Anacostia River, Recreation, and Health: Is There an Association Between Limited-Contact Water Recreation and Adverse Health Outcomes?

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THE ANACOSTIA RIVER

- The Anacostia River has become extensively degraded over several decades as a result of poor management, littering and industrial and urban activities. A number of hazards, including legacy pollution sites, discharges of wastes and runoff of heavy metals and toxic compounds directly to the river's main stem have contributed to the highly contaminated state of the river. Toxic chemicals such as metals, Polycyclic Aromatic Hydrocarbons (PAHs), Polychlorinated Biphenyls (PCBs), and other compounds have been released from these facilities and other sites into the Anacostia River.

- Another major source of contamination for the river are the combined sewer overflows (CSOs) that discharge a combination of stormwater and sewage into the Anacostia River, Rock Creek, the Potomac River, and tributary waters during periods of significant rainfall. An estimated average 2 billion gallons of untreated sewage mixed with stormwater overflows from 15 CSOs into the Anacostia River each year, introducing a mix of fecal waste, bacteria and other pathogens into the river and exposing recreational users to these harmful microbial contaminants.

LIMITED CONTACT WATER RECREATION

- A large body of scientific literature exists which demonstrates associations between full contact water recreation such as swimming and reports of symptoms of gastrointestinal (GI) illness in recreational waters where fecal indicator organisms have been detected. However, little research into health risks of those who engage in limited –contact water recreation has been performed.

- Despite the river's high state of contamination, it is a haven for recreational activities, including kayaking, canoeing, boating, rowing, paddling and sport fishing. The chemical contaminants which persist in the sediment of the Anacostia and the wastewater from CSOs which introduces microbes, viruses, and pathogens to the river pose health concerns for these recreational users.

PURPOSE OF STUDY

The purpose of this study is to assess patterns of recreational use by limited-contact recreationalists of the Anacostia River and their related exposure and potential health risks. No research has been performed to assess exposure and health risks for limited-contact users of this region, particularly users of the Anacostia River. This study was formally termed Risks of Exposure to Community Recreational Enthusiasts: Anacostia Toxics in the Environment (Project RECREATE).

RESEARCH METHODS

1. Recruitment
- Study was marketed as Project RECREATE - Fliers and Q&A Sheets
- Anacostia Watershed Society (AWS) was enlisted as a study partner
- Dedicated Project RECREATE with study information and survey link
- Outreach directly to regional clubs/associations through emails
- Promotion by AWS – email listerv, official Facebook page and Twitter account

2. Survey
- Survey design was adapted from the US EPA's NEEAR study and the CHEERS study
- Survey was offered entirely online through the Qualtrics survey software
- Participants could take the survey on their own time (self-administered) or in-person with study team
- Study team visited recreational locations and events on the Anacostia River to recruit participants

3. Exposure Assessment
- Questions included type of recreational activities, frequency of recreation and duration of activities up to one year prior to taking the survey
- Participants were asked to evaluate their degree of water exposure experienced while recreating by region of the body (i.e., head, face, torso, upper extremity, and lower extremity)

4. Health Risks
- Respondents were asked to indicate whether they had experienced symptoms typically associated with GI illness.
- Additional questions focused on respiratory symptoms and diseases, smoking history, presence of other smokers in the household, use of alcohol, medical history, underlying disease and medication use.

5. Statistical Analysis
Basic statistical analyses were conducted using Qualtrics and logistic regression modeling was performed using SAS

RESEARCH FINDINGS

Figure 1. The Anacostia Watershed, Indicating its Span across Maryland and the District of Columbia
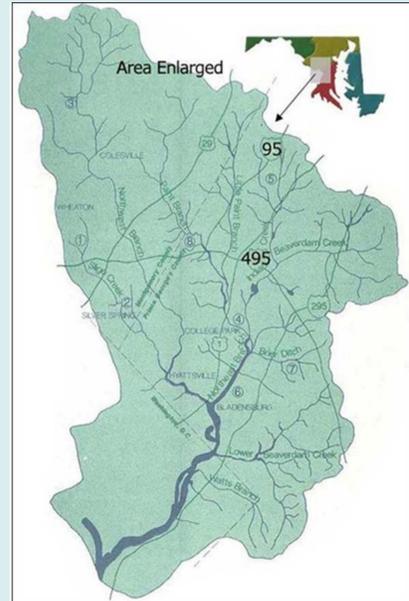

Figure 2: Map of the Anacostia River highlighting the toxic hotspots along the river
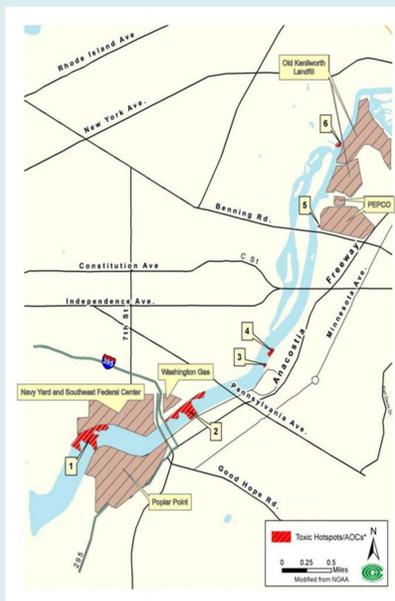
Table 1: Sociodemographic (SOD) Characteristics of RECREATE Participants

Sociodemographic Variables	Category	Recreate in the Anacostia River (n=151) No. (% of n)	Do not recreate in the Anacostia River (n=46) No. (% of n)
Gender	Male	61 (40)	16 (35)
	Female	90 (60)	29 (63)
Race/Ethnicity	White / Caucasian	93 (61.59)	23 (50.0)
	Non-White	58 (38.41)	23 (50.0)
Age (years)	18-29	36 (23.85)	17 (36.96)
	30-44	52 (34.43)	15 (32.61)
	45-54	28 (18.54)	11 (23.91)
	55+	35 (23.18)	3 (6.52)
Marital status	Single	73 (48.99)	30 (68.18)
	Married	55 (36.91)	12 (27.27)
	Other	21 (14.1)	2 (4.54)
Education	Less than High School	2 (1.32)	1 (2.22)
	Finished High School	5 (3.31)	5 (11.11)
	Some College	17 (11.26)	8 (17.78)
	College Degree or Greater	127 (84.11)	31 (68.89)
Annual household income	< $20,000 - $49,999	24 (17.38)	5 (13.89)
	$50,000 - $89,999	45 (32.61)	8 (22.22)
	$90,000 - $129,999	33 (23.91)	5 (13.89)
	> $130,000	36 (26.09)	7 (19.44)

Table 2. Frequency of Symptoms Associated with GI Illness in Recreational Users vs. Non-Users of the Anacostia River

		Recreational Users	Non-users
		Number (% of users)	Number (% of non-users)
Symptom experienced within the last 12 months	Diarrhea	37 (24.83)	9 (19.6)
	Vomiting	28 (18.79)	6 (13.0)
	Dizziness	23 (15.54)	8 (17.4)
	Nausea	35 (23.49)	10 (21.7)
	Skin Rash	12 (8.05)	1 (2.2)
	Lung Irritation	46 (30.87)	8 (17.4)

Table 3. Adjusted Odds Ratio (OR) and 95% Confidence Interval (CI) Estimates for Symptoms Experienced by Users and Non-Users of The Anacostia River by Specific Sociodemographic Characteristics

Variable	Category	Diarrhea OR (95%CI)	Vomiting OR (95%CI)	Dizziness OR (95%CI)	Nausea OR (95%CI)	Skin Rash OR (95%CI)	Lung Irritation OR (95%CI)
Recreation							
	Non-User	1.00	1.00	1.00	1.00	1.00	1.00
	User	2.21 (0.91, 5.35)	0.97 (0.36, 2.63)	1.22 (0.49, 3.03)	1.53 (0.63, 3.75)	1.17 (0.43. 3.20)	2.52 (0.45, 14.16)
Gender							
	Female	1.00	1.00	1.00	1.00	1.00	1.00
	Male	1.36 (0.67, 2.78)	1.50 (0.58, 3.89)	4.44 (1.73, 11.41)	2.50 (1.10, 5.69)	0.76 (0.34, 1.71)	3.16 (0.76, 13.07)
Age							
	18-24	1.00	1.00	1.00	1.00	1.00	1.00
	25-29	1.39 (0.35, 5.56)	1.93 (0.39, 9.63)	1.10 (0.22, 5.41)	1.16 (0.28, 4.73)	1.12 (0.22, 5.81)	2.57 (0.16, 40.23)
	30-34	1.31 (0.34, 5.06)	3.16 (0.71, 14.11)	2.78 (0.64, 12.04)	1.42 (0.37, 5.50)	1.75 (0.38, 8.18)	4.65 (0.35, 62.06)
	35-44	1.10 (0.32, 3.79)	0.42 (0.08, 2.13)	1.00 (0.26, 3.80)	0.67 (0.19, 2.36)	0.93 (0.21, 4.16)	1.65 (0.14, 19.60)
	45-54	0.90 (0.27, 3.07)	0.49 (0.11, 2.19)	1.29 (0.36, 4.57)	0.73 (0.22, 2.49)	0.82 (0.18, 3.66)	2.57 (0.22, 30.06)
	55+	0.72 (0.20, 2.60)	0.45 (0.09, 2.34)	0.80 (0.20, 3.15)	0.53 (0.14, 1.95)	1.35 (0.30, 6.02)	2.38 (0.48, 59.94)
Ethnicity							
	White	1.00	1.00	1.00	1.00	1.00	1.00
	Non-white	1.36 (0.66, 2.78)	0.61 (0.25, 1.49)	0.43 (0.19, 0.99)	0.50 (0.23, 1.08)	0.77 (0.33, 1.79)	0.48 (0.12, 1.97
Education							
	≥ College Education	1.00	1.00	1.00	1.00	1.00	1.00
	< College Education	1.16 (0.45, 2.93)	3.73 (1.27, 10.92)	2.65 (0.98, 7.20)	1.87 (0.72, 4.89)	0.78 (0.25, 2.43)	1.16 (0.20, 6.67)
Smoking							
	Non-smoker	-	-	-	-	-	1.00
	Smoker	-	-	-	-	-	0.87 (0.05, 15.43)

Note: All diseases/symptoms investigated were adjusted for the following variables: Age, gender, race/ethnicity and education. Additionally, Lung irritation was also adjusted for smoking status

RESEARCH FINDINGS

- A total of 227 people attempted the survey and 197 individuals completed the survey (completion rate of 52%). 151 individuals participate in limited-contact recreation on the Anacostia River (at least once within the last year) while 46 did not recreate.

- Most recreational users (40%) reported limited recreation on the river spanning 1-5 years while 29.3% participated for less than one year. Another 20.6% reported participating in recreational activities for a period between 5-19 years. 4% of users have recreated on the Anacostia River for 20-24 years and 6% reported participating in recreational activities for more than 25 years.

- The most popular form of limited-contact water recreation on the Anacostia River was found to be canoeing (43.0%), followed closely by boating (41.5%), rowing (36.3%), kayaking (35.6%), paddling (21.1%), sailing (9.6%) and fishing on a pier/shore (9.6%) or on a boat (7.4%).

- Table 2 indicates that approximately 30.9% of recreational users reported having diarrhea within the last 12 months, 24.8% experienced nausea, 23.5% experienced dizziness, 18.8% reported a skin rash, 15.5% experienced vomiting and 8.05% reported experiencing lung irritation.

- Table 3 shows statistically significant associations between educational attainment and symptoms of vomiting, and associations also exist between gender and symptoms of dizziness and nausea.

- The results indicate that recreational users without a college education had higher odds of experiencing vomiting (OR= 3.73; 95% CI, 1.27-10.92).

- Male participants who recreate also had a higher odds of experiencing symptoms of dizziness (OR= 2.50; 95% CI, 1.10-5.69) and nausea (OR=2.50; 95% CI, 1.10, 5.69) compared to female recreational users.

CONCLUSIONS

- Recreational users in this study experienced symptoms related to GI illness; however, these symptoms cannot be conclusively associated with exposure to microbial contaminants in the Anacostia River as further investigation into actual exposure and environmental analyses are required.

- Statistically significant associations were detected between certain sociodemographc variables and symptoms of vomiting, dizziness and nausea. Further investigation is required to determine their true meaning.

FUTURE RECOMMENDATIONS

- The use of biomarkers to compare body burden of chemical contaminants for populations of users and non-users using a prospective cohort study design.

- Investigation of not only user symptoms, but also level of symptom severity. Collection of personal and environmental water samples following a rain event will be included, as microbial levels are known to be particularly high in the river after such an event as a result of the CSO system.

- Development of a system to provide daily water quality information to recreational users, such as if levels of microbial and chemical contaminants that may pose a threat to the health and safety of users are within safe limits for recreation.

PUBLIC HEALTH SIGNIFICANCE

This pilot research investigated important features of limited-contact water recreational user exposure and health outcomes in the Anacostia River watershed. Given the high level of contamination known to be present in the river and the popularity of its use for recreation, this work has important implications for the health of river recreationalists.

ACKNOWLEDGEMENTS