Cardiovascular Disease Biomarkers in Association with PFAS and Mixtures of Halogenated Pollutants in the Anniston Community Health Survey II

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Abstract

Anniston, Alabama residents were highly exposed to legacy persistent organic pollutants (i.e., polychlorinated biphenyls) due to longstanding manufacturing. The Anniston Community Health Surveys (ACHS-I, & -II) were conducted during 2005 and 2014 to determine the body burden of these pollutants and associations with disease risk. Although per and polyfluoroalkyl substances (PFAS) were not a focus originally, we recently measured 8 legacy and emerging PFAS in ACHS and determined that residents were highly exposed to PFOS. Thus, this cohort provides a useful dataset including measurements of legacy and emerging halogenated pollutants and clinical biomarkers over time.

Exposure to some PFAS, and other legacy pollutants, have been associated with chronic diseases, including cardiovascular disease[1]. Using ACHS II data (n ~ 333), we utilized linear regression modeling to determine associations between PFAS and biomarkers of cardiovascular disease (e.g., lipids, blood pressure), accounting for relevant covariates (e.g., sex, race). We then investigated if levels of dioxin-like pollutants impacted associations between PFAS and CVD using toxic equivalency factor (TEQ) mixture approach.

Our simple models showed positive correlations between total PFAS and total, HDL, and LDL cholesterol, as well as total lipids, even after adjustment for covariates. Total PFAS and diastolic blood pressure showed no significant associations. Interestingly, adding an interaction with Total Dioxin TEQ resulted in significant positive associations between PFAS and diastolic blood pressure, which were driven by individuals with highest dioxin-like pollutant exposure. This initial analysis supports utilizing pollutant mixtures to more accurately reflect the variety of chemicals that humans are exposed to.

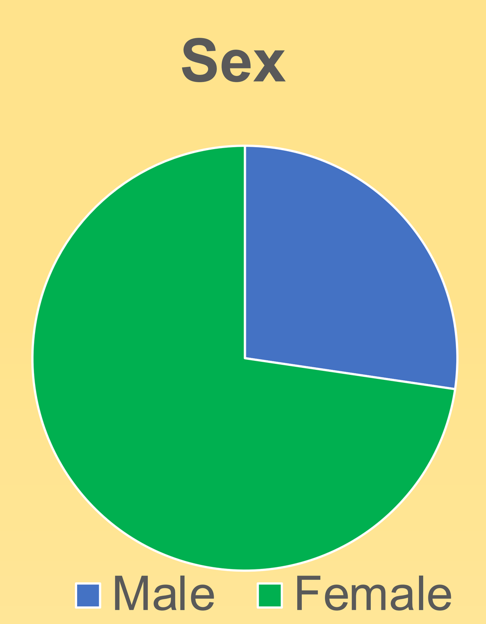
Introduction

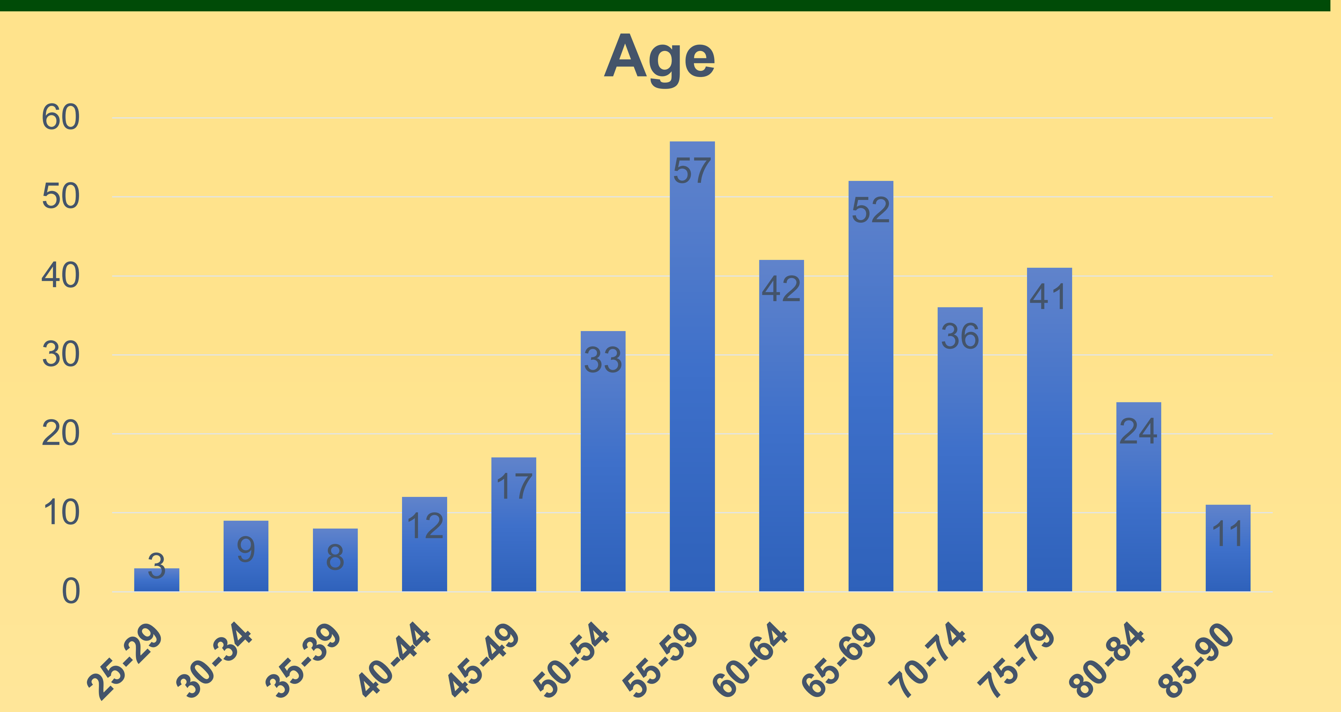
- Residents of Anniston, AL were exposed to high levels of polychlorinated biphenyls (PCBs) due to longstanding manufacturing in the area. These residents were found to also have high levels of per- and polyfluoroalkyl substances (PFAS) in serum
- The Anniston Community Health Surveys (ACHS I and II) were conducted in 2005 and 2014, respectively, to assess the body burden of these persistent organic pollutants (POPs)
- PFAS and PCBs have been linked to many adverse health outcomes, including cardiovascular disease[2-5]
- Mixtures of pollutant classes can have a unique body burden that has been under-investigated

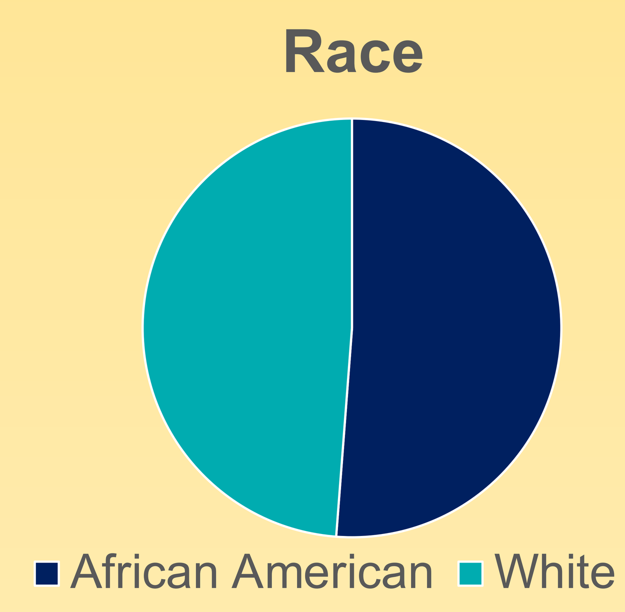
Methods

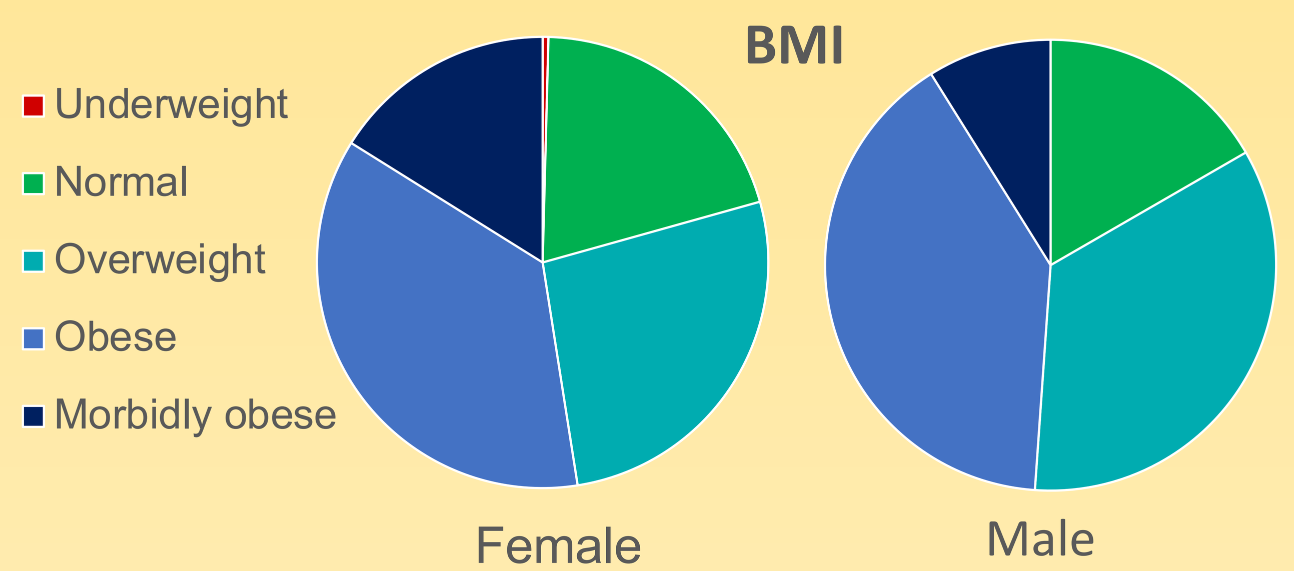
- Data from ACHS II (n ~ 333) – bivariate and multivariate linear regression analyses to model associations between PFAS and systolic and diastolic blood pressures, total cholesterol and distribution (LDL, HDL, VLDL), and other biomarkers of cardiovascular disease
- Covariates associated with cardiovascular disease (e.g., sex, race, BMI, etc.) and additional halogenated pollutant exposure
- Dioxin TeQ total: Dioxin toxic equivalency factor. Dioxin-like pollutants relative to TCDD to reflect body burden

Demographics





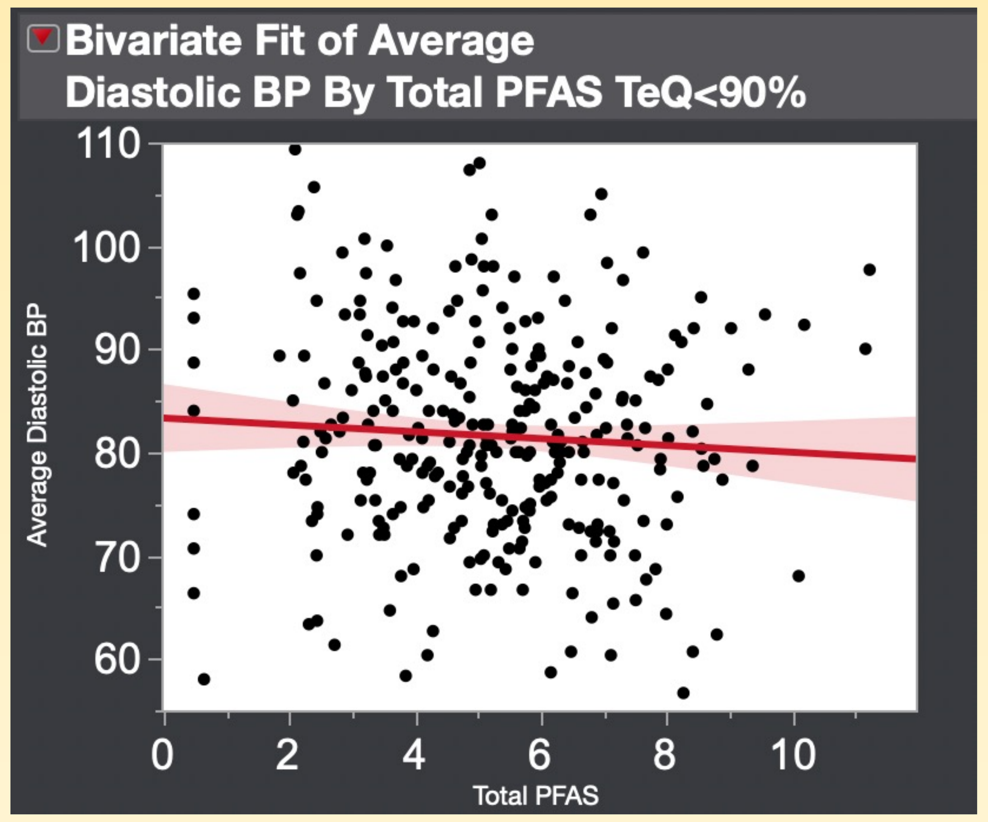




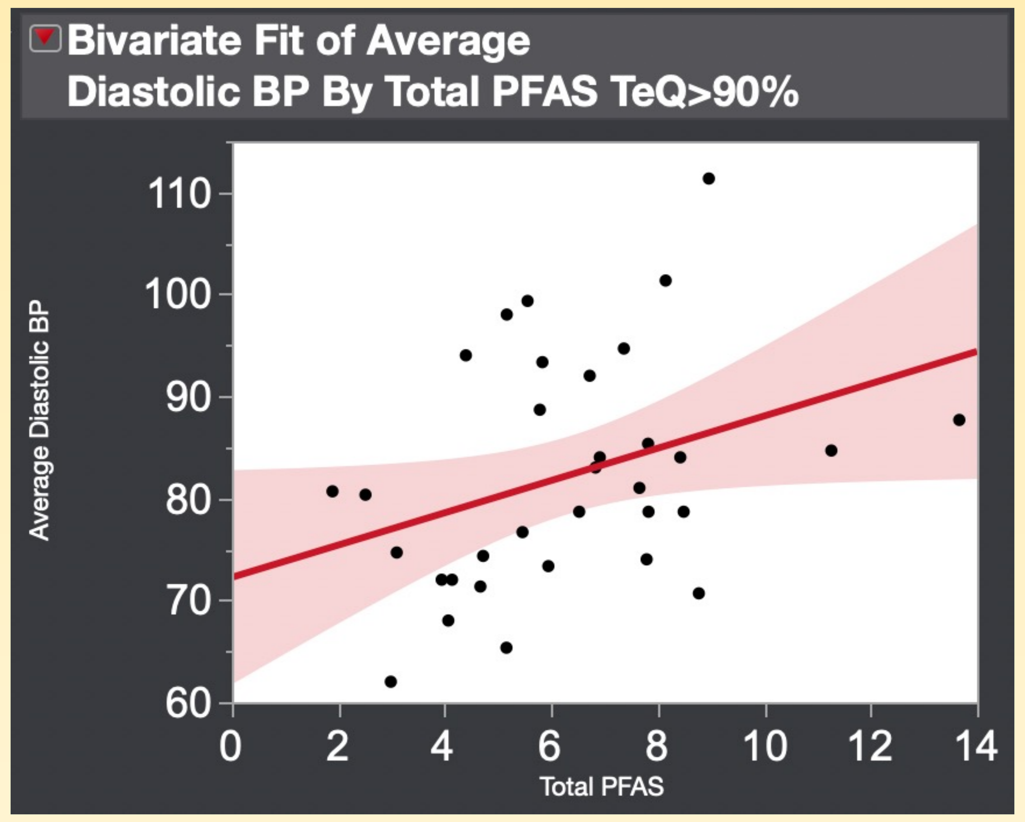
Results: Total PFAS Positively Associated with Diastolic Blood Pressure in Those with Highest Dioxin Levels

Response: Average Diastolic BP	r^2= 0.069		N= 328
Variable	Estimated Regression Coefficient	Standard Error	P-value
SumtotalPFAS	-0.3117	0.2906	0.2843
Sex	-3.2713	1.2800	**0.0111**
Race	3.1145	1.1271	**0.0061**
Age	-0.0260	0.0465	0.5760
BMI	0.1832	0.0781	**0.0196**
Smoker	2.4757	1.4295	0.0843

Response: Average Diastolic	R^2=0.103		N=328
Term	Estimated Regression Coefficient	Standard Error	P-value
SumtotalPFAS	-0.4829	0.2923	0.0995
Sex	-3.8050	1.3208	**0.0042**
Race	3.0828	1.1563	**0.0081**
Age	-0.0116	0.0589	0.8440
BMI	0.1475	0.0781	0.0600
Smoker	3.1405	1.4264	**0.0284**
TeQtotal	0.4197	1.0134	0.6790
PFAS x TeQtotal	1.1212	0.3231	**0.0006**



N=296 p=0.2659 r^2=0.0042 CC= -0.332



N=33 **p=0.0457** r=0.1227 CC=1.582

Individuals with TEQ total in the 90[th]% showed significant positive associations between total PFAS and diastolic blood pressures. There was no association in remaining participants.

Conclusion

- PFAS were positively associated with increased diastolic blood pressures only after accounting for other pollutants, specifically dioxin and its like pollutants
- Using mixtures of pollutants is essential to more accurately reflect the environment that humans are exposed to
- This initial pollutant mixture interaction analysis demonstrates that significant associations may only be identified when including a variety of chemicals and their molecular interplay

References

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