COMMUNITY PERCEPTIONS REGARDING POLYCHLORINATED BIPHENYL CONTAMINATION, EXPOSURE, AND HEALTH EFFECTS IN ANNISTON, ALABAMA

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Introduction

Anniston, AL was a major US production site for PCBs from the 1920s to 1970s. It has been the focus of media reports, litigation, and remediation efforts in the last few decades due to widespread PCB contamination of local soils, rivers, fish, livestock, and people.[1,2] Many Anniston residents are concerned about potential adverse health effects due to their PCB exposures; in the early 2000s community organizations lobbied Congress for a health study. Through the community's efforts the Anniston Environmental Health Research Consortium was established in late 2003, with the goals of further examining PCB exposures and health outcomes in the community.

The toxicity of PCBs is well established, especially with respect to carcinogenic effects at high doses.[3] However, previous research has shown that a fear of severe health consequences can also be strongly related to community action to mitigate risk.[4] This report discusses community perceptions of PCB contamination and health effects in Anniston. The two major aims of this study are to ascertain the public's beliefs on the severity of PCB contamination in Anniston and to determine the types and severity of health effects community members believe are associated with PCB exposure.

Materials and methods

Study Setting & Design

The Anniston Community Health Survey (ACHS) was developed in conjunction with community representatives, primarily from the organization Community Against Pollution which had been central in efforts to establish the research consortium. Community health concerns were also shared during a public meeting attended by several hundred residents at the initiation of the consortium. The ACHS was designed to cover a broad range of self-reported health outcomes, exposure behaviors, and PCB exposure/health perceptions.

The ACHS entailed a representative survey of adults living in Anniston, Alabama, a city in Northeast Alabama at the southern end of the Blue Ridge Mountains. Anniston has an estimated population of 23,689 in 2007, with roughly equal proportions of whites and African Americans (49% each), and a poverty rate of 23%.[5] A two-stage sample design was used to randomly select households, and then one adult was selected within each household. The sample frame was comprised of a list of all residential addresses in Anniston that was purchased from a commercial provider. The sample was stratified geographically between West and East Anniston with two-thirds of the sample selected from West Anniston and one-third from East Anniston, in order to include more participants who lived closer to the PCB production site. A total of 3300 households were sampled, out of which 1110 households agreed to participate.

The survey was conducted by local residents and graduate students trained in proper interviewing techniques, study specific procedures, and human subjects protection. They completed in-person structured interviews with respondents at their homes, with an average interview length of 40 minutes. Respondents were compensated with a $10 gift card for participation in the questionnaire phase. Data collection began in November, 2005 and was completed in October, 2007. The study received prior approval from the Institutional Review Board at the University of Alabama at Birmingham.

Instrument

The survey contained 297 questions, divided into 13 sections that included General Health, Diabetes, Emotional Health, Health Behaviors, Health Care Access, Quality of Life, Women's Reproductive Health History, Men's Reproductive Health History, Children's Health History, Environmental Perceptions, PCB and Litigation Knowledge, Demographics, and Residential and Occupational History. Many questions were used from existing surveys including the Behavioral Risk Factor Surveillance System[6], SF-12v2[7], and Brief Symptom Inventory[8], along with newly developed questions. ACHS data have been analyzed and discussed in several other publications.[9-11] Only those questions directly relevant to the present analysis are reported here.

To assess awareness of PCB contamination, respondents were asked if they had "ever heard of the term PCBs," and if they "were aware of any PCB contamination in Anniston." Respondents were further asked to "rate the level of PCB contamination in Anniston" and "rate the level of PCB contamination in your neighborhood" on a scale of 1 to 10 with 1 being very mild and 10 being very severe. In addition, respondents were asked if they "were aware of litigation involving PCB contamination in Anniston" and if they have "been involved in any of the litigation." People were also asked if they "were aware of health advisories for eating fish" caught from local streams or for "working in home gardens" because of possible PCB contamination. Finally, respondents were asked to rate "how worried are you about PCB contamination in Anniston on a 10-point scale with 1 being not at all worried and 10 being extremely worried."

Perceptions of personal exposure were examined using the question "do you believe that you have or have not been personally exposed to PCBs?" Respondents who said they have been exposed were asked to rate "the amount of PCB exposure that you have received" on a 10-point scale with 1 being very low and 10 being very high. In addition, respondents were asked if they had ever had PCB levels measured in their blood or around their homes.

Perceptions of the health effects of PCBs were asked at a general level and specific to the individual respondent. At the general level, respondents were asked "Some people believe that PCB contamination has negative health effects on humans, while other people do not. In your opinion how would you rate the health effects of PCBs on humans on scale from 1 to 10 where 1 is no negative health effects and 10 is severe negative health effects?" In addition, respondents were asked "do you believe that PCB exposure is related or unrelated to each of the following health conditions" with the list consisting of cancer, diabetes, reproductive problems, birth defects, child developmental problems, asthma, cardiovascular disease, and lupus. At the individual level, respondents who reported personal exposure to PCBs were asked "do you believe that you have or have not personally had negative health effects from exposure to PCBs?" Respondents stating they have had negative health effects were further asked an open-ended question to "please describe those negative health effects" and "how severe would you rate those negative health effects on a scale from 1 to 10, where 1 is very mild and 10 is very severe?"

Responses were weighted to correct for differences in the probability of selection[12] based on geographic stratification (West or East Anniston) and number of adults in the household. Additional poststratification weighting was applied to standardize to the 2000 Anniston census population proportions for sex, age, and race.

Results and discussion:
Demographics
83% of ACHS participants were West Anniston residents, 69% were female, and 52% were white. 23% were under age 40, 19% were age 40-49, and 54% were 50-79. Demographic differences in location, sex, race, and age were also examined between participants and non-participants to explore potential response bias. Participants and non-participants (those who were randomly selected but declined to participate) were similar in the proportions of males, 31.3% vs. 34.0%, and African Americans, 47.5% vs. 41.7%, respectively. However, more participants than non-participants were under 50 years of age (42.9% vs. 33.9%) and were from Western Anniston (83.3% vs. 73.4%).

Exposure Perception
Weighted results showed almost all respondents (95.6%) had heard of the term PCBs and, of those, 92.2% were aware of PCB contamination in Anniston. Overall, respondents rated PCB contamination in Anniston as quite

high (mean = 8.42) with 51.1% giving a rating of 10 (or very severe). PCB contamination in respondent's neighborhoods received a significantly lower mean rating of 6.34 ($p < .001$). Similarly, almost all respondents (91.3%) were aware of litigation in Anniston regarding PCBs, and of those who were aware, 39.4% have been involved in litigation. Of the 978 respondents who were aware of PCB contamination in Anniston, 64.1% believe they have personally been exposed to PCBs. For those respondents who thought they have been personally exposed to PCBs, the mean rating of exposure on the 10-point scale was 7.25, with 35.8% giving a rating of 10 or very high exposure.

Only about half of the respondents (53.2%) were aware of the health advisories for eating fish caught from local streams, while even fewer, 33.7%, were aware of the health advisories for working in home gardens.

Multiple linear regression was used to examine predictors of ratings of perceived PCB contamination in Anniston and in respondents' neighborhoods. The independent variables were place of residence, age (in years), sex, race, negative health effects, awareness of fish advisories, awareness of home garden advisory, blood measurement, soil measurement, litigation experience, length of residency, and contamination in neighborhood or Anniston. Ratings of PCB contamination in Anniston were significantly related to negative health effects, neighborhood contamination, and litigation experience (adjusted $R^2 = .323$). Ratings of neighborhood contamination were significantly related to place of residence, age, race, soil measurement, and Anniston contamination (adjusted $R^2 = .444$), with greater perceived neighborhood contamination among West Anniston residents, African Americans, and older participants.

Multiple linear regression was also conducted to assess predictors of ratings of personal PCB exposure severity. The independent variables for the for personal PCB exposure severity analysis included place of residence, age, sex, race, had negative health effects, rating of PCB contamination in Anniston, rating of PCB contamination in neighborhood, health effects on humans, blood measurement, soil measurement, and litigation experience. Ratings of perceived personal PCB exposure were significantly affected by place of residence, having negative health effects, rating of Anniston contamination, rating of neighborhood contamination, blood measurement, and litigation experience (adjusted $R^2 = .331$).

Health Effects Perception
Respondents gave high ratings of the severity of negative health effects of PCBs on humans (mean = 8.60, with 38.0% using the maximum severity rating of 10). Only 5% of the respondents rated the severity as less than 5. Respondents were asked if each of eight health problems in humans was related or unrelated to PCBs. A large proportion of respondents believed that PCBs were related to cancer (84.2%), birth defects (80.7%), and child development problems (80.6%) followed by reproductive problems (75.7%), asthma (69.0%), cardiovascular disease (66.4%), diabetes (56.0%) and lupus (56.0%).

The 627 respondents who indicated they were personally exposed to PCBs were asked if they had negative health effects as a result of the exposure. Two-thirds of those exposed (67.4%) felt they had suffered negative health effects. Multiple linear regression was used to assess predictors of ratings of negative health effects. The independent variables for ratings of negative health effects were place of residence, age, sex, race, rating of Anniston contamination, rating of neighborhood contamination, health effects on humans, blood measurement, soil measurement, and litigation experience. Rating of perceived negative health effects as a result of PCBs were significantly affected by place of residence, race, rating of Anniston contamination, and rating of neighborhood contamination (adjusted $R^2 = .333$).

The 423 respondents who said they had suffered negative health effects from PCB exposure were also asked an open-ended question to describe these effects. Respondents could report more than one condition. The most frequently mentioned health problems attributed to PCB exposure were breathing problems (29%), hypertension (15%), skin problems (14%), heart problems (13%), general sickness (11%), allergies (11%), diabetes (11%), arthritis (11%), mental health problems (10%), and cancer (10%).

Discussion

In general, about two-thirds of respondents felt they have been exposed to PCBs and that this exposure was at a high level. However, not everyone feels they have been exposed to PCBs, and many are not aware of health advisories regarding exposure sources such as local fish and home gardening. In April 2008 we held another public meeting to share preliminary results from the ACHS; PCB exposure sources and local health advisories were a major focus of that meeting.

About two-thirds of respondents reporting PCB exposure said they had experienced severe negative health effects as a result. The most frequently reported conditions resulting from PCB exposure were breathing problems, hypertension, skin problems, and heart problems. Previous research with objective exposure measures has shown associations of PCBs with cardiovascular disease[9] and with skin conditions[3]. However, an association between measured PCB exposure and breathing problems has not yet been demonstrated.

Residents in Anniston and in another community with high levels of PCB contamination believe that the toxicity of the pollutants is the cause of a variety of individual and community health problems.[13] Discrepancies between resident and expert perceptions regarding PCB exposures and health risks can suggest targets for health research, community education, and continued dialogue.

References:
1. US Environmental Protection Agency (2010); *FACT SHEET- Pathways Analysis Report OPERABLE UNIT 04 ANNISTON PCB SITE ANNISTON, ALABAMA.*
2. CBS News (2009); *Toxic Secret.* February 11.
3. Agency for Toxic Substances & Disease Registry (2000); *Toxicological Profile for Polychlorinated Biphenyls (PCBs).*
4. Sjoberg, L (1999); *Ambio.* 28(6): 543-9.
5. US Census (2007). *American Community Survey.*
6. Centers for Disease Control and Prevention (2004). *Behavioral Risk Factor Surveillance System Survey Questionnaire.*
7. Ware JE, Kosinski M, Keller SD (1996). *Medical Care* 34(3):220-33.
8. Derogatis, L (1975). *Brief Symptom Inventory.*
9. Goncharova A, Pavuk M, Foushee HR, Carpenter DO for the Anniston Environmental Health Research Consortium (2011). *Environ Health Perspect* 119(3): 319-25.
10. Silverstone AE, Weinstock RS, Rosenbaum PF, Foushee RS, Pavuk M for the Anniston Environmental Health Research Consortium (2009). *Organohalogen Compounds* 71: 1059-63.
11. Pavuk M, Olson JR, Sjodin A, Bonner M, Dearwent SM, Turner WJ, Needham LL for the Anniston Environmental Health Research Consortium (2009). *Organohalogen Compounds* 71: 1083-86.
12. Groves R, Fowler F, Couper M, Lepkowski J, Singer E, Tourangeau R (2009). *Survey Methodology, 2ⁿᵈ Edition*.
13. Hovander L, Linderholm L, Athanasiadou M, Athanassiadis I, Bignert A, Fangstrom B, Kocan A, Petrik J, Trnovec T, Bergman A (2006). *Environ. Science & Technol.* 40: 3696-703.