



Expanding perceptions of subsistence fish consumption: Evidence of high commercial fish consumption and dietary mercury exposure in an urban coastal community ☆☆☆

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ABSTRACT

Through collaborative partnerships established between current researchers and The Moton Community House (a local community center), African American women (ages 16–49 yrs) from the Southeast Community of Newport News, Virginia, USA were surveyed to assess the reproducibility and consistency of fish consumption patterns (ingestion rates, exposure frequencies, weight, and fish consumption rates) derived from a community-specific fish consumption survey. Women were also surveyed to assess the reliability of the survey responses, and to estimate daily mercury intake. Fish consumption patterns were reproducible and the survey responses were reliable. Comparison between years revealed that fish consumption patterns remained consistent over time. In addition, the high fish consumption rate estimated in 2008 (147.8 g/day; 95% CI: 117.6–185.8 g/day) was confirmed with a rate (134.9 g/day; 95% CI: 88–207 g/day) not materially different and still considerably higher than mean fish consumption rates reported for U.S. women. Daily mercury intake rates were estimated using consumption data from 2008 and three consumption scenarios (canned white, canned light, and no tuna) due to confirmed differences in mercury concentration between canned white and light tuna. Arithmetic mean daily mercury intake rates were 0.284 µg/kg bw/day (95% CI: 0.229–0.340 µg/kg bw/day) using canned white tuna, 0.212 µg/kg bw/day (95% CI: 0.165–0.259 µg/kg bw/day) using light tuna, and 0.197 µg/kg bw/day (95% CI: 0.151–0.243 µg/kg bw/day) using no tuna. Approximately 58%–73% of the daily mercury intake rates for African American women in the Southeast Community exceeded US EPA's oral reference dose (RfD) of 0.10 µg/kg bw/day for mercury. In addition, 2% of the rates exceeded a level (1.00 µg/kg bw/day) documented to produce adverse health effects. Past and current investigations confirmed that even though women in this community were not subsistence fishers, they are subsistence fish consumers.

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1. Introduction

The estimation of finfish and shellfish (further referred to as fish) consumption and contaminant exposure in US subpopulations (e.g. subsistence fishers, ethnic minorities, or recreational anglers) can be

greatly influenced by an assessor's perception and the selection of parameter values used to estimate exposure; especially, in subpopulations where peer reviewed publications and exposure data are limited, and an assessor is left to their own “best” judgment. Due to limited exposure data for certain US subpopulations (e.g., ethnic minorities), Federal and State default values are often used when estimating fish consumption and contaminant exposure (e.g. mercury, polychlorinated biphenyls, or endocrine disrupters) in these populations. However, more thought and consideration needs to be given when selecting such values because they typically are not reflective of many US subpopulations and are based on both consumers and non consumers of fish as opposed to only fish consumers (National Environmental Justice Advisory Council (NEJAC), 2002). For Federal and State assessors, narrowly held perceptions of certain subpopulations could lead to incorrect assumptions of fish consumption and contaminant exposure that in turn could result in environmental policies and standards that do not effectively protect these subpopulations.

Subsistence fishers are generally defined as those that rely on non-commercially caught fish as a major source of protein to their diet (US

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Environmental Protection Agency (US EPA, 2000a, 2000b). In the US, subsistence fishers represent subpopulations that are potentially highly exposed to contaminated fish and exhibit the highest fish consumption rates reported, as suggested by US EPA's default consumption rate for subsistence fishers (142.4 g/day) and peer reviewed publications (Toy et al., 1996; Sechena et al., 1999, 2003; Duncan, 2000; Judd et al., 2004). The high fish consumption rates exhibited by subsistence fishers strongly support the use of the adjective "subsistence" in describing their fish consumption patterns; although, subsistence fish consumers are often only thought of as individuals with high consumption rates who "fish" for, instead of "purchase," fish. This perception of subsistence fish consumers (and consumption), currently held by many exposure and risk assessors, stymies the use of the adjective "subsistence" to also describe subpopulations that do not fish but whose consumption of fish provides a major source of protein to their diet, is commercially purchased, and is comparable to that of subsistence fishers. Recently we suggested that currently held perceptions of subsistence fish consumers (and consumption) be broadened to include other subpopulations populations with comparable subsistence fish consumption patterns and contaminant exposures (Holloman and Newman, 2010). We define subsistence fish consumers broadly as those who rely on noncommercially caught or commercially purchased fish as a major source of protein in their diets (Holloman and Newman, 2010).

In 2004, the US EPA and Food and Drug Administration (US FDA) jointly developed fish consumption advice for one specific contaminant, mercury (US EPA/FDA, 2004). This joint effort reflected an understanding that human exposure to mercury contaminated fish involves the consumption of both commercial and noncommercial items. Mercury poses a human-health risk because of the adverse neurodevelopmental effects that have been linked with exposure. Methylmercury (MeHg), the predominant form of mercury associated with fish, is known for its neurotoxicity and developmental toxicity (National Research Council (NRC), 2000; Castoldi et al., 2008). In addition, some studies have linked methylmercury exposure from fish consumption to cardiovascular toxicity (Salonen et al., 1995; Guallar et al., 2002; Virtanen et al., 2005; Roman et al., 2011) while others have found no associations (Ahlgqvist et al., 1999; Hallgren et al., 2001; Yoshizawa et al., 2002; Mozaffarian 2009; Mozaffarian et al., 2011). To protect humans against chronic and developmental mercury toxicity, US EPA developed an oral reference dose (RfD) of 0.10 µg/kg bw/day, an estimate of a daily oral exposure that is likely to be without an appreciable risk of adverse health effects over a lifetime (US EPA, 2001a, 2001b).

In the US, African Americans represent a subpopulation whose dietary mercury exposure may potentially be underestimated due to misperceptions about subsistence fish consumption. Numerous studies continue to report that African Americans have higher fish consumption rates and associated contaminant exposures than the general US population or other subpopulations such as recreational anglers (e.g., Burger et al., 1999, 2001; Mahaffey et al., 2004; Gibson and McClafferty, 2005; Derrick et al., 2008; Shilling et al., 2008; Mahaffey et al., 2009; McGraw and Waller, 2009; Holloman and Newman, 2010; Shilling et al., 2010). However, peer-reviewed publications remain limited regarding African American fish consumption patterns and contaminant exposures (Weintraub and Birnbaum, 2008; Derrick et al., 2008; McGraw and Waller, 2009; Holloman and Newman, 2010) and cultural and lifestyle factors influencing such exposures (Beehler et al., 2001; Cecelski, 2001; Weintraub and Birnbaum, 2008).

Through collaborative partnerships established between current researchers and a local community center (The Moton Community House), a community-based participatory research (CBPR) approach was used to explore fish consumption and dietary mercury exposure for African American women of childbearing age (ages 16–49 yrs) residing in the Southeast Community of Newport News, Virginia, USA.

During April and May 2008, we administered a community-based fish consumption survey to African American women ($n = 95$) for the purpose of estimating fish consumption patterns (Holloman and Newman 2010). Our results suggest that even though African American women in this community are not subsistence fishers, they are subsistence fish consumers and that their consumption of commercially purchased items is high enough to warrant concerns of dietary mercury exposure (Holloman and Newman, 2010).

The goals of the present investigation were to confirm that the consumption survey used to estimate fish consumption patterns was reproducible and to estimate dietary mercury exposures for African American women (ages 16–49 yrs) residing in the Southeast Community of Newport News, Virginia. Specific objectives were to: 1) assess the reproducibility of the East End Fish Consumption Survey, 2) quantify the reliability of the responses used to estimate fish consumption rates, 3) assess the consistency of fish consumption patterns in the community, 4) determine mercury concentrations in commonly consumed fish items, and 5) generate deterministic (point) estimates of daily mercury intake. We hypothesized that fish consumption rates for African American women in the Southeast Community were greater than US EPA default values. We also hypothesized that daily mercury exposures, as well as percentage of the population exceeding US EPA's oral RfD for mercury, for African American women in this community were higher than reported estimates and exceedances for general US women.

2. Materials and methods

2.1. Survey design

The 2010 East End Fish Consumption Survey was based on the consumption survey administered during April and May 2008 (Holloman and Newman, 2010). The East End Fish Consumption Survey was designed to estimate the ingestion rate (IR, g/meal), exposure frequency (EF, meals/year), and consumption rate (CR, g/day) of individual fish (fin-fish and shellfish) items consumed by, and the body weight (Wgt, kg) of, low-income African American women residing in the Southeast Community of Newport News, Virginia, USA. Methods previously published (Holloman and Newman, 2010) were used in determining IR, EF, and CR for the current survey. All questions asked in the 2008 survey were included in the 2010 version of the East End Fish Consumption Survey.

Changes in the 2010 version of the East End Fish Consumption Survey included the use of different visual aids, clarification of cooking methods, and an additional question used to quantify reliability of responses. It was noted that the validity of the estimates (i.e., Wgt, IR, EF, and CR) was important but was not quantified due to limited resources. In the current survey, 68 new individual fish items were vacuum sealed and used based on visual aid methods previously published (Holloman and Newman, 2010). For clarification of cooking methods, the same questions asked in 2008 were asked in the current survey but separately for fish and shellfish. To assess the reliability of the responses given by the participants, they were asked initially to state consumption information for all fish items they listed. Then at the end of the survey, they were asked to restate consumption information pertaining specifically to the first fish item listed. A measure of concordance between the two responses (beginning and end) was determined and used as a relative measure of reliability in responses given by the participants.

2.2. Sample size and recruitment

The number of women used to assess the consistency of fish consumption and reproducibility of the East End Fish Consumption Survey was based on confidence interval precision using SAS PROC POWER (Version 9.2 software; SAS Institute Inc, Cary, NC). We were interested in confidently detecting a difference between 2010 estimates for IR, EF, and Wgt that was at most, 30% of the 2008 mean estimates. Because

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