model			0.91			0.23			0.14
Lowest PCB tercile	10.7	(9.1 – 12.3)		9.5	(7.3 – 11.7)		9.6	(7.6 – 11.5)	
Middle PCB tercile	11.4	(9.6 – 13.1)		11.5	(9.7 – 13.2)		11.0	(9.2 – 12.7)	
Highest PCB tercile	10.5	(8.7 – 12.3)		11.6	(9.1 – 14.1)		12.1	(9.9 – 14.3)	

[a] Adjusted for age, gender, education, smoking status, body mass index, and mental health index; CI = confidence interval.