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Fishing and Fish Consumption Patterns in the Gullah/Geechee Sea Island Population

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FISHING AND FISH CONSUMPTION PATTERNS IN THE GULLAH/GEECHEE SEA ISLAND POPULATION

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DEDICATION

I dedicate this work to my husband, Tyrone, who has remained my best friend, my counselor, and my love through every journey we have ever made together. To my children, Jameson, Jaelyn, and Justin, you are the most incredible people I know. Your passion for life and the things you love make me always want to reach for the stars. I am so thankful to be your mother. To my parents, Jim and Lil, who make me believe that I can do anything of greatness. Thank you for always seeing the best in me. You are the best parents anyone could have. To Cathey, my mother-in-law, thank you for the constant stream of encouragement and prayers. You provided quiet strength when I needed it most. To Miss Nettie, there really are no words to capture everything you have been to our family during this endeavor. Your patience, wisdom, and support have been immeasurable. To Eddie Ganaway, though you sleep, I will forever be grateful. You will always be an inspiration to me. Lastly, to my precious grandparents, Zacheus, Julie, James, and Nora who instilled in me a deep love for God, family, and our environment.

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ABSTRACT

The Gullah/Geechee (G/G) people are descendants of West African slaves who remained in seclusion on the Sea Islands of South Carolina (SC), North Carolina, Georgia, and Florida until the end of the Civil War in 1865. Today, the Gullah-speaking population is over 700,000 and no longer limited by geographical or externally-imposed social boundaries. In addition to retaining their unique cultural language as well as traditions surrounding crafts and the arts, they also remain largely a fishing subsistence population. Decades of urban development have reduced the G/G population's access to traditional fishing locations and have increased exposures to environmental contaminants in some bodies of water that are frequently fished by the G/G.

Approximately 98.4% of SC rivers and streams and 77.6% of lakes have been assessed for aquatic use support (including consumption safety) regarding impacts of mercury to water bodies; and 100% of bays and estuaries have been assessed for aquatic life use support. Fish advisories have been placed on 63 of the water bodies that serve as dietary fish sources in Beaufort, Charleston, and Colleton counties (the study area). Prior to the current research, it was unclear if the fish species listed in the fish advisories were the most commonly consumed in large quantities by the G/G population. This study explored fishing and fish consumption patterns, how these patterns influenced methylmercury (MeHg) exposure levels, and the awareness of fish advisories in the

South Carolina G/G population. It also tested the null hypothesis that there was no statistical difference between the estimated exposures to MeHg in the African American (AA) Sea Island population and the 2009-2010 NHANES MeHg exposures reported for the general U.S. population. This was the first study to explore motivations for fishing and fish consumption choices of G/G and AA Sea Island men and women in the South Carolina Lowcountry. Our findings indicated that both rural and urban participants are motivated to fish primarily by influences from childhood fishing experiences and the desire to preserve fishing and fish consumption practices that are considered a part of the culture in this population. Both groups indicated that preserving fishing traditions as a part of the culture was important. Rural participants made more reference to income and livelihood (for survival) as being a key motivation for fishing and as playing a central role in the G/G heritage. Therefore, income was not only considered a general motivation for fishing, but also a part of the community that is grounded in cultural beliefs and traditions.

Similar seafood consumption patterns were observed between the G/G/AA study group and the 2009-2010 NHANES population, with both groups sharing 7 of 11 of the most commonly consumed species and both frequently consuming canned fish, including tuna and salmon. Based on the mathematical model presented in this work, the mean blood mercury level in the G/G population was predicted to be 0.0002µg/L (range 3.4 x 10-5 – 0.003 µg/L) versus 0.2695 µg/L in the 2009-2010 NHANES population (range 0.25-0.64 µg/L) once outliers were removed. Further research is recommended which focuses on shark consumption, canned seafood consumption, and seafood consumption levels for women and children in the G/G/AA population.

Since confusion between fish advisories and fishing regulations was consistent, particularly in rural areas, education is needed to better inform G/G and AA Sea Island communities about fish and seafood that could potentially expose them to elevated levels of MeHg. Providing clear and culturally tailored health messages regarding existing fish advisories will allow the population to make informed choices about fish consumption that will minimize potential exposures to MeHg. Health messages should clearly delineate the scope of fishing regulations from fish consumption advisories. A G/G/AA mercury risk model was developed to guide fish consumption patterns in the SC Sea Islands.

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List of Abbreviations

AA.....African American

ANCSA..... Alaska Native Claims Settlement Act of 1971

ANILCA .....Alaska National Interest Lands Conservation Act of 1980

BHg..... Blood mercury

CNS..... Central Nervous System

DHA.....docosahexaenoic acid

G/G.....Gullah/Geechee

GGCHC..... Gullah/Geechee Cultural Heritage Corridor

Hg.....Mercury

Hg^{o} ..... Elemental Mercury

Hg (II) ..... Inorganic Mercury

LCPUFA ..... Long chain polyunsaturated fatty acid

LOAEL .....Low Observed Adverse Effect Level

MeHg ..... Methylmercury

MSFCMA .....Magnuson-Stevens Fishery Conservation and Management Act

NAI .....Native American Indian

NHANES ..... National Health and Nutrition Examination Survey

NOAA .....National Oceanographic and Atmospheric Administration

RfD.....Reference Dose

SC..... South Carolina

NOAEL .....No Observed Adverse Effect Level

Ppm .....Parts per million

SCDHEC..... South Carolina Department of Health and Environmental Control

SRS .....Savannah River Site

TMDL .....Total Maximum Daily Loads

µg ..... Microgram

UNFAO..... United Nations Food and Agriculture Organization

U.S. ..... United States

U.S. EPA..... United States Environmental Protection Agency

U.S FDA ..... United States Food and Drug Administration

WFT .....World Fisheries Trust

WHO .....World Health Organization

CHAPTER 1

INTRODUCTION

A Glimpse Into Gullah Culture

"Fishing is the heart of the Gullah Geechee people."

-Marquetta Goodwine, Chieftess of the Gullah/Geechee Nation, 2010

The roots of the Gullah/Geechee (G/G) culture are anchored within the annals of slavery, bearing witness to a heritage that has endured the changing environmental and social climates that have evolved around the G/G culture for more than a century. During the seventeenth and eighteen centuries, European English plantation owners earned fortunes through slave labor in rice fields along the western coast of Africa, enough to finance fleets of English trade ships (Wood, 1974). Slaves from West African countries, including Sierra Leone, Senegal, Angola, and Liberia, mastered the survival of rice, cotton, and indigo crops despite extreme climatic conditions (Pollitzer, 1999; Tibbetts, 2000). In an effort to capitalize on this success, plantation owners in the coastal region of South Carolina (SC), United States (U.S.), increasingly sought to purchase slaves from Sierra Leone, commonly referred to as the "Windward Coast" where rice production thrived in the midst of drought conditions and tornado seasons (Wood, 1974). The demeaning and oftentimes brutal labor endured by the West African slaves significantly

contributed to the wealthy plantation economy that thrived in the southeastern U.S. for more than 200 years (Gallay, 2008).

In 1787, the U.S. Constitution brought to an end the act of importing or transporting humans for the purpose of slavery. On January 1, 1808, the United States abolished its slave trade from Africa. The transport and sale of Africans to the Sea Islands of SC persisted for more than fifty years after the official prohibition of slavery until the commencement of the Civil War in 1861 (Greaves, 2010). Post Civil War, the G/G remained in geographical and social isolation as self-sufficient farmers and fishers, retaining many of the cultural beliefs and traditions that were practiced during and prior to the Civil War era (Tibbetts, 2000, Brown, 2004). Gullah/Geechee slaves and descendants developed and retained a unique language as a result of this isolation (Pollitzer, 1999). Some researchers have reported that the Gullah language originated from an African tribe in Liberia known as the "Gola" (Jarrett, 2003), while others have suggested strong ties to Sierra Leone and influences from other West African countries (Brouwer, 1995). Most studies have reported that the Gullah language originated in West Africa. Other traditions maintained by the G/G include handcrafts such as sweetgrass basket weaving, cast net fishing, and the syncopated spirituals which continue to fill the sanctuaries of churches throughout the Lowcountry (Appiah et al., 2008; Baiocchi, 2008).

The 1950s ushered in an era of tourism and commercial development in coastal SC that not only exploited and diminished the cultural contributions and relevance of the Gullah population to the historical appeal of Charleston; but it also marked the beginning of large-scale displacement of Gullah residents from their coastal and urban homes in an effort to capitalize on the burgeoning coastal real estate industry (Hargrove, 2009). In

1999, the G/G population solicited help from the United Nations to address the ongoing and increasing issues related to encroachment on and loss of land by Gullah families (Jarrett et al., 2002). This led to the formation of a National Park Service (NPS) study that resulted in the introduction by SC Congressman Jim Clyburn of the Gullah/Geechee Cultural Preservation Act. This act designated all barrier islands and adjacent coastal cities from Wilmington, North Carolina to Jacksonville, Florida and 30 miles inland as the Gullah/Geechee Cultural Heritage Corridor (GGCHC) (NPS, 2011). The NPS and the United States Department of the Interior manages the GGCHC and has established goals of recognizing key G/G contributions to the greater coastal communities in which they live and of preserving G/G history through public education programs.

Today, the Gullah-speaking population numbers greater than 700,000 (Pollitzer, 1999) and is no longer limited by geographical or externally-imposed social boundaries. The rich and complex details of the Gullah population's religious beliefs, social interactions, craftsmanship, and other traditions have captivated anthropologists for decades. Over the past decade, a growing interest from the medical research field in Gullah health exposures and outcomes has brought a renewed curiosity about the Gullah population. Of particular interest is that the Gullah population has maintained a relatively low level of admixture with the Caucasian population (~3.5%), making them the most genetically homogenous African American (AA) group in the U.S. (Garvey, et al., 2003). Genetic and environmental determinants of complex diseases can be more easily identified and better understood when evaluating them in a homogenous genetic pool; this is because admixture of different populations complicates the ability of scientist to trace genetic dispositions back to specific gene sequencing that may be more prevalent in

one race or ethnic group than another (Xu et al., 1997). Factors such as genetic homogeneity, shared dietary patterns and clustering of certain diseases have made the Gullah population one of significant interest to the scientific community (Divers et al., 2010). Health disparities and environmental exposure studies have been based on racial and ethnic models that fail to consider the local dynamics of a population (Jackson, 2008), including cultural, geographic, and socioeconomic factors. Over the past decade, epidemiological studies have shed light on disparities such as Type 2 diabetes prevalence, periodontal disease and oral health effects on diabetes (Fernandes et al., 2009; Yuen et al, 2009; Bandyopadhyay et al., 2010), and the prevalence of lupus in the G/G population (Kamen et al., 2008, Gilkeson et al., 2011). Studies assessing environmental exposures as potential determinants of health outcomes in the G/G population are limited (Table 1.1).

Table 1.1 Gullah population health studies

Study	Primary focus	Methods	Findings
Fernandes et al., 2009; Yuen et al., 2009; Bandyopadhyay et al., 2010	Prevalence of periodontal disease	Diabetes control assessed by % of glycosylated hemoglobin, periodontal status determined; Compared to NHANES data	Diabetes control not associated with periodontal disease
Kamen et al., 2008; Gilkeson et al., 2011;	Systemic lupus erythematosus	Assessed the prevalence of lupus and levels of vitamin D in young women in the two cohorts	Similar prevalence of serum antinuclear antibodies in two cohorts
Johnson-Spruill et al, 2009	Self-management of Type 2 diabetes	Descriptive statistics used to analyzed self-management practices	Diabetes self-management behaviors inconsistent with ADA recommendations
Marlow et al., 2011	Serum albumin and root caries in type 2 diabetes patients	Evaluated associations between root caries and serum albumin concentrations	No association between serum albumin

Notes: ADA = American Diabetes Association.

G/G people have historically relied on subsistence fishing as a primary source of protein (Smith, 1991, Jarrett, 2003; Hurley, et al. 2008), but decades of urban development have reduced G/G access to traditional fishing locations and have increased exposures to environmental contaminants in some bodies of water that are frequently fished by the G/G. This has presented another challenge to the Gullah population since fishing is an important part of the culture. Exposure to environmental contaminants through fish consumption may be a concern based on the frequency with which the G/G population consumes fish and seafood (Danielson et al., 1995). Marquetta Goodwine,

Chieftess of the G/G Nation stated in a 2010 interview (Smith, 2010), "We know our culture can only be sustained if the estuaries and marshes where we fish are healthy—and if we have access to the water." She continued to state that "fishing is the heart of the G/G people." Research suggests that AA subsistence fishers in the Southeastern United States may be more likely to consume larger amounts of fish (Burger et. al., 1999), potentially exposing them to higher levels of the neurotoxin methylmercury (MeHg). This is particularly the case for known subsistence populations like the G/G who also live in areas that continue to undergo development. Numerous studies have been conducted on the effects of acute and toxic exposure to MeHg through various media; however, the levels of exposure to MeHg through fish consumption in the G/G population have not been researched. The purpose of this dissertation was to explore fishing and fish consumption patterns in the G/G and African American Sea Island population. The rationale for this research was to add to the research a better understanding of G/G fishing and fish consumption patterns and exposure to MeHg in the G/G population based on fish consumption choices.

Specific Aims

The specific aims (SA) and respective research questions (RQ) of this study were:

Specific Aim 1: To explore fishing and fish consumption patterns within the G/G & AA Sea Island population.

RQ: How does culture influence fish consumption in the Gullah population?

Specific Aim 2: To evaluate awareness of the current SC fish consumption advisories and determinants of fish consumption.

RQ1: What factors predict fish consumption choices in the G/G and AA population?

RQ2: How does the level of awareness regarding the state fish advisories impact fish consumption choices?

Specific Aim 3: To evaluate MeHg exposure through fish consumption using mathematical modeling.

RQ1: What are the levels of exposure to MeHg through fish consumption in the G/G population?

RQ2: Is there a statistical difference between the estimated exposures to MeHg in the G/G and AA and 2009-2010 NHANES population?

CHAPTER 2

LITERATURE REVIEW

Perspectives of Global Subsistence Fish Consumption and Potential Exposures to Methylmercury

Mercury (Hg) is a heavy metal which is released into the environment from both natural sources (50%) such as volcanoes, rocks, and soil and anthropogenic sources (50%) like coal-fired power plants, gold mines, and smelters (Hansell et al., 2006). Human exposure to Hg occurs in three common forms: elemental mercury (Hg°), inorganic mercury (Hg (II)), and organic methylmercury (MeHg) (Clarkson, 1997). Hg° is often referred to as quicksilver and is most commonly presented to humans through occupational activities or dental amalgams. Although there are rare cases of systemic poisoning due to ingestion or leaks from ileus patients being treated for bowel-obstruction, Hg° is not typically associated with chronic illness or death (Clarkson and Magos, 2006). Other inorganic forms of Hg include mercurous Hg, which was used historically in laxatives, teething powders, and antiseptic products and mercuric Hg, frequently used in skin lightening creams (Clarkson et al., 2006). Mercury vapor is stable in the atmosphere, but is quickly distributed throughout the bloodstream once it is inhaled. MeHg is an organic form of mercury which targets the central nervous system and is particularly harmful to unborn and infant children and

to adults who have been acutely exposed to high levels of the constituent (Grandjean et al., 2003). In humans, fish consumption is the major route of exposure for MeHg (Swain et al., 2007; Zhang et al. 2009).

MeHg is ubiquitous in aquatic ecosystems (Weber, 1993, Bravo et al., 2009, Ward et al., 2010) due to methylation of inorganic Hg by microorganisms in aquatic environments. In sediments that are depleted of oxygen, inorganic Hg (II) is converted to MeHg by anaerobic bacteria, including sulfate-reducing bacteria (the primary methylators) and iron-reducing bacteria (Ullrich et al., 2001). Methylmercury is passed up the food web through the benthic and pelagic food webs. As MeHg continues up the food chain to the largest piscivorous fish, concentrations continually increase in the lean muscle tissue in a process known as biomagnification. Most MeHg is not excreted, while inorganic Hg (II) can be excreted. For this reason, piscivores are often considered the most reliable indicators of mercury pollution in aquatic systems (Koli et al. 1977). Larger and older fish absorb more MeHg as they eat other fish (OEHHA, 2007). Human intake of MeHg through fish consumption depends on the quantity and type of fish species consumed (Clarkson et al. 2006; Pereira et al. 2009).

Historical Cases of Acute Methylmercury Exposure

The first recorded acute exposures to organic Hg took place in the 19th century when a physician named George Nelson Edwards observed abnormal neurological symptoms following laboratory accidents in which three technicians were exposed to dimethylmercury in the lab (Edwards, 1865; Clarkson et al., 2003a). Two of the technicians died within a month of exposure; the third eventually had a full recovery. Although the results from this incident were well documented and publicized, they were

considered anomalies and subsequently forgotten (Grandjean et al., 2010). In 1953, the first reported MeHg poisoning by consumption of fish occurred in Minamata, Japan. The Chrisso Corporation, a fertilizer and petrochemical company dumped Hg into the Minimata bay which dispersed into the Shiranui Sea (Tamashiro, 1984, Grandjean et al., 2010). Minamata was a small town in which most people earned a living in the fishing industry (Harada, 1995). Epidemiological studies suggest that people on the coast of the Shiranui Sea were affected by long-term dietary exposures through fish consumption to MeHg, many developing severe central nervous system damage, eventually succumbing to the disease (Ninomiya et al., 1995).

During the Minamata release, Hg poisoning was responsible for symptoms associated with Fetal Minamata Disease, including abnormal reflexes, impaired speech patterns, and seizures, in approximately 7% of children who experienced elevated levels of prenatal Hg exposure through maternal fish consumption. Adverse health outcomes associated with Hg exposures were significantly greater in fetuses than in their mothers. Peripheral neuropathy, speech disorders, tremor, lack of voluntary muscle coordination, gait disturbance, visual and audio impairment, forgetfulness and fatigue were included in a suite of symptoms used in combination to identify Minamata Disease in adults (NRC, 2000). Minamata was the first large-scale toxicological release of MeHg.

During the winter of 1971, a large shipment of wheat coated with MeHg fungicide was shipped to a rural Iraqi village to be used as seed grain. Although there were markings on the wheat packages, warning users of the dangers associated with consumption of the grain, they were presented in Spanish and incomprehensible to the Arabic farmers. The wheat was ultimately washed to remove red dye (known in western

countries as a warning) and used to bake bread throughout the community. There were no immediate effects, but within a month of exposure, people began to experience paresthesia, ataxia, and loss of vision (Clarkson et al., 2006). Ultimately, 6,530 Iraqis experienced adverse neurological effects and 459 others died as a result of consuming the tainted seed grain (Kuban et al., 2009). In 1995, the U.S. Environmental Protection Agency (U.S. EPA) developed a reference dose (RfD) for MeHg intake which was based on the MeHg poisoning episode in Iraq (U.S. EPA, 1995). Data on adverse neurological effects in Iraqi infants were used to derive the RfD of 0.1 µg/kg/day (0.0001 parts per million, ppm). The Iraqi poisonings and subsequent research served as the seminal study for cohort studies on MeHg exposure through fish consumption in New Zealand, the Faroe Islands, and the Seychelles Islands (U.S. EPA, 1995). Table 2.1 shows seminal studies on the health effects of MeHg.

Cohort Studies on Methylmercury Exposure through Fish Consumption

Beginning in the late 1980's, several long-term studies were conducted to characterize health effects of chronic exposure to Hg through fish consumption (Clarkson et al., 2006). Subsistence populations thought to have high Hg intake from seafood diets were selected. The first study was conducted in New Zealand, located in the South Pacific Ocean, which evaluated seafood consumption patterns of 935 mother-infant pairs in three regional ethnic groups: the Maori, Polynesian, and Caucasian immigrants (Kelljstrom et al. 1986). Weekly shark meals were the primary exposure path of Hg and all participants reported eating three or more fish meals per week.

Table 2.1 Seminal studies on the health effects of methylmercury

Author(s)	Geographical location	Population /Exposure	Biomarker tested	Hair Hg levels	Outcomes
Tsubaki and Irukajama, 1977	Minamata, Japan	103 adults/ Maternal fish consumption	Hair, blood, urine	56.8-570 ug/g (hair); 6.4-90.8 ug/dl (blood); 92-915 ug/g (urine)	Range from sensory disturbance of bilateral distal extremities to death
Amin-Zaki et al., 1976; Marsh et al., 1981, 1987	Iraq	81 mother-infant pairs/ Maternal bread consumption	Maternal hair Hg levels	10-20ppb (prenatal);	Age of 1st talking and walking
Grandjean et al., 1997	Faroe Islands	900 mother-infant pairs/ Whale meat and blubber	Cord-blood Hg; maternal hair Hg	23 ppb (mean); 4.3 ppm (mean)	Specific behavioral domains
Myers et al., 1995a-c, 1997; Davidson et al., 1995, 1998	Seychelles Islands	779 mother-infant pairs (birth to 5.5 yrs)/ Various fish species	Maternal hair Hg levels	6.1 ppm (median)	Neuropsychological endpoints
Salonen et al., 1995	Finland	1833 men aged 42 to 60 yrs/Fish consumption	Hair and urine	.00192 ppm (mean); .00118 ppm (mean)	Coronary and cardiovascular disease and death
Kjellstrom et al., 1986, 1989	New Zealand	61 mothers/ Maternal saltwater fish consumption	Maternal hair Hg levels	6-20 ppm	Inverse correlation between IQ in children and maternal Hg level
McKeown-Eyssen et al., 1983	Montreal, Canada	325 infants/ Maternal freshwater fish consumption	Maternal hair Hg levels	14-24 ppm	Abnormal muscle tone and deep tendon reflexes in boys only

Tissue analysis of shark in the region provided results as high as 4 mg/kg. Of the adult participants, 73 had mean hair Hg levels that exceeded 6 mg/kg, well above the U.S. EPA RfD of 0.1 ug/kg (0.0001 mg/kg/day). Of the children analyzed, 74 were reported as having high mercury exposure. Subtle impairments were reported in some of

the children's neurological development screening, with high maternal hair levels correlating to low intelligence quotient scores in their children (Clarkson et al., 2006).

In the 1990s, another study was conducted in the Faroe Islands, located in the North Sea, which followed the motor coordination and dexterity of 1,022 single-birth children (from birth until 21-months old) whose mothers consumed regular meals of whale meat during pregnancy (Grandjean et al., 1997). Mild developmental effects were noted for children whose mothers had a mean hair Hg level of 4.3 mg/kg. In a subsequent study of this cohort, consistent maternal Hg exposure during pregnancy was associated with impaired neuropsychological capabilities; these effects were observed when the children were seven years of age (Mergler et al., 2007). Alternately, this population regularly consumed whale blubber and codfish in addition to whale meat which both have low levels of Hg and high levels of beneficial micronutrients (Clarkson et al., 2006). Strain (2008) reported that the benefits associated with consuming seafood and seafood products high in micronutrients may far outweigh the adverse effects of MeHg in children who were breastfed.

The Seychelles Islands is an island country in the Indian Ocean where a high percentage of people consume a diverse range of fish species daily. A cohort study comprised of approximately 1500 infant-mother pairs per year (804 from the pilot study and 779 in the main study) was designed to examine the implications of health outcomes in the Iraqi MeHg poisonings on prenatal brain development (Marsh et. al., 1995, Clarkson et al., 2003b;). Maternal hair was used as a biomarker to determine prenatal exposure to MeHg and a series of tests were conducted assessing the mental and physical development of children (from birth to seven years old) whose mothers regularly

consumed fish during pregnancy. The mean maternal hair level in the Seychelles study was 6.1 mg/kg, significantly higher than levels set for no adverse effects in prenatal development in the Iraqi study. No association was found between maternal hair Hg levels and negative effects on visual memory, attention, mental development or psychomotor development in children (Clarkson et al., 2003b), and in fact some associations were positive. Marsh (1995) showed positive correlations in four different tests between pre- and post-natal hair Hg levels and test scores, with the highest scores observed in a measure of errors drawing test called the Bender-Gestalt. Error scores were reduced by 45% in children age 66 months whose mothers had post-natal hair Hg levels ranging from 1.0-25.0 mg/kg.

Discussion

There are several factors to consider in comparing the New Zealand, Faroe Islands, and Seychelles Islands studies. In the New Zealand study, consumption of shark was considered "episodic" as was the consumption of whale meat in the Faroe Islands, while people in the Seychelles Islands study consumed fish daily. However, the average fish consumption in the Seychelles was reported to be ten times lower than in New Zealand and the Faroe Islands (Clarkson et al., 2006). The species and size of fish consumed are also important consideration when evaluating potential MeHg exposures and adverse health outcomes. Shark, for instance, has been identified in numerous studies as having elevated levels of Hg. One study on Hg levels in sharks, conducted in northern of Australia, showed that total Hg concentrations in 16 species of sharks ranged from 1.5 - 3.0 mg/kg (Lyle, 1986, Pethybridge et al., 2010). This is a common finding for shark tissue, but high levels of MeHg are not unique to shark species. Age and length

often play an important role in the biomagnification of Hg in shark tissue and in other fish species (Suk et al., 2009, Verdouw et al., 2011). Similarly, whale meat has consistently tested at high levels of Hg (Choi et al., 2009, Sakamoto et al., 2011) frequently correlating with high hair Hg levels (Myers et al., 2007, Grandjean et al., 2010). Shark consumption is often based either on regional dietary patterns or on socioeconomic means and accessibility (Clarkson et al., 2006), while whale consumption is typically based on regional and cultural dynamics (Davidson et al., 2008, Choi et al., 2009); but, the most common pattern of fish consumption globally reflects the varied fish diet presented in the Seychelles study.

The Seychelles study began in 1989 after the 1986 pilot study, when a cohort of 779 newborn children were enrolled in a study to assess associations between prenatal MeHg exposure and neurodevelopment in children at 6.5, 19, and 29 months of age (Davidson et al., 1995, Myers et al., 1995a, Myers et al., 1995b). No definitive associations were determined in this study. In 2001, a new cohort of 229 mother-infant pairs were studied at age nine months and 30 months to investigate the interaction between prenatal exposure to methylmercury and long chain polyunsaturated fatty acids (Davidson et al., 2008, Strain et al., 2008). Fish tissue has been shown to be rich in docosahexaenoic acid (DHA), an omega-3 long chain polyunsaturated fatty acid (LCPUFA) associated with enhanced motor and cognitive development in children (Clarkson et al., 2003b). In the 2001 study, a positive association was demonstrated between psychomotor development and prenatal omega-3 fatty acid intake at nine months, but no significant association was found at 30 months (Strain et al, 2008). No association was determined between prenatal Hg or omega-3 fatty acid exposure and

mental development at age nine months or 30 months. Although participants in the Seychelles cohort frequently consumed a variety of fish species, the micronutrients in the fish they consumed were thought to have health benefits that outweighed the adverse effects of Hg (Clarkson et al., 2003b, Davidson et al., 2006, Strain et al., 2008, Bonham et al., 2009).

Linoleic and linolenic acids, also found in fish, have also been proven important to LCPUFA production and saturation of LCPUFAs which is vital to fetal and neonatal development that must take place for proper brain development to occur (Strain et al., 2008, Davidson et al., 2008, Gibson et al., 2011). Long chain polyunsaturated fatty acids are most critical in the third trimester of pregnancy when the majority of brain development takes place (Bonham et al., 2008, Hadders-Algra, 2008, Dirix et al., 2009). In the Seychelles study, prenatal exposure to MeHg was analyzed through maternal hair and LCPUFA through maternal serum (Clarkson et al., 2003b, Strain et al., 2008). Although exposure to prenatal and postnatal elevated MeHg levels through fish consumption have been associated with adverse neurodevelopmental, maternal fish consumption also provides nutrients in the diet that promote fetal and infant neurodevelopment. Thus, it is critical that maternal consumption of fish not be dissuaded, but that proper choices of fish species for consumption are made. Developing recommendations for fish consumption to different populations should vary regionally and in accordance with the availability and accessibility of fish species with low levels of MeHg and high levels of omega-3 fatty acids.

Global studies on the exposures of MeHg in fishing and fish subsistence communities in developing countries have contributed to the research by providing a

perspective on fish consumption from the vantage of communities that rely heavily on fish as a food source. In addition to the cohort studies discussed previously, there are numerous populations that have been exposed to MeHg through fish consumption due to the indirect impacts of small-scale artisanal mining activities that eventually deposit Hg into the local water bodies (Olivero et al., 2002; Castilhos et al., 2006; Marques et al., 2012). Dietary protein from fish is often a staple in these populations. Although the National Health and Nutrition Examination Survey (NHANES) reflects a decline in fish consumption within the general population, it also provides evidence of elevated fish consumption and blood Hg levels in the highest and lowest socioeconomic brackets in the United States (Mahaffey et al., 2009).

Some studies have been conducted within the United States and Canada that show confirmed or potentially elevated exposures in some watersheds and fish tissue in areas of both countries (Kosatsky et al., 2000, Mergler et al., 2002, Dellinger, 2004, Schantz et al., 2010). Chronic, low-levels of exposure to MeHg through fish consumption is of particular concern in U.S. subsistence communities that may be overlooked when state regulatory agencies are establishing or disseminating information on fish advisories. There are many opportunities to explore subsistence populations in the United States based on the range of variables that determine fish choices and the regional differences in U.S. subsistence populations.

CHAPTER 3

LITERATURE REVIEW

An Evaluation of Global Subsistence Fish Consumption and Potential Exposures to Methylmercury

In 2011, the Food and Agriculture Organization of the United Nations (UNFAO, 2012) estimated that 540 million people, globally, were sustained by aquaculture and fisheries activities, with fish products being the most traded food commodity around the world. Fishing plays diverse roles, internationally, based on the needs of varying subpopulations, including recreational, commercial, and subsistence fishing. In the United States, for instance, recreational fishing may be defined as fishing for personal consumption, pleasure, relaxation, and bonding time with family and friends. Alternately, commercial fishing is defined by the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA) as "fishing in which the fish harvested, either in whole or in part, are intended to enter commerce or enter commerce through sale, barter or trade" (MSFCMA, 1996). Although there is no standard definition for the term subsistence, one definition that characterizes subsistence fishing relevant to the current research is that of "local, non-commercial fisheries, oriented not primarily for recreation but for the procurement of fish for consumption of the fishers, their families, and community" (Berkes, 1988, p. 1). Studies have been conducted on subsistence fishing communities based on concepts ranging from small-scale fishing communities in

artisanal mining villages in the Brazilian Amazon to transient Asian populations in the United States seeking to maintain their traditional fish consumption practices (Holsbeek et al. 1996, Sousa Passos et al. 2008, Shilling et al. 2010). There are few fish consumption studies that include a comprehensive investigation of the contextual meaning of subsistence. The purpose of this review is to describe the term subsistence, the potential consumption patterns that correlate to varying degrees of subsistence, and the potential exposure to MeHg based on fish subsistence patterns.

Studies on Methylmercury Exposure through Fish Consumption

Fish is a protein source with substantiated human health benefits related to omega-3 fatty acids (Clarkson et al. 2003b; Mahaffey, 2004). Fish consumption, however, is also the major route of exposure for MeHg in humans (Swain et al. 2007). Methylmercury (CH_3Hg) is an organic, highly toxic form of mercury composed of a methyl group (CH3-) and a mercury ion (Hg+). It is a positively charged ion which combines readily with anions (e.g. chloride, hydroxide, and nitrate). Although MeHg can be released into the environment through industrial activities, including coal-fired power plants or chemical manufacturing facilities, MeHg may also be introduced into the environment through biomethylation in sulfate-reducing bacteria that live in anoxic aquatic environments. Because it is not easily eliminated from the body, MeHg often accumulates in predatory fish species and increases human exposure to the contaminant. The U.S. EPA defines a reference dose (RfD) as the daily maximum amount of orally administered exposure to a contaminant that a person can be exposed to without the risk of appreciable harmful effects over a lifetime. The USEPA has established an RfD for mercury of 0.1 ug/kg (0.0001 mg/kg/day).

Studies on fish consumption became popularized with the advent of well-documented releases of the neurotoxin MeHg. Methylmercury is an organic form of mercury in which the primary target is the central nervous system (CNS). Two historically significant releases of mercury occurred in Japan and Iraq. These environmental exposures led to further studies on the adverse health effects of MeHg. The first large-scale release of mercury into the environment was from the 1950s-1960s by a fertilizer and petrochemical company into Minamata Bay, Japan (Grandjean et al. 2010) in which CNS degeneration was observed in approximately 1,400 people (Tamashiro et al. 1984). In 1971, another episode of widespread exposure occurred in Iraq when large shipments of seed grain treated with MeHg as a fungicide were used to prepare breads (Clarkson et al. 2006). The breads were consumed throughout the rural Iraqi community and led to numerous cases of severe prenatal MeHg poisoning, which resulted in adverse neurological developmental effects in newborns and infants.

The Minamata Bay and Iraqi outbreaks led to three major studies conducted to examine the health effects of MeHg intake through fish consumption in New Zealand (Kjellstrom et al. 1986), the Faroe Islands (Grandjean et al. 1997), and the Seychelles Islands (Myers et al. 2003). The primary fish source for the Faroese was whale meat and blubber that also had high levels of MeHg (average 1.6 mg/kg) while the primary fish consumed in the New Zealand study was shark (~4.0 mg/kg) (Clarkson et al. 2006). Methylmercury concentrations in humans are commonly analyzed using scalp hair as the biomarker, though blood may be used to determine shorter term exposures (Grandjean et al. 2003). In Seychelles, however, a wide variety of marine fish species (average 5.8 mg/kg) were consumed. Unlike the Faroe Islands and New Zealand studies, the

Seychelles study indicated that there were no or low-observed effects from exposure to MeHg through fish consumption (Myers et al. 2000). Numerous studies have addressed exposure to MeHg through fish consumption in subsistence populations; but, few regional or global fishing and fish consumption studies provide a contextual definition that either pertains to the inherent nature of subsistence as a primary means of livelihood or contrasts varying levels of dependence on fish among different nations.

Subsistence Defined Globally

The dynamic of subsistence populations is different for developed versus developing countries. The FAO estimated that the percent of total protein consumed in 2007 by the general U.S. population through fish was 4.9%, far below the 40.4% estimated for the Maldives, a small developing Southeast Asian island nation (UNFAO, 2012), clearly indicating differences between fish consumption patterns among countries. The U.S. EPA defines subsistence fishers in the United States as people who rely on fish as an affordable food source, as a primary dietary staple or for whom fish are culturally important (U.S. EPA, 2000). In other regions of the world, the term subsistence has the exclusive implication of direct consumption for the purpose of survival or meeting the minimum nutritional requirements to live (Freemen, 1993). The World Fisheries Trust (WFT), a Canadian non-profit organization committed to aquaculture sustainability, characterized subsistence fishing as an activity conducted for non-recreational purposes, which are carried out primarily by impoverished communities to feed their families using small-scale fishing techniques (WFT, 2008). Numerous populations in developed and developing countries depend on fish for nutrition as a primary source of energy, trace elements, and other nutrients (Holsbeek et al., 1996; Al-Majed et al., 2000; Sousa Passos et al., 2008). Fish consumption choices, in both developed and developing nations,

comprise a complex set of variables including education, socioeconomic status, age, and gender, as well as geographical boundaries (Kearney, 2010).

Subsistence in Developing Nations

Fishing subsistence scenarios in developing countries are pervasive and include such studies as those conducted in Bangladesh, Kuwait and South America in which people rely on fish as a primary or critical source of dietary protein (Holsbeek et al., 1996; Al-Majed et al. 2000; Sousa Passos et al. 2008). These studies are based on populations that rely on local fish for both nutrition and survival (Table 3.1). In the context of these studies, the term subsistence frequently implies daily hand-to-mouth living conditions in which the basic nutritional needs are barely met (Freeman, 1993). In a Bangladeshi study, both freshwater and saltwater fish species were consumed, comprising approximately 80% of the daily protein intake in the study population (Holsbeek et al., 1996). Hair Hg levels in this population were moderately low at 0.0044 mg/kg, which was attributed to a lack of gold mining and industrial activities in this area in conjunction with annual floods and heavy rainfalls that wash contaminated sediments from the area, preventing the accumulation of mercury in soils. Populations that live under these conditions are frequently bound geographically and economically to areas that inherently restrict access and availability to a variety of foods.

Table 3.1 Fish consumption studies: Global subsistence populations

Author(s)	Geographic Location	Population description	N	Mean Hair Hg (ug/kg)	Range (ug/kg)	Comments
Holsbeek et al., 1996	Bangladesh	Male fishers	219	0.44	0.02-0.95	Fish 80% daily protein intake
Al-Majed et al., 2000	Kuwait	Male fishers	100	4.18	1.0-6.0	Fish 82% daily protein intake
Barbosa et al., 2001	Negro River, Brazil	Small riparian village	76	21.4	1.66-59.01	Population eats fish twice daily; Consumes fish at levels comparable to ocean-fish eating populations
Santos et al., 2002	Caxiuana, Brazil	Small riparian village	214	8.58	0.61-45.59	Comparison of Hg hair levels between riparian and artisanal communities
Bjornberg et al., 2005	Sweden	Women of childbearing age	127	700	80-6600	79% consumed species listed in advisories; 10% consumed these species >once/wk
Sousa Passos et al., 2008	Tapajos River , South America	Six riparian villages	256	17.9	0.2-58.3	Examines the association between mercury intake and bioindicators of exposure
Ashe, 2012	Madre de Dios, Peru	Gold miners and mining camps	100	2.67	0.36-20.26	Contribution of mining activities to elevated levels of hair Hg in men

Notes: N=Sample size; ppm = parts per million

In Kuwait, a study showed a positive correlation between hair Hg levels (5.0 mg/kg) in 100 Egyptian men and the amount of fish they consumed (at least one fish

meal per day) (Al-Majed et al., 2000). In this scenario, the men studied were fishermen who frequently brought fish home to their families and themselves and consumed some of the fish that were caught during their workday. Unlike the consumption pattern observed in the Bangladeshi study, 82% of the participants in this study also reported eating canned tuna once a week, shifting the context in which subsistence is characterized. In the Kuwaiti study, fish subsistence is a socially structured phenomenon where both market-based distribution and nutrition serve as a backdrop for primary and secondary motivations for fishing patterns. This study is limited in that, due to cultural dynamics in Kuwait, women and children were not included in the study. Although hair mercury levels in men were well below the World Health Organization threshold level of 10 ug/kg (WHO, 1994), adverse neurological-health effects in young children have been observed below the U.S. EPA (2000) RfD of 0.1ug/kg. It is not possible to make a determination of the impact the Kuwaiti's subsistence patterns had on gestational health or on the health of newborn and infant children. An assessment of the risk to the most sensitive populations in subsistence communities, in this case, women of childbearing age and children should have been included in the Kuwait study since other studies implicate children as a demographic having the highest likelihood of negative impacts from MeHg exposure (Grandjean et al., 1997, Clarkson et al., 2006, Mergler et al., 2007).

In another study of 256 South American riparian villagers, the average consumption was seven fish meals per week, with piscivorous fish comprising an average of 45% of the fish diet (Sousa Passos et al., 2008). These populations lived along the Amazonian Nile River and were also restricted within the geographical boundaries of this study, resulting in dependence by default on the fish species in this region for survival.

Each of these studies represents numerous subsistence scenarios in developing countries of people who depend on the local fish supply to feed their families. These studies show that survival subsistence populations do not generally have alternative protein sources; therefore, fish becomes a dietary protein staple, and exposures to elevated levels of MeHg are inevitable if source watersheds are heavily impacted by Hg due to mining or natural deposition.

Subsistence in Developed Nations

In developed countries the extent to which populations depend on fish as a primary food source may be more closely associated with cultural or socioeconomic variables than with survival (Burger et al. 2001, Moses et al. 2009, Abelsohn, 2011). The literature on subsistence fishing covers a broad range of definitions and topics, including economic and environmental sustainability; however, literature on subsistence fishing in developed nations can be categorized generally according to culture and preference. Although the motivation for subsistence fishing may differ generally amongst developed and developing nations, fish consumption levels and the potential for MeHg exposure through fish consumption are oftentimes characterized similarly when evaluating subpopulations abroad.

Several Native Alaskan and American Indian studies indicate that there is evidence of elevated Hg exposure in some communities that are considered to be subsistence populations. An Inuit population in northern Quebec, who rely primarily on fish for dietary protein, was analyzed for hair, cord blood, and maternal blood Hg levels and found to have moderate levels of Hg observed above the general population in both the United States and Canada (Muckle et al., 2001). The results of analyzed biomarkers

were similar to results found in the third trimester of women sampled in the Faroe Islands studies, which were associated with cognitive developmental delays in children. A study conducted in the Central Valley Delta of California included a survey of 373 anglers who fished in the Central Valley Delta region (Shilling, et al., 2010). The cohort included people of various race and ethnic classifications. Of the total sample population, there were six Native American Indian (NAI), 32 African American (AA), 57 Caucasian, and 152 Southeast Asian participants. Lao Southeast-Asian immigrants (N=38) had the highest average daily Hg intake at 0.0280 mg, followed by 0.0208 mg for both AA and NAI participants, and 0.0204 mg for the Vietnamese Southeast-Asian participants (N=30). The average daily intake of Hg through fish consumption in the Caucasian population was 12.1 µg. Fish tissue samples from the local watershed were analyzed for MeHg, resulting in an average concentration of .4146 mg/kg for the 14 most commonly consumed fish in the Northern Central Valley Delta region.

The sample population in this study included Southeast Asian immigrants to the United States who sought to maintain fish consumption patterns that were practiced in their native country; but, it also included an NAI population with cultural practices that are well-known to include fish consumption as one element of their customs and beliefs and an AA population who consumed high quantities of fish based on preference and accessibility. Because of the high Hg deposits that have impacted the Central Valley Delta, which serves as the primary source watershed for fish species that these populations consume, MeHg exposures were disproportionately higher in some populations than in others (Dellinger, 2004). This study provides a unique snapshot of contrasting fish consumption patterns in a developed country between the general

population and those of subpopulations who assume subsistence practices by choice rather than by necessity.

Cultural Subsistence Fishing

The cultural significance of fish in some populations represents heritage, traditions, culture and even prosperity. Cultural factors in a community are the ideals that bind a group of people through beliefs, practices, and customs. In many NAI populations, for instance, fishing not only represents food for subsistence, but a symbiotic relationship between man and the environment. Many studies have been conducted in Native Alaskan and American Indian populations to monitor subsistence status through fish consumption studies because the U.S. Government has committed to protect natural resources available to them through the Alaska Native Claims Settlement Act of 1971 (ANCSA, 1971) and through Title VIII of the Alaska National Interest Lands Conservation Act of 1980 (ANILCA, 1980); yet, as discussed in the previous section, there are numerous subpopulations of people in the United States who rely on fish as a primary source of protein without assurances of water-quality protection or the health of fish species that they consume.

Cultural factors often are in direct conflict with adverse negative environmental impacts that have affected the levels of MeHg in regional fish sources. In Clear Water, California, NAI found Hg levels of 0.0156 mg/kg in blood due to activities associated with a neighboring active mining facility (Harnly et al. 1997). Although some of the NAI participants in this study expressed an interest in possible remediation approaches, they were not concerned with making lifestyle changes that might interfere with cultural fishing and consumption habits. A Cree Indian population in Quebec, Canada was

considered to be at risk of adverse health effects to unborn babies, not due to acute toxic MeHg exposure, but rather due to lifelong seasonal exposure to MeHg through fish consumption (Dumont et al. 1998). For Canadian Inuits, these exposures may be difficult to eliminate because the population not only relies on fish for survival, but also for cultural identity since they have established fish consumption patterns that have become an inherent part of the Inuit lifestyle (Wheatley et al. 1996).

Subsistence Fishing by Choice

In addition to survival and cultural identity, another consideration in determining the subsistence patterns will be that some populations have access to a variety of foods, but choose fish as a primary protein source and consume fish at levels comparable to subsistence-for-survival populations as a matter of preference (Holloman et al. 2010). In order to evaluate subsistence status of populations in developed nations, several U.S. and Canadian studies were reviewed. In a sample of 2288 rural and urban residents surveyed along the St. Lawrence River, Canadian fishers who consumed less than one fish meal per week consistently had lower levels of Hg in hair and in blood than did fishers who consumed one or more fish meals per week (Kosatsky et al. 2000). These residents fished year-round but were aware of fish advisories associated with Hg. While there was a strong correlation between hair and blood Hg levels, none were above the screening levels for Hg in Canada. In this study, 25% of sport fishers who live along the St. Lawrence River in agricultural or isolated villages reported consuming 43-57% of the fish they ate from open or ice water in the surrounding areas in quantities greater than one meal per week (Kosatsky et al. 2000). Of the sample population, 32% reported an annual income less than $15,000, 35% reported having an annual income of $15,000-29,000, and

approximately 68% of study participants reported consuming commercial fish more than once per week. Similar results were found for a population situated along the Upper St. Lawrence River where residents were also aware of fish advisories suggesting limited or restricted fish consumption, but residents continued to consume fish as a frequent dietary protein source (Mergler, 2002). An assessment may be made that people in this area, though not high income earners, had the opportunity to make different choices in protein purchases, but regularly chose fish based on preference.

The capture and consumption of fish in developed nations is generally driven by choice rather than by necessity as opposed to in developing nations where most fish that are caught are used for direct consumption by human inhabitants as a means of survival (Holsbeek, et al. 1996). In many international coastal regions, small scale fisheries provide the primary protein source as well as employment in respective communities (Speer, 1995). These populations are frequently exposed to high levels of MeHg (Sousa Passos et al. 2008). Conversely, the U.S. ranks third in global fish consumption (below China and Japan), with declining fish consumption rates in the general population primarily due to a drop in the consumption of canned seafood (NOAA, 2009). In the United States, elevated levels of MeHg in hair samples were found in older, white, married women who had achieved advanced levels of education and were in higher socioeconomic brackets; this may have been attributed to the tendency of this group to eat more store and/or restaurant-purchased fish (Miranda et al. 2011). One study showed that high levels of fish consumption in low income, minority populations resulted in elevated levels of MeHg exposure (Lincoln et al. 2011). This study indicated that there was a positive association between Hg intake and hair Hg levels for a population

consuming fish primarily from local water bodies impacted by elevated levels of Hg. Subsistence fishers in developing countries are generally identified based on lack of material and food availability. Even though the United States is a developed nation with greater general access to foods, there remain populations that identify themselves as subsistence fishers based on cultural identity (USEPA, 2000). Table 3.1 provides a summary of fish consumption studies, including subsistence status of populations in developed nations.

Table 3.2 Fish consumption studies in developed nations

Author(s)	Study Population	Location	Hair Hg level	Blood Hg level	Subsistence status
Kosatsky et al. 2000	Canadian	Montreal, Canada	0.00082 ppm	0.00303 ppm	No
Harnly et al. 1997	NA	Clear Lake California	0.64 ppm (tribal); 1.60 ppm (non-tribal)	0.0156 ppm	No
Wheatley et al., 1994	Inuit (Canadian)	Canada	0.016 ppm	0.1 ppm	Yes
Mergler, 2002	Canadian	Quebec, Canada	--	0.8 ppm	No
Dumont et al., 1998	Cree Indians	James Bay, Quebec, Canada	--	--	Yes
Muckle et al., 2001	Inuit	Nuvanik (Northern Quebec), Canada	0.0037 ppm	0.0104 ppm	Yes
Rothschild et al., 2002	Yupik Eskimo	Napakiak (Southwest), Alaska	1.45 ppm	--	Yes
Canuel et al., 2006	Aboriginal	Eastern Canada	3.8, 4.3,4.5 ppm respectively	--	Yes
Holloman et al., 2010	AA women	James River, Virginia	--	--	No
Dellinger, 2004	NA Indians	Wisconsin, Michigan, Minnesota	--	0.0118 ppm	Yes
Schantz et al., 2010	Southeast AI	Wisconsin	--	1.64 ng/ml	Yes
McKelvey et al., 2007	AI	New York	--	0.004 (0.007) ppm	Yes

Notes: AA – African American, NA – Native American, AI – Asian Immigrants

DISCUSSION

In many developing nations, small-scale mining activities contribute significantly to the Hg load on watersheds from which surrounding communities catch fish. It is often the case that people in developing nations who rely on fish as a primary protein source do so because they are economically and geographically bound to the communities in which they live. As a result of these limitations, reliance on fish is both by default and by necessity. Chronic exposures may be an issue in populations who rely on fish as a primary food source because of the potential exposures to MeHg, particularly in riparian villages where artisanal mining is prevalent. For geographically bound populations that are educated on the adverse health effects of MeHg, it is critical that they are given alternate choices in terms of the best fish choices for low-level MeHg intake.

In developed nations, fish consumption patterns and fishing habits are typically dictated by affordability, accessibility, and availability. Anglers in developed nations are categorized generally as recreational, commercial, or subsistence fishers. The terms recreational and commercial in the context of fishing generally maintain a universal meaning. What constitutes subsistence fishing, however, is conditional on a number of variables ranging from the economic status of a nation (developed versus developing) to the socioeconomic status of a subpopulation within a nation. Subsistence fishing may be established by centuries of a cultural heritage that intends to maintain balance with the environment, seeking not only to take fish from the environment for personal gain, but to protect fish as a natural resource that contributes to the natural environmental balance. In fish consumption studies conducted in developed nations, subsistence fishing is not mandated by socioeconomic status or geographic boundaries as it often is in developing

nations. Even for populations living at or below the poverty line in developed countries, government subsidies are in place that assists with economic access to a variety of foods so that fish consumption choices are based on availability, accessibility, and affordability, not on necessity. For some populations in developed countries, subsistence fishing and fish consumption may be based solely on preference, where some affluent populations may frequently consume premium, large off-shore seafood catches or canned tuna that have high Hg concentrations. Other populations may fish daily for meals based on affordability, availability, and accessibility, unaware of fish advisories that place restrictions on consumption of certain quantities or types of fish.

In developing nations as in subpopulations of developed countries where subsistence fishing is the main source of food, MeHg presents potential human-health concerns where Hg has significantly impacted source watersheds (Hornberger et al., 1999, Domagalski 2001, Muckle et al. 2001, Alpers et al. 2005, Burger et al. 2005). Methylmercury is of particular concern to pregnant women, unborn babies, and young children because of the potential adverse effects on the development of the neurological system; however, there also are numerous health benefits associated with fish consumption, the most important being those associated with omega-3 fatty acids (Clarkson et al. 2003, Mahaffey 2004, Mozafarrian et al. 2008, Stokes-Riner et al. 2011). Omega-3 fatty acids are found to be at high levels in oily fish such as salmon, trout, sardines, and herring and have shown to lower heart rate and blood pressure in adults (Kris-Etherton et al. 2002, Covington 2003, Kris-Etherton et al. 2003, Harris et al. 2008). While caution should be taken regarding the impact of MeHg intake through fish on prenatal and childhood neurological development, fish is also a source of

docosahexaenoic (DHA), which is a beneficial fatty acid that specifically targets brain development in infants (Horrocks et al. 1999, Myers et al. 2007, Davidson et al. 2008, Strain et al. 2008). Research on subsistence populations is important because it can offer a unique perspective into the role of humans in different global ecosystems and how political, economic, geographic, and health-related factors influence the framework of how subsistence is defined. Scientists should continue to research the potential adverse health effects of MeHg in populations where fish is the sole or primary protein source, particularly where watersheds have been or are being impacted by significant Hg deposits. In the process of conducting such research, it seems critical that the overall benefits of consuming fish are weighed against the potential risks associated with MeHg exposure. Understanding the need to delineate levels of subsistence, including types of fish consumed and fish sources in a given population, is a first step in developing this type of risk assessment.

CHAPTER 4

METHODS

The purpose of this chapter is to: (1) describe the research methodology of this study, (2) explain sample selection, (3) discuss the research design, and (4) describe the data processing and analysis.

Research Goal. The goal of this study was to explore fishing and fish consumption patterns in the Gullah/Geechee (G/G and African American (AA) Sea Island population. The following specific aims and subsequent research questions (RQ) were addressed:

Specific Aim 1: To explore fishing and fish consumption patterns within the G/G & AA Sea Island population.

RQ: How does culture influence fish consumption in the Gullah population?

Specific Aim 2: To evaluate awareness of the current SC fish consumption advisories and determinants of fish consumption.

RQ1: What factors predict fish consumption choices in the G/G and AA population?

RQ2: How does the level of awareness regarding the state fish advisories impact fish consumption choices?

Specific Aim 3: To evaluate MeHg exposure through fish consumption using mathematical modeling.

RQ1: What are the levels of exposure to Methylmercury through fish consumption in the Gullah population?

RQ2: Is there a statistical difference between the estimated exposures to MeHg in the G/G and AA and 2009-2010 NHANES population?

Research Methodology

The first aim explored G/G and AA fish consumption characteristics based on focus groups and participant interviews. This qualitative aim focused primarily on gaining understanding of G/G and AA lived experiences and how these lived experiences influenced fish consumption choices through phenomenological methodology. Phenomenological methodology was used to explore the phenomenon of cultural impacts on fish consumption in the G/G and AA population. Phenomenology is both inductive and descriptive in nature, meaning that the researcher begins by making specific observations upon which more general assumptions and theories can be made and that observations can be made within the context of existing theories to confirm rationale deduced from those observations (Thomas, 2006). The goal of phenomenology is to study and describe human experiences as they are perceived by participants in the target audience. Besides being based on human experiences, phenomenology is also advantageous to researchers conducting qualitative research because it allows for deeper meanings in the spoken word to be explored (Sorrell et al., 1995). This study collected and analyzed emerging themes in order to develop theoretical inferences regarding the meaning of fishing and fish consumption in the G/G and AA population.

The Theory of Planned Behavior (TpB) was used to guide development of the survey and interview questions as well as the moderation techniques used during focus groups (Ajzen, 1991). The TpB has been used in previous fish consumption studies to identify determinants of fish consumption behaviors based on personal influences on fish consumption intentions and frequency (Prell and Berg et al., 2002; Verbeke and Vackier, 2005, Lauber and Connelly et al., 2011). In one study, participants were asked open-ended questions based on the TpB about variables that potentially influence fish consumption choices such as perceived attitudes regarding fish consumption in their social circles, perceived positive and negative effects of eating fish, perceived barriers to consuming fish, and current sources of information about the risks and benefits of eating fish (Lauber et al., 2011).

Specific aim 2 was a quantitative aim focused on descriptive statistical analyses of the study population. Univariate logistic regression was conducted in order to evaluate the significance ($p=0.05$) and direction of the relationship between predictor variables, also referred to as determinants (county of residence, gender, age, income, and education) and response variables (serving size of fish per meal, frequency of fish consumption, and awareness of fish advisories). For specific aim 3, a mathematical model was developed using both the United States Environmental Protection Agency's Stochastic Human Exposure and Dose Simulation (SHEDs) model and one-compartment dose model to calculate the mean blood mercury level in the G/G and AA population. The mean blood mercury level in the G/G population was compared with the mean blood level in the 2009-2010 NHANES data by testing the null hypothesis that there are no statistical

differences between the two populations. The research design for this study is shown in figure 4.1.

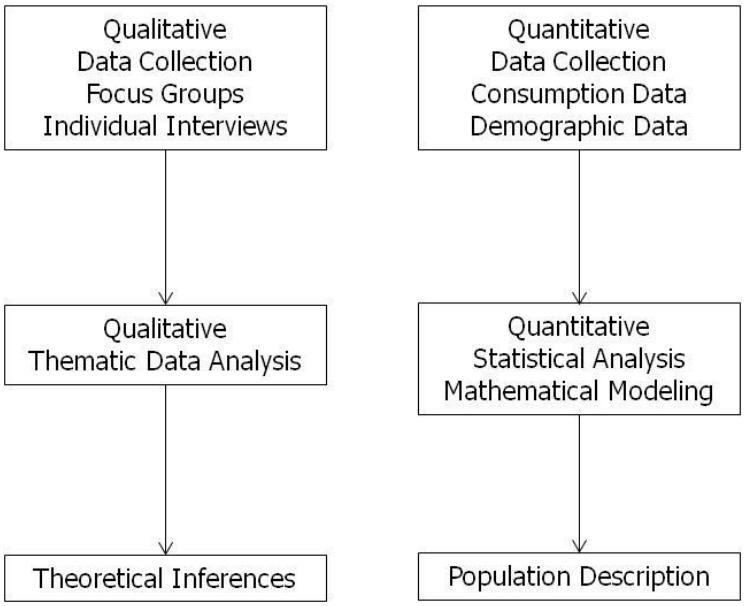

Figure 4.1 G/G and AA fish consumption study research design

Study Area. The study area included South Carolina (SC) counties Charleston, Colleton, and Beaufort within the Gullah/Geechee Cultural Heritage Corridor (GGCHC), a geographical, cultural, and linguistic designation from Wilmington, North Carolina to Jacksonville, Florida and 30 miles inland managed by the National Parks Service and the United States Department of the Interior.

Pilot Study. Ten Gullah/Geechee and AA participants on one of the (SC) Lowcountry Sea Islands, Johns Island, were administered an 11-question data collection instrument with quantitative and qualitative questions regarding fishing and fish consumption. One question included a 47-item fish and seafood consumption spreadsheet that asked participants about species, serving size, and source of fish and seafood. The findings of the pilot study indicated that eight out of the ten G/G and AA

residents interviewed eat between 5-8 fish meals per week (Ellis unpublished, May 2011).

Participant Recruitment and Selection. Participants were recruited for focus groups and individual interviews to explore beliefs and perceptions about and motivations for fishing and fish consumption in the G/G and AA population. G/G and AA men and women, aged 18 and older, were recruited from three coastal counties in South Carolina. Participants were also required to be fishers, fish consumers, or fish preparers in order to validate participant knowledge of fish species. Recruitment flyers were sent via e-mail or mail to Lowcountry churches and community organizations within the study area. Clergy and community leaders encouraged participation from G/G and AA communities by word-of-mouth. Focus groups and individual interviews were hosted at respective churches and community centers.

Focus Group/Individual Interview Protocol. Four focus groups with a total of 34 participants and 102 individual interviews were conducted for an overall study sample of 136 participants. The TpB and previous fish consumption studies (Perenchio, 2001, Brunso et al. 2009, Lauber et al. 2011, and Kamen et al. 2012) guided protocol and question development. The researcher conducted focus groups from 60 to 120 minutes and individual interviews from 20-40 minutes. For the first three focus groups, a moderator facilitated and took general notes while a notetaker ensured completion of consent forms, assisted with audio recordings, and took detailed notes. The fourth focus group was conducted by only a moderator because a notetaker was unable to be scheduled during the date and time proposed by the respective key informant and collaborating focus group participants. All focus groups were recorded on two digital

recorders. Individual interviews (n=85) were audio recorded on a single digital recorder. Seven data collection instruments were mailed-in and 8 instruments were completed by participants while the researcher read each question. The researcher experienced technical difficulties with audio recordings of two individual interviews, so audio files were not available for those interviews. Hard copies of all data collection instruments were collected.

Study participants completed a 49-item semi-structured interview survey on childhood fishing experiences, perceptions of the fishing culture, seafood preparation, and seafood consumption and a 10-item demographic survey. Each participant received a $10 cash incentive in appreciation for their time and input (Wessells and Anderson, 1995, Kuntz, 2007, Kuntz et al. 2009). Qualitative responses to nine open-ended questions were transcribed verbatim for each focus group/interview and compared with audio recordings to ensure accuracy and completion of transcriptions. All personal identifiers were removed from transcripts prior to analysis.

Data Collection. Focus groups were held as a method of conducting formative research. Key informants who served on focus groups had a deeper perspective of the temporal, political, and cultural dynamics in this population. Formative research helped to better understand the needs and perspectives of the target audience through direct involvement of the population being studied (Middlestat et al., 1996; Ulin, 2005). The survey included four general sections relevant to obtaining quantitative and qualitative data for this study: (1) motivations for fish consumption and fish consumption choices, (2) frequency of fishing and fish consumption, (3) awareness about fish advisories, and (4) socio-demographic information (gender, age, ethnicity, income, and education). It

has been shown in previous studies that focus groups are effective because they are a sample of the target audience that can be convened to gather relevant information to strengthen feedback ranging from program planning to strategies for disseminating health messages to a community (ICN, 2008). Focus groups served in a similar capacity in this study. Prior to the researcher conducting individual interviews throughout the study area, focus groups played an integral role in refining the questions and ensuring that the survey instrument was practical and relevant to the Gullah/Geechee population. If formative research is excluded or not properly executed, the goal of ultimately implementing the health message in the target population may have limited success (Stetler et al., 2006). The health message may be ineffective if the target audience does not perceive the ultimate message as credible, as relevant to their community, or if they perceive themselves as specimen rather than stakeholders (Einsiedel, 1990).

The first focus group was held in May 2012 on Johns Island, SC. There were 12 participants in this discussion. The second focus group was held in an urban area of Charleston, SC in which there were 7 participants. Seven people also participated in the third focus group which was held in Mount Pleasant, SC. The first three focus groups were held in churches in Charleston County. The fourth focus group was held with a fishing organization in a community center. Each focus group was targeted to include between seven and ten participants since this has been established as a practical number for gaining varied and thoughtful insights from focus group participants in a manageable setting (Krueger, 1994, Kreuger and Casey, 2000). There were 12 participants in the first focus group due to the pastor's efforts to ensure there were a sufficient number of participants. The researcher made a decision not to turn away two additional people in

order to avoid negatively impacting participant morale or perceptions of the researcher and of the discussion topic. Focus group #1 took place in a cohesive church community. Excluding participants from the group discussion at the start of the meeting would potentially have biased participant discussion.

The data collection instrument included qualitative questions related to childhood fishing experiences, the role of fishing in the social structure of the Gullah/Geechee population, and perceptions about the role of culture in fishing and fish consumption. Quantitative survey questions included demographic information, quantities of specific species that were consumed by the participants over the past 12 months, and awareness of the fish advisories. Feedback collected during focus groups was used to refine instrument questions. A fourth and final focus group was held on October 11, 2012 with seven members of the Gullah/Geechee Fishing Association on St. Helena Island, SC, Beaufort County.

Responses from focus group discussions were collected using a semi-structured data collection instrument. A semi-structured format allowed for additional questions by the researcher for clarification of and elaboration on any participant responses during focus group discussions (Patton, 2002). It also allowed the interviewer to ask probing questions to generate varied responses in order to capture the broader perspective of the study population. In addition, the use of a semi-structured in-depth interview format allowed for flexibility during focus groups, but it also increased the likelihood of respondents answering a standard set of questions during the individual interview phase. Semi-structured questions were chosen rather than open-ended questions since open-ended questions would require more time and money to analyze and data may be more

difficult to interpret when evaluating combined qualitative and quantitative data (Ulin, 2005). In addition to providing a more standard framework for the interviewer, using a semi-structured survey guide as a method of data collection strengthened the validity of this research since emerging qualitative theories informed quantitative results (Ulin, 2005).

The term “focus group” was eliminated during group discussions after Focus Group #2 and substituted with the phrase "small group discussion" or "group discussion" in order to promote a more informal setting and to use less intimidating language during focus groups (Krueger, Kit #6). Focus group questions followed the exact sequence of questions as outlined in the survey instrument (Krueger, Kit #6). Participants in the first three focus groups seemed to provide candid responses regarding past and present fish consumption and fishing habits. The most significant challenge for all three focus groups was the logistics of the species-specific spreadsheet. The use of PowerPoint slides with pictures of the fish and shellfish species listed on the spreadsheet was helpful in participant identification of specific species. However, consumption frequency ranges were somewhat confusing to participants in all groups, particularly in Focus Group #3. Because participants did not readily comprehend the consumption frequency descriptions used during focus groups 1-3, the researcher used consumption descriptions applied in Luk et al 2006 (e.g. daily, >once per week, once per week, once per 2 weeks, etc.) in Focus Group 4. These consumption descriptions were subsequently used in the individual interview surveys. Questions regarding knowledge about the potential harmful effects of methylmercury were removed after Focus Group #2; and the positive and negative effects of fish consumption were weighted to allow participants the same

opportunity to address their knowledge of the pros and cons associated with fish consumption. The size of fish meals (in ounces) were also added to the individual interview survey instrument after Focus Group #2.

With the exception of Focus Group #4 (FG4), focus group discussions were audio-recorded, with additional handwritten notes made by the notetaker (Krueger, Kit#6). The moderator reiterated the purpose of the group discussion and summarized the key points from the discussion to the group (Krueger, Kit #6). Immediately following the focus group discussion, the moderator and notetaker debriefed regarding the highlights from the discussion in order to compare and contrast perceptions of key discussion points. Additional notes were made by the moderator in the margins of handwritten notes taken by the notetaker (Krueger, Kit #6). Because no notetaker was available for FG4, hand-written notes were re-written with additional notes an hour after the close of FG4. The moderator typed transcripts for FG4 on the same evening of the meeting to ensure that critical nuisances during the discussion were not lost.

Seven preliminary individual interviews were conducted on St. Helena Island, SC on November 8, 2012. Based on these interviews, no questions were changed, but the order of questions was rearranged to provide a more logical flow during the interview survey. The researcher modified the data collection instrument based on committee feedback and submitted the amended instrument to the IRB. Formal individual interview surveys were scheduled for December 11, 2012 in Awendaw, SC (Charleston County), December 15, 2012 in Walterboro, SC (Colleton County), and January 14, 2103 in Summerville, SC (with Charleston County residents). The data collection process primarily followed the traditional steps of conducting individual interviews, making

observations, taking field notes, and producing audio recordings (Miles and Huberman, 1984, p. 21). The interviews were audio-recorded and transcribed, verbatim. The transcripts served as the primary source of data for content analysis. In order to achieve accuracy, the researcher compared audio recordings with transcripts to ensure literal transcriptions of focus groups and individual interviews. Names and addresses were removed to protect personal identification of participants. Conclusions about fish consumption determinants were made based on common themes extracted from the data. Throughout data analysis the graduate researcher sought data saturation. Data saturation was reached when minimal or no new information arises related to the study and all data fits into the established codes (Strauss and Corbin, 1998, Bowen, 2008). Continued recruitment of survey participants was considered unnecessary for qualitative, open-ended interview survey questions when the information and generated themes obtained through interviews become repetitive, hence reaching data saturation (Creswell, 2003, Guest and Bunce, et al., 2006, Francis and Johnston, et al, 2010).

The survey instrument was designed with the purpose of both converging quantitative and qualitative data and for strengthening the integrity of the study's findings (Johnson et al., 2004, p. 17, Creswell et al., 2007, p. 65, Hesse-Beiber, S.N., 2010, p. 3). In this study, participant enrichment was reached through purposeful sampling and review of the inclusion criteria with participants prior to administering a survey instrument with both quantitative and qualitative questions. Conducting a preliminary study and four focus groups ensured the validity, consistency, trustworthiness, contextual value, and potential participant barriers of the survey instrument used in individual surveys and were key to instrument and treatment fidelity throughout the data collection

process (Collins et al, 2006). Significance enhancement used qualitative data to enrich the quantitative data collected from the survey (Collins et al, 2006).

Qualitative Data Analysis. After transcribing the interviews, the researcher began by reading the text, coding and categorizing themes, and linking sections of text that represented comparable phenomena, making notes of any unusual events or outliers (Bryman et al., 2011). NVivo 10.0 was used to organize themes and codes as interviews were conducted and analyzed. The process of categorizing themes and dimensions of data is called open coding (Creswell, 1998). Open coding was based on key words, phrases, or sentences that carried significant meaning in the text and represented acts, activities, meanings, participation, relationships, or settings (Lofland, Snow & Anderson). Codes also represented conditions, interactions, strategies, tactics, and consequences (Strauss, 1987), or the financial resources, social or economic environment, and bureaucratic powers or constraint (Sabatier, 1986) as perceived by participants. Schamber defined a coding unit as "a word or group of words that could be coded under one criterion category" (Schamber, 2000, p.739). The researcher read the complete transcript, making manual notations in the margins of the document and underlining or highlighting key words that represented codes. The text was then systematically marked, indicating sections of text that represented themes. Once themes were noted, they were indexed and the codes were reviewed, eliminating repetition in coding in order to combine similar themes throughout the text. This is often referred to as data reduction (Miles et al., 1994, Namey, 2007).

Data reduction involved delineating, reducing, and transforming raw data that were collected through interviews, field notes, observations, and transcriptions. Data

reduction is not independent of or synonymous with data analysis (Miles et al., 1994). According to Miles and Huberman (1994), data reduction is a part of data analysis that helps to shape the emerging theory and should be done throughout the process. At this stage, the code list was lengthy since codes ranged from single words to paragraphs (Bryman et al., 2011). Once coding was complete, the researcher began to relate theoretical ideas to the text based both on inductive and deductive analysis. From the initial coding list, themes were interpreted based on interconnected codes, relation of the codes to the research question, and to the existing literature (Bryman et al., 2011). Data reduction allowed for central phenomenon, exploration of causal conditions, and identification of context and intervening condition to be documented. This process of taking numerous codes or ideas determined from open coding and reassembling them in this research into themes that explain the central phenomenon of fishing and fish consumption in the Gullah/Geechee population was called axial coding (Creswell, 1998).

The overall process of data analysis was an iteration of coding the sample of data, testing intercoder agreement, and revising the coding scheme. Intercoder agreement involved coding consistencies between members of the research team. A dissertation committee member with expertise in qualitative research worked with the researcher to carry out intercoder evaluation of themes. Both coders independently read and coded a randomly selected portion of all two focus groups. If the percentage of agreement did not reach an acceptable level, the coding scheme was revised (Schamber, 1991). Intercoder agreement was established during in-person meetings where coders counted the number of times their line-specific codes agreed or disagreed (Laditka and Corwin et al, 2009).

The selected transcript segments were re-coded by each coder until 100% agreement was reached.

Coding was informed by deductive analysis, in that the study's conceptual model was based on the Theory of Planned Behavior (TpB) (Ajzen, 1991). The theory of planned behavior was founded on behavioral variables that influence behaviors that are both planned and deliberate. TpB suggest that a person's behavior is guided by an individual's intentions to behave a certain way and is based on three basic predictors: an individual's attitude toward the behavior, the subjective norms that prompt the behavior, and the individual's perception of how easy it is to perform the intended behavior (behavioral control). Attitude toward the behavior is determined by an individual's beliefs regarding the benefits and risks associated with a behavior. Subjective norm is defined as an individual's perception of whether people important to the individual think the behavior should be performed (Ajzen, 1991). TPB implies that people control their behavior based on motivations guided by personal beliefs and on external factors that define personal norms (Eagly and Chaiken, 1993).

The TpB allowed the researcher to examine how the attitudes, perceived subjective norms, and perceived individual control of participants determined fish consumption decisions (behavioral outcomes) in the G/G and AA Sea Island population. In order to strengthen the validity of the quantitative design, random samples and sufficient sample size are often considered as indicators of validity in the data (Bambereger, 2006). However, the research question must drive the method of recruitment for data collection. In this study, purposeful sampling was used rather than random sampling because of the need for gathering information on the phenomenological

motivations (Patton, 2002) for fishing and fish consumption in the G/G and AA Sea Island population as well as for evaluating the variables that interacted within this population to predict which demographics were more likely to exhibit certain behaviors.

Data Validation. As data were collected and analyzed, there were a few considerations the researcher made in order to ensure validity of the study. Validity involves establishing the degree to which researcher's conclusions corresponded to the reality of the population being studied (Cho and Trent, 2006). Theoretical validity is the ability of a study to explain the phenomena studied, including its main concepts and the relationships between them (Andersen and Herr et al., 1994). Theoretical validity aligns both the concepts and categories of a given study with those of existing theory to show how constructs from each are related. The explicit purpose of this study was not to generalize findings to other populations.

Generalizability or generalized validity is accomplished when the same findings are arrived at with different data sets. Internal generalizability is when the same findings are found within the study population, while external generalizability involves findings that are generalized to the general population (Andersen and Herr et al., 1994). Generalized validity was not addressed under the scope of this research. Evaluative validity is the level of description and understanding researchers can achieve without being judgmental (Andersen and Herr et al., 1994). Factors that influenced evaluative validity were having a comprehensive set of data sources (focus groups, interviews, literature reviews), cultural competence of the data collection team, and having an adequate method of analyzing data once it had been collected.

Creswell and Plano Clark (2007, p. 145) stated that the inherent nature of combining quantitative and qualitative data introduces potential validity issues (Onwuegbuzie & Johnson, 2004; Tashakkori & Teddlie, 1998, 2003a). Data triangulation was employed in this study. It involved using different sources of information in order to increase the validity of the study. When all data were collected, participant responses from the pilot study, preliminary interviews, focus groups, and individual interviews were compared in order to gain insight into the perspectives of the study group. Throughout data collection and analysis, feedback from each of these groups was compared to determine areas of convergent and divergent perceptions. Validity was established once consistent themes from the pilot study, preliminary interviews, focus groups, and individual interviews emerged.

CHAPTER 5

RESULTS

A Qualitative Exploration of Fishing and Fish Consumption in the Gullah/Geechee Culture

Introduction

Gullah/Geechee people are descendants of enslaved Africans who remained in cultural and geographical isolation on the Sea Islands of the Southeast U.S. coast from Wilmington, North Carolina to Jacksonville, Florida until the 1950s. The heritage of the G/G people is deeply rooted in a culture largely dependent on fish and seafood as a primary source of protein (Jarrett, 2003; Bonnekessen, 2010; Green, 2013). Decades of urban development have reduced the G/G population's access to traditional fishing locations and has increased exposures to environmental contaminants in some bodies of water that are frequently fished by G/G communities. Research suggests that AA subsistence fishers in the Southeastern United States may be more likely to consume larger amounts of fish (Burger et. al., 1999, Katner et al. 2011, Kamen et al. 2012, Lynch et al. 2012), potentially exposing them to higher levels of contaminants such as the neurotoxin MeHg.

In communities that are historically bound by religious faith, it is often effective to disseminate health messages through faith-based institutions; this is particularly true in African American churches where the incorporation of spiritual and cultural relevance to health messages has been shown to have positive salutary effects (Krause, 2004,

Holt et al., 2006, Campbell et al., 2007, Debnam et al., 2012). A 2010 Gallup poll indicated African Americans among demographic groups having the highest weekly church attendance in the U.S. (Newton, 2010). Religion and spiritual beliefs are integral to the most fundamental aspects of the Gullah/Geechee culture because they generally guide the life choices people make in this community (Creel, 1988, Moore, 1992, Jarrett et al., 2002). Church and community group leaders will serve as key informants in identifying focus group and individual survey participants. These leaders will also be involved during the course of and at the conclusion of the research (focus groups, instrument administration, disseminating results, etc.) in order to increase awareness of study findings to the study population.

Cultural competence is the understanding that people of different cultures have different ways of communicating, behaving, and problem solving; it is having the willingness and the ability to adapt the way one works to fit that cultural background (Bensley et al., 2003). When a person perceives another to share world perspectives, these similarities are thought to enhance the likelihood of receiving information, trusting shared information, and increasing the likelihood to lead to inferences of attitudinal similarities between the information source and the recipient (Kennedy, 2010). Audience segmentation is a process of grouping individuals into segments so the researcher can focus on identifying the right health message for a subpopulation in a manner that will be most effective in communicating a health message targeted to that population (Slater, 1996, Grier et al., 2005, Bryant et al., 2007, Davis et al., 2012). In this study, the African American Sea Island population is the subpopulation being segmented from the general population based on unique fish consumption patterns that

differ significantly from the fish consumption patterns in the general population. Research supports that effective formative research designs can include both qualitative and quantitative methods (Middlestadt et al., 1996).

The purpose of this study was to explore in-depth the motivations for fishing and fish consumption patterns of rural and urban residents in G/G and AA Sea Island communities. Gaining a better understanding of the perceptions and motivations for fishing and fish consumption can help identify why people make specific fish consumption choices. It will also better inform researchers and health educators on the most practical and effective health communication strategies for promoting healthy fish consumption choices in both urban and rural G/G communities. This is significant since there are known discrepancies in the effectiveness of health communications between urban and rural ethnic populations (NRHA, 2013).

Conceptual Framework

The conceptual framework guiding this study (Figure 4.1) was informed by the Theory of Planned Behavior (TpB) (Ajzen 1991) which suggests that a person's behavior is guided by an individual's attitude or belief toward a behavior, cultural factors that lead to a behavior, and how much control an individual perceives himself as having in performing a behavior. TpB implies that people control their behavior based on motivations guided by personal beliefs and on external factors that define personal norms (Eagly et al. 1993). Ajzen (2011) suggests that formative research is necessary when developing research questions that are relevant to a population and that questions must be validated prior to finalizing a survey instrument.

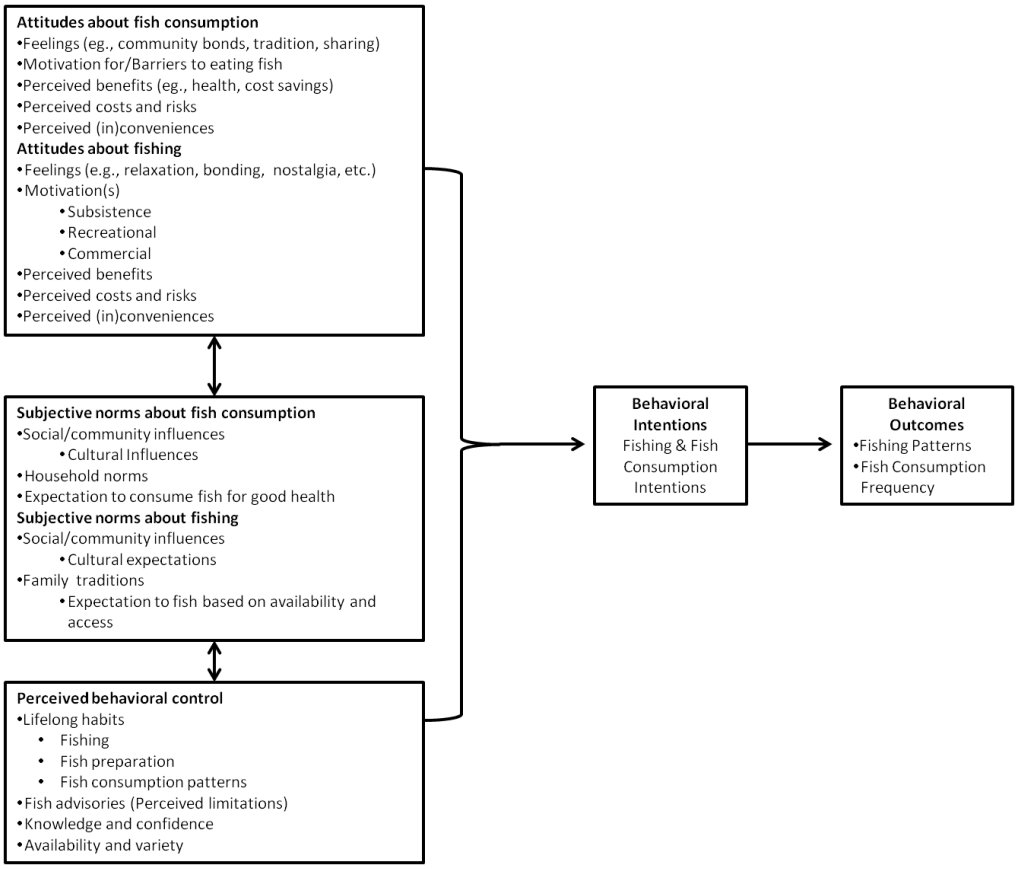

Figure 5.1 Conceptual framework for evaluating fishing and fish consumption patterns in the SC African American Sea Islands population

The TpB has been used in previous fish consumption studies to identify determinants of fish consumption behaviors based on personal influences on fish consumption intentions and frequency (Prell et al. 2002; Verbeke at el. 2005; Lauber et al. 2011). In a Great Lakes study, participants were asked open-ended questions based on the TpB about variables that potentially influenced fish consumption choices such as perceived attitudes regarding fish consumption in their social circles, perceived positive and negative effects of eating fish, perceived barriers to consuming fish, and current sources of information about the risks and benefits of eating fish (Lauber et al. 2011). Focus groups were conducted with three groups of interest: women of childbearing age,

urban anglers, and retirees to determine modified consumption based on fish advisories, geographical restrictions to urban fishing locations, and increased fish consumption based on having more time to fish, respectively. The sample was comprised primarily of Caucasian participants and fish consumption was based largely on choice, even by urban anglers who relied to some degree on the fish they caught for food. The study indicated that Caucasian fishers were aware of ethnic groups who consumed fish caught in specific urban locations, but themselves were unwilling to consume fish from those bodies of water (Lauber et al. 2011). In other studies, the TpB has been used to develop a questionnaire designed to examine motivational factors for fish consumption in Swedish adolescent students (Prell et al. 2002) and to explain intentions to purchase and consume seafood by Danish consumers (Bredahl et al. 1995). The current study sought to determine fishing and fish consumption patterns and cultural influences on these choices in the G/G population, a Sea Island subpopulation that has relied on fish and seafood based on culture, tradition, and geographic boundaries for over a century.

The main TpB components incorporated into the current study's model include: Attitudes about fishing and fish consumption, cultural norms associated with fishing and fish consumption, and perceived levels of behavioral control linked to traditions, accessibility, availability, and efficacy of rudimentary and contemporary fishing techniques. These factors may influence fishers' intentions to fish and consume fish which determine where and how people fish and the types and amounts of fish that people consume. This study addresses a gap in our knowledge on fishing and fish consumption patterns in this population which relies significantly on fish as a dietary staple. It is innovative because it addresses the relationship between fishing and fish

consumption frequencies and the socio-cultural factors that play a role in dietary fish choices.

Methods

Participant Recruitment and Selection

Participants were recruited for focus groups or individual interviews to explore beliefs and perceptions about and motivations for fishing and fish consumption in the G/G and AA population. The State Rural Plan for South Carolina was used to establish rural vs. urban status in this study (SCRHRC, 2008). The South Carolina Rural Health Plan identified Beaufort and Colleton counties as "micropolitan rural" areas with an urban core of no less than 10,000 people, but no more than 50,000 people. Charleston County was classified as metropolitan (urban), a county with 50,000 people or more. G/G and AA men and women, ages 18 and older, were recruited from the two rural counties (Beaufort and Colleton Counties) and one urban county (Charleston County) in coastal South Carolina. All three counties are located within the geographical footprint designated by the G/G Cultural Preservation Act as the G/G Cultural Heritage Corridor (GGCHC) (NPS, 2001). Recruitment flyers were e-mailed or mailed to various churches and community organizations within the tri-county study area. Researchers collaborated with clergy and community leaders who encouraged participation from the community by word-of-mouth and hosted focus groups or individual interviews at respective churches or community centers.

Focus Group/Individual Interview Protocol

Four focus groups with a total of 34 participants and 102 individual interviews were conducted for an overall study sample of 136 participants. Focus groups ranged

from 60 to 120 minutes. Individual interviews ranged from 20-40 minutes. The TpB and previous fish consumption studies (Perenchio, 2001, Brunso et al. 2009, Lauber et al. 2011, and Kamen et al. 2012) were used to guide development of the focus group and interview protocol and questions.

A moderator and notetaker were present for three focus groups. One of the focus groups was conducted by a moderator only. Two digital recorders were used to audio record all four focus groups. A single digital recorder was used to audio record 85 individual interviews. Seven individual interviews were mail-in interviews and 8 individual interviews were group facilitated in order to accommodate some participant's work and family schedules. Two interviews were not audio-recorded because the researcher experienced technical difficulties with audio recorders. Hard copies of the two interviews that were not audio-recorded were marked accordingly in the files.

Participants in both focus groups and interviews completed a 49-item semi-structured interview survey on childhood fishing experiences, perceptions of the fishing culture, seafood preparation, and seafood consumption and a 10-item demographic survey. Each participant received a $10 cash incentive in appreciation for their time and input (Wessells and Anderson, 1995, Kuntz, 2007, Kuntz et al. 2009).

Qualitative responses to nine open-ended questions were transcribed verbatim for each focus group/interview and compared with audio recordings to ensure accuracy and completion of transcriptions. All personal identifiers were removed from transcripts prior to analysis.

Analysis

A thematic analysis was conducted for the nine qualitative interview and focus group questions. Initial analyses involved coding verbatim transcriptions line by line for the purpose of extracting as many emerging ideas as possible. A comprehensive list of conceptual and theoretical ideas were compiled through this process called open coding (Strauss & Corbin, 1990). In order to develop the codebook, the primary author conducted open coding of two focus groups and three individual interviews. The codebook was provided to a second author who independently coded one focus group and one individual interview. The two coders convened to discuss and compare codes until 100% consensus about the meaning and definitions of codes were achieved. The combined list of codes agreed upon by authors was used to develop a more comprehensive codebook which was uploaded into NVivo® 10 (QSR, 2012), a qualitative data and organization management software. The remaining focus groups and individual interviews were converted to pdf files, uploaded into NVivo® 10, and coded. Axial coding was used to reassemble and link categories and ideas from open coding, allowing researchers to begin forming initial themes (Strauss & Corbin, 1998). Quotes taken from verbatim transcripts were used to validate the coding process used by authors and to support interpretation of the data. Demographic survey data were entered into Excel© and analyzed using nonparametric frequencies and percentages.

Results

Participant Demographics

A total of 136 individuals (60 urban, 76 rural) participated in focus groups or individual interviews. Of the 135 participants who completed the demographics survey,

100 (74%) were male and 35 (26%) were female. Participant ages ranged from 18 to over 66 years of age, with most participants between 56-65 (n = 49/133, 36.8%) and over 66 years of age (n = 36/133, 27.1%). Most study participants had annual incomes below $25,000 (n = 45/125, 36.0%) or between $25,000 and $44,999 (n = 36/125, 28.8%). Fifty-six of 127 participants (44.1%) were high school graduates; 16 (12.6%) had some college or had earned an associate's degree; and 11 (8.7%) had obtained a college or graduate degree. Demographic characteristics by rural and urban classification are shown in Table 4.1.

The majority of participants (90.0%) across the study area reported fishing as a child; however, most participants (52.3% rural and 42.3% urban) fished less frequently than in their childhood at the time of the survey. The main reason reported for fish consumption in rural areas was for health reasons (60.0%), followed by taste (33.3%), and affordability (6.7%), with similar feedback from urban participants. Approximately 90% of participants in both urban and rural areas reported eating fish for recreation. Twenty-nine percent considered themselves subsistence fishers and approximately 9% were commercial fishers.

Table 5.1
Participant Demographics by Rural vs. Urban

Characteristics	Total (N=136)	Rural (n=76, 55.9%)	Urban (n=60, 44.1%)
Gender			
Male	100	54 (71.0%)	46 (79.3%)
Female	34	22 (29.0%)	12 (20.7%)
		Total N = 76	Total N = 58
Age			
18-25	4	4 (5.4%)	0 (0.0%)
26-35	2	2 (2.7%)	0 (0.0%)
36-45	18	12 (16.2%)	6 (10.2%)
46-55	24	16 (21.6%)	8 (13.6%)
56-65	49	**24 (32.4%)**	**25 (42.4%)**
66+	36	16 (21.6%)	20 (33.9%)
		Total N = 74	Total N = 59
Income			
<$25,000K	45	**30 (41.7%)**	15 (28.3%)
$25,000-44,999K	36	20 (27.8%)	**16 (30.2%)**
$45,000-64,999K	15	9 (12.5%)	6 (11.3%)
$65,000-84,999K	18	6 (8.3%)	12 (22.6%)
>$85,000K	11	7 (9.7%)	4 (7.5%)
		Total N = 72	Total N = 53
Education			
<High school	12	9 (12.5%)	3 (5.5%)
High school graduate	56	**32 (44.4%)**	**24 (43.6%)**
Some College/Associate Degree	32	16 (22.2%)	16 (29.1%)
College Degree	16	10 (13.9%)	6 (10.9%)
Post-College/Graduate Degree	11	5 (6.9%)	6 (10.9%)
		Total N = 72	Total N = 55
Fished as Child			
Yes	90	65 (84.4%)	39 (79.6%)
No	20	12 (15.6%)	10 (20.4%)
		Total N = 77	Total N = 49
Fishing Habits Changed			
Fish More	27	17 (26.2%)	10 (38.5%)
Fish Less	45	34 (52.3%)	11 (42.3%)
Fish the Same	16	12 (18.5%)	4 (15.4%)
Other	3	2 (3.1%)	1 (3.9%)
		Total N = 65	Total N = 26
Main Reason for Eating Fish			
Good for health	89	35 (60.3%)	24 (46.5%)
Taste good	37	19 (32.8%)	18 (27.9%)
Affordable	11	4 (6.9%)	7 (7.0%)
		Total N = 58	Total N = 49

(continued)

Characteristics	Total (N=136)	Rural (n=76, 55.9%)	Urban (n=60, 44.1%)
Awareness of Fish Advisories			
Yes	70	30 (44.8%)	40 (69.2%)
No	55	37 (55.2%)	18 (30.8%)
		Total N = 67	Total N = 58
Source of Fish Advisory Info			
Fish advisory signs			
SCDHEC	3 (7.9%)	**11 (16.4%)**	3 (7.9%)
SCDNR	1 (2.6%)	6 (9.0%)	1 (2.6%)
Television	**13 (34.2%)**	10 (14.9%)	**13 (34.2%)**
Family	5 (13.2%)	9 (13.4%)	5 (13.2%)
Newspaper	2 (5.0%)	6 (9.0%)	2 (5.0%)
Internet	2 (5.0%)	10 (14.9%)	2 (5.0%)
Radio	1 (2.6%)	0 (0.0%)	1 (2.6%)
Other	1 (2.6%)	2 (3.0%)	1 (2.6%)
	10 (26.3%)	13 (19.4%)	10 (26.3%)
	Total N = 40	Total N = 20	Total N = 40
Interested in learning more about fish advisories			
Yes	82	48 (72.7%)	34 (77.3%)
No	28	18 (27.3%)	10 (22.7%)
		Total N = 56	Total N = 44

Qualitative themes

Themes emerging from interviews and focus groups are categorized and presented according to frequency of mention. They included: (1) strategies for communicating with communities about fishing and fishing advisories, (2) beliefs about the role of fishing and fish consumption in the culture, (3) motivations for fishing, and (4) perceptions about fish consumption advisories. Quotes from participants were used to support the themes from which they originated. Table 4.2 describes and ranks themes and subthemes by location (urban versus rural).

Table 5.2
Emerging Themes Associated with Fish Consumption by Geographic Location

Themes and subthemes	Geographic Status	
	Rural	Urban
1. *Strategies for communicating about fishing/fish advisories*		
Pamphlets/Flyers	**1**	2
Churches	2	**1**
Internet	3	3
Newspapers	4	4
Grocery stores	5	5
Word of mouth	6	7
Television	7	6
2. *Beliefs about role of fishing and fish consumption in the culture*		
Relaxation/Recreation	3	**1**
Main reason for eating fish	2	4
Income	**1**	3
Inherent to culture	4	2
3. *Motivations for fishing*		
Childhood experiences	**1**	**1**
Cultural preservation	2	2
Income/Livelihood	3	4
Passing traditions to future generations	4	3
4. *Perceptions about fish advisories*		
Confusion between fishing regulations and advisories	**1**	**1**
Perceived barriers to fishing	2	3
Limited trust in government	3	2

Note. Rankings were based on how frequently subthemes were mentioned in focus groups and interviews

Strategies for communicating about fishing and fishing advisories.

The survey instrument included questions regarding the most effective methods for communicating fish advisory information as well as the best methods for disseminating the results of this study to the G/G and AA Sea Island population. Responses indicated that rural participants preferred pamphlets and flyers as a primary information source, while urban participants preferred to receive information through their churches. The Internet, local newspapers, grocery stores, word-of-mouth, and television were also listed as viable dissemination methods within G/G and AA

communities.

Pamphlets/flyers. Pamphlets and flyers were the most frequently suggested method of dissemination in rural areas and the second most commonly mentioned method of dissemination in urban areas. One urban participant remarked, "…If you made some brochures and …you're trying to get it to the people…You trying to make something like a book or something like that…you can probably distribute it like at the churches, a lot of people would get ahold of that." Another urban participant commented, "A lot of people don't use the internet. You ain't got…things you could just pass out?...Just pamphlets to just pass out 'cuz that, I mean, you'd get them out quicker like that." A rural participant commented that "I would suggest you have those out there. I would put it in BP (gas station), I'd go and just put it in stores. Some people you can't talk to, and some people are rude so I would put it in stores. And if someone asks what this is, I would give them to the best of my knowledge." Another rural participant suggested, "You can print flyers, flyers the mailbox or you could carry it to a … a prayer meeting or a church service."

Churches. The majority of urban participants suggested using churches to communicate fish consumption advisories as well as study results for this research because "people eat together at the church" and "we do a lot of mouth to mouth" (suggesting word of mouth communication). Communicating health messages through churches was not mentioned as much in rural areas as in urban areas. One urban participant suggested, "I think the churches would be…one of the manners to get the information out effectively…and in this area, there's, what, about 15 churches…? Every corner has a church." A rural participant recommended sharing fish advisory at her churches' monthly fish fry. Another rural participant remarked that churches were the

best place to share information "because that's where…everybody congregates."

Internet. A slight majority of the study participants (52%) reported not using the Internet. Most of those participants were from rural areas. Many non-Internet using participants relied on family members, typically a wife or daughter if the participant was a male and an offspring if the participant was a female. Some participants used the Internet, but not as a source of information for fish consumption advisories. One rural participant stated, "I use the Internet all the time, but I don't use it for fish stuff." With regards to obtaining fish consumption advisory information from the Internet, one urban participant stated, "You better go through the churches. (Laughs) Oh man, you know what I'm saying?…Because ain't too much people got access like that, you know." Although most participants overall did not use the Internet, most participants age 45 and younger used the Internet on a daily basis with one participant stating "I use it every day…that almost make the library obsolete."

Beliefs about the role of fishing and fish consumption in the culture

Relaxation/recreation. More people in urban than in rural areas said they fished for relaxation. When asked about the role that fishing plays in the sea island community, one urban participant responded, **"**Well, I would say fishing, what it plays in the culture of the African [American] community, it is a source of food. It is a, uh, type of therapy. It's very relaxing. Uh, you have a tendency to forget about all your problems, eh, because, ah, you're concentrating just on that reel to bend or that cork to go under, and so all your attention is focused on that." Another urban participant stated, "Well, it tells you certain habits. …Where the fish at. Where do, uh, what type. Um, it tells you about the character of the people you're with…Because fishing is relaxing to me." A

representative quote about the role of fishing from a rural participant was, "To fish, it's fishing, but it's also a peaceful, tranquil thing. Go out there, you have any problems you just go out there with your fishing line and you have chance to think because it's such a beautiful, you know, surrounding." More urban participants said they fished more frequently for sport, however, some rural participants also cites recreation as their main reason for fishing.

Income. Almost all references to fishing for income were made by rural participants. One rural participant stated, "Uh, for here, you know, it was a way of living. You know, let's say everybody I knew when I grew up here in the late 70s, early 80s, you know, that's what everybody was. Everybody was a fisherman or a carpenter." Another participant commented, "Well a lot of people, this is their livelihood, this is what they do for a living." Still another participant stated, "…Being a native islander it was very important that, that we fish because, um, my, my grandparents fished an awful lot, and they taught us, you know, that it was very important to live off the creek. You know, that's how they made their living back in the day…Well,…they lived off, off the creek. You know, they fished, they crabbed, they shrimped. That's how they made their living. Um, and the creek was their lifeline because they was in, there was not anything else. So, that's how they made their living. I mean, that's how they sustained themselves. So, uh, yeah, it's, it's very important that, uh. It was a very important part of our culture, even when I was growing up as a young boy." While most participants who spoke of income as playing a significant role in the culture were hopeful that the community could continue relying on fishing as a primary source of income, some were discouraged about the future of fishing for livelihood. For example, one rural participant commented, "We

make a good living for raising the family." But when asked if the younger generation was embracing fishing traditions, the same participant responded, "Nope…Because they…don't want to learn. I start to tell you that, when I'm gone, after this generation…Fishing might be going out."

Perception of fishing/fish consumption as inherent to the culture. Similar to discussions regarding passing down fishing traditions to younger generations, urban and rural participants alike believed that AAs enjoyed eating fish because it was inherent to the culture – a way of life. Urban participants felt that AAs "love fish and they've been doing this for, I guess, for centuries and fishing is something that gives them a lot of pleasure" and that [for most AAs] "fishing is a tradition…most people that's all they want is fish, some prefer chicken, but fish is the main part." One urban participant stated, "coming up that's, you know, that's the only meat, you know, food back then but now a lot of people do it for game. Well, I do it for game but a lot of fellas still go fishing to eat and stuff…I just love to fish." Rural participants made similar comments stating, "It's very important in our culture, eating fish. Basically that's what we were raised on a long time ago you know, fish. You know we go and they get the oysters, clams, crabs, and that's what we did." An urban participant remarked that "this is what they (AAs) do, this they've been doing this for you know like a lifetime thing." Another rural participant stated, "Fishing is a way of life for the people in (her town). You know, from our ancestors and stuff like that…That's all they had to do." The same sentiments reverberated with numerous participants throughout the study area and could be best summarized by the comment, "We carry it through generations, that's what we've been taught" and fishing was a way of life here for many, for many of us…as black people."

Main reasons for eating fish. When asked the main reason for eating fish given the choices Health, Tastes, or Affordability, 60% (n=54) of overall responses were that people ate fish because it was good for their health. Of the remaining participant responses, 33.33% (n=30) ate fish because it tasted good and 6.67% (n=6) ate fish primarily because it was affordable. Of the participants who cited health as the primary reason for eating fish, most attributed benefits to Omega 3 fish oils or fish as "brain food". One comment from a rural participant was that fish contained "Vitamin A, like [O]mega 3, they got the fish oil, and that's why we start eating more fish, because they more healthier for you." Another participant from a rural area stated, "And, you know, the survey they did about the fish oil that they sell in the little capsules now, so that's why they always say fish is brain food, but now they got the research to back it up. That fish is a good part of your diet. You know, the[y] cut some of hormones out of those animals and being as grown from nature the right way. You know, you don't find the steroids and all the other things that come along with the land animals that we eat. So it's a very, very healthy – fish is very healthy and good for you. So that's good for the mind because that fish oil helps you keep sharp. Fights against, you know what I'm sayin', though, diseases, like, Alzheimer's and stuff like that, you know." In addition to perceived benefits of consuming fish, some participants were aware of potential exposures to contaminants as expressed by a participant in an urban area: "…Because they recommend, uh, that you eat a certain portion of fish…because of Omega oil…fish is a, supposed to be a healthy source, but now some of the fish, uh contaminated …with Hg…and they do advise you as to what fish that have a certain amount of that…mercury in it, you know…" Even though a few participants were aware of some contamination

associated with fish consumption and a few called mercury by name as a contaminant of concern, most participants indicated their intentions to continue consuming fish for both health and taste.

Motivations for fishing

Childhood experiences. In both rural and urban areas, most G/G participants indicated that the importance of fishing as a child was because it was their livelihood and it served as a main protein food source for the family. One urban participant shared that, "back…when I was in childhood…fishing…wasn't recreation then. It was to…catch fish for food," while another participant in a rural county stated that, "when we fished we brought it home because it was 8 of us (kids), mother and father. So, that's how we were fed really…Fish was always around the house." Whereas necessity motivated the majority of participants' families to fish during childhood, some of the participants indicated that the importance of fishing as a child was based on recreation or fun, while a smaller group of participants stated family time as a factor for family fishing during their youth. Of fishing as family time, one participant remarked, "Um, it was like a tradition every Saturday and Sunday morning, we would go after church, and we would have a big fish fry. That was like every day, every Saturday, Sunday thing, that we did every week, me and my grandmother and her friends, and sometimes me and my cousins, we'd just go on our own."

When asked to discuss recollections of fishing during youth, the majority of rural participants cited casting nets and using of rudimentary fishing techniques as a routine part of their fishing experience. A rural participant commented, "We did crab fishing which is netting. We did mullet fishing which was netting…Those the resources we used

to feed our family…Now when it come to hook and line fishing, that was a sport. And that was only done periodically." In urban areas, the primary childhood memories associated with fishing were simply for recreation and fun.

Cultural preservation. A majority of rural participants addressed different aspects of cultural preservation regarding fishing traditions in G/G communities. A focus group in a rural area revealed that a significant motivation for fishing in the G/G population was to preserve fishing as a mainstay of the G/G culture. One rural participant responded when asked why he felt teaching children to fish was important, "Because they will not only be able to sustain themselves, but to sustain the culture of the community as well as learning a family tradition. I think that's critical." When asked to discuss issues important to them regarding the G/G fishing culture, rural focus group participants responded as follows.

Participant 1: We've been sustained here because of the sea…because of these waters…and we want to continue to do that…without fines
Participant 2: It's been a tradition. I think it should continue to be a tradition.

The belief that fishing is intricately woven into the G/G culture is one that was interspersed throughout almost every interview conducted, but was particularly evident in interviews with rural participants. One rural participant related fishing to life, "…When a big fish break your line, it gives you the tenacity to wanna catch it and adrenaline pumpin'. And you fix another line go out there just like in life, you know. When you have a setback, you can't give up. You gotta go after it again and say I'm on a mission today, but I'm going back next week, I'm going to catch it next week. I'm going to bring a stronger line. So all that, you can relate with fishin' has to do with everyday life. That's why I love to fish because you learn from your experiences. And life is just like

fishing."

Income/livelihood. A primary motivation for fishing among the majority of participants was income or a means of livelihood. One rural participant stated, "It's a source of living, and, and, and, um, really, how we survive, mainly at the river, even today." Another rural participant remarked, "Being on an island, being a native islander it was very important that, that we fish because, um, my, my grandparents fished an awful lot, and they taught us, you know, that it was very important to live off the creek. You know, that's how they made their living back in the day. … Well, they, they lived, they lived off, off the creek. You know, they fished, they crabbed, they shrimped. That's how they made their living. Um, and the creek was their lifeline because they was in, there was not anything else. So, that's how they made their living. I mean, that's how they sustained themselves. So, uh, yeah, it's, it's very important that, uh. It was a very important part of our culture, even when I was growing up as a young boy."

Passing fishing traditions to future generations. Most participants in urban and rural areas not only expressed positive feelings about childhood fishing experiences, but also thought it was important to teach children to fish. Rural residents mentioned passing fishing traditions to future generations more often than urban participants. One rural participant spoke of fishing as a way to keep children out of trouble and to focus on the 'important things in life', "When you out there fishin' and you get excited about fishin', you know what I'm sayin', and just being out there right in the water, enjoying the nature, you know what I'm sayin', and, like, God designed it for us to enjoy it. It keeps your mind focused on other things, which is more important things in life…Because it teaches you patience. It teaches you patience and, see, patience is a virtue. You must

have patience, and to sit there and patiently wait for the fish to bite. And on the days that they don't bite, still being able to enjoy the nature, being out there among nature…like it says in our Father's prayer, you know, that's what it's all about. It gives you a wholesome good feelin', warm tingling feelin'. Another rural participant stated, "I love it. I love it and I've uh taught my sons how to fish and I've taught my grandsons how to fish…You know so we pass it down the line just like my grandfather did me and grandfather's father did him. You know, we try to pass it down the line…Uh-huh, show them there's more than one way how to survive or keep the family alive you know..." Often concurrent sentiments of passing down fishing traditions and livelihood were expressed. For example, one participant stated, "I believe it's just, um, kind of first thing, keep them out of trouble. That…they can actually go out and work…if they choose to, usually, that's an employment on the river." When asked why teaching children to fish was important in the culture, one rural participant responded, "Because it's, it's a culture that we, um, grew up with and, we don't wanna lose that. And we don't want our children to lose that. I think it will be very important, especially around here."

While almost all participants indicated that the role of fishing in the culture was important, some participants felt that the fishing tradition had been diminished over decades due to development and competition with commercial fishers. One rural fisher stated, "And the fishing was good for about forty … at least forty-five years…After that it start decline. Went downhill… A lot of things start going bad, but you had it real good for about forty years." Another rural participant stated, "If I go back 20, 25 years, it was very important. The African-America was, uh…making the best living fishing, oystering, uh … and catching fish, shrimp, oyster. But for African-America(n), that was

the best thing they could…Best thing, uh, for them…around St. Helena Island to Gullah…to Gullah Island, but uh...Whatever...There wasn't much other job they could make much money off." When asked by the interviewer if he currently felt that fishing was a viable means of income, the participant responded, "No, it's not the same now."

Perceptions about the South Carolina fish consumption advisories

Confusion between fishing regulations and fish consumption advisories. Although the vast majority of participants stated that they were aware of the state fish consumption advisories, there was confusion between the South Carolina fish consumption advisories and the state fishing regulations with nearly half of rural participants and over a third of urban residents placing misplaced frustrations on the fish consumption advisories. About one third of participants were completely unaware of fish consumption advisories. More confusion about fish consumption advisories was evident in rural focus groups and interviews. Representative statements included, "I know about 'em. I know that you can only catch so many of certain type of fish. So, yeah, you can say that, you know" and "That wouldn't be the thing that tells you what's the calorie, the, um, cholesterol?...Because I see that sometimes at the market". This indicates confusion between fish advisories and regulations. Many participants made references to fishing regulations when asked about the fish consumption advisories. One rural participant expressed, "There's a lot of times that they print it out in some of these magazines and a lot of people can't read…they just go out there and catch these fishes and when uh, SCDNR comes up on your boat…then they are going to charge you for these fish. But a lot, a lot of elderly guys can't read..." Another participant responded, "Well, it's where you get your license…That tell you all [the] rules…and how much kind of fish you catch

and how the size it got to be and all that stuff." He went on to explain, "You catch it when you get your license...If you don't have a, um, a permit, then you get locked up." One rural participant stated, "They put a thing on it saying 'hey you know, this is what we're going to do. You can only catch uh, seven, seven spot tail bass 13 inches long, three winter trouts.' The rules that they…they put and I don't know if it's coming from the north and its moving to the south or you know…I just quit because like I told my partner, it isn't worth it to me to gas up my boat to go out there to catch three winter trout." Some participants' understanding of fish advisories were misaligned to the extent that they didn't relate the advisories directly to fishing with one participant remarking, "I've heard about people going fishing in boats and getting lost because they didn't pay attention to the advisory."

Limited trust in government agencies regarding fishing laws and fish consumption advisories. Participants who demonstrated some level of confusion about the fish consumption advisories frequently expressed a lack of trust in government agencies regarding fishing laws and advisories. Lack of trust was a common theme in both rural and urban counties, but mentioned more often by urban participants during interviews and focus groups. One rural participant discussed the fact that in the past their community was always invited to meetings within their congressional district to outline anticipated changes in fishing regulations. "They no longer do that," he explained, "When you know of a change sometimes now, you have the law enforcement officer writing a ticket to you. And that's when you find out." In an urban focus group, participants responded when asked if they trust the state health department's fish consumption advisories as follows:

Participant 1: "I could go with [the state environmental agency]…
Participant 2: Some time the government don't tell you everything.
Participant 1: That's exactly...
Participant 2: You find out 5 years later. You be dead by then.
Participant 1: That's right."

When asked if they had seen fish consumption advisory signs, rural participants responded with comments such as "I never seen 'em. They must be hide 'em" and "So you can buy fish and they make you sick." An urban participant shared similar beliefs that state agencies purposely limited information on fishing restrictions in order to penalize fishers. "You know, like we got a sheet where all the different fishes are on there…But you know, there are still fish that we catch is not on there…No pictures of them then we don't know what we have and when we get caught with them, you know that's easy for DNR (South Carolina Department of Natural Resources) to say you know you got illegal fish." A few participants, mostly urban, felt that the state fish consumption advisory system was effective, but several of those statements were mixed with sentiments that knowledge of contamination in fish was 'common sense'. When asked whether they thought the South Carolina fish consumption advisories were effective, one rural participant replied: "Yes. I think that if something really was wrong, certain species of fish, after a period…I mean, we probably would find out about it sooner or later. All it takes is maybe a couple of people getting sick or something like that...A lot of that comes from the past. Our parents and stuff, teach us what we learn and little common sense so forth. Umhmm. And then, I think we've been eating fish for so long we're immune to it. We've become…immune to it."

Perceived barriers to fishing. While most fishers in both rural and urban areas were frequent fishers, many expressed limitations that hindered what they considered

normal fishing practices. Many rural participants cited cost as a barrier to fishing as expressed by one participant who stated, "Like it is now. It ain't too much going for fishing right now…The cost of fuel and the cost…It's so high that, uh … It just ain't like it used to be." Some rural fishers cited commercial development and fishing regulations as limiting factors for fishing. "It's difficult to describe that because prior to the bridge coming to Hilton Head, fishing was considered a major part of family diet year round. Now, that have changed. Because of regulations, it has driven many persons away from fishing. Restrictive regulations," stated one rural participant. Another rural participant stated that he no longer fishes frequently, "And the reason is that the regulations on fish, catch, size, and number have changed dramatically…the restrictions have gotten to the point that…it is not fun to go out to fish anymore."

Discussion

This qualitative study was the first to explore motivations for fishing and fish consumption choices of G/G and AA Sea Island men and women in rural and urban areas of the South Carolina Lowcountry. Our findings show that both rural and urban participants are motivated to fish primarily by influences from childhood fishing experiences and by the desire to preserve fishing and fish consumption practices that are considered a part of the culture in this population. This is consistent with previous studies that suggest a link between childhood interactions with natural environments and lifelong adult perspectives on the natural environment (Toth et al., 1997, Wells et al., 2006, and Chawla, 2007). Participants in both areas frequently discussed their families' reliance on fish for food during their childhood, but currently consume fish frequently for reasons including necessity, availability, health, recreation, and tradition. Most

participants linked their current fish consumption choices to childhood experiences with fish consumption, but fishing practices had evolved from rudimentary fishing techniques to use of more advanced fishing equipment and techniques because people today have relatively more financial capital.

Both groups indicated that preserving fishing traditions as a part of the culture was important. A majority of rural participants expressed a desire to pass fishing traditions to the next generation, with reasons ranging from a method of teaching children how to live and feed their families from creeks and rivers to educating children about alternative ways to make a living (income) if other options were not available. Participants frequently spoke fondly of childhood fishing experiences as well as family gatherings and celebrations centered on fish fries. Family bonding and quality time, getting to know other people in the community, and sharing fish with people who were unable to catch or purchase their own fish were also common sentiments regarding motivations for fishing, all tied to cultural preservation (Ellison, 1990, Mair et al. 2010, Nation et al. 2010). Noted primarily by rural participants, an additional factor that negatively impacted the cultural preservation of fishing traditions was the building of a bridge in the 1950s from the mainland to the Sea Islands and subsequent commercial development. This is of particular interest because although the history of commercial development in this area is well documented, the impact it has had on the culture from the G/G perspective is not widely referenced in the literature (Smith, 1991a, b, Hargrove, 2009, Hazzard, 2012).

Rural participants made more reference to income and livelihood (for survival) as being a key motivation for fishing and as playing a central role in the G/G heritage.

Therefore, income was not only considered a general motivation for fishing, but it was considered to be a part of the community that is grounded in cultural beliefs and traditions that have been practiced for over a century. For rural fishers particularly, there was an expectation that younger fishers would carry on commercial fishing practices as a part of the family business or due to expectations based on local traditions. Not surprisingly, there was a common sentiment of disappointment with the dwindling numbers of young G/G and AAs who pursue careers as fishermen or oystermen on the Sea Islands. Whereas the role of fishing was largely attributed to income and/or livelihood in most rural areas, it was significantly more important for relaxation and recreation in urban areas, with many urban participants labeling fishing activities as "therapeutic" a theme cited in other studies on fishing in urban AA communities (Beehler et al., 2001, Steinzor et al., 2012).

When asked about their awareness of the state fish consumption advisories, most urban and rural participants responded positively to having knowledge about fish advisories. However, a major theme that emerged from this study for rural participants was confusion between fishing regulations and fish consumption advisories. This discovery is particularly interesting because the research team could find no references to it in published literature. In addition to confusion between fishing regulations and fish advisories, there was an undercurrent of distrust in government agencies that links motivations for fishing with a lack of understanding about advisories. Many of the sentiments expressed by participants were consistent with feelings of distrust among AAs towards medical research and government institutions (Ejiogu et al., 2011, Friedman et al., 2013, Ford et al., 2013). Rural participants also cited more often than their urban

counterparts the negative impacts that restrictive fishing regulations had placed on lifelong fishing practices. This population is similar to some subpopulations in other studies that consume higher levels of seafood and fish for both recreation and subsistence (Dellenbarger et al., 1993, Belanger et al., 2000, Lincoln et al., 2010), potentially exposing them to higher levels of environmental contaminants, including Hg. Our findings showed that over half of all study participants had read, seen or held some level of familiarity with fish consumption advisories, similar to other studies (Burger and Waishwell, 2001; Imm et al.,2005).

Most rural participants suggested pamphlets or flyers as a means of receiving results from this study. Participants willingly gave simple examples of how they would outline materials and places they would distribute pamphlets in order for the material to be better received by participants in the G/G population. Providing health information in a way that is relatable to the target audience has been shown to be effective in previous studies (Plimpton, 1994, Bernard et al., 2007, De La Rue et al., 2011). Recommendations from rural residents to provide pamphlets with simple language, bulleted items, large print and pictures are commensurate with previous studies, which showed that target audiences often have difficulty with too much information that is too technical that isn't supplemented by visuals (Plimpton, 1994, Doak et al., 1998, Friedman et al., 2006, Dowse et al., 2011). Some suggested distributing pamphlets through churches during worship services and after announcements had been made or during religious or community-related activities at churches, such as fish fries, so that participants would be more receptive. This method of priming participants prior to presenting health information has been successfully implemented in other studies (Fishbein and Yzer,

2003, Ma et al., 2011). Our findings were also commensurate with another study (Friedman et al., 2013) in which 41.7% of rural study participants compared to 29.7% of urban participants preferred to receive health messages in pamphlets/brochures. Urban participants mentioned disseminating survey results through churches more frequently than rural participants. Other research has shown that in communities that are historically bound by religious faith, it is often effective to disseminate health messages through faith-based institutions, particularly in AA churches that incorporate cultural relevance to health messages (Holt et al., 2006, Krause, 2006, Campbell et al., 2007, Faridi et al., 2010, Debnam et al., 2012). Dissemination at church implies an institution in which there is trust (church). This is a very important aspect of the G/G and AA culture in which churches are not only considered trustworthy, but are oftentimes considered a symbol for authority of truth.

Limitations

This study had some limitations. Although this research presents an in-depth qualitative exploration of G/G motivations for fishing in both rural and urban areas, the sample size was relatively small and participants were recruited using purposeful sampling of only G/G and AA men and women within in a relatively limited geographical footprint. Because of the focused nature of questions and the attention to cultural impacts on fish consumption patterns in the Gullah Geechee population, this study was not intended to be generalized to the main population or to other racial or ethnic groups, including AAs outside of the geographic boundaries of the G/G Cultural Heritage Corridor. While both men and women were included in this study, this paper did not compare and contrast themes/subthemes by gender or age.

Conclusions and Implications

Both rural and urban G/G and AA Sea Island fishers are motivated to fish by childhood fishing experiences that were frequently interwoven into their daily lives and by a sense of cultural preservation of the role and value fishing and fish consumption carries in this population. Although motivations for fishing and fish consumption are shared, beliefs about the role they play in the culture differ for rural and urban participants. Rural participants mentioned more often the role fishing plays as a source of income while urban participants commented more often about fishing as recreation and relaxation. This may result in part because urban G/G and AA people have jobs other than fishing so that fishing becomes something other than income-driven. In rural areas where there may be a lack of job opportunities, income becomes a more significant factor. This in-depth qualitative analysis showed that both rural and urban fishers report having awareness of fish advisories, with urban fishers having slightly more awareness than rural fishers. However, both rural and urban fishers exhibited confusion between fishing regulations and fish advisories. The South Carolina Department of Health and Environmental Control (SCDHEC) fish consumption advisories are state implemented recommendations for limits or restrictions on fish consumption of specific fish based on potential human exposures to certain contaminants, such as Hg. The South Carolina Department of Natural Resources (SCDNR) fishing regulations are legally binding, enforceable restrictions on the type, size, and quantity of specific types of fish for the purpose of preventing overfishing of certain fish species.

Since confusion between fish advisories and fishing regulations was consistent, particularly in rural areas, education is needed to better inform G/G and AA Sea Island

communities about fish and seafood that could potentially expose them to elevated levels of MeHg. Fishing and consumption levels are not anticipated to change in the population based on participant feedback, but providing clear and culturally tailored (Rootman et al. 1994, Betancourt et al. 2003, Garcia, 2006, Friedman et al. 2012, Rosea et al. 2013) health messages regarding existing fish advisories will allow the population to make informed choices about fish consumption that will minimize potential exposures to MeHg. Health messages should clearly delineate the scope of fishing regulations from those of the fish advisories.

Study participants not only offered specific examples of effective methods for presenting the results of this study in their communities, they explained why they would be most effective. Their willingness to have open dialogue about how to share health messages within the G/G population provides an opportunity for state agencies to involve this population in enhancing the state fish advisories to better reach this population. This approach may create an opportunity to ensure that areas where G/G and AA Sea Island people fish are monitored and that advisories in these areas are more protective for MeHg exposure to fish consumers. It is important that fishers are protected from exposures without deterring fish consumption habits that are healthy. It is also important to consider that some fish species may not be included in advisories based on the assumption that they are less frequently consumed in the general population (Katner et al., 2011). Future research should examine monitoring activities and outreach programs regarding fishing and fish consumption in the G/G population. These programs should be evaluated in order to provide state agencies with sufficient information and suggested considerations for modifying fish advisories to best reach these fishing communities.

CHAPTER 6

RESULTS

Determinants of Fish Consumption and Awareness of Fish Advisories in Gullah/Geechee Communities

Introduction

Gullah/Geechee (G/G) and AA people in the South Carolina (SC) Lowcountry have historically relied on subsistence fishing as a primary source of protein dating back to the antebellum period (Jarrett 2003). Although the population continues to share relatively homogenous cultural practices, fish consumption patterns may vary based on factors including migration to other areas within the SC Sea Islands, having limited physical access to fish based on commercial development, or fishing less frequently or not at all as a result of aging and the physical rigor oftentimes required for fishing activities. Previous studies have suggested that various factors influence fish consumption choices. Social norms, cultural values, role of fish consumption, and demographic factors are determinants that have been described in the literature (Burger et al.1999, Beehler et al. 2001, Burger 2004, Chess et al. 2005, Verbeke et al. 2005). Regional and geographical influences within the United States (U.S.) may also factor into fish consumption choices. Karouna-Renier (2008) evaluated fish consumption habits and hair mercury (Hg) levels of 601 women, 16-49 years of age, who lived in two Florida counties. The study suggested that exposure to the neurotoxin Methylmercury (MeHg) may vary regionally, with significant differences possible within a state based on the

species of fish consumed, frequency of fish consumption, and contaminants related to source water bodies for sport-caught fish. Another study analyzed associations between polychlorinated biphenyl (PCB) levels in breast milk and PCB levels in yellow perch caught in local water bodies that had been adversely impacted by industrial activities (Hwang et al. 2000). In this study, comparisons were made between breast milk of women and fish tissue samples collected in two New York counties and a Native American reservation. The purpose of the current research was to evaluate awareness of the current SC fish consumption advisories and determinants of fish consumption in the study area. Research questions were "what factors predict fish consumption choices in the G/G and AA population?" and "how does awareness regarding the state fish advisories impact fish consumption choices?"

Fish provides numerous health benefits for populations that rely on it as a regular source of food (Silver et al. 2007, Bell et al. 2009). Previous studies show that fish is generally perceived as a healthy food (Pieniak et al. 2010, Clonan et al., 2012), and many people are aware of the health benefits associated with fish consumption (Burger et al. 2009). Some studies indicate an increase in fish consumption based on perceived health benefits (Verbeke et al. 2005, Olsen et al. 2007), but there is a paucity of data on determinants of fish and seafood consumption, particularly in U.S. subpopulations who maintain a subsistence level of consumption (Loring et al. 2010, Driscoll et al. 2012, Busilacchi et al. 2013). One study conducted a survey of participants, ages 18-84 years, to evaluate predictors of fish and seafood consumption (Pieniak et al. 2010). The study indicated that study participants with a higher education level, people with more interest in eating healthy foods, and those who generally knew more about fish ate fish with a

greater frequency. In another study, greater quantities of fish consumption in women aged 45-69 were associated with higher education, increasing age, and larger household size (Myrland et al. 2000). Women are more likely to consume fish weekly compared to men and people over 40 years of age are more likely to consume fish compared with people younger than 25 years of age (Verbeke et al. 2005). These studies indicated that fish and seafood consumption were predicted by gender, household size, education level, age, and awareness a person had about health benefits associated with consuming fish and seafood.

Fish consumption rates vary significantly for subpopulations throughout the United States (McKelvey et al. 2007, Holloman et al. 2010, Lincoln et al. 2011). Although there are known health benefits linked with fish consumption (Cohen et al. 2005, Budtz-Jorgensen et al. 2007, Mahaffey et al. 2011), some studies suggest that consumption of fish in some U.S. subpopulations may be at levels that potentially expose them to higher levels of the neurotoxin MeHg (Gobeille et al. 2006, Mahaffey et al. 2009, Lincoln et al. 2011). Given the balance that subsistence level fish consumers should seek between the benefits and risks of consuming large quantities of fish, it is important to understand what factors predict fish consumption in these subpopulations in order to assist them in making healthy fish and seafood choices.

Cultural and socioeconomic status sometimes play a role in U.S. subpopulations consuming greater quantities of fish and with greater frequency than in the general population (Burger et al. 1999, Muckle et al. 2001, Dellinger 2004; Holloman et al. 2010; Holloman et al. 2012). Research suggests that AA subsistence fishers in the Southeastern United States may be more likely to consume larger amounts of fish (Burger et al. 1999,

Katner et al. 2011; Kamen et al. 2012, Lynch et al. 2012). There is limited research regarding fish and seafood consumption and awareness of fish advisories in the G/G population (Frithsen et al. 2009; Kamen et al. 2012). The present study evaluated fishing and fish consumption patterns in three counties in the Lowcountry of South Carolina (SC), U.S.A. The SC Lowcountry is the land mass located between the Atlantic Ocean and the Piedmont region and includes coastal areas surrounding and including Charleston, Colleton, Beaufort, Berkeley, Dorchester, and Georgetown counties (Chibarro 1999, Parra et al. 2001, Halfacre 2012).

The aim of this study was to evaluate awareness of fish consumption advisories in the tri-county study area and to examine how demographic factors (county of residence, gender, age, education, and income) influence the average serving size of fish and seafood per meal, the frequency of fish and seafood consumed, and awareness of fish consumption advisories in the G/G and African American (AA) population.

Methods

Study setting

The study area was comprised of the area of Beaufort, Charleston, and Colleton SC counties which overlaps the Gullah Geechee Cultural Heritage Corridor (GGCHC). The GGCHC was designated in 2006 as a national heritage area (Figure 5.1 inset). The study area extends from the southwestern edge of Beaufort County to the northeastern edge of Charleston County and inland 30 miles based on the established GGCHC inland boundaries. The South Carolina Department of Health and Environmental Control (SCDHEC) divided the state into five regions (called "sections") for issuing fish consumption advisories on lakes, reservoirs, rivers, streams, and estuaries in counties that

are within or across the designated regions (Figure 5.2). Neither contamination in fish nor in water sheds is definitively bound by county or sections; however, these distinctions are helpful in providing guidance on reducing contaminant exposures through fish consumption. Fish advisories are placed on water bodies in the geographic locations where fish have been caught by SCDHEC, analyzed for specific contaminants, and have been determined to exceed the United States Environmental Protection Agency reference dose which is 0.1 µg/kg bw/day for MeHg (EPA, 2009).

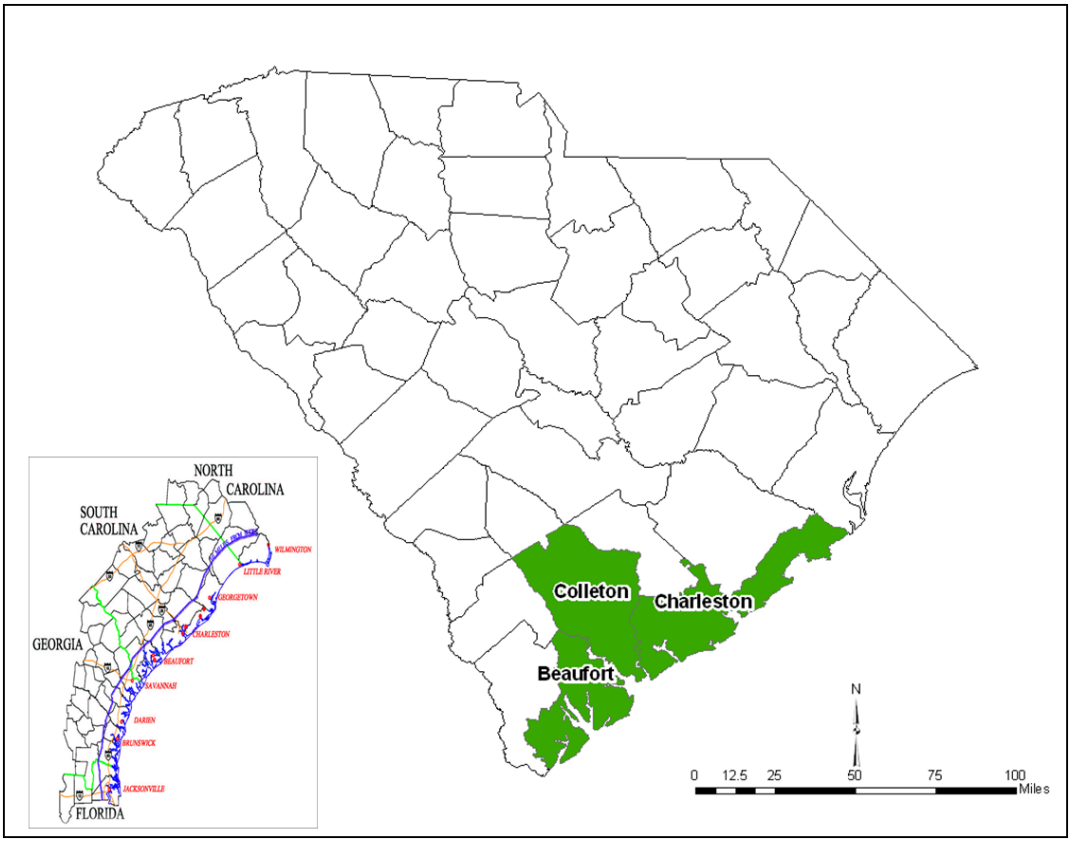

Figure 6.1. Study Area with Gullah/Geechee Cultural Heritage Corridor Inset

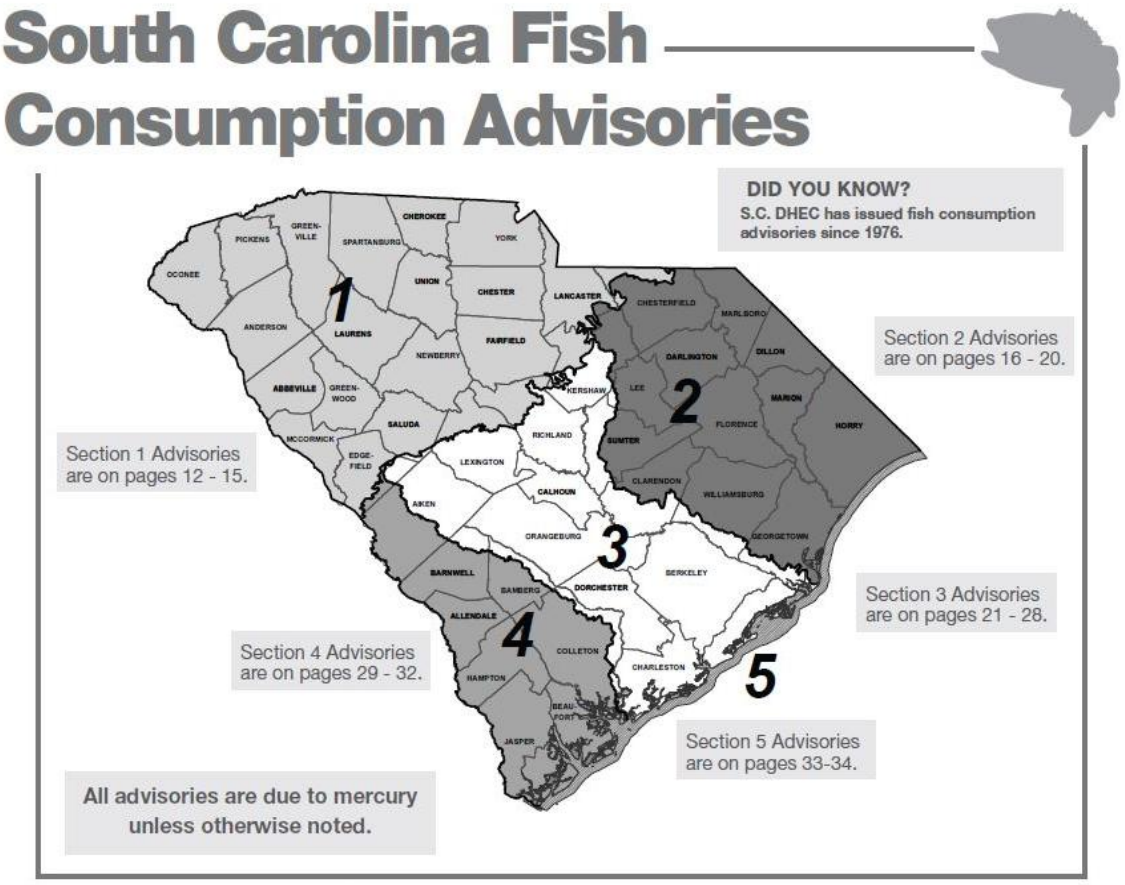

Figure 6.2. 2013 South Carolina Fish Consumption Advisories by Section

Study population

Inclusion criteria required that participants: (1) 18 years of age or older, (2) self-identify as G/G and/or AA, (3) currently live within Beaufort, Charleston, or Colleton counties, and (4) be any combination of fishers, fish consumers, and/or fish preparers.

Survey design and data collection

Purposive sampling (Creswell 2002, Patton 2002, Maxwell 2005;) of G/G and/or AA Sea Island men and women from the tri-county study area was implemented to recruit survey participants. Participants were recruited using key informants identified by African American clergy and community organizers in the study area. This study was a

cross-sectional analysis of fish and seafood consumption in the G/G and African American SC Sea Island population. Interviews (n=136) were conducted between April 2012 and January 2013. Face-to-face interviews were used to ask closed-ended and open-ended questions. In this study, closed-ended quantitative questions regarding demographic information were evaluated as potential determinants of fishing and fish consumption frequencies, species-specific consumption, and awareness of fish advisories among participants. Of the participants interviewed, 87 were conducted as face-to face interviews, 7 were mailed-in, and 8 were administered as questionnaires, and 34 people participated in focus groups that served as a pilot for the final version of interview questions used for interviews. Focus groups ranged from 60 to 120 minutes. Individual interviews ranged from 20-40 minutes. Recruitment flyers were mailed to various churches and community organizations within the tri-county study area. The researcher also collaborated with clergy and community leaders who encouraged participation from the community by word of mouth and who hosted focus groups or individual interviews at respective churches or community centers.

Questions on the interview survey instrument were based on prior fishing and fish consumption research in the G/G population and in other populations that are frequent fish consumers (Brunso et al. 2009; Kamen et al. 2012; Lauber et al. 2011; Perenchio 2001). A moderator and notetaker were present for three focus groups. One of the focus groups was conducted by a moderator only. A consent form was shared with study participants prior to completing the survey. A consent form and conditions including the manner in which interview results would be used and the voluntary nature of the interview were shared with study participants prior to the taped portion of the survey.

Each individual interview participant was offered a $10 cash incentive ($10 gift cards for mailed surveys) upon completion of the survey instrument (Wessells et al. 1995, Kuntz 2007, Kuntz et al. 2009).

Survey content

Participants completed a 49-item semi-structured interview survey on childhood fishing experiences, perceptions of the fishing culture, seafood preparation, and seafood consumption and a 10-item demographic survey. Of the 49 questions included on the survey, 40 questions were designed to elicit quantifiable results which served as the basis for this study. The researcher collected data on serving sizes and frequency of fish and seafood consumption. Only closed-ended questions were used to address Specific Aim 2 to evaluate awareness about current SC fish advisories and determinants of fish consumption. Participants were asked to respond to the average portion size of fish in a single meal by selecting 6, 9, 12, 15, or greater than 15 ounces. In order to provide study participants with a physical and visual aid in determining portion sizes, mock fish samples were prepared by the PI using small brown paper bags lined with sandwich bags, tare weighted and filled with all-purpose flour. Mock fish samples were weighed on kitchen scales for accuracy and sealed. Fish consumption frequencies were identified by: Never, Once/year, Once/4 months, Once/month, Once/2 weeks, Once/week, >Once/week, and Daily.

Demographic information included county, gender, age, height, weight, education, and income and comprised the set of predictor variables for this study. Predictor variables used to predict fish consumption patterns were categorized as follows: county (Charleston, Colleton, and Beaufort), gender (male/female), age (18-25, 26-35,

36-45, 46-55, 56-65, 66+ years), highest education level (less than high school, high school graduate, some college/associates degree, college degree, and post-college or graduate), and annual household income (<$25K, $25-44K, $45-64.9K, $65-84.9K, and >$85K). Physical mailing addresses were collected and study participants were categorized by county for analyses.

Statistical analysis

Descriptive statistics were displayed using table frequencies created in SAS to describe demographic and socioeconomic data. The response variables in this study were average serving size of fish and seafood per meal, frequency of fish and seafood consumption, and awareness of fish consumption advisories. Predictor variables included county, gender, age, education, and income. Frequency tables indicated that several variable levels had fewer than five data points. In order to address issues with separation of the data due to sample size, variable levels for age, annual household income, education, serving size, and fish consumption frequency were evaluated for practical and relevant categorical separations and dichotomized accordingly (Kutyniok, 2011). Dummy variables were created for each predictor and response variable based on the reduced variables as follows: age (0 for ≤45 years and 1 for ≥46 years), annual household income (0 for ≤ $44,999 and 1 for ≥ $45,000), education (0 for high school diploma or less and 1 for some college or more), serving size (0 for 6-9 ounces and 1 for > 9 ounces), and fish consumption frequency (0 for ≤ once/2 weeks and 1 for ≥ once/week). County variables were unchanged.

Univariate logistic regression was conducted for each response variable. Unadjusted odds ratios (OR) and respective 95% confidence intervals were determined to

estimate the relationship between each response and predictor variable. P-values of 0.05 were considered statistically significant. Statistical analyses were performed using SAS 9.3 for Windows (SAS Institute, Inc., Cary, NC, USA, 2011). The protocol for this study was approved by the University of South Carolina Institution Review Board.

Results

There were 136 G/G and AA participants in the study who ranged in age from 18 to over 66 years. Of these participants, 84.2% (n=112) were ≥ 46 years of age, 75.2% (n=100) were men, 53.9% (n=69) had achieved a high school diploma as the highest level of education, and 76.8% (n=96) had an annual income less than $44,999. Frequency tables indicated that Charleston County participants were relatively older and had a higher level of education. Colleton County had relatively equal numbers of male and female participants with the youngest average age range and the most people reporting being unaware of fish consumption advisories (n=23, 17.7%). Charleston County reported the highest fish consumption frequency (n=36, 26.9% consuming fish and seafood ≥once per week). Table 5.1 shows frequency table of outcomes.

Table 6.1
Frequency table of predictor variable outcomes

Participant Characteristics	N(%)	Serving Size		Fish Consumption Frequency		Fish Advisories Awareness	
		6-9 ozs. (%)	>9 ozs. (%)	≤once/ 2 weeks (%)	≥once/ week (%)	No (%)	Yes (%)
County							
Charleston	59 (43.4)	28 (21.9)	28 (21.9)	23 (17.2)	36 (26.9)	13 (10.0)	43 (33.1)
Colleton	34 (25.0)	22 (17.2)	11 (8.6)	12 (9.0)	22 (16.4)	23 (17.7)	11 (8.5)
Beaufort	43 (31.6)	20 (15.6)	19 (14.8)	6 (4.5)	35 (26.1)	15 (11.5)	25 (19.2)
Total	136	70	58	41	93	51	79
Gender							
Male	100 (75.2)	51 (40.5)	44 (34.9)	29 (22.0)	70 (53.0)	27 (21.1)	69 (53.9)
Female	33 (24.8)	18 (14.3)	13 (10.3)	10 (7.6)	23 (17.4)	22 (17.2)	10 (7.81)
Total	133	69	57	39	93	49	79
Age							
18-45	21 (15.8)	11 (8.7)	7 (5.6)	8 (6.1)	13 (9.9)	14 (10.9)	7 (5.5)
≥46	112 (84.2)	58 (46,0)	50 (39.7)	31 (23.5)	80 (60.6)	35 (27.3)	72 (56.3)
Total	133	69	57	39	93	49	79
Income							
<$44,999	96 (76.8)	53 (44.5)	40 (33.6)	27 (21.8)	68 (54.8)	36 (30.0)	56 (46.7)
≥$45,000	29 (23.8)	13 (10.9)	13 (10.9)	7 (5.7)	22 (17.7)	10 (8.3)	18 (15.0)
Total	125	66	53	34	90	46	74
Education							
≤High school	69 (53.9)	40 (33.1)	26 (21.5)	22 (17.3)	46 (36.2)	25 (20.3)	41 (33.3)
≥Some College	59 (46.1)	25 (20.7)	30 (24.8)	16 (12.6)	43 (33.9)	23 (18.7)	34 (27.6)
Total	128	65	56	38	89	48	75

When predictor variables were evaluated as determinants for serving size per fish meal, for frequency of fish consumption, and for awareness of fish advisories using univariate logistic regression, the only predictor variable with statistical significance was county (p=0.0351) as a determinant of fish consumption frequency. Only Beaufort County had statistical significance (p=0.0125) when compared with Charleston County (the referent county).

Table 6.2 Determinants of fish consumption frequency

Predictor Variables	n (%)	Univariate Odds ratio (95% CI)	p-value
County	36 (26.9)	Ref	0.2584
Charleston	22 (16.4)	0.854 (0.355-2.051)	0.0125
Colleton	35 (26.1)	0.268 (0.098-0.738)	
Beaufort			
Gender			
Male	70 (53.0)	Ref	0.9119
Female	23 (17.4)	1.050 (0.445-2.479)	
Age			
18-45	13 (9.9)	Ref	0.3516
≥46	80 (60.6)	0.630 (0.238-1.667)	
Income			
<$44,999	68 (54.8)	Ref	0.6513
≥$45,000	22 (17.7)	0.801 (0.307-2.094)	
Education			
≤High school	46 (36.2)	Ref	0.5210
≥Some College	43 (33.9)	0.778 (0.361-1.674)	

Fish consumption frequency did not differ significantly between Charleston (reference) and Colleton counties. The point estimate of the odds ratio was 0.854 and its 95% CI was 0.355-2.051. The point estimate for Beaufort county however was 0.268 (95% CI, 0.098-0.738). The OR was calculated at -1.33 and interpreted as participants in Charleston county being 1.33 times less likely to consume fish as frequently as study participants in Beaufort county. Furthermore, it can be stated with 95% confidence that Beaufort county participants consume fish more frequently than those in Charleston county since the odds ratio is between 0.098 and 0.738, an interval below 1.00.

Discussion

The results of this study indicated that there were no significant differences in the average serving size or in awareness of fish advisories in the G/G and AA population based on all predictor variables. The county in which G/G participants lived was a statistically significant determinant of fish consumption frequency, with Beaufort county

participants consuming more fish than participants in Charleston. Participants ≥ 46 years of age, represented 84.2% (N=112). Participants between the ages of 18 and 45 were not well represented because they were working or engaged in family activities during the interview times scheduled by key informants. Of study participants reporting on awareness of fish advisories, 17.2% of women reported having no awareness of advisories while 53.9% of men reported being aware of the fish consumption advisories. Awareness of fish advisories among all participants was 57%, similar to other studies of fish consumption advisories in AA and ethnic populations (Burger et al., 1999, Silver et al., 2007).

The majority of data collection was conducted using face-to-face interviews with the intent of reducing non-responses since it was anticipated that the interviewer could more readily guide the study participant to completing all questions. However, some participants expressed some concerns about not knowing how to answer some questions which led to some unanswered questions. In general, most unanswered questions were found on mailed-in surveys and on surveys completed independently while the researcher facilitated questions. Some participants may have given answers to questions that they perceived as socially desirable answers, and some declined to provide answers for a few questions (such as education and income). Missing data due to unanswered questions may have contributed to issues of data separation in the analysis. Although there were issues with data separation, reducing the variable levels allowed for more reliable analysis of the data. Future surveys conducted in the G/G and AA population regarding fish consumption using the current instrument would require some modification of the

survey in order to more easily conduct a logistic regression analysis based on either dichotomized or continuous variables.

It is unclear why education, income, and gender were not determinants of fish consumption frequency, serving size, or awareness of fish advisories which have all been shown to have associations in previous studies. Findings from a study of Sacramento-San Joaquin Delta participants in California showed that there were disparate exposures to MeHg through fish consumption among various ethnic groups with AAs consuming more fish per day (41.2 g/day) than all other groups and 61% of participants having achieved a high school diploma as the highest level of education(Silver et al., 2007).

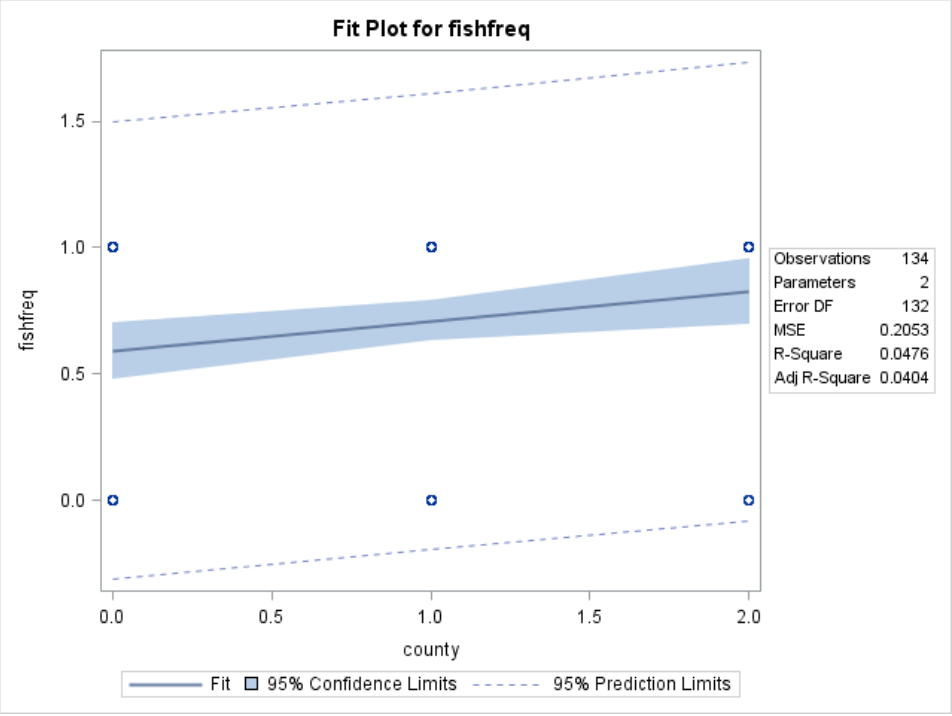

Figure 6.3 Fit plot for fish consumption frequency vs. county

This research has some limitations. The R^2 value for the model including fish consumption frequency and county was 0.0476 (Table 6.3). The R^2 for the overall model

was 0.0658. Low R^2 values may have contributed to the lack of statistical significance between predictor variables and the response variables in the model. Results of this study cannot be generalized to the entire population. However, findings of this research are generally supported by other studies that indicate frequent consumption of fish and seafood consumption, elevated serving size per fish meal, and relatively low levels of awareness of fish advisories in AA communities.

Conclusions

The aim of this study was to evaluate awareness of fish consumption advisories in the study area and to examine how demographic factors influence the average serving size of fish and seafood consumed per meal, the frequency of fish and seafood consumption, and awareness of fish consumption advisories in the G/G and African American (AA) population. In addition to determining what factors predicted fish consumption choices, this study also examined whether awareness of fish advisories impacted fish consumption.

Higher levels of fish consumption among AA fishers compared to other ethnic groups have been reported in previous research (Burger et al. 1999, Katner et al. 2011, Kamen et al. 2012, Lynch et al. 2012). This is the first published study, however, to quantify fish consumption among G/G and AA fishers and fish consumers in the Lowcountry of SC based on demographic predictors and awareness of fish advisories. This study revealed that 69.4% (93/134) of study participants consumed fish ≥once/week, with Beaufort county participants consuming higher levels of fish than those in Charleston and Colleton County.

The South Carolina Department of Health and Environmental Control (SCDHEC) developed a comprehensive fish tissue monitoring program in 1976 with the primary goal of providing guidance for healthy fish consumption choices. Although more research has been conducted in recent years that address the factors which contribute to unique fish consumption patterns in minority and subsistence communities (Burger et al. 2009, Holloman et al. 2010, Lincoln et al. 2011), U.S. and South Carolina data on fish consumption patterns of subpopulations remain limited.

A number of additional predictors should be modeled for awareness, serving size, and fish consumption frequency in the G/G and AA Sea Island population. Proximity to water bodies, access to water bodies, and restrictions placed on specific water bodies are other factors that may play a significant role in the motivations for and quantities of fish that people consume. Although there were some limitations in the study, this study has strengths that add to the knowledge base on G/G and AA fish consumption in the SC Lowcountry. This study shows that fish consumption in the population is high when considering that 69.4% of participants report consuming fish and seafood more than once per week. Additionally, thirty-nine percent of participants in the study area report being unaware of fish advisories. Based on high fish consumption frequency coupled with significant numbers of participant unawareness of advisories, this study also indicates a need for fish consumption advisories to be revisited and health messages to be improved by state regulatory agencies in order to effectively reach populations that are consuming subsistence levels of fish and seafood.

CHAPTER 7

RESULTS

Comparison of Estimated Blood Mercury Levels in the Gullah/Geechee Population and the 2009-2010 NHANES Sample

Introduction

Previous studies have been conducted on the effects of acute and toxic exposures to the neurotoxin methylmercury (MeHg) (Edwards, 1865, Tsubaki and Irukajama, 1977, Marsh et al., 1981, 1987, Grandjean et al. 1997*).* The primary path of human exposure to MeHg is through fish consumption (Davidson et al. 1998, Clarkson et al. 2003b, Mahaffey et al. 2004, Mergler et al. 2007, Swain et al. 2007, Zhang et al. 2009). In the United States (U.S.), data on fishing and fish consumption patterns in subpopulations remain relatively limited. However, previous studies show that for subpopulations across the United States, fish consumption patterns may vary significantly (Harnly et at., 1997, Rothschild et al., 2002, McKelvey et al., 2007, Holloman et al., 2010, Lincoln et al., 2011). The National Health and Nutrition Examination Survey (NHANES) is a continuous survey of the health and nutritional status of the U.S. population that collects data from individual participants through interviews and physical examinations and publishes aggregate results every two years. One aim of the NHANES is to conduct a study of the impacts of fish consumption on mercury (Hg) exposure via measurement of total and inorganic Hg levels in blood which can be generalized to the U.S. population

(NHANES, 2012). However, NHANES does not consider regional factors for subpopulations that rely heavily on fish as a primary source of protein in their diets (McDowell, et al., 2004, Schober, 2006). The 2007 NHANES reported that although there was a decline in fish consumption within the general population, there is evidence of elevated fish consumption and blood Hg levels in the highest and lowest socioeconomic brackets in the U.S (NHANES, 2005, Mahaffey et al., 2009). In 2006, the Institute of Medicine (IOM) asserted that U.S. fish and seafood consumption had been consistently increasing over several decades, but that subpopulations of high fish consumers may be unaccounted for because of the focus on fish consumption patterns of the general population in NHANES reports (IOM, 2006).

NHANES provides information that may be useful in gaining an understanding of potential exposures to MeHg in the general population, but it does not provide a method estimating or calculating exposures to MeHg based on fish consumption, particularly for U.S. subpopulations who consume higher quantities of fish. Most existing models for Hg exposure through fish consumption are based on some combination of human biomarkers, fish tissue analysis, food frequency questionnaires (FFQ) or fish consumption surveys and toxicokinetic modeling. One study estimated human exposure to MeHg through fish consumption using mathematical modeling (Luk et al., 2006). Methods for this study included obtaining MeHg bioaccumulation data for fish tissue combined with fish consumption patterns (estimated daily exposure to MeHg) obtained through a food survey. The research team developed a tool to estimate MeHg uptake from a fish diet based on consumption frequency, fish species and fish size. This approach required in depth knowledge and access to data on food, water, and excretion

pathways for the human study sample as well as information regarding size, age, bioenergetics, diet, and absorption efficiency of fish (Luk et al., 2006).

In another study, dietary exposures to Hg for a population that consumed a large variety of fish and seafood were estimated by measuring total mercury in blood (BHg). Fish consumption frequencies and THg concentration of study participants were used to evaluate correlations between dietary THg and measured BHg. Factors that explained variances in BHg levels in a linear regression model included gender, majority of fish consumed being self-caught, living in coastal communities, and consumption frequency and quantities. Study participants completed a comprehensive food frequency questionnaire. Results from FFQs were combined with a database on THg concentrations in foods consumed by the population and results from participant urine and blood Hg analysis to estimate exposures. A similar study was conducted by Bergsten (2004) in which participants completed a semi-structured FFQ which researchers compared results from with urine and blood analysis to estimate exposure to environmental contaminants, including Hg. Noisel et al., 2011 compared results of a toxicokinetic model and an administered FFQ to estimate Hg exposure. This study estimated daily MeHg intake of 23 fishermen by comparing and contrasting results from the completed FFQs and toxicokinetic modeling. Each of the fishermen provided hair and blood samples for the study. Each of these studies involved FFQs or toxicokinetic models in combination with analysis of fish tissue or human biomarkers in order to estimate MeHg exposures. However, the scope of research is often restricted by budgetary constraints, so that laboratory analyses are not always feasible.

Specific aim 3 of this research is to evaluate MeHg exposure through fish consumption using mathematical modeling, with the research questions 'What are the levels of exposure to MeHg through fish consumption in the Gullah population?' and 'Is there a statistical difference between the estimated exposures to MeHg in the G/G and AA and 2009-2010 NHANES population?' This study tested the null hypothesis that there is no statistical difference between the estimated exposures to MeHg in the G/G and AA Sea Island population and the 2009-2010 NHANES MeHg exposures reported for the general U.S. population.

Methods and Materials

Description of dataset

This study compared data analyzed in the 2009-2010 NHANES with a survey administered by the researcher in G/G and AA Sea Island communities. All NHANES protocols were authorized by the Centers for Disease Control and Prevention, National Center for Health Statistics Research Ethics Review Board (Centers for Disease Control and Prevention, 2012). The 2009-2010 NHANES report was a purposeful oversampling of select groups including adolescents, the elderly, non-Hispanic blacks, Mexican Americans, and low-income non-Hispanic whites. The selected groups were oversampled in order to increase the accuracy of health indicators estimated for these groups. The 2009-2010 NHANES survey was chosen rather than surveys from earlier years because it provided the most recent results on fish consumption in the general population.

Study subjects and data collection

G/G and AA study participants, ages 18 and older, were recruited from three counties in coastal SC (Beaufort, Charleston, and Colleton Counties). Recruitment flyers for study participants were mailed, physically and electronically, to churches, community organizations, and fishing groups within the tri-county study area for the purpose of recruiting study participants. The researcher also collaborated with clergy and community leaders who encouraged participation from the community by word of mouth and provided meeting accommodations for study participants' data collection at respective churches or community centers. Surveys were administered to 137 participants between April 2012 and January 2013. Of the 137 participants in this study, 73 (53%) completed every question on the survey. There were 6200 participants in the reference group (2009-2010 NHANES survey). Survey participants were from Beaufort (n=43), Charleston (n=59), and Colleton (n=34) counties. The project protocol was approved by the University of South Carolina Institution Review Board.

Dietary information

Dietary information was obtained for a one year period preceding the survey using a structured survey instrument. The survey instrument included 40 questions specifically related to quantifiable fishing habits, fish consumption practices, and demographic information. Survey questions were based on a prior fishing and fish consumption survey conducted in the G/G population by Kamen et al. 2012 and in other populations with similar fish consumption patterns (Perenchio, 2001, Brunso et al. 2009, and Lauber et al. 2011). The survey instrument was modified to reflect fish and seafood commonly consumed by the G/G population, including a single chart with 33 different

fish and seafood items for which participants described consumption frequencies. For each item, the participants were asked to report consumption frequency by selecting one out of eight choices on a scale ranging from never eaten to daily. Canned seafood and fish purchased from local markets or grocery stores were also included on the survey instrument.

Dietary Exposure Calculations: Analytical methods

The model developed for this study was a combined approach which used fish tissue data from the South Carolina Department of Health and Environmental Control (SCDHEC), the U.S. Food and Drug Administration (FDA), and the National Oceanographic and Atmospheric Administration (NOAA), as well as the U.S. EPA's one-compartment dose-conversion model, and elements of the U.S. EPA SHEDS (Stochastic Human Exposure and Dose Simulation) Model to estimate blood Hg (BHg, µg/L) exposure levels in the G/G population. The SHEDS model has been used to predict ranges of MeHg and pesticide exposures in populations in previous studies as well as to identify critical pathways and enhance dose model estimates (Xue et al. 2010, Xue et al. 2012, Zatarian et al. 2012). EPA's SHEDS-Dietary model allows scientists to make assessments of environmental exposures by creating simulation models of individual exposures to contaminants in food and drinking water in a given time frame. It is the primary model used by the U.S. EPA for recreating cumulative or aggregate exposure scenarios for a variety of environmental pathways for a suite of chemical contaminants (U.S. EPA, 2013b). A 2010 EPA Scientific Advisory Panel developed a model that linked residential characteristics with dietary patterns in order to simulate

exposures. Methods in this study involved merging individual level SAS codes for pesticide use and dietary patterns to estimate exposure levels.

In addition to the U.S. EPA SHEDS model, this study also employed the dose-response model used by the U.S. EPA. In 1995, the U.S. EPA used the benchmark dose (BMD) method to analyze the relationship between MeHg exposures and adverse health outcomes. When making a risk assessment of a chemical dose on an adverse health effect, the most important consideration is generally the lowest dose at which a critical risk exists, referred to as the lowest observed adverse effect level. The NOAEL (no observed adverse effect level) is often used in threshold models to determine the point of departure at which no effect is observed after exposure to the first occurrence of adverse health effects. This method, however, is subjective due to its dependence on sample size and may lead to uncertainty in establishing safe levels of exposure to a chemical. The U.S. EPA has determined that the BMD method is more conservative and reliable because it is based on predetermined levels of exposure that are more protective of health than are generally found when using the threshold approach. Cord blood from the Faroe Islands study was the biomarker used as the baseline for developing the U.S. EPA reference dose of 0.1 µg/kg/day for MeHg. Blood Hg levels were converted to a daily consumption rate that represented fetal BMDL exposure levels in blood.

Total Hg was used in the initial calculations study rather than MeHg (Cernichiari et al., 1995). Numerous studies show that MeHg comprises 95-99% of total Hg (Bloom, 1992, U.S. EPA, 1997). For this study, 95% of total Hg was used to estimate MeHg in blood. Participants were asked about frequency of consumption based on never, once/year, once/4 months, once/month, once/2 weeks, once/week, >once/week, or daily

for each fish and seafood species through face-to-face interviews. A frequency table was developed to show the highest overall count for the most frequently consumed fish and seafood based on species that were consumed once per month or greater. Although 33 fish species were included in the G/G survey instrument, only the top 11 most frequently consumed fish and seafood were used to estimate BHg levels.

Fish tissue Hg data was obtained from U.S. FDA, NOAA, and Savannah River Site databases (SRS, 2001, 2005, Balthis et al. 2012, U.S. FDA, 2013). Elements of the U.S. EPA SHEDS Model were adopted to simulate Hg exposure for each type of fish and seafood species by multiplying consumption frequency with the Hg levels found in each type of fish and seafood species (Figure 6.1). Daily Hg intake for each participant was estimated and a cumulative distribution function (based on weighted averages of the top 11 most consumed species) was performed for each participant. The EPA one-compartment model for dose conversion was then used to estimate BHg exposures for each participant. The concentration of blood Hg was estimated by multiplying the daily Hg intake (d, µg), absorption factor (A), 0.95, the fraction of absorbed dose taken up by blood (f), 0.059, and body weight (bw, kg) and dividing it by the elimination constant ($0.014\ days^{-1}$) times the volume of blood in the body (5 L), (U.S. EPA, 1999).

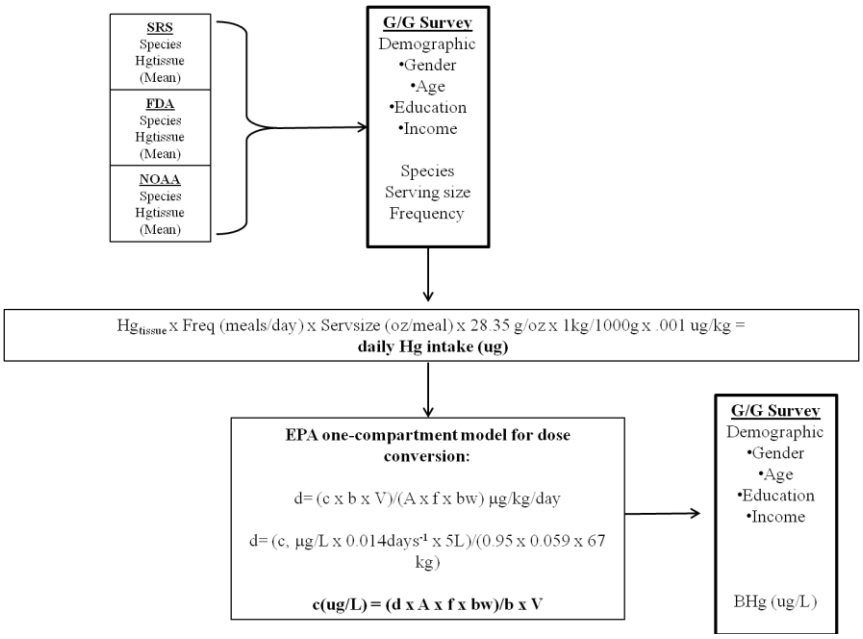

Figure 7.1. Model estimation of blood mercury levels in the study population

Statistical analysis

Statistical analyses were performed using SAS 9.3 for Windows (SAS Institute, Inc., Cary, NC, USA, 2011). All independent and dependent variables were dichotomized using cut off points that were relevant to the study. Categories were dichotomized in order to address issues of data separation based on the small sample size (Kutyniok, 2011) and to make practical comparisons between the G/G and NHANES study groups. Variable levels for age, annual household income, education, serving size, and fish consumption frequency were evaluated for practical and relevant categorical separations and dummy variables were created for each independent and dependent variable in the G/G group as follows: age (0 for ≤45 years and 1 for ≥46 years), annual household income (0 for ≤ $44,999 and 1 for ≥ $45,000), education (0 for high school diploma or less and 1 for some college or more), serving size (0 for 6-9 ounces and 1 for > 9 ounces), and fish consumption frequency (0 for ≤ once/2 weeks and 1 for ≥

once/week). All of the descriptive categories summarized for the G/G population (gender, age, income, and education) are consistent with those summarized in the NHANES data set. "Don't know" and "refused" responses were recorded as "missing" and indicated by "." NHANES data set.

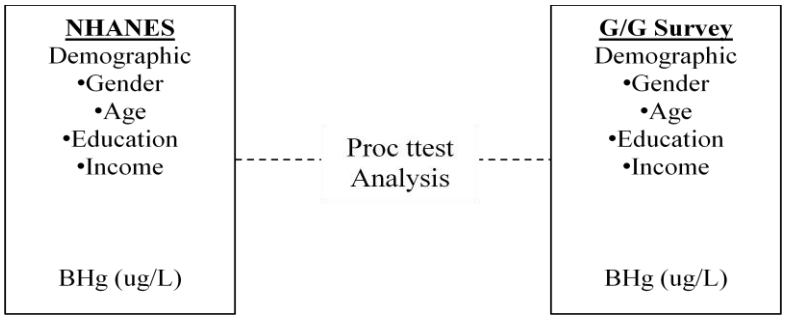

Figure 7.2. Model for statistical comparisons between mean Blood mercury (BHg) levels in both samples

The proc *t* test was run in SAS© to perform a *t* test which compared the means between estimated BHg levels in the G/G study and BHg levels reported in the 2009-2010 NHANES data. The COCHRAN option was used in the proc *t* test because it was anticipated that the distributions of BHg levels in the G/G and NHANES data would have unequal variances. Confidence intervals were set to have equal tails and to have the most uniformly powerful unbiased confidence intervals.

Results

There were 136 study participants in the G/G survey. The number of 2009-2010 NHANES participants who were analyzed for Hg was 6200. Table 6.1 provides a summary of demographic data for both study groups.

Table 7.1. Demographic characteristics of the study samples

Descriptive Statistics	G/G Study	2009-10 NHANES Data
Sample Size	133	6200
Male	75.2%	48.7%
Female	24.8%	51.3%
18 - 45 Years of Age	15.8%	46.9%
46 or older Years of Age	84.2%	53.1%
Income: < $45,000	66.4%	52.0%
Income: > $45,000	33.6%	48.0%
High School Diploma or less	53.9%	55.7%
Some College or more	46.1%	44.3%

Table 7.2. Most consumed fish and seafood in Gullah study (rank, weight, and mean Hg levels)

Fish/Seafood	Frequency	Weight	Mean Hg (mg/kg weight wet)
Whiting	79	0.15	0.167+
Shrimp	72	0.13	0.05•
Crabs	60	0.11	0.15•
Salmon	60	0.11	0.05•
Tuna	57	0.11	0.17•
Sardines	42	0.08	0.03•
Bream	38	0.07	0.03^*
Oysters	36	0.07	0.05•
Spot	35	0.06	0.07*
Flounder	35	0.06	0.09•
Shark	27	0.05	0.96•

Note. Mean Hg fish tissue levels were obtained from the U.S. FDA (United States Food and Drug Administration, 2013, SRS (Savannah River Site, 2001, 2005), and NOAA (National Oceanographic and Atmospheric Administration, Balthis et al., 2012), represented by the symbols: •, ^, *, and +, respectively.

In order to determine the cumulative levels of Hg consumed by each participant in the G/G population, the frequency of consumption for each of the top 11 most consumed fish and seafood species was ranked, weighted, and summed for each participant. Table

7.2 presents the list and rank of the most commonly consumed fish and seafood in the G/G study with corresponding frequencies and mean Hg tissue levels. The number of valid observations from the data set were N=126 for the G/G survey and N=5446 for the NHANES data. The mean BHg level in the G/G population is 0.0002 µg/L (range 3.4 x 10-5 – 0.003 µg/L) and 0.2695 µg/L in the 2009-2010 NHANES population (range 0.25-0.64 µg/L) once outliers were removed. The p-value of <0.0001 indicated that there was a significant difference between mean BHg levels in the G/G and NHANES study participants, with G/G participants having significantly lower BHg levels than NHANES participants.

Discussion

The aim of this chapter was to evaluate MeHg exposure through fish consumption using mathematical modeling. Research questions included 'What are the levels of exposure to MeHg through fish consumption in the Gullah population?' and 'Is there a statistical difference between the estimated exposures to MeHg in the G/G and AA and 2009-2010 NHANES population?' This study tested the null hypothesis that there is no statistical difference between the estimated exposures to MeHg in the G/G and AA Sea Island population and the 2009-2010 NHANES MeHg exposures reported for the general U.S. population. The research combined the US EPA SHEDs model with the US EPA one-compartment model for dose to design a mathematical modeling approach for estimating BHg levels. Within the context of this research BHg levels served as a proxy for MeHg exposure.

One of the most notable characteristics of fish and seafood consumption in the G/G population is the frequency with which canned seafood is consumed. Of the most

frequently consumed species, canned salmon, tuna, and sardines ranked in the top six fish and seafood most consumed. Another interesting observation was that although whiting was the most consumed species throughout the study area, shellfish (shrimp and crabs) ranked as the second and third most consumed species. Placing most locally caught fish lower in rank for consumption than anticipated by the researcher.

Shrimp and blue crabs were the second and third most frequently consumed fish and seafood in this study, respectively. Studies have shown significant differences between Hg levels in fish tissue and shellfish (Burger et al., 2005). In a New Jersey study of commercial consumers of fish and seafood, species that were least expensive and most available, including whiting, were the most frequently consumed fish. Such is the case in this study where whiting was consumed by the majority of study participants three times more than shark which ranked 11th on the list of frequently consumed fish (Table 6.2). Total Hg levels in whiting were recorded as non-detectable in the New Jersey study. Evans et al., 2000 showed that shrimp caught from Lavaca Bay, Texas and analyzed for total Hg were consistently and significantly lower (≤ 0.28 μg/g) than in blue crabs. Consistently lower levels of Hg in shrimp than in crabs were observed in secondary data used for the present study.

Study participants provided consumption frequencies for 33 species using a closed-ended survey. The most common food consumption surveys are based on a 24-hour recall. This type of survey often yields the most accurate results because participants can more readily recall the exact details of their diet in the previous 24-hour window. However, short term recall surveys often lack data on long term variation of food consumption both for individuals and for consumption across a sample of people

(LSRO, 1989, Pao et al. 1990). A one-year survey on the other hand, offers more comprehensive insight into a person's dietary habits verses a simple recall of a day where any number of unique circumstances could impact a departure from the normal intake for an individual. A longer recall period, however, is more likely to have less accuracy since people are recalling frequencies of specific meals spanning 12-months. Given the differences between information gathering methods and variances in recall periods between the two surveys, there are some limitations to this study based on assumptions made in the model. The timeframe reflected in the NHANES data is based on a 30-day recall period versus a one-year recall period for the G/G study. Although units on fish tissue data and formulas are mathematically sound, conversion factors for time may affect the results of the model and subsequently, interpretation of the model.

SCDHEC has developed advisories for 14 fish species in estuarine and marine waters. Included in this list are spot and flounder from the commonly consumed list in this study for which there are no consumption restrictions. It is recommended, however, that at-risk groups (women of childbearing age, nursing mothers, and children below the age of 14 years) not consume shark at any time. Based on survey responses, no participants in this study were pregnant or had a pregnant person residing in their home at the time the surveys were conducted. Questions regarding fish meals served to children in the home were not included on the survey.

The FDA advises the general population to limit their consumption of fish species having MeHg levels of approximately 1.0 ppm to about seven ounces or the equivalent of one serving per week (Risher et al. 1999). Further, no more than two servings (approximately 14 ounces per week) of fish with an average 0.5 ppm of MeHg are

advised. In this study, only 23.5% of participants consumed six ounces or less per meal. The majority of participants consumed either nine ounces (33.8%) or 12 ounces (29.4%) of fish or seafood per meal. Of the 119 participants that responded to the question of how often they consumed fish or seafood, 41% reported eating fish once per week while 26.9% ate fish >once per week. Only 4.2% reported eating fish or seafood daily.

In addition to the use of limited secondary fish tissue data in the model, the researcher explored the possibility of disparate species consumption patterns between the G/G population and the NHANES sample contributing to differences in mean BHg levels between the two populations. Table 6.3 shows the most consumed fish and seafood in the 2009-2010 NHANES data. Based on this data, the consumption patterns between the two groups are relatively similar with whiting, bream, spot, and shark in the G/G population and catfish, cod, clams, and lobster in the NHANES data representing differences in species consumption. Significant differences between BHg levels are not explained or supported by the similarity in consumption patterns between the two data sets and warrant further research in order to identify uncertainties in the model. Additionally, collecting and analyzing fish tissue and shellfish from water bodies frequently fished by the G/G population would further strengthen the model.

Table 7.3 Most Consumed Fish and Seafood in 2009-2010 NHANES data

Fish/Seafood	Frequency	Mean Hg (mg/kg wet weight)
Shrimp	3854	0.05•
Tuna	2382	0.17•
Salmon	1745	0.05•
Crabs	1011	0.15•
Catfish	745	0.01•
Cod	655	0.08•
Clams	486	0.02•
Scallops	462	0.00•
Flatfish (eg. Flounder)	383	0.09•
Oysters	381	0.05•
Lobster	329	0.14•

Note. Mean Hg fish tissue levels were obtained from the U.S. FDA (United States Food and Drug Administration), 2013, represented by the symbol: •.

Conclusions

Based on frequency tables for the most commonly consumed seafood in the G/G and AA population, researchers recommend a continued diet of oysters, bream, sardines, salmon, and shrimp in order to minimize MeHg exposures, while gaining the health benefits of consuming nutrient-rich seafood species. Alternately, consumption of tuna, whiting, and blue crab should be limited to once per week. Shark should be consumed no more than once per month. The current study presents a comprehensive G/G/AA Hg Risk Model (Figure 7.3) that may be used to help guide the decision-making process for seafood consumption.

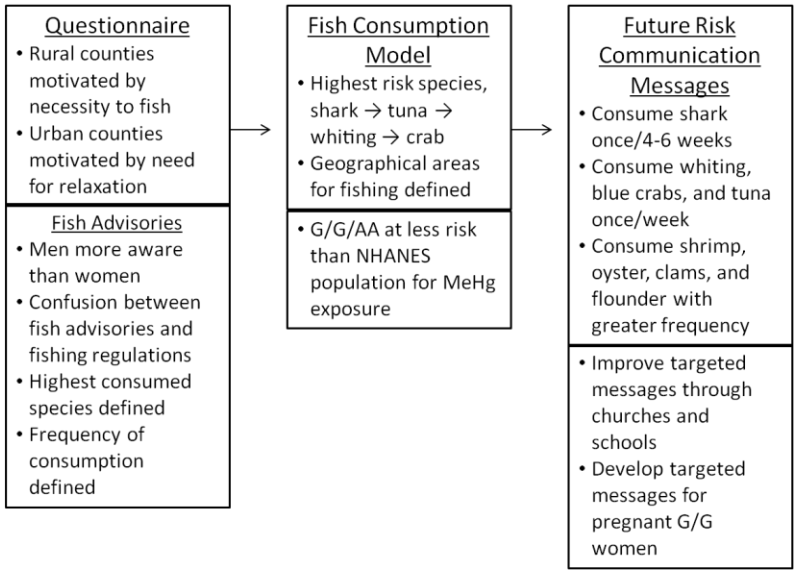

Figure 7.3 G/G/AA Hg Risk Model

The IOM study of risks and benefits associated with fish and seafood consumption also included several recommendations (IOM, 2006). Included in those recommendations was the need to increase monitoring of MeHg and persistent organic pollutants in seafood and to make those results easily accessible to the public. The IOM also suggested that federal agencies develop health messages geared towards specific groups of fish and seafood consumers and that innovative tools for fish consumption risk assessments should be developed in order to better characterize risk-benefit analysis in a way that is accessible to, interactive with, and more informative to the public as well as to other stakeholders.

It is important that scientists continue to develop and implement practical and innovative strategies for estimating MeHg exposure through fish consumption in vulnerable populations. Understanding exposures in subpopulations will help provide

information that can strengthen health messages in those communities when consumption patterns and MeHg exposures are significantly higher than in the general population.

Although this model has some limitations, it may be beneficial to local government, academic institutions, and community groups who may have limited funding to collect or analyze biological samples. The model presented here provides a conservative approach for estimating potential MeHg exposures to fish consumption. Stakeholders with concerns about MeHg exposures can use this model to estimate those exposures. Moderately simple calculations can be used to make model determinations. The model not only provides a useful tool for estimating MeHg exposures, but may be beneficial in promoting dialogue between stakeholders that may decrease exposures to MeHg while empowering communities to promote the healthiest choices for fish and seafood consumption within and throughout subpopulations of people who maintain subsistence levels of fish consumption.

CHAPTER 8

CONCLUSIONS

The purpose of this dissertation was to explore fishing and fish consumption patterns in the G/G and AA Sea Island population. The specific aims (SA) and respective research questions (RQ) of this study were to (1) explore fishing and fish consumption patterns within the G/G and AA Sea Island population by studying how culture influences fish consumption in the G/G population, (2) to evaluate awareness of the current SC fish consumption advisories and determinants of fish consumption by investigating factors that predict fish consumption choices and what levels of awareness the G/G and AA population has of the current fish consumption advisories, and (3) to evaluate MeHg exposure through fish consumption using mathematical modeling by developing a model to estimate the mean BHg level in the G/G population and comparing BHg means of both population to determine whether a statistical difference exists.

A review of the literature examining the history of fish consumption habits in G/G communities and the health effects of MeHg through fish consumption revealed that the increase of tourism and commercial development in SC coastal and Sea Island communities has impacted geographical access to many water bodies that were used by the G/G people for decades. Increased development and industrial activities along the coast have also increased exposures to contaminants, including MeHg, through fish

consumption in many water bodies. Approximately 98.4% of SC rivers and streams and 77.6% of lakes have been assessed for aquatic use support (including consumption safety) regarding impacts of Hg to water bodies; and 100% of bays and estuaries have been assessed for aquatic life use support. All of these water bodies have been assessed for overall use, but none for primary contact recreation (U.S. EPA, 2013).MeHg exposure through fish consumption remains a complex issue when determining exposures. There continue to be challenges in making exposure assessments based on modeling, particularly in communities like the G/G and AA Sea Island community where analytical data for fish tissues are limited for the species most consumed by the population.

Increased development, an influx of tourist, and people relocating to South Carolina coastal communities to become permanent residents have all impacted the G/G fishing culture. Research on G/G and AA cultural perspectives on fishing are limited. Findings from this research contribute to the knowledge base regarding the significance of fishing in the G/G and AA Sea Island population and fill a gap in better understanding the motivations for fishing in this population that may lead to elevated exposures to MeHg. The research presented in Chapter 5 provided a qualitative perspective on beliefs and motivations for fishing and fish consumption and how beliefs influence both fishing and fish consumption patterns in the G/G and AA population. The key themes to emerge from the qualitative study were the significance of strategies for disseminating fishing and fish advisories, beliefs about the role of fishing and fish consumption in the culture, motivations for fishing, and perceptions about fish consumption advisories. Strategies for disseminating fishing and fish consumption advisories were paramount for the overall study area with participants from rural areas preferring to receive this information in

flyers or pamphlets while urban-residing participants preferred to receive information through churches. Although most participants aged ≤ 45 years reported using the internet daily, they represented only 15.8% of study participants. Most participants in the study (52%) reported not using the internet at all. Of the participants who did use the internet frequently, only 1.5% used the Internet to search for information about fish consumption advisories at any time. In terms of exploring awareness about the SC fish consumption advisories, the most significant disparity was found in the number of participants who were completely unaware of fish advisories (approximately one-third) and the majority of participants who demonstrated confusion between fishing regulations and fish consumption advisories. Confusion between fishing regulations and fish consumption advisories were generally further confounded by participants having limited trust in government agencies and perceptions of increased costs due to restrictive fishing regulations. The current size restrictions for many fish species often focus on the harvest of younger and smaller species, which will result in lower levels of Hg exposure than would be found in older and larger fish. The affect of size restrictions on Hg exposure should be studied further to fully address this issue.

Chapter 6 presented a statistical analysis of socio-demographic factors as determinants (county, gender, age, education, and income) of average serving size per meal of fish and seafood, frequency of fish and seafood consumption, and awareness of fish consumption advisories in the G/G and AA Sea Island population. Results from this study indicated that there was only a significant statistical difference between the predictor variable county and the response variable fish consumption frequency. The lack of statistical significance for income as a predictor variable may have been limited

by a narrower range of income than would have been observed with a random cross section of the SC population. Income ranges were not well distributed, but were clustered (nested) within the G/G and AA population. These results may indicate the need for a modified approach to disseminating fish advisory information in these communities, particularly in Colleton county where awareness of fish advisories are low compared to Charleston and Beaufort counties.

In Chapter 7, consumption data from this research, secondary fish tissue data, and existing exposure models were used to estimate BHg levels in the G/G and AA population. These exposures were then compared to BHg levels in the 2009-2010 NHANES data. This model offers a viable framework for determining human exposure to MeHg; but it also presents challenges due to the mass balance scenario for total body burden of MeHg in fish. Factors such as efficiency of assimilation, energy equivalence, and low routine metabolism in fish are not readily available in the literature for fish species consumed by the G/G population. Predictive modeling was instead used to estimate exposures to MeHg through fish consumption. Results indicated that there was a significant difference in MeHg exposure between the 2009-2010 NHANES study sample and the G/G study participants in this research. Results showed that mean BHg levels of 2009-2010 NHANES participants were as much as 10^3 times higher than those in the G/G population. This is likely due to the complexity of variables required for an exposure model that extends beyond the resources available for this study but does not negate the value of using mathematical models. The logic that supports predictive models is that if the evidence is accurate and the supporting mathematical calculations are precise, then the predictions provided in the model are reliable. Models also support

the development of hypotheses that can be tested. This study presents a model that provides both the necessary logic and a tested hypothesis.

Based on results from the qualitative study, it may be beneficial to increase fish consumption advisory communication through pamphlets and flyers distributed in fish markets, grocery stores, churches, and fishing supply stores. Several participants spoke of visibility of organizations or stakeholders promoting health messages in person throughout the community as a means of increasing the receptiveness of health messages based on participant comments that there is increased trust when there are face-to-face interactions. Additionally, increased messaging to rural coastal counties through fish markets, physicians, health departments, and churches may increase levels of awareness in this demographic. There are opportunities to target younger fishers and consumers of fish and seafood by better informing young adults on how to access fish advisory information on the South Carolina Department of Health and Environmental Control (SCDHEC) website as well as to develop outreach and education programs through other forms of social media. There are also opportunities to create educational models that can easily be incorporated into the curriculum of elementary schools. Teaching elementary age children about healthy and safe fish consumption choices, relevant to their region, would serve to introduce the topic of fish consumption safety in a way that would lay the foundation for children to be empowered and self-motivated not only to seek out healthy fish choices for themselves, but to teach their elders about best fish consumption choices at home and throughout the community.

This study demonstrated that fishing and fish consumption in SC G/G and AA Sea Island communities remain a vital resource as well as a cultural cornerstone.

Employing qualitative methods served to enrich findings in the analysis of demographic determinants of fish consumption and awareness of fish advisories as well as to provide insight into outcomes of modeling MeHg exposure in the G/G community based on fish consumption. Although there are limitations in the study, the conversations and data compiled throughout this research add to the literature on fish consumption habits and motivations for fishing in the G/G and AA population.

Future studies regarding fishing and fish consumption in the G/G and AA population should include a larger sample, with a particular emphasis on women of childbearing age. Findings from this study justify further research in the G/G and AA Sea Island community in order to increase awareness and understanding about fish consumption advisories, to continue developing predictive models that are representative of the mass balance specific to this population (species-specific fish tissue analysis, sediment samples, and water samples), and to test outcomes of study participant hair samples with results from the fish consumption survey administered in this study. Continued efforts in developing mathematical models would be an invaluable tool for stakeholders with limited funding since mathematical modeling is less expensive than conducting experiments in real systems and require less time.

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APPENDIX A: Consent Form

UNIVERSITY OF SOUTH CAROLINA

Consent Form

Fishing and Fish Consumption Patterns in the African American and Gullah/Geechee Sea Island Population

Principal Investigator: Jamelle H. Ellis

Introduction and Purpose

You are invited to participate in a research study conducted by Jamelle H. Ellis. I am a doctoral student in the Department of Environmental Health Sciences at the University of South Carolina. I am conducting a research study as part of the requirements for my Doctor of Philosophy degree in Environmental Health Sciences, and I would like to invite you to participate. The purpose of this survey is to gain a better understanding of the African American local fishing patterns, dietary fish preferences, and awareness of fish advisories in Beaufort, Charleston, and Colleton counties. This form explains what you will be asked to do if you decide to participate in this study. Please read it carefully and feel free to ask any questions you like before you make a decision about participating.

Description of Study Procedures

You must be 18 years of age to participate, self-identify as African American and/or a Gullah Sea Islander, and rent or own your place of residence in Beaufort, Charleston, or Colleton County. This interview includes a one-time survey. Participation in this study is voluntary. You are free not to participate or to withdraw at any time, for whatever reason, without negative consequences. In the event that you do withdraw from this study, the information you have already provided will be kept in a confidential manner.

Risks of Participation

There are no known risks associated with participating in this research. Participation in this study is confidential. Study information will be kept in a secure location at the University of South Carolina. The results of the study may be published or presented at professional meetings, but your identity will not be disclosed. Audio taped discussions will be destroyed upon completion of this study.

Benefits of Participation

There may not be direct benefits to you as a participant of this survey, but the results from this study are anticipated to add to the research on the Africa American Sea Island population in South Carolina.

Incentives for Participation

There will be a $10 compensation if you decide to complete this survey.

Contact Persons

For more information concerning this research, you should contact Jamelle H. Ellis (doctoral student) at 803-240-3471 or ellis3@email.sc.edu or Dwayne E. Porter (faculty adviser) at 803-777-4615 or porter@sc.edu. If you have any questions about your rights as a research participant, you may contact the Office of Research Compliance at the University of South Carolina at 803-777-7095.

Thank you for participating in this focus group.

Consent Form

Fishing and Fish Consumption Patterns in the African American and Gullah/Geechee Sea Island Population

Principal Investigator: Jamelle H. Ellis

I have read the contents of this consent form and have been encouraged to ask questions. I have received answers to my questions. I give my consent to participate and be recorded in this interview for the study, although I have been told that I may withdraw at any time without negative consequences. I have received (or will receive) a copy of this form for my records and future reference.

Signature: _____

Date: _____

As a representative of this study, I have explained to the participant the purpose, the procedures, the risks of this research study, and how privacy will be protected.

Signature: _____

Date: _____

APPENDIX B: Survey Instrument

The purpose of this study is *not* to discourage you from eating fish since fish has known health benefits. The purpose of this survey is to discuss the most common types of fish that African American Sea Islanders eat, where people catch fish locally, and what you know about South Carolina fish advisories. I am also interested in why you eat the fish you eat. Are there any questions?

Fishing Patterns

1. Did you fish as a child? Yes__ No__ (If no, skip to number 7)

2. How was fishing important to your family when you were a child?

3. What do you recall most about fishing as a child?

4. Who taught you to fish?
   - O Parent
   - O Grandparent
   - O Uncle/Aunt
   - O Cousin
   - O Friend
   - O Church member
   - O Other_____

5. What did this experience mean to you?

6. Have your fishing habits changed since you were a child?
   - O Fish more
   - O Fish less
   - O Fish the same
   - O Other_____

7. Is fishing important in your family today?

8. Do you currently fish? (If no, skip to number 16)

For purposes of this interview *subsistence fishing* is defined as *catching fish as your primary dietary protein source from local water bodies for the purpose of personal or community consumption, excluding catching fish for profit. Please circle the best answer.*

Question: Do you consider yourself a subsistence fisher? Yes No

For purposes of this interview, *recreational fishing* is defined as fishing for pleasure, relaxation, bonding time with family and friends, or competition.

Question: Do you consider yourself a recreational fisher? Yes No

For purposes of this interview, *commercial fishing* is defined as fishing for profit and as a means of primary household income.

Question: Do you consider yourself a commercial fisher? Yes No

9. Who do you <u>most often</u> fish with? *Please check the <u>best</u> answer below.*

   O Family members
   O Friends
   O Spouse
   O Fishing club
   O Church group
   O Community group
   O Other_____

10. Do you share fish with family and friends in your community? Yes__ No__

11. On average, what is the farthest distance you travel to fish (in miles)?
    _____

12. How many years have you fished in local water bodies? _____

13. Where do you fish <u>most often</u> (>75% of the time)?

    Freshwater Saltwater Brackish

14. Where do you fish <u>most often</u> (>75% of the time)?

    Boat Bridge Pier Bank Dock

15. In what county do you fish most often (>75% of the time)?

    Beaufort Berkeley Charleston Colleton Georgetown

    Jasper Other_____

16. Is fishing important in the culture of the African American Sea Island community? Yes__ No__ *(If no, skip to number 18)*

17. Describe the role you believe fishing plays in the culture of the African American Sea Island community.

18. At any time in your adult life, have you taught a younger member of your community to fish? Yes__ No__

19. Is teaching children in your community to fish important to you? Yes__ No__ *(If no, skip to number 22)*

20. Why do you believe teaching children to fish is important?

21. Have younger members of the community embraced fishing as a part of the Sea Island culture? Yes__ No__

Fish Consumption

Please circle the best answer for each of the following questions

22. Are there fish you ate as a child that you no longer eat? Yes__ No__ (If no, skip to number 24)

23. What were the main types of fish and seafood you ate as a child?

O _____

O_____

O_____

O_____

O_____

O_____

24. How do you most often cook your fish (>75% of the time)?

Fried Baked Other_____

25. How do you most often eat your fish (>75% of the time)?

With Skin on With Skin off

26. How do you most often prepare your fish (>75% of the time)?

Whole Filets

27. What type of fish do you most often eat (>75% of the time)?

Freshwater Saltwater Brackish

28. How long do you keep frozen fish before cooking it? _____

Do not freeze 1 week 1 month 6 months 1 year Other_____

29. When do you clean the fish that you eat? Please circle one answer below.

Before freezing it After thawing (and just before cooking it)

30. What is the average portion size of fish you eat in a single meal that includes fish?

Please circle one answer below.

6 ounces 9 ounces 12 ounces 15 ounces >15 ounces

31. Do you eat fish daily? Yes No

32. If you answered Yes in number 31, how many total ounces do you eat daily?

_____

33. On average, how many fish meals do you eat per month? *Please check the best answer.*

O Daily

O >Once/week

O Once/week

O Once/2 weeks

O Once/month

O Once/ 4 months

O Once/year

O Other_____

O Never

How often do you eat the following fish? *Place a check mark under the best answer.*

	Consumption Frequency							
Species	Daily	>Once/ wk	Once/ wk	Once/ 2 wks	Once/ month	Once/ 4 months	Once/ year	Never
Black Sea Bass								
Blue fish								
Bowfin or Mudfish								
Bream (Sunfish/Bluegill)								
Canned Salmon								
Canned Tuna								
Catfish								
Clams								
Crabs								
Crappie								
Croaker and Spot								
Dolphin fish/Mahi Mahi								
Drum								
Eel								
Flounder								
Grouper								
Largemouth bass								
Mackerel								
Mullet								
Mussels								
Oysters								
Porgy								
Sardines and anchovies								
Scallops								
Shad								
Shark								
Sheepshead								
Shrimp								
Snapper								
Spotted Seatrout (Winter trout, Speckled seatrout)								
Striped Bass								
Weakfish (Summer trout)								
Whiting								
Other_____								
Other_____								
Other_____								
Other_____								
Other_____								
Other_____								

Knowledge about Fish Advisories

34. Are you aware of the South Carolina Fish Consumption Advisories? Yes
No
(If no, skip to question 44)

35. Where have you seen fish advisory information?

(Check all that apply)

O Fish advisory signs
O South Carolina Department of Health and Environmental Control booklet/brochure
O South Carolina Department of Natural Resources booklet/brochure
O Television
O Family/Friends
O Newspaper
O Internet
O Radio
O Other _____

36. Have you ever seen fish advisory signs in local fishing areas? Yes
No

37. Have you ever seen fish advisory signs in areas specifically where you fish? Yes
No
(If no, skip to question 44)

38. Have you read the fish advisory sign(s)? Yes
No
(If no, go to next question; If yes, skip to question 41)

39. What is the main reason you haven't read the fish advisory sign? *(Check one and go to)*

O Did not notice it
O Don't eat fish
O Already know
O Other_____

40. Where have you seen fish advisory signs?_____

41. Which of the following describe your feelings about fish advisory signs? *(Please check the best answer)*

O I understand all information provided in state fish advisory brochures and on fish advisory signs

O I understand most of the information provided in state fish advisory brochures and on fish advisory signs, but I still have some questions regarding some parts of the fish advisories

O I do not understand the information in state fish advisory brochures or on the fish advisory signs

42. Describe any suggestions for presenting fish advisory signs to make sure that local fishers see and understand them.

43. Are you interested in learning more about SC fish advisories? Yes No

44. What is the main reason you eat fish? *Please circle the best answer below.*
It is good for my health It tastes good It is affordable

45. Do you use the Internet? Yes No

46. How often do you use the Internet? *Please circle the best answer below.*

Daily Once per week Twice per month Once per month Never

47. How would you suggest distributing information from this study throughout your community?

48. Is there anything else that you would like to comment on regarding fishing, fish consumption, or fish advisories in your community?

Thank you for your participation in today's discussion. Please keep the first page of the consent form with contact information so that you may follow-up with any questions you may have after today.

Thank you again!

Short Survey

1. Gender
    a. Male
    b. Female

2. Age
    a. 18-25
    b. 26-35
    c. 36-45
    d. 46-55
    e. 56-65
    f. 66+

3. Height _____

4. Weight _____

5. Ethnicity
    a. African-American
    b. Caucasian
    c. Other_____

6. Do you identify yourself as a Gullah Sea Islander?
    a. Yes
    b. No

7. Annual household income
    a. Less than $25,000
    b. $25,000-44,999
    c. $45,000-64,999
    d. $65,000-84,999
    e. Over $85,000

8. Highest level of education
    a. Less than High School
    b. High school graduate
    c. Some College/Associates degree
    d. College degree
    e. Post-college or graduate

9. Are you pregnant?
    a. Yes
    b. No

10. Is someone else who lives in your home pregnant?
    a. Yes
    b. No

Short Survey

11. Do you have additional thoughts or comments about anything that we have discussed today?

12. May I contact you in the future with additional questions concerning fishing and fish consumption?

Name:

_____

Address:

_____

_____

_____

Telephone number:

_____

Thank you for taking time to complete this survey. If you have any comments, please feel free to write them below.