Fish Consumption, Nutrition, and Potential Exposure to Contaminants Among Columbia River Basin Tribes

A Thesis

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CERTIFICATE OF APPROVAL

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Abstract

BACKGROUND: Tribes of the Columbia River Basin have been shown to consume higher amounts of fish per day than the general population. Regular consumption of fish is beneficial to all age groups of these tribes. However, there are potential risks to consumption due to the presence of pollutants in the water and its accumulation in fish tissues. Children, women of child-bearing age, and elders may be particularly susceptible to adverse health effects of these pollutants. OBJECTIVE: To describe fish consumption patterns in these at-risk groups, and identify characteristics associated with fish consumption, fish parts consumed, and cooking methods. METHODS: A database was re-created using the original data sheets from the 1990 Columbia River Inter-tribal Fish Commission (CRITFC) fish consumption survey. Univariate associations between personal characteristics and consumption patterns were tested for using Chi-square tests for categorical data, independent T-tests and analysis of variance (ANOVA) for continuous data. Multivariate linear regression modeling was employed to determine characteristics associated with fish consumption (gpd). Dietary 24-hour recall data entered into a nutrient analysis program and micro- and macronutrients was analyzed for differences according to tribe, age groups, and gender. RESULTS: Women and elders report fish consumption similar to the all survey participants. Factors positively associated with fish consumption were breastfeeding most recent child and percent of fish obtained non-commercially for women who recently gave birth, living off the reservation and not having a child in the household for elders, and weight for children under the age of 5 years. Approximately 50% of women, 80% of elders, and at least 40% of children report consuming non-fillet fish parts. Baking was the most frequently reported method

of cooking fish for women and elders. Males consumed a higher caloric diet than females. Less than half of males and females consume recommended dietary intakes for fiber, saturated and total fat. CONCLUSION: Opportunities exist to enhance awareness on methods to minimize contaminant exposure while still enjoying the health benefits of fish. Current diets are associated with chronic diseases, and there should be continuing efforts to promote consumption of traditional diets that include fish, adequate sources of fiber, and lower amounts of saturated fat.

Background

A Vital Resource

Since time immemorial, Northwest tribes of Umatilla, Warm Springs, Yakama, and Nez Perce have lived in the Columbia River Basin. These tribes have regarded the fish that inhabit the Basin as a vital resource for their subsistence and culture. When forced to cede land to the United States, treaties made with each tribe established the right to fish in their usual and accustomed places. Although tribes have met with opposition regarding their right to fish, the U.S. Constitution deems treaties the "supreme law of the land," which enable tribes to sustain their cultural subsistence practices.[1]

North American tribes have traditionally relied on wild game and fish as a main source of nutrition. Northwest and other coastal tribes have been documented consuming as much as ten-fold more fish than the U.S. average.[2] Tribal members of the Upper Great Lakes region report consumption rates as high as 60 grams/day.[3] Mohawk men and women consume an average of 21.2 and 31 fish meals per year, respectively.[4, 5] The 1991 Columbia River Inter-Tribal Fish Commission (CRITFC) fish consumption survey established that Northwest tribal members consume on average 58 grams/day.[6] In comparison, the U. S. Environmental Protection Agency (U.S. EPA) defines the 99th percentile of daily consumption of fish at 17.5 gpd nationally, based on national survey data.[7] The consumption of fish at the levels reported by the tribes may provide substantial health benefits across all age and gender groups. However, as in the case of Northwest and other fish-consuming tribes, the loss of wild fish stocks, and the accumulation of pollutants in the aquatic environment may contribute to less consumption of fish and thus a ripple effect upon their dietary and health profile.

Health Benefits of Fish Consumption

There are numerous health benefits associated with consuming fish on a regular basis. Fish are a rich source of protein and contain less saturated fat than most beef products. In equal 3 oz. portion sizes, a typical cut of beef will have 22 grams of fat in comparison to 9 grams in baked salmon.[8] Coldwater fish, including salmon, also contain high amounts of omega-3 polyunsaturated fatty acids (PUFAs).[9] Individuals who consume regular meals of fish are shown to have high serum levels of omega-3 PUFAs and an improved lipid profile, specifically high-density lipoproteins (HDLs).[10] Omega-3 PUFAs, in part through increasing HDL, have been shown to provide protection from coronary heart disease and cardiovascular-related mortality.[11]

In addition to providing a low-fat meal rich in protein, fish have benefits for the elderly and children. Several studies have investigated the role of fish consumption and the development of neurological decline. Frequent fish consumption has been shown to be inversely associated with cognitive impairment in a cross-sectional study.[12] A prospective cohort study reported that weekly fish consumption was associated with a 60% reduction in the risk of developing Alzheimer Disease among seniors (age 65 years and older).[13] These and other studies have investigated the role of individual n-3 fatty acids in Alzheimer Disease with varied results, but suggest that the fatty acids contribute a neuroprotective benefit against cognitive decline and Alzheimer Disease.[12-15] The role of PUFAs in cognitive decline remains an active area of research.

The polyunsaturated fatty acids present in fish also are an integral component in neuronal membrane, retinal and visual cortex maturation during fetal development.[16]

Lactating mothers are capable of mobilizing n-3 fatty acids for breast milk to aid in continued neonatal and infant neuronal development. Malnourished or formula-fed infants without n-3 supplementation may be at increased risk for psychomotor and visual development delays.[17] Regular fish consumption provide direct sources of these fatty acids in sufficient amounts to provide infants with important building blocks for normal neuronal development.

It is clear that there are health benefits for those who consume fish regularly. Nutrients in fish provide cardio-protection in adults, may delay cognitive decline in older adult populations, and play a vital role in fetal and infant neurological development.[10-12, 16-20] The tribes of the Northwest are in a unique position because their cultural reliance on fish coincides with many health benefits associated with regular fish consumption. Northwest tribes in particular have additional incentive to consume large amounts of fish given the rising prevalence of both diabetes mellitus and cardiovascular diseases.[21] However, construction of dams over the years has led to loss of fish stocks in such magnitude that traditional consumption patterns have been threatened. Additionally, the presence of man-made pollutants in the Columbia River Basin have also led some to fear that the fish may not be safe for consumption.

Barriers to Fish Consumption

Northwest tribes have long held that the People's well-being and health is tightly connected with that of the environment and its animal inhabitants. Disruption in the environment such as the damming of rivers or the presence of pollutants in water has damaging effect not only on the aquatic life, but also on the People who live in the same area. As a result, whether the tribes' members maintain their traditional diet or turn to

other sources of food and adapt to other cultures, profound changes in individual nutrition and health may occur.

Changing Food Choices

With the 19th century European westward expansion, Native Americans were resigned to live in specified land tracts. In conjunction with the limited, diminishing plant and animal resources and damming of major fish runs throughout the Northwest, the U.S. government heralded the beginning of the transition away from traditional harvesting practices by providing tribes processed, canned and other non-traditional foods that was often poorer in quality than the food to which they had been accustomed.[22]

Only relatively recently has research sought to quantify the nutritional intake patterns of Native Americans.[23] The data that has been published mostly comprises information on tribes from the Midwest and Southwestern U.S.[22-25] The studies have shown that Native American tribes from Mid- to Southwestern U.S., like the general U.S. population, are consuming more foods that are processed, fat-fried, and removed of healthy nutrients and vitamins.[26] Saturated fats, related to the development of cardiovascular disease, when consumed in excess amounts, represent 35-45% of caloric intake among different Native American tribes.[23] Most Native Americans in these studies do not meet American Heart Association guidelines for reducing risk for cardiovascular disease.[20] As Native Americans consume a more Western diet, reports indicate that the prevalence of risk factors for cardiovascular disease among some tribes are rising.[21]

The U.S. population has been turning towards consumption of convenience foods and this has resulted in increases in obesity and other related endocrine and cardiovascular diseases.[27] Among Native Americans and other indigenous cultures, traditional dietary practices are now being supplanted by a Western diet (which includes convenience foods) which is associated with an increased prevalence of obesity and diabetes mellitus (type II).[28] Dietary practices of Northwest tribes may be significantly different given the importance of fish in their culture. At this time, there are no reports that describe the typical diet of Northwest Native Americans.

Contamination of Fish

Over the past century, populations of fish, particularly salmonid species, have been decimated through the construction and operation of dams, agricultural discharge, and over-fishing by commercial entities.[29] Tribal and state restoration programs have been working to increase the amount of fish and their health in the Columbia River Basin.[30] Although runs of salmon and other fish stocks have been re-established to a limited extent, pollution continues to affect the health of aquatic life.

Currently, tribes, states and local governments have issued consumption advisories for fish and shellfish in 48 states that include Washington, Oregon, and Idaho. Depending on the nature of the advisory, recommendations are usually given to limit or avoid certain fish species in a particular water source (lake, river, etc.). Primarily driven by concerns for mercury toxicity in women who are pregnant or of childbearing age and young children, the U.S. EPA guidelines call for consuming no more than 6 oz. of fish caught in freshwater or 12 oz. of commercially caught fish per week in cases where advisories are not available.[6,7] In the U.S., 35% of the nation's lake acreage and 24%

of the total river miles have advisory warnings for fish consumption.[31] In Oregon currently, 2.6% of the lake acreage and 0.5% of the river miles are under mercury advisories compared to 100% for both categories in Washington.[31] These warnings are most often related to the presence of mercury and other heavy metals, but also due to pollution by organochlorine compounds, including dioxins, polychlorinated biphenyls (PCBs), and DDT/DDE. Such compounds are found in the Columbia River Basin, persist in the environment, and accumulate in fish tissues.[32-34]

The compounds present in fish tissues have been found in those who consume them frequently.[3-5, 35] Additionally, PCBs and other compounds have been found in fetal cord blood and in breast milk.[36] Studies have shown that compounds consumed in high enough quantities can cause adverse health effects to reproductive, immune, hepatic and central nervous systems.[34, 37, 38] The Institute of Medicine has also concluded that fish contaminated with chemicals and toxins can pose an appreciable risk to human health if consumed in large quantities.[39]

In addition to the presence of contaminants in the environment, consideration must be given to fish life cycles when considering the extent of fish tissue contamination. Some fish species that reside primarily in freshwater contain more pollutants than anadromous fish such as salmon and lamprey, that spend portions of their life cycle in both salt and freshwater.[31, 40] Further, a U.S. EPA fish contaminant study gave consideration to the fact that some compounds are prone to accumulate in fatty tissues near the skin, and in the brain and organs.[34] Therefore, consumption of fish parts may expose individuals to more contaminants than when they consume only the fillet. Northwest tribes may be at more risk than the average population given their reliance on

fish, consumption of many types of species, and the variety of parts used in the preparation of meals.[6]

While the U.S. EPA has published advisories for specific fish and waterways, they have also informed the public about methods known to reduce the amount of pollutants in fish tissues. Methods such as grilling, broiling or baking and allowing the fat to drain from the fish decrease the amount of pollutants in the meat.[41] In addition, the EPA has recommended that fat, skin and organs are removed from the fillet prior to cooking.

Fish consumption among Columbia River Basin tribes

In 1989, a U.S. EPA analysis of chemical contaminants in fish collected from the Columbia River documented high levels of dioxins.[42] Concerns from Northwest tribes arose about exposure to the contaminants and potential health risks for its people. In response to this concern, the Columbia River Inter-Tribal Fish Commission (CRITFC), conducted a survey in 1991-1992 of fish consumption in a sample of 514 adults from its four member tribes: Nez Perce, Warm Springs, Umatilla, and Yakama Nation. Detailed questions were asked regarding all food consumed over a 24-hour period and fish consumption patterns including species consumed, the frequency of consumption, portion size, parts often consumed, and preparation methods commonly used. The primary purpose of this research was to provide definitive scientific documentation of the rates of consumption of fish by tribal members. The CRITFC report, published in 1994, is recognized as the most accurate source of information on subsistence fish consumption on Northwest tribes, and has been used by State and Federal agencies in regulatory rulemaking and the development of exposure factors for quantitative risk assessment.[43]

Rationale

Although the CRITFC survey did establish the frequency of preparation methods used and fish parts often consumed among all members, the 1994 report did not investigate consumption patterns of subgroups of people who may be particularly susceptible to environmental contaminants present in fish: pregnant and nursing mothers, older adults, and children. Nor did the 1994 report use the data on total diet from the 24-hour recall questions.

Information on fish consumption practices among these subgroups would be of substantive benefit to tribal governments, health care workers and nutritionists in guiding educational efforts to maximize health benefits of fish consumption, and reduce unnecessary exposure to toxins. Additionally, this information will augment current knowledge and help tribes increase water quality standards and provide a cleaner aquatic environment. In the long-term, better water quality standards will hopefully contribute to smaller concentrations of fish contaminants.

Objective

We conducted a secondary analysis using of the 1991 CRITFC data to differentiate characteristics associated with fish consumption patterns (e.g., fish consumption levels, frequency of fish species and their respective parts consumed, and cooking methods) among three susceptible subgroups: women who gave birth in the past 5 years, elders aged 55 years and older, and children under the age of 5 years. Additionally, to characterize the diets of Columbia River Basin tribes, we conducted an analysis of food reported in the 24-hour recall portion of the survey, to evaluate nutrient components across gender and tribe.

Methods

Overview of original study design

The original survey carried out in 1991 covered four Northwest tribes totaling 514 individuals with approximately equal samples of 125 adults from each tribe. Individuals were selected from Indian Health Service patient registration rolls on each reservation. Individuals less than 18 years of age and non-members of the tribes were not eligible for the survey. Those participants who had a child five years old or younger living in the same household had additional information about one child's fish consumption patterns recorded.

The questionnaire consisted of two major components: fish consumption questions and a 24-hour dietary recall. Questions were asked about the types of fish species, parts of fish consumed, and the preparation methods used. The survey also asked questions regarding breastfeeding practices and the consumption patterns among children five years old or younger living in the households. Additional sections of the survey assessed where people obtain their fish, if they catch their own fish, consumption patterns with regard to community event attendance. In addition to asking about the frequency of fish consumption, the survey interview also asked respondents to recall all food and beverages and their respective amounts consumed over the previous 24-hour period.

Subgroups of interest

In this analysis, we examined three subgroups whom may especially vulnerable to contaminants present in fish tissues: women who have given birth in the past 5 years,

elders aged 55 years and older, and children under the age of 5 years. The original study examined fish consumption in women who reported every breast feeding their children, regardless of age of their children. We chose to examine consumption patterns in women who had recently given birth. We defined a woman as having given birth recently if she birthed a child less than or equal to five years from 1991. We postulated that some women may breastfeed for as long as 2 years and may adjust fish consumption patterns during this time period and maintain them after ceasing breastfeeding for a period of time. Using 5 years as a cutoff also increases the number of women in this group for which to make comparisons.

There is a section in the questionnaire devoted to consumption patterns of children under the age of 5 years living with the adult respondent. We utilized some personal characteristics of the adult respondent in examining consumption patterns among children.

Consumption patterns according to age distributions were not examined in the original study. In this analysis, we were interested in differences in consumption among elderly tribal members who were defined as individuals 55 years of age and older.

Potential variables associated with consumption patterns

Adult and child personal characteristics and consumption practices potentially associated with fish consumption rates were included in the multivariable analysis and examination of non-fillet consumption and cooking methods (Table 1 & 2).

Table 1. Variables and variable type used in statistical analysis in adults.

Predictor	Variable type
Gender	Dichotomous
Age	Continuous
Residence (On/off reservation)	Dichotomous
Tribe	Nominal
Weekly event/ceremony attendance	Dichotomous
Catch own fish	Dichotomous
Regularly prepare meals	Dichotomous
Percent fish obtained non-commercially	Continuous
Breast fed most recent child	Dichotomous

Table 2. Variables and variable type used in statistical analysis in children.

Predictor	Variable type
Gender	Dichotomous
Weight	Continuous
Age of 1st fish meal	Continuous
Adult's tribe	Nominal
Fish obtained non-commercially	Continuous
Family residence (On/off reservation)	Dichotomous

Outcomes of interest

The outcomes of interest for each subgroup are daily fish consumption level (high, medium, and low) and rate (amount per day), consumption of non-fillet fish parts, and frequent cooking methods.

Fish consumption rate

Fish consumption rates in grams/day were calculated by using two variables in the database: (1) average fish meal size (in ounces) and (2) average number of fish meals weekly throughout the year. From these variables we used the following formulae to obtain grams of fish consumed per day:

1. # ounces x # meals per week = # oz./week
2. # oz./week / 7 days per week = # oz/day
3. # oz./day x 28.35 grams per ounce = # grams per day (gpd).

Fish parts consumed

The survey asked respondents whether they consume fillets, skin, head, eggs, bones or other organs for each species on the survey (10 different species). Previous studies of fish tissue contaminants examined either whole fish, fillet with skin or fillet only.[34] For this reason, fish parts variables for each species was transformed into a dichotomous outcome variable (yes/no) of consumption of non-fillet fish parts.

Frequent cooking methods

Each cooking method can be reported as used more than once per week, less than once per week but more than once per month, and less than once per month. Certain

cooking methods are known to be efficient at removing tissue contaminants. We limited our consideration to the most frequently used cooking methods by coding responses into a dichotomous variable (yes/no) of whether they used a particular cooking method at least once per week.

Nutrient intake

Micro- and macronutrients were reported for each individual (Table 3) and reported as grams, micrograms or International Units (IU). Percent energy from protein, carbohydrates and fat were calculated by dividing the kcal from each category by the total kcal for each individual. This analysis examined mean nutrient values by gender and tribe. Estimations of individual intake using recall data is not likely to be representative of long-term diets, especially in this survey where only one day of dietary information was collected. Therefore, analyzing means of dietary intake by group provides a higher degree of stability.[44]

Table 3. Micro- & macronutrients obtained from dietary recall data

Carbohydrates (g)	Vitamin D-IU (IU)
Protein (g)	Vitamin E-AlphaTp (mg)
Fiber (g)	Folic Acid (mcg)
Fat-Total (g)	Calcium (mg)
Fat-Saturated (g)	Iron (mg)
Fat-Monounsaturated (g)	Magnesium (mg)
Fat-Polyunsaturated (g)	Potassium (mg)
Cholesterol (mg)	Selenium (mcg)
Vitamin A-IU (IU)	Sodium (mg)
Vitamin B3 (mg)	Zinc (mg)
Vitamin B12 (mcg)	Omega 3 (g)
Vitamin C (mg)	Omega 6 (g)

Data management

Datasheets available to us were entered directly into an electronic database (Epi Info 6.04b, Centers for Disease Control and Prevention, Atlanta, GA) with the exception of the 24-hour dietary recall data. The diet data were entered into the nutrition software, *The Food Processor* (SQL Edition v. 9.5.0, ESHA Research, Salem, OR). Database reports of macro- & micronutrients values were then exported into Microsoft Excel (Version 11.2.0, Microsoft Corp., Redmond, WA). After both the questionnaire and nutrition databases were complete they were imported into SPSS (Version 11.0.4, SPSS Inc., Chicago, IL) for file management and statistical analysis. The two databases were linked using a unique respondent number found on each survey datasheet.

Data analysis

Because each tribe's total population differs greatly, the tribe samples were weighted by frequency using the "Weight by Frequency" option in SPSS.

Non-fillet fish part consumption

Consumption of non-fillet parts was transformed into a dichotomous variable for each fish species. Personal and consumption characteristics of women who recently gave birth and elders were tested against this variable using Chi-square statistics and crude odds ratios. Further univariate analyses examined differences in personal and consumption characteristics between those who did and did not recently give birth, and between non-elders and elders, respectively. Crude unadjusted odds ratios were calculated. Mean values for continuous variables age, fish consumption (gpd), and percent sources of fish were calculated and tested using t-tests.

Cooking methods

We examined use of individual cooking methods one or more times per week. For each subgroup we determined whether there were any differences in the frequency of each cooking methods using Chi-square statistics. We also calculated crude unadjusted odds ratios for personal and consumption characteristics. Mean values for continuous variables (age, fish consumption (gpd), and percent sources of fish) were calculated and tested using t-tests.

Fish consumption (gpd)

To characterize the tribes and each subgroup, we examined demographic and consumption-related characteristics. We next examined these characteristics with respect to our outcomes of interest. Mean gpd estimates were compared using t-tests for dichotomous variables and analysis of variance (ANOVA) for categorical variables with more than two groups.

Univariate analysis was conducted for modeling the outcome variable fish consumption (gpd). Diagnostics indicated the need for natural log transformation of the outcome variable. Continuous variables were plotted against fish consumption rate to assess relationships and observe for potential outliers. Univariate linear regression with the natural log-transformed outcome variable was performed for each potential variable and those with $p < .25$ were considered for inclusion in the multivariate regression model. Once all potential variables were entered into the model, backward modeling was performed, excluding those variables that did not meet significance criteria of $p < .05$. We determined that age and tribe were important variables to control for and were included in the model regardless of significance.

Graphical analysis of measures of Cook's distance by case number and residual plots were performed to identify extreme values to potentially be excluded from the analysis. Outlier analysis for women who gave birth recently identified one extreme case that was excluded which resulted in the variable "residence" being removed from the final model. Similarly, the child linear regression model contained one outlier, but affected the model very little (r^2 change from .067 with outlier, to .073 when removed). Post-hoc analyses were performed to determine the power achieved in the final models.

Fish consumption was derived using two separate frequency questions to estimate fish consumed (gpd). The conversion of the responses to frequency questions resulted in some discontinuity and modes in the distribution of gpd. This may invalid the use of linear regression in the models. Therefore, ordinal analysis of grams per day consumption was performed by re-categorizing gpd into tertiles. We examined whether the associations observed in univariate linear regressions using gpd as the independent variable were similar to associations observed at using tertiles of fish consumption (high, medium, and low) using Pearson Chi-square tests.

Dietary intake

Mean values of nutrient intake were analyzed with t-tests for two-category variables (gender) and by ANOVA for variables with more than two categories (tribe and quartile age groups: 18-26, 27-35, 36-48.7 and ≥ 48.8 years). We compared mean nutrient intakes by tribe controlled for age groups and gender. We also compared mean nutrient intakes between men and women controlled for tribe and age groups. Descriptive comparisons were made between the total sample and NHANES III, Phase 1

mean nutrient intake data that were collected near the same time (1988-1991) as the CRITFC consumption survey.

Results

The statistical analysis focused on the identification of factors that are associated with fish consumption, and thereby may inform the design of interventions to reduce unnecessary exposure to chemical contamination, or increase the choice to eat fish for its beneficial contribution to a nutritious diet. Therefore, the analyses considered amounts and types of fish eaten, means of preparation, and personal characteristics. The findings are organized by the three at-risk groups: women who have given birth in the past 5 years, adults ages 55 years and older, and children less than 5 years of age. In the final section of the Results, findings from the analysis of the 24-hour dietary recall data are presented.

1. Women who recently gave birth (≤ 5 years)

Demographic and consumption-related characteristics

Personal and consumption characteristics among women who recently gave birth are presented in Tables 4 & 5. Women comprised 278 out of a total of 514 participants in the 1991 CRITFC fish consumption survey. When weighted by frequency based on each tribe's population in 1991, 194 out of 692 women (26%), reported giving birth within 5 years of the time of the survey (Table 4). The mean (± standard deviation) age was 28 ± 6.7 years. A little less than half reported having breastfed their most recent child (43%). The mean grams per day of fish consumed was 69.3 ± 70.6 (Table 5).

Table 4. Personal characteristics of women who gave birth in the past 5 years.

Characteristic	Value
Number of total women (unweighted/weighted)	278/692
Number of women who recently gave birth	72/194
Age - years	
Mean (SD)	28 (6.7)
Range	18-45
Enrolled member - no. (%)	194 (100)
Tribe - no. (%)	
1	22 (11.6)
2	16 (8.3)
3	39 (20.2)
4	116 (59.9)
Childbearing age - no. (%)	
No	7 (3.5)
Yes	187 (96.5)
Regularly prepare meals in house - no. (%)	
No	30 (15.4)
Yes	164 (84.6)
Most recent child breast fed? - no. (%)	
No	110 (56.7)
Yes	84 (43.3)
Event or ceremony attendance - no. (%):	
Never	6 (3.1)
<1 / mo.	77 (29.5)
1-3 / mo.	85 (44)
4-6 / mo.	19 (9.7)
> 6 / mo.	7 (3.6)

Table 5. Fish consumption characteristics of women who have gave birth in the past 5 years.

Characteristic	Value
Catch own fish? - no. (%)	
No	137 (70.9)
Yes	56 (29.1)
Fish meals per week	
Mean (SD)	1.99 (1.74)
Range	0 - 10
Grams of fish/day	
Mean (SD)	69.3 (70.6)
Range	0 - 340.2
50th percentile	48.6
75th percentile	72.9
90th percentile	162
95th percentile	194.4
99th percentile	340.2
average portion size (g)	
Mean (SD)	235 (76.3)
Range	0 - 453.6
Percent source from:	
Caught	
Mean (SD)	47.5 (37.4)
Range	0 - 100
Grocery store	
Mean (SD)	10 (22.4)
Range	0 - 95
Friends	
Mean (SD)	16.3 (23.5)
Range	0 - 80
Ceremonies	
Mean (SD)	10 (17.8)
Range	0 - 100
Tribe distributions	
Mean (SD)	14 (21.4)
Range	0 - 100
Non-Commercial*	87.9 (25)
Mean (SD)	100
Range	0-100

** Combined term of sources except Grocery store*

The top three reported fish species eaten were salmon (100% of all fish consumers), trout (62.6%) and smelt (51.2%) (Table 6). Among women eating salmon and trout, approximately 40% ate only the fillets. Among women eating lamprey and smelt, a majority consumed the whole fish, including head, bones, and internal organs. Overall, the skin was the most consumed fish parts other than fillet for all ten species of food fish (Table 7, Figures 1 & 2).

Table 6. Frequency of consumption of fish species and non-fillet parts reported by women who have gave birth in the past 5 years.

Species	Species No. (%)	Non-fillet consumption No. (% of species consumers)
Salmon/Steelhead	189(100)	115 (60.8)
Lamprey	78(41.1)	78 (100)
Resident Trout	118(62.6)	65 (57.8)
Smelt	97(51.2)	86 (97.7)
Whitefish	35(18.7)	17 (54.7)
Sturgeon	33(17.2)	14 (42.4)
Walleye	4(2)	2 (50)
N. Pike Minnow	12(6.3)	5 (42.7)
Sucker	13(6.9)	12 (92.2)
Shad	2 (1)	0 (0)

Table 7. Frequency of fish part consumption according to recent childbirth status.

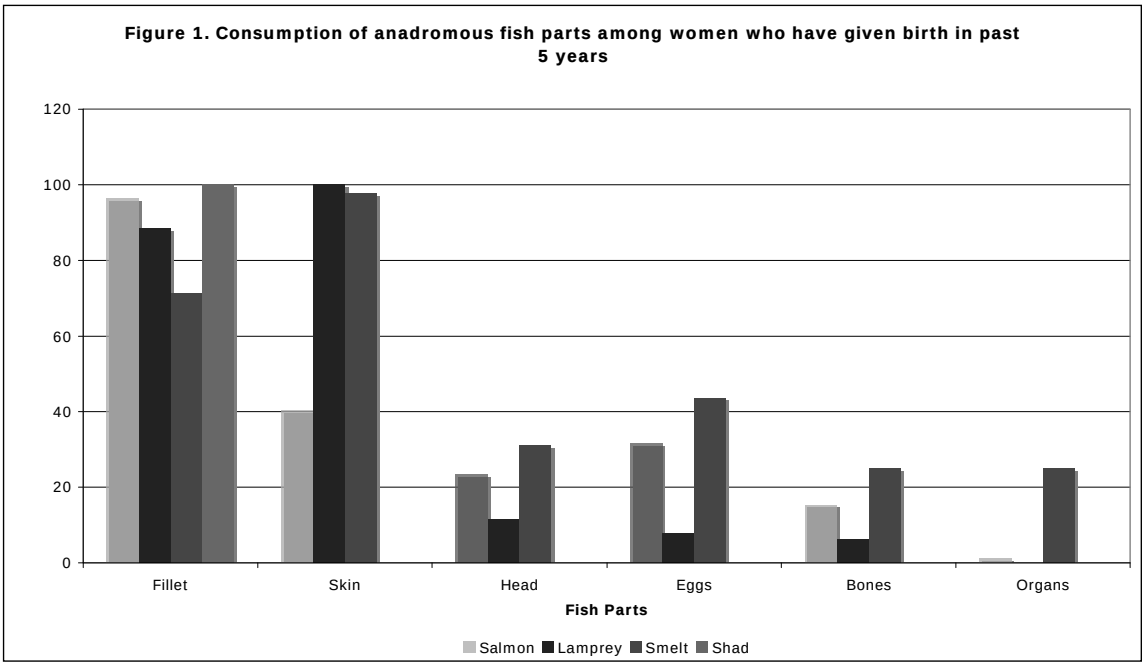
Women who have recently given birth

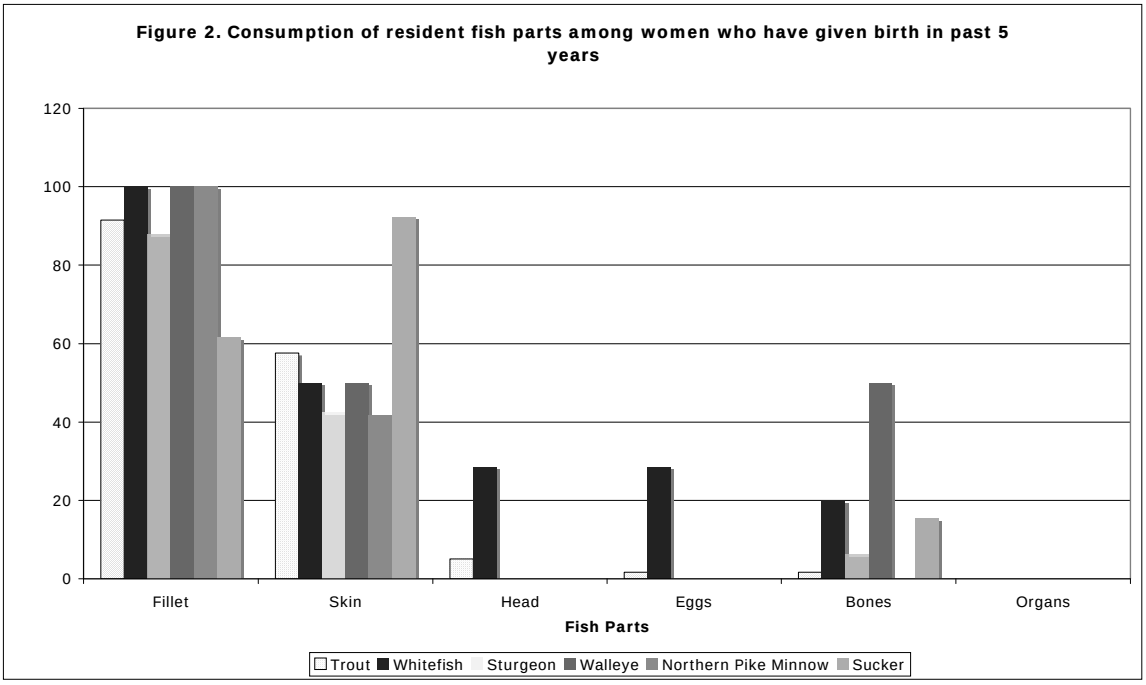
Species	Parts											
	Fillet		Skin		Head		Eggs		Bones		Organs	
	Weighted N	% of species consumers	Weighted N	% of species consumers	Weighted N	% of species consumers	Weighted N	% of species consumers	Weighted N	% of species consumers	Weighted N	% of species consumers
Salmon	182	96.3	76	40.2	44	23.3	60	31.7	29	15.3	2	1.1
Lamprey	69	88.5	78	100#	9	11.5	6	7.7	5	6.4	0	0
Trout	108	91.5	68	57.6	6	5.1	2	1.7	2	1.7	0	0
Smelt	62	71.3	86	97.7	27	31	38	43.7	22	25	22	25
Whitefish	35	100	15	50	10	28.6	10	28.6	7	20	0	0
Sturgeon	29	87.9#	14	42.4	0	0	0	0	2	6.1	0	0
Walleye	4	100	2	50	0	0	0	0	2	50	0	0
N. Pike Minnow	12	100	5	41.7	0	0	0	0	0	0	0	0
Sucker	8	61.5#	12	92.3	0	0	0	0#	2	15.4	0	0
Shad	2	100	0	0	0	0	0	0	0	0	0	0

Women who have not recently given birth

Species	Parts											
	Fillet		Skin		Head		Eggs		Bones		Organs	
	Weighted N	% of species consumers	Weighted N	% of species consumers	Weighted N	% of species consumers	Weighted N	% of species consumers	Weighted N	% of species consumers	Weighted N	% of species consumers
Salmon	336	96	184	52.6	177	50.6	149	40.6	37	10.5	10	2.9
Lamprey	162	92	162	87.1#	33	17.7	10	5.4	5	2.7	2	1.1
Trout	232	92.4	171	68.1	28	11.1	26	10.4	20	8	7	2.8
Smelt	174	88.8	179	91.3	71	36.2	85	43.8	50	25.6	42	21.6
Whitefish	83	100	32	36.8	13	15.7	18	21.7	8	9.6	0	0
Sturgeon	82	100#	12	14.8	5	6.2	6	7.4	5	6.2	1	1.2
Walleye	44	100	6	13.6	5	11.4	10	22.7	0	0	1	2.3
N. Pike Minnow	10	100	1	10	0	0	1	10	1	10	0	0
Sucker	31	100#	12	37.5	8	25	11	35.5#	3	9.7	1	3.2
Shad	3	60	2	40	0	0	0	0	0	0	0	0

Shading denotes significant difference between groups of women (p<.05)
Fisher Exact Test





The most frequently reported way of preparing fish was baking (Table 8), and this method was used significantly more often than boiling for soup/stew, canned preparations, and pan-frying (Table 9). Roasting or barbecuing, and broiling were used much less frequently.

Table 8. Fish preparation methods reported by women who gave birth in past 5 years.

Method	Ever Prepared	Use Method at least weekly
	No. (%)	No. (%)
Pan fried	134 (71.1)	37 (27.5)
Deep fried	52 (27.3)	13 (24.6)
Poached in water	26 (13.6)	13 (51)
Soup or stew	145 (76.6)	42 (29.3)
Baked	187 (99.1)	80 (44)
Broiled	50 (27.2)	13 (23.7)
Smoked	120 (63.7)	13 (10.9)
Dried	112 (59.1)	23 (21.6)
Eaten raw	1 (0.5)	0 (0)
Roasted/BBQ	126 (66.9)	13 (9.9)
Canned	143 (75.9)	39 (27)

Table 9. Differences in cooking methods among women who gave birth in past 5 years.

Rank (by frequency)	Cooking Method	Chi-Square*	P-value
1	Baked		
		#	.043#
2	Boiled as Soup/Stew		
		2.96	0.085
3	Canned		
		0.529	0.467
4	Pan-fried		
		15.96	<.001
5	Roasted/BBQ		
		38.83	<.001
6	Smoked		
		15.7	<.001
7	Dried		
		4.41	0.036
8	Deep-fried		
		1.35	0.245
9	Broiled		
		10.89	0.001
10	Poached in Water		
		#	.059#
11	Raw		

* Chi-Square test between cooking methods

Fisher's Exact Test

Fish consumption analysis

A. Overall fish consumption

Mean levels of daily fish consumption were examined by personal characteristics (Table 10). Correlations were explored using univariate linear regression, and four variables reached the level of significance necessary ($p < 0.25$) for consideration for inclusion in the multivariate regression model. These candidate variables were residence on or off the reservation (p=.019), weekly attendance at community event or ceremony (p=0.23), percent fish obtained from non-commercial source (p=<0.001), and breastfed most recent child (p=.029) (Table 11).

Table 10. Mean fish consumption (gpd) according to personal characteristics among women who gave birth in past 5 years.

Characteristic	Mean gpd	P-value
Tribe		
1	86.424	
2	27.7128	
3	59.6842	
4	74.9574	0.039§
Regularly prepare meals in house		
No	55.6865	
Yes	71.7832	0.253*
Most recent child breast fed		
No	51.8292	
Yes	92.1727	<.001*
Weekly event/ceremony attendance		
No	69.3806	
Yes	78.0999	0.565
Catch own fish		
No	68.9041	
Yes	70.2641	0.903*

§ One-way ANOVA

* Independent samples T-test

Table 11. Potential determinants of fish consumption [ln(gpd)] among women who gave birth in past 5 years using univariate linear regression.

Characteristic	Beta	95% CI	P-value
Age	0.033	(.015, .052)	<.001
Tribe			
1	-0.303	(-.679, .072)	0.113
2	-0.909	(-1.37, -.449)	<.001
3	-0.119	(-.432, .195)	0.456
4	0	-	-
Residence			
Off the reservation	0	-	-
On the reservation	0.646	(.109, 1.18)	0.019
Weekly event/ceremony attendance			
No	0	-	-
Yes	0.219	(-.141, .578)	0.232
Catch own fish			
No	0	-	-
Yes	0.032	(-.238, .302)	0.816
Regularly prepare meals			
No	0	-	-
Yes	0.027	(-.325, .378)	0.881
Percent fish obtained non-commercially	0.013	(.008, .018)	<.001
Breastfeed most recent child			
No	0	-	-
Yes	0.276	(.029, .523)	0.029

Through examination of residual and probability-probability (P-P) plots, it was necessary to natural log transform the variable of total fish consumption in grams per day. Using a significance level of $p < 0.05$ to be included in the final model, two variables maintained significance: percent of fish obtained non-commercially and breastfeeding most recent child (Table 12). Figure 3 displays changes in gpd according to changes for age, percent sources of fish and breast feeding status. For example, a 25-

year-old member of tribe 1 who obtains 50% of fish from non-commercial sources and who has breast fed her most recent child consumed 11.7 gpd of fish compared to a similar woman who did not breast feed (31 vs. 19.3 gpd, Figure 3). Similarly using the same woman as an example, fish consumption increases by 13 gpd (44 vs. 31 gpd) when a woman increases sources of fish from non-commercial sources from 50 to 75%. Additionally, age was positively associated with gpd in the multivariate model. The final multivariate linear regression model accounted for 30% of the variability in grams/day values between these women ($r^2 = 0.30$). A post-hoc analysis of the multivariate linear regression model on the power of two variables to detect a change in r^2 of .05 after adjustment of four independent variables with a baseline r^2 of 0.14 was 88% ($\beta = 0.88$).

Table 12. Determinants of fish consumption [ln(gpd)] in women who gave birth in past 5 years using multivariate linear regression analysis.

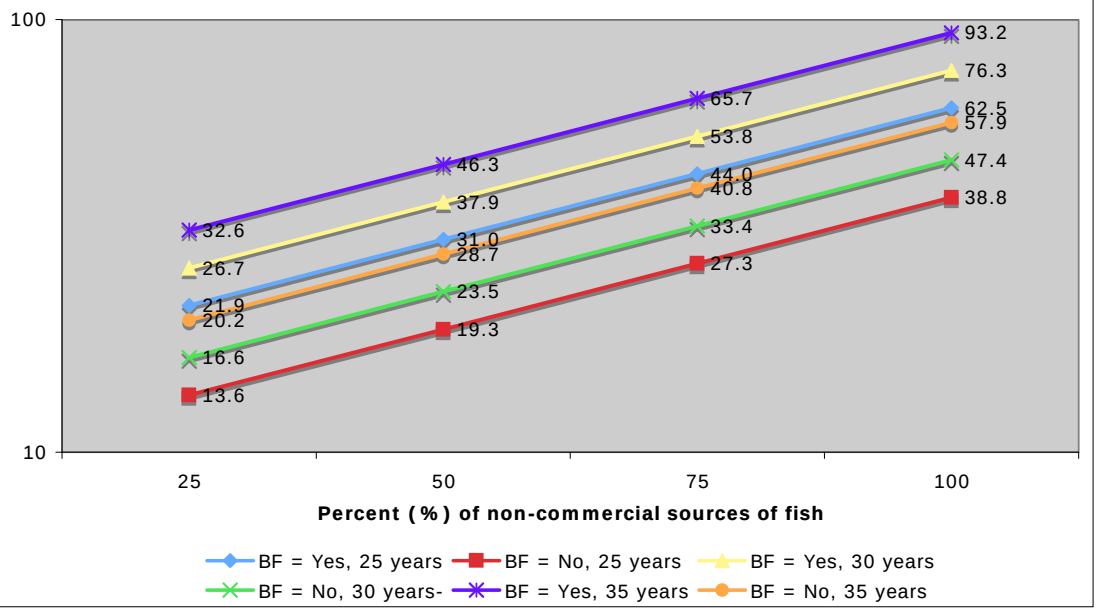
Characteristic	Beta	95% CI	P-value
Constant	1.466	(.727, 2.20)	
Age (years)	0.04	(.023, .057)	<.001
Tribe			
1	-0.208	(-.551, .134)	0.231
2	-0.746	(-1.18, -.312)	0.001
3	0.03	(-.332, .271)	0.843
4	0	-	-
Percent fish obtained non-commercially	0.014	(.008, .019)	<.001
Breastfeed most recent child			
No	0	-	-
Yes	0.477	(.25, .705)	<.001

Model: Tribes, Age (years) r^2 = .139

Model: Tribes, Age (years), Percent of fish obtained non-commercially r^2 = .256

Model: Tribes, Age (years), Percent of fish obtained non-commercially, Breast fed most recent child r^2 = .324

Figure 3. Predicted fish consumption (g/day) according to % source of non-commercial fish for selected ages and breastfeeding status for Tribe 1 women who gave birth in past 5 years using multivariate linear regression. (BF = Breast fed)



Fish consumption (gpd) was categorized into tertiles and tested against personal characteristics. Overall, the results were similar to the ln(gpd) univariate linear regression analysis with the exception of variable "catch own fish", which became significant and would be included in modeling procedures of fish consumption (Table 13).

Table 13. Characteristics of women who recently gave birth by tertiles of fish consumption in grams/day (% within tertile)

Characteristic	Tertiles of fish consumption			P-value
	0 - 32.3	32.4 - 64.7	>= 64.8	
Age				0.01 $
Mean (SD)	27 (6.2)	28 (4.8)	30 (8.5)	
Tribe - No. (%)				0.15 *
1	12 (15)	5 (8)	5 (9)	
2	11 (14)	4 (7)	1 (2)	
3	16 (20)	12 (20)	12 (23)	
4	40 (35)	40 (35)	35 (66)	
Residence - No. (%)				0.12 *
On the reservation	5 (6)	5 (8)	-	
Off the reservation	74 (94)	57 (92)	53 (100)	
Weekly event/ceremony attendance - No. (%)				.009 *
No	70 (96)	49 (80)	43 (80)	
Yes	3 (4)	12 (20)	11 (20)	
Catch own fish - No. (%)				0.002 *
No	65 (82)	34 (56)	39 (74)	
Yes	14 (18)	27 (44)	14 (26)	
Regularly prepare meals at home - No. (%)				0.31 *
No	16 (20)	8 (13)	6 (11)	
Yes	63 (80)	53 (87)	47 (89)	
Percent non-commercial fish				<0.001 $
Mean (SD)	80 (32)	89 (21)	99 (7.7)	
Most recent child breast fed - No. (%)				0.005 *
No	55 (70)	33 (53)	22 (42)	
Yes	24 (30)	29 (47)	31 (58)	

* Pearson Chi-square test
$ ANOVA F-test

In addition to considering factors associated with total consumption of all fish, analyses were also performed to identify factors associated with the consumption of salmon/steelhead and trout (Appendix I, Tables 1 to 4). Obtaining fish from non-commercial sources, catching own fish, and breast feeding most recent child were all positively associated with daily fish consumption.

Consumption of non-fillet fish parts analysis

The frequency of eating fish parts other than fillets was tabulated by species (Table 7) and consolidated into a dichotomous variable based on whether an individual consumed any non-fillet parts. Univariate statistics were performed to examine differences in personal and consumption characteristics according to non-fillet consumer status among women who recently gave birth for salmon/steelhead, resident trout, and whitefish, the most commonly eaten fish species of large size where fillets can be cut, and the skin, heads, organs, and bones can be removed. Among these species (Appendix I, Tables 5 to 7), those who reported eating non-fillet fish parts tended to be older, consumed more fish meals per week (and grams per day), obtained fish from friends, and ate fish at ceremonies. Women who reported eating fish parts were more likely to have breast fed their most recent child than women who did not consume non-fillet parts of salmon (OR = 3.3, 95%CI 1.74-6.15) and whitefish (OR = 5.6, 95%CI 1.08-28.6).

Fish preparation methods analysis

Associations were investigated by strata of women reporting frequent use of specific cooking methods (Appendix I, Tables 8 to 11). Frequent use was defined as using the method at least once per week. Women who frequently pan fry, bake, and can their fish consume significantly more fish (gpd) than those who do not. Women who pan

fry and boil obtain a significantly larger percentage of their fish from non-commercial sources. Frequent pan-frying is associated with weekly attendance at community events or ceremonies. A significantly higher percentage of those who frequently used baking and canning preparations caught their own fish. Finally, a higher percentage of women who frequently use canning preparations breast fed their most recent child.

Comparisons of consumption patterns according to childbirth status

Comparisons of women who have given birth within the past 5 years against all women allowed investigation of the personal and fish consumption characteristics of this group relative to all women. As presented in Table 14 women who recently gave birth were significantly younger (mean age of 28 vs. 47 years), consumed more fish (69 vs. 53 gpd), and were 2 times more likely to report residing on the reservation (OR = 2.2, 95%CI 1.08-4.5).

Table 14. Comparison of characteristics according to recent childbirth status.

Characteristic	Recently Given Birth (within 5 years)		P-value	Odds Ratio (95% CI)
	No	*Yes*		
n	*392*	*194*		
Age (mean, se)	46.9 (12.3)	28 (6.7)	<.001	
Grams of fish/day (Mean, SD)	53.3 (59.6)	69.3 (70.6)	0.004	
Source of consumed fish (Mean %, SD)				
Caught by family/self	35.6 (33.3)	47.5 (37.4)	<.001	
Grocery stores	9.4 (19.9)	10 (22.4)	0.724	
Friends	12.9 (21.4)	16.3 (23.5)	0.089	
Ceremonies	13.5 (19.4)	10 (17.8)	0.032	
Tribal distributions	21.9 (28)	14 (21.4)	<.001	
Non-commercial*	83.8 (29)	87.9 (25)	0.08	
Residence on the rez - No. (%)	350 (89)	184 (95)	0.026	2.21 (1.08,4.5)
Tribe# - No. (%)				
1	88 (22)	22 (11)	0.001	0.44 (.27,.74)
2	42 (11)	16 (8)	0.35	0.75 (.41,1.37)
3	65 (17)	39 (20)	0.29	1.27 (.82,1.97)
4	197 (50)	116 (60)	0.029	1.42 (1.04,2.09)
Weekly event/ceremony attendance - No. (%)	66 (18)	26 (14)	0.2	0.73 (.44,1.19)
Catch own fish - No. (%)	108 (28)	56 (29)	0.74	1.07 (.73,1.56)
Regularly prepare meals - No. (%)	350 (89)	164 (85)	0.09	0.66 (0.4,1.09)
Breast fed most recent child - No. (%)	162 (42)	84 (43)	0.8	1.05 (0.74,1.49)

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

$ Fisher's Exact Test

A. Fish consumption differences

Multivariate linear regression was used to determine whether childbirth status was associated with fish consumption (gpd) for all women. As candidate variables were evaluated for inclusion in the multivariate analysis, univariate linear regression identified breastfeeding, percent non-commercial sources, catching fish, weekly community event or ceremony attendance, residence, and recent childbirth as potential variables for multivariate linear regression (Appendix I, Table I-12). After natural-log transforming grams/day and removing three outliers using Cook's distance values and examining residual and P-P plots, recent childbirth, breastfeeding and percent of non-commercial fish remained significant when controlling for age and tribe (Table 15). Controlling for age, tribe and percent source of fish from non-commercial sources, women who recently gave birth had 0.22 higher ln(gpd) than women who did not. Age was not a significant determinant in ln(gpd) in the model. The final multivariate linear regression model accounted for 14% of the variability in ln(gpd) ($r^2 = 0.14$).

Table 15. Determinants of fish consumption [ln(gpd)] in all women using multivariate linear regression analysis.

Determinant	Beta	95% CI	P-value
Constant	3.375	(2.912, 3.839)	0
Age (years)	0.0038	(-.003, .011)	0.299
Recent childbirth (< 5 years)			
No	0	-	-
Yes	0.22	(.018, 4.22)	0.033
Tribe			
1	-0.34	(-.528, -.151)	<.001
2	-0.952	(-1.193, -.711)	<.001
3	-0.152	(-.351, .046)	0.133
4	0	-	-
Breastfed most recent child			
No	0	-	-
Yes	0.205	(.063, .348)	0.005
Percent fish obtained non-commercially	0.0033	(.006, .964)	0.023

Model: Tribes, Age (years), Recent birth within 5 years $r^2 = 0.107$

Model: Tribes, Age (years), Recent birth within 5 years, Percent non-commercial fish $r^2 = 0.125$

B. Non-fillet fish parts

Among those who recently gave birth, a larger proportion consumed non-fillet fish parts of sturgeon (Table 16). They also more frequently consumed lamprey and smelt, species that are eaten as whole fish. As observed in other analyses, women who recently gave birth ate more total fish, obtained fish from a variety of non-commercial sources, and women from some tribes ate significantly more salmon/steelhead than observed in others (Appendix I, Tables I-13 and I-14.)

Table 16. Percent reporting any non-fillet consumption according to recent childbirth status.*

Species	Recently child birth		P-value
	No	Yes	
	No. (%)$		
Salmon/Steelhead	254 (72.6%)	115 (60.8%)	0.005
Lamprey	162 (87.1)	78 (100)	0.001
Resident Trout	174 (69)	65 (57.5)	0.032
Smelt	177 (91.2)	86 (97.7)	0.044
Whitefish	44 (53)	17 (54.8)	0.862
Sturgeon	14 (17.3)	14 (42.4)	0.005
Walleye	16 (36.4)	2 (50)	0.624#
Northern Pike Minnow	1(10)	5 (41.7)	0.162#
Sucker	17 (53.1)	12 (92.3)	.016#
Shad	2 (40)	0 (0)	1.0#

*Participant considered to consume non-fillet fish parts if they reported "commonly consuming" one ore more of: skin, head, eggs, bones or other organs.

Fisher Exact test

$ Percent of those who consume the fish species

C. Cooking methods

The types of fish cooking methods differed by recent childbirth status (Table 17). Those who recently gave birth were more likely to pan fry, deep fry, poach in water, boil and bake their fish. There was also a tendency to eat more dried fish, although not statistically significant. No significant differences were observed in the proportions of women broiling, roasting, or canning fish.

Table 17. Comparison of cooking methods used at least weekly according to recent childbirth status (birth within 5 years).

Cooking Method	Birth within 5 years		P-value	Odds Ratio (95% CI)
	No	Yes		
	No. (%)			
Pan-fried	41 (14.5)	37 (28)	0.001	2.24 (1.36,3.71)
Deep-fried	5 (7)	13 (25)	0.005	4.4 (1.46,13.28)
Poached in Water	11 (13)	13 (50)	<.001	6.45 (2.38,17.5)
Boiled as Soup/Stew	33 (13)	42 (29)	<.001	2.73 (1.64,4.56)
Baked	110 (32)	80 (44)	0.006	1.68 (1.16,2.44)
Broiled	27 (19)	13 (24)	0.47	1.32 (0.63,2.79)
Smoked	15 (8)	13 (11)	0.34	1.46 (0.67,3.18)
Dried	33 (14)	23 (21.5)	0.065	1.73 (0.96,3.13)
Raw	0(0)	0(0)	-	-
Roasted/BBQ	19 (8)	13 (10)	0.44	1.33 (0.64,2.79)
Canned	66 (24)	39 (27)	0.52	1.17 (0.74,1.85)

Personal and consumption characteristics were compared according to recent childbirth status for weekly pan-frying, boiling, baking and canning (Appendix I, Tables I-15 to I-18). Women who recently gave birth reported a higher percentage of non-commercial sources of fish among those who frequently pan fry, boil, and bake their fish, and some variation among tribes was observed.

Among women who frequently pan-fried fish, those who recently gave birth were 80% less likely to catch their own fish (OR = 0.16, 95% CI 0.06-0.44). Among women who frequently boiled fish, those who recently gave birth were 4 times more likely to

catch their own fish (OR = 4.17, 95% CI 1.23-14.1). When considering breast feeding their most recent child, women who recently gave birth were less likely to use boiling methods weekly (OR = 0.32, 95% CI 0.12-0.82) whereas they were more likely to use canned preparations weekly (OR = 2.62, 95% CI 1.16-5.93).

2. Elders (≥ 55 years old)

Demographic and Consumption-related characteristics

Personal and consumption characteristics are presented in Table 18 & 19. There were a total of 184 elders in the CRITFC survey (when weighted by frequency). The mean age of elders was 64 years ± 7.4. The mean grams of fish consumed per day was 65 ± 116.

Table 18. Personal characteristics of elders (>= 55 years).

Characteristic	Value
Sample n (unweighted/weighted)	94/184
Age - years	
Mean (SD)	64.4 (7.4)
Median	63
Range	55 - 92
Enrolled member - no. (%)	184 (100)
Residence on reservation - no. (%)	159 (86.5)
Tribe - no. (%)	
1	61 (33)
2	37 (20.1)
3	16 (8.5)
4	71 (38.4)
Regularly prepare meals in house - no. (%)	
No	42 (22.6)
Yes	142 (77.4)
Ceremony attendance - no. (%):	
Never	11 (6.2)
<1 / mo.	95 (51.8)
1-3 / mo.	53 (28.9)
4-6 / mo.	19 (10.1)
> 6 / mo.	5 (3)

Table 19. Fish consumption characteristics of elders (>= 55 years).

Characteristic	Value
Catch own fish? - no. (%)	
No	113 (62.3)
Yes	69 (37.7)
Fish meals per week	
Mean (SD)	2.08 (3.6)
Median	1
Range	0 - 30
Grams of fish/day	
Mean (SD)	65.1 (116.8)
Median	32.4
Range	0 - 972
90th percentile	97.2
95th percentile	170.1
99th percentile	939
Average portion size (g)	
Mean (SD)	211.7 (94.1)
Median	226.8
Range	0 - 567
Percent source from:	
Caught	
Mean (SD)	41 (35.2)
Median	50
Range	0 - 100
Grocery store	
Mean (SD)	8.8 (20.4)
Median	0
Range	0 - 100
Friends	
Mean (SD)	11.8 (22.2)
Median	0
Range	0 - 100
Ceremonies	
Mean (SD)	6.9 (10.7)
Median	3
Range	0 - 50
Tribe distributions	
Mean (SD)	28.3 (31.7)
Median	15

Range	0 - 100
Non-commercial sources*	
Mean (SD)	88 (24.4)
Median	100
Range	0 - 100

** Combined term of sources except grocery store*

The frequency of consuming species and non-fillet parts of fish is presented in Table 20. Salmon, resident trout, and smelt were the most frequently reported species consumed. The highest proportion of non-fillet parts consumed was salmon (83%), trout (83%) and smelt species (91%). Each fish part was reported being consumed, as shown on Table 21. Overall, fillet and skin were the most consumed fish parts for all ten species (Graph 4 & 5). Fish preparation methods used among elders is presented in Table 22. Baking, boiling, and dried preparations were the methods used at most frequently. Differences in cooking methods are shown in Table 23. Baking was statistically the most frequent cooking method reported. Broiling was ranked 8th, and was not statistically different in frequency from deep-frying and poaching in water.

Table 20. Frequency of consumption of fish species and non-fillet parts reported by elders (>= 55 years).

Species	Consume Species No. (%)	Consume non-fillet parts No. (% of all elders)	% of species consumers
Salmon/Steelhead	170 (98)	141 (76.6)	83.2
Lamprey	128 (73.9)	100 (54.2)	80.1
Resident Trout	146 (83.3)	112 (60.7)	82.9
Smelt	134 (78.3)	104 (56.8)	90.7
Whitefish	62 (35.8)	47 (25.4)	78.1
Sturgeon	65 (37.3)	25 (13.7)	41.5
Walleye	16 (9.2)	3 (1.6)	19.1
N. Pike Minnow	5 (3)	2 (0.9)	33
Sucker	32 (18.6)	20 (10.6)	57.7
Shad	5 (2.9)	0 (0)	0

Table 21. Frequency of fish part consumption according to elder status

Consumption frequency of fish parts reported by elders (>= 55 years).

Species	Parts											
	Fillet		Skin		Head		Eggs		Bones		Organs	
	Weighted N	% of Species Consumers	Weighted N	% of Species Consumers	Weighted N	% of Species Consumers	Weighted N	% of Species Consumers	Weighted N	% of Species Consumers	Weighted N	% of Species Consumers
Salmon	160	94.1	103	60.9	115	67.8	99	58.2	25	14.9	3	1.8
Lamprey	99	81.9	101	80.4	22	17.3	7	5.6	12	9.6	5	4.1
Trout	117	85.2	112	81.7	30	22.1	21	15.2	16	11.7	3	2.6
Smelt	93	77.5	110	91.1	47	39.2	55	46.2	31	25.9	26	23.5
Whitefish	52	83.7	47	75.1	16	25.1	21	33.6	7	11.4	0	0
Sturgeon	60	92.2	14	21.8	6	9.4	15	23.3	6	9.4	1	1.7
Walleye	16	100	3	19.1	1	6.4	1	6.4	1	6.4	1	6.4
N. Pike Minnow	3	66.7	2	33.3	2	33.3	2	33.3	0	0	0	0
Sucker	27	100	15	45.1	9	27.3	17	51.5	3	9.3	1	3.1
Shad	5	100	0	0	0	0	0	0	0	0	-	-

Consumption frequency of fish parts reported by non-elders (< 55 years).

Species	Parts											
	Fillet		Skin		Head		Eggs		Bones		Organs	
	Weighted N	% of Species Consumers	Weighted N	% of Species Consumers	Weighted N	% of Species Consumers	Weighted N	% of Species Consumers	Weighted N	% of Species Consumers	Weighted N	% of Species Consumers
Salmon	904	94.9	520	54.4	364	38.1	373	39.1	111	11.6	39	4
Lamprey	426	87.2	462	92.6	93	18.7	22	4.5	26	5.3	16	3.3
Trout	620	89.9	459	66.2	79	11.5	50	7.3	43	6.3	17	2.5
Smelt	350	76.7	410	89.3	168	36.5	213	46.1	133	28.8	131	28.7
Whitefish	204	96.7	100	48.8	27	12.9	36	17.2	10	4.5	0	0
Sturgeon	212	95.2	39	17.7	12	5.4	19	8.5	2	0.8	0	0
Walleye	100	100	21	20.6	6	6.1	10	10.1	2	1.7	0	0
N. Pike Minnow	27	93.9	10	34.3	1	3.5	2	7	2	7	0	0
Sucker	55	91.6	33	54	10	15.8	12	20.1	6	10.3	1	1.7
Shad	21	91.5	5	20.5	0	0	0	0	1	4.3	0	0

Figure 4. Proportion of anadromous fish part consumption among elders (>= 55 years old).

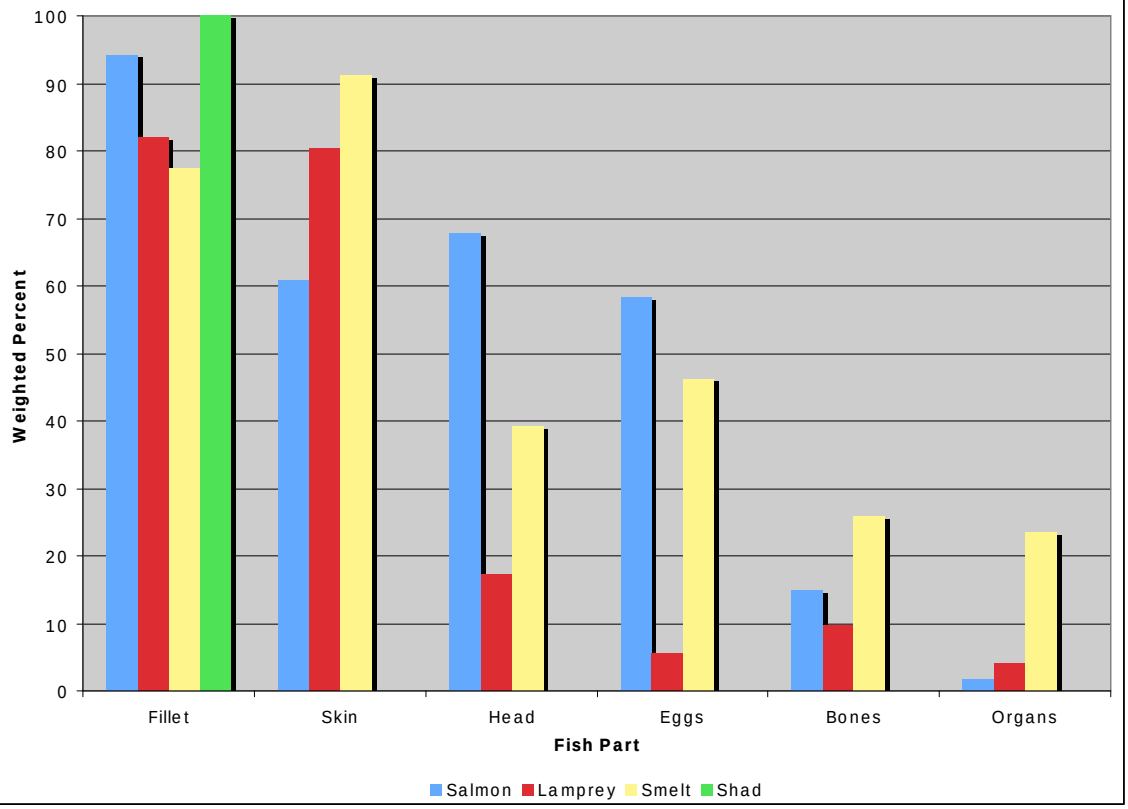


Figure 5. Proportion of resident fish part consumption among elders (>= 55 years old).

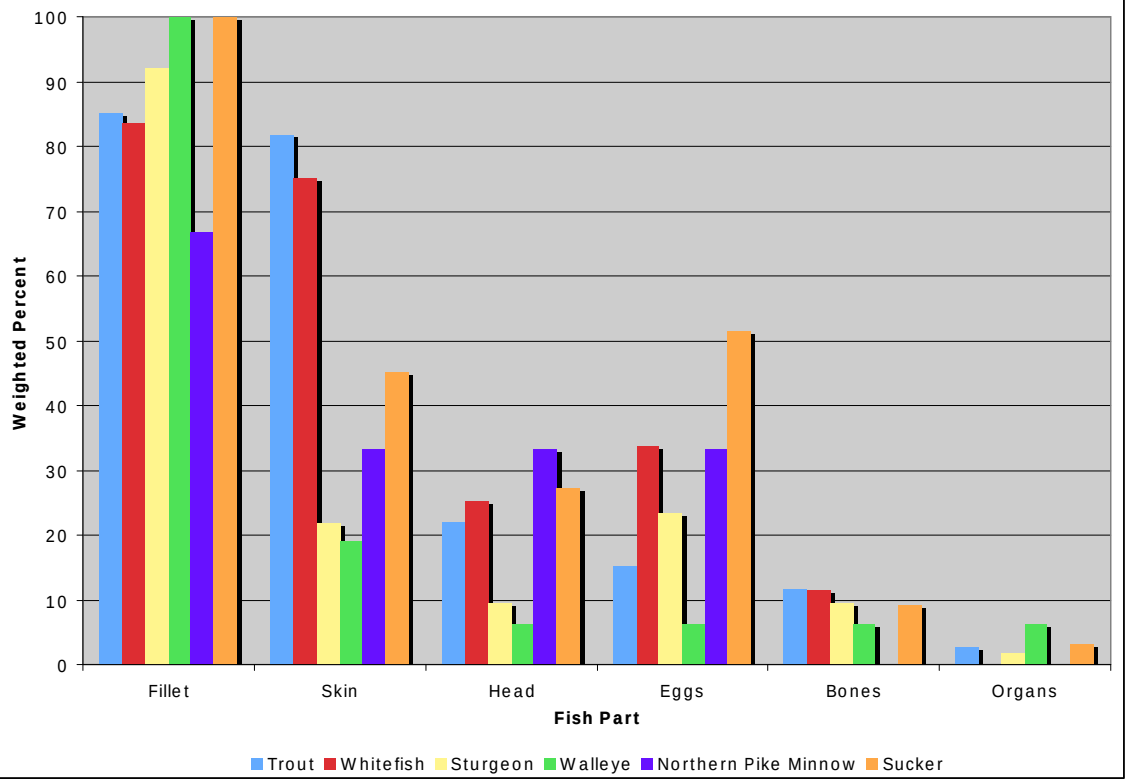


Table 22. Fish preparation methods reported by elders (>= 55 years).

Method	Ever Prepared	Use Method at least weekly
	No. (%)	No. (%)
Pan fried	148 (83.3)	29 (19.4)
Deep fried	53 (30)	4 (8.4)
Poached in water	39 (23)	13 (32.5)
Soup or stew	141 (79.5)	39 (27.5)
Baked	170 (95.4)	64 (38.1
Broiled	93 (53)	21 (22.6)
Smoked	112 (63.2)	25 (22.1)
Dried	120 (67.3)	27 (22.6
Eaten raw	2 (1)	0 (0)
Roasted/BBQ	120 (67.6)	10 (8.7)
Canned	147 (83.7)	33 (22.5)

Table 23. Differences in cooking methods among elders.

Rank (by frequency)	Cooking Method	Chi-Square*	P-value
1	Baked	$	.024$
2	Canned	$	0.775
3	Pan Fried	1.124	0.315
4	Soup or Stew	3.796	0.051
5	Roasted/BBQ	7.641	0.006
6	Dried	6.544	0.011
7	Smoked	5.573	0.018
8	Broiled	0	0.999
9	Deep Fried	0.611	0.434
10	Poached in water	$	.052$
11	Eaten Raw		

* Chi-Square test between cooking method

Fisher's Exact Test

Fish consumption (gpd) analysis

A. Overall fish consumption (grams/day)

Mean levels fish consumption by personal and consumption characteristics are shown on Table 24.

Table 24. Mean fish consumption (gpd) according to personal characteristics among elders.

Characteristic	Mean gpd	P-value
Gender		
Male	72.9 (141.1)	
Female	52.9 (61.2)	0.26*
Tribe		
1	87.7034	
2	46.9416	
3	42.525	
4	60.75	0.288§
Child living in house		
No	71.1 (131.5)	
Yes	44.4 (28)	0.197
Residence		
On reservation	60 (19)	
Off reservation	65.9 (125.5)	0.82*
Regularly prepare meals in house		
No	105.2 (198)	
Yes	53.2 (75.2)	0.253*
Weekly event/ceremony attendance:		
No	65.5 (126.3)	
Yes	61.3 (29.2)	0.88*
Catch own fish		
No	68 (140)	
Yes	61.8 (62)	0.73*

§ One-way ANOVA

* Independent samples T-test

Using univariate linear regression to identify potential determinants of gpd, four variables were considered for inclusion in multivariate linear regression in addition to the control variables of age and tribe (Table 25). After plotting residuals and P-P plots, we natural-log transformed grams/day of fish. The final model shown in Table 26 included residence ($p = 0.01$), weekly attendance ($p = 0.001$) and child living in house ($p = 0.016$).

Table 25. Potential determinants of fish consumption [ln(gpd)] in elders using univariate linear regression.

Determinant	Beta	95% CI	P-value
Age	-0.0058	(-.026, .014)	0.568
Gender			
Female	0	-	-
Male	-0.037	(-.32,.24)	0.791
Age quartiles			
18-28	0	-	-
29-36	0.154	(-.25, .558)	0.453
36-50	0.289	(-.117, 696)	0.162
> 50	0.049	(-.381, 48)	0.821
Child Living in House			
No	0	-	-
Yes	-0.245	(-.56, .069)	0.126
Residence			
Off the reservation	0	-	-
On the reservation	-0.331	(-.714, .052)	0.09
Tribe			
1	-0.266	(-.584, .052)	0.1
2	-0.585	(-.941, -.23)	0.001
3	-0.269	(-.754, .217)	0.276
4	0	-	-
Weekly event/ceremony attendance			
No	0	-	-
Yes	0.292	(-.107, .691)	0.151
Catch own fish			
No	0	-	-
Yes	0.154	(-.123, .43)	0.274
Regularly prepare meals			
No	0	-	-
Yes	-0.317	(-.638, .003)	0.052
Percent fish obtained non-commercially	0.00016	(-.006, .006)	0.96

Table 26. Determinants of fish consumption [ln(gpd)] in elders using multivariate linear regression.

Determinant	Beta	95% CI	P-value
Constant	4.761	(3.75, 5.77)	<.001
Age	-0.007	(-.023, .008)	0.37
Tribe			
1	-0.592	(-.868, -.316)	<.001
2	-0.645	(-.929, -.362)	<.001
3	-0.347	(-.744, .05)	0.086
4	0	-	-
Residence			
Off the reservation	0	-	-
On the reservation	-0.409	(-.72, -.097)	0.011
Weekly event/ceremony attendance			
No	0	-	-
Yes	0.54	(.213, .868)	0.001
Child Living in House			
No	0	-	-
Yes	-0.326	(-.597, -.056)	0.018

Model: Age, Tribes r^2 = .156

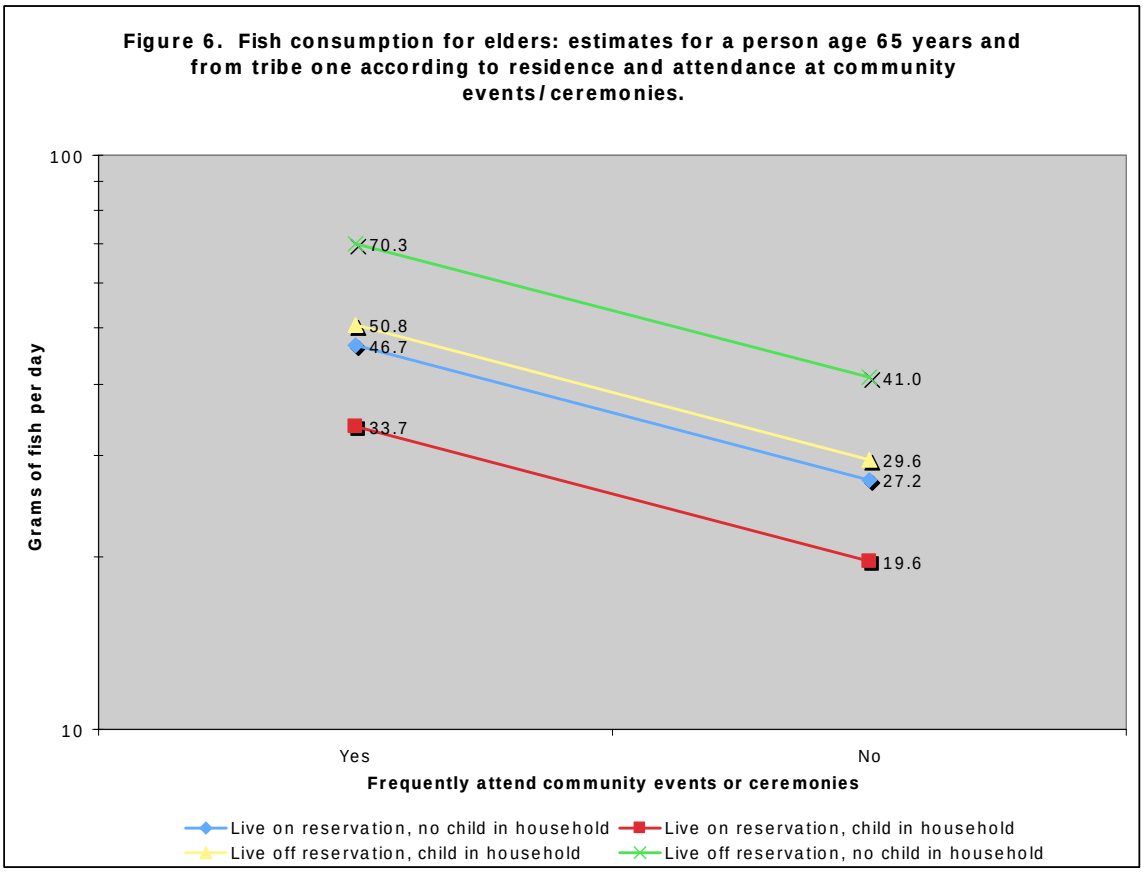
Model: Age, Tribes, Residence r^2 = .184

Model: Age, Tribes, Residence, Weekly attendance r^2 = .219

Model: Age, Tribes, Residence, Weekly attendance, Child Living in House r^2 = .247

Figure 6 displays gpd based on attendance at community events, location of residence and whether a child lives in the household. For example, a 65-year-old member of tribe 1 who with a child and resides on the reservation and attends community events or ceremonies at least weekly consumes more fish (14.1 gpd) than a similar individual who does not attend events weekly (33.7 vs. 19.6 gpd). Likewise, this same type of individual

consumes less fish (13 gpd) than an individual who does not live with a child (33.7 gpd vs. 46.7). Finally, this same individual consumes less fish (17.1 gpd) than an individual who lives off the reservation (33.7 vs. 50.8 gpd). The final multivariate linear regression model accounted for 25% of the variability in ln(gpd) ($r^2 = 0.25$). A post-hoc analysis of the multivariate linear regression model on the power of two variables to detect a change in r^2 of .05 after adjustment of four independent variables with a baseline r^2 of 0.16 was 82% ($\beta = 0.82$).



Fish consumption (gpd) was categorized into tertiles and tested against personal characteristics (Table 27). The results were similar to the univariate linear regression analysis of ln(gpd) with the exception of the variable Child living in house, which

became non-significant to the degree where it would not be considered in modeling procedures using significance criteria used in this analysis' modeling procedures ($p < 0.25$).

Table 27. Characteristics of elders by tertiles of fish consumption in gpd (% within tertile)

Characteristic	Tertiles of fish consumption			P-value
	0 - 32.3	32.4 - 64.7	>= 64.8	
Age				0.003 $
Mean (SD)	67 (9)	63 (6.5)	63.8 (5.9)	
Gender - No. (%)				0.13 *
Female	34 (68)	34 (52)	44 (66)	
Male	16 (32)	32 (48)	23 (34)	
Child living in house - No. (%)				0.3 *
No	36 (72)	55 (83)	50 (75)	
Yes	14 (28)	11 (17)	17 (25)	
Residence - No. (%)				<0.001 *
On the reservation	3 (6)	3 (5)	19 (28)	
Off the reservation	47 (94)	63 (95)	48 (72)	
Tribe - No. (%)				<0.001 *
1	28 (56)	16 (24)	16 (24)	
2	15 (30)	13 (20)	9 (13)	
3	2 (4)	12 (18)	2 (3)	
4	5 (10)	25 (38)	40 (60)	
Weekly event/ceremony attendance - No. (%)				0.03 *
No	40 (93)	58 (92)	50 (78)	
Yes	3 (7)	5 (8)	14 (22)	
Catch own fish - No. (%)				0.1 *
No	33 (69)	45 (68)	35 (52)	
Yes	15 (31)	21 (32)	32 (48)	
Regularly prepare meals at home - No. (%)				0.001 *
No	12 (24)	6 (9)	24 (36)	
Yes	38 (76)	60 (91)	43 (64)	
Percent non-commercial fish				0.03 $
Mean (SD)	80 (31)	91 (16)	90 (24)	

* Pearson Chi-square test
$ ANOVA F-test

In addition to considering factors associated with total consumption of all fish, analyses were also performed to identify factors associated the consumption of salmon/steelhead and trout (Appendix II, Tables 1 to 4). Catching own fish was positively associated with fish consumption (ln(gpd)) while being male or living on the reservation were negatively associated.

Consumption of non-fillet fish parts analysis

The frequency of consuming individual fish parts by species was tabulated in Table 20 and consolidated into a dichotomous variable based on whether an individual consumed any non-fillet parts. Univariate statistics were performed to examine differences in personal characteristics according to non-fillet consumer status among elders for salmon/steelhead, resident trout, and whitefish (Appendix II, Tables 5 to 7).

The only significant difference in salmon non-fillet consumption was a higher percentage of friends as a source of fish. Male elders were 9 times more likely to consume trout non-fillet parts than females. A higher percentage of trout non-fillet consumers caught their own fish (41%) than non-consumers (14%). Finally, significantly more individuals living on the reservation consume non-fillet parts than those who do not live on the reservation (94% to 69%).

Fish preparation methods analysis

Associations between frequent cooking methods and personal characteristics were examined among elders. We examined the four most frequent methods of preparation used at least weekly: baking, boiling, canning, and dried preparations (Appendix II, Tables 8 to 11). Elders who caught their own fish were over 2 times more likely to frequently bake fish and 3 times more likely to boil their than those who do not catch

fish. Elders who use canned preparations of fish report obtaining a smaller percentage of fish from non-commercial sources. Elders who report frequent use of dried and canned preparations are more likely to attend community events or ceremonies weekly.

Comparisons of consumption patterns according to elder status

Comparisons of personal characteristics were made according to elder status (Table 28). Elders obtain a smaller percent of fish from ceremonies ($p<0.001$), larger percent from tribal distributions ($p<0.001$), and are more likely to prepare meals at home ($p<0.03$).

Table 28. Comparison of personal characteristics according to elder status (>= 55 years).

Characteristic	Age >= 55 years		P-value	Odds Ratio (95% CI)
	No	*Yes*		
n	*1027*	*184*		
Age (Mean, SD)	34 (10)	62 (7.4)	<0.001	
Grams of fish/day (Mean, SD)	61.5 (79.2)	65.1 (116.8)	0.6	
Source of consumed fish (Mean %, SD)				
Caught by family/self	45 (36)	41 (35)	0.13	
Grocery stores	7.4 (18)	8.8 (20.4)	0.338	
Friends	14 (21.5)	11.8 (22)	0.22	
Ceremonies	11.5 (19)	6.9 (10.7)	<0.001	
Tribal distributions	15.6 (24)	28.2 (31.7)	<0.001	
Non-commercial*	86.6 (26.7)	88 (24.3)	0.5	
Residence on the reservation - No. (%)	911 (89)	159 (86)	0.37	0.81 (0.51,1.29)
Weekly event/ceremony attendance - No. (%)	157 (16)	24 (14)	0.42	0.83 (0.52,1.31)

Catch own fish - No. (%)	519 (50.5)	69 (38)	0.002	0.6 (0.43,0.83)
Regularly prepare meals - No. (%)	709 (69)	142 (77)	0.027	1.51 (1.05,2.19)
Child living in house - No. (%)	452 (44)	41 (22)	<0.001	0.36 (0.25,0.53)

* Cumulation of all sources except grocery stores.

A. Non-fillet fish parts

Non-fillet consumption by fish species were compared according to elder status (Table 29). By univariate comparisons, elders are more likely to consume salmon, trout, sturgeon and whitefish non-fillet parts than non-elders. For salmon, trout, and whitefish non-fillet consumption, elders were less likely to report going to ceremonies or community events weekly, and catch their own fish for salmon (elders 62% vs. 57% for non-elders), but not trout or whitefish (Appendix II, Tables 12 to 14).

Table 29. Consumption of non-fillet fish parts according to elder status (>= 55 years).

Species	Non-Elder No. (%)	Elder No. (%)	P-value	Odds Ratio (95% CI)
Salmon/Steelhead	676 (71)	141 (83)	0.001	2.03 (1.32, 3.11)
Lamprey	460 (93)	100 (80)	<.001	0.32 (0.18, 0.56)
Resident Trout	446 (66)	112 (83)	<.001	2.49 (1.55, 4.01)
Smelt	406 (89)	104 (90)	0.752	1.12 (0.56, 2.23)
Whitefish	114 (55)	47 (78)	0.001	2.92 (1.49, 5.72)
Sturgeon	62 (28)	25 (42)	0.041	1.84 (1.02, 3.33)
Walleye	31 (31)	3 (19)	0.389#	0.51 (0.14, 1.93)
Northern Pike Minnow	10 (34.5)	2 (40)	1#	1.27 (0.18, 8.87)
Sucker	39 (65)	20 (59)	0.552	0.77 (0.32, 1.83)
Shad	4 (18)	0 (0)	1#	-

Fisher's Exact Test

B. Cooking methods

Boiled and smoked preparations used weekly were more frequently reported for elders than non-elders (Table 30). Comparisons of personal characteristics according to elder status were made for frequent pan frying, canned, baked, and boiled preparations (Appendix II, Tables 15-18). Elders obtain a smaller percentage of fish from non-commercial sources than non-elders for pan frying and canned preparations. Elders were two times more likely to attend events or ceremonies than non-elders and were over 80%

less likely to catch their own fish for canned preparations. Elders obtain a higher percentage of fish from tribal distributions for boiled and baked preparations.

Table 30. Comparison of cooking methods used frequently according to elder status (>= 55 years).

Cooking Method	Non-elder	Elder	P-value	Odds Ratio (95% CI)
Pan-fried	165 (22%)	29 (20%)	0.531	0.87 (0.56, 1.35)
Deep-fried	25 (11)	4 (7.5)	0.42	0.64 (.21, 1.92)
Poached in water	39 (26)	13 (32.5)	0.41	1.37 (0.64, 2.92)
Boiled as soup/stew	134 (20)	39 (27.5)	0.039	1.54 (1.02, 2.33)
Baked	310 (33)	64 (38)	0.2	1.25 (0.9, 1.75)
Broiled	85 (24)	21 (23)	0.73	0.9 (0.53, 1.57)
Smoked	70 (11)	25 (22)	0.001	2.29 (1.38, 3.81)
Dried	103 (17)	27 (23)	0.12	1.46 (0.91, 2.36)
Raw	5 (18)	0 (0)	1#	N/A
Roasted/BBQ	65 (9.5)	10 (8.5)	0.72	0.88 (0.44, 1.77)
Canned	177 (25)	33 (22)	0.44	0.85 (0.55, 1.29)

Fisher's Exact Test

3. Children under the age of 5 years

Personal and consumption characteristics

There were 200 children (491 weighted) in the survey, with approximately equal genders (Table 31). Children consume a mean of 1.5 fish meals per week and 26.7 grams of fish per day (Table 32).

Table 31. Personal and consumption characteristics by children under the age of 5 years.

Characteristic	Value
Total n (unweighted/weighted)	200/491
Gender - No. (%)	
Male	235(48)
Female	251 (51)
Missing	5 (1)
Age at first fish meal (Months)	
Mean (SD)	9.7(4)
Median	10
Range	0 - 18
Weight (pounds)	
Mean (SD)	34.2 (14.4)
Median	32
Range	7.0 - 85
Adult enrolled in tribe - no. (%)	498(100)
Residence on reservation - no. (%)	444(90.4)
Tribe - no. (%)	
1	69 (14)
2	48 (10)
3	122 (25)
4	253 (51)
Adult regularly prepare meals in house - no. (%)	363(74)

Table 32. Fish consumption characteristics by children under the age of 5 years.

Characteristic	Value
Catch own fish? - no. (%)	
No	255(52)
Yes	236(48)
Fish meals per week	
Mean (SD)	1.5(1.8)
Median	1
Range	0 - 12
Grams of fish/day	
Mean (SD)	26.7(30.3)
Median	16.2
Range	0 - 162
90th percentile	64.8
95th percentile	81
99th percentile	162
average portion size (0z.)	
Mean (SD)	17(27.8)
Median	4
Range	1.0 - 77.0

The top two most commonly consumed fish species were salmon (81% of all children) and trout (43%) (Table 33). Children most frequently reported consuming salon non-fillet fish parts. The highest percentage of non-fillet consumption among those who consume the fish species was lamprey and smelt.

Table 33. Frequency of children consumption of fish species and non-fillet parts.

Species	Consume Species	Consume non-fillet parts	% of who consume the species
	No. (%)	No. (% of all children)	No. (%)
Salmon/Steelhead	400(81)	161(33)	40.2
Lamprey	105(21)	84(17)	88
Resident Trout	212(43)	96(19.5)	51
Smelt	140(28.5)	98(20)	76
Whitefish	51(10)	12(2.4)	32
Sturgeon	45(9)	4(0.8)	10.4
Walleye	11(2.1)	0(0)	0
N. Pike Minnow	10(2)	5(1)	50
Sucker	5(1)	1(0.2)	21
Shad	12(2.4)	0(0)	0

Fish consumption (gpd) analysis

Child and adult characteristics were analyzed for mean grams of fish/day (Table 34). The only significantly characteristic was adults regularly preparing meals at home (29 vs 18 gpd).

Table 34. Comparison of children mean gpd of fish consumed according to personal characteristics.

Characteristic	Mean gpd	P-value
Gender		0.47*
Male	25.4(29.2)	
Female	27.6(31.6)	
Tribe		0.055§
1	24(30.8)	
2	16(17.6)	
3	29.7(33)	
4	28.2(30.6)	
Child living in house		0.197
No	71.1 (131.5)	
Yes	44.4 (28)	
Residence		0.99*
On reservation	26.7(15.4)	
Off reservation	26.7(31.4)	
Regularly prepare meals in house		<0.001*
No	17.8(16.7)	
Yes	29.8(33.2)	
Weekly event/ceremony attendance:		0.88*
No	65.5 (126.3)	
Yes	61.3 (29.2)	
Catch own fish		0.24*
No	28.3(33)	
Yes	24.9(26.6)	

§ One-way ANOVA

* Independent samples T-test

Personal and consumption characteristics were analyzed by univariate linear regression for possible inclusion into the multivariate model (Table 35). Child's weight, in pounds (lb.) ($p<0.001$) and adults' regularly preparing meals ($p = .04$) met criteria for

potential inclusion. The other directly related personal characteristic, age at first fish meal, was not a significant determinant in the amount of fish the child consumed. We chose to include gender and tribe in the model regardless of univariate significance. After analyzing residual and P-P plots, we natural log-transformed the outcome variable (gpd).

Table 35. Potential determinants of fish consumption [ln(gpd)] in children under the age of 5 years using univariate linear regression.

Determinant	Beta	95% CI	P-value
Age at first fish meal (months)	0.001	(-.006,.008)	0.777
Weight (lb.)	0.016	(.009,.024)	<.001
Gender			
Female	0	-	-
Male	0.028	(-1.8,.23)	0.789
Residence			
Off the reservation	0	-	-
On the reservation	-0.11	(-.45,.23)	0.521
Tribe			
1	-0.392	(-.70, -.08	0.014
2	-0.561	(-.91,-.212)	0.002
3	-0.274	(-.517,-.03)	0.028
4	0	-	-
Adult in household catch fish			
No	0	-	-
Yes	0.015	(-.19,.221)	0.882
Regularly prepare meals			
No	0	-	-
Yes	0.249	(.012,.487)	0.039
Percent fish obtained non-commercially	0.00064	(-.005,.006)	0.806

The child's weight remained positively associated with ln(gpd) in the model (Table 36). For example, a male child from tribe 1 who weighs 10 pounds (lb) consumes 11.6 gpd in contrast to a 20 lb child who consumes 13.5 gpd. The variables in the multivariate model accounted for 7% of the variance in ln(gpd).

Table 36. Determinants of fish consumption [ln(gpd)] in children under the age of 5 years using multivariate linear regression.

Determinant	Beta	95% CI	P-value
Constant	2.52	(2.19,2.85)	<.001
Gender			
Female	0	-	-
Male	-0.035	(-.238,.167)	0.73
Tribe			
1	-0.182	(-.5,.136)	0.26
2	-0.464	(-.81,-.12)	0.008
3	-0.172	(-.42,.07)	0.164
4			
Child's Weight	0.015	(.008,.023)	<.001

** Removed one case based on Cook's Distance measures: Case 366*
Model: gender, tribe r^2 = .032
Model: gender, tribe, weight r^2 = .067
Model: gender, tribe, weight; outlier removed r^2 = .073

When fish consumption (gpd) was categorized into tertiles, there were differences from the univariate linear regression analysis of ln(gpd) including the variables Age at first meal, and Residence, both of which correlated with gpd and would be considered in modeling procedures (Table 37).

Table 37. Characteristics of children under 5 years old by tertiles of fish consumption in gpd (% within tertile).

Characteristic	Tertiles of fish consumption			P-value
	0 - 15.8	15.9-32.3	>= 32.4	
Age at first meal				<0.001 $
Mean (SD)	33 (32)	13 (18)	13 (16)	
Weight (lb)				<0.001 $
Mean (SD)	28 (14)	37 (14)	40 (13)	
Gender - No. (%)				0.08 *
Female	84 (59)	61 (46)	73 (49)	
Male	58 (41)	71 (54)	76 (51)	
Residence - No. (%)				0.03 *
On the reservation	5 (3)	14 (11)	18 (12)	
Off the reservation	137 (97)	118 (89)	135 (88)	
Tribe - No. (%)				<0.001 *
1	21 (15)	17 (13)	16 (10)	
2	25 (17)	13 (10)	7 (5)	
3	41 (29)	22 (16)	35 (23)	
4	56 (39)	81 (61)	96 (62)	
Adult catch own fish - No. (%)				0.27 *
No	82 (58)	65 (49)	87 (57)	
Yes	60 (42)	68 (51)	66 (43)	
Regularly prepare meals at home - No. (%)				0.05 *
No	47 (33)	29 (22)	34 (22)	
Yes	96 (67)	104 (78)	119 (78)	
Percent non-commercial fish				0.8 $
Mean (SD)	92 (18)	91 (23)	93 (18)	

* Pearson Chi-square test
$ ANOVA F-test

Non-fillet fish part analysis

We examined personal characteristics according to whether children consumed salmon and trout non-fillet parts (Appendix III, Tables 1 and 2). Children who consumed

salmon non-fillet parts weighed significantly more (38.8 lbs vs. 35.7 lbs.) and lived in a household where a significantly larger percentage of fish came from non-commercial sources (94.5% vs. 89%). Children who consumed trout non-fillet parts were three times more likely to be male and live in households that obtain a larger percentage of fish from friends (19% vs. 11%).

4. Dietary recall analysis

In the original study, 126 to 133 adults were interviewed from each tribe.[6] The median age of respondents was 36 years. The majority of those surveyed (59%) were 18 to 39 years old. Thirty-one percent were between the ages of 40 to 59 years, and 10% were 60 years of age or older. The majority of the sample, 58%, were female. These subjects provided recall of all foods eaten during the previous 24-hour period.

The mean daily intake of nutrients from adult respondents is summarized in Table 38. Total calorie intake and its major components are presented for men and women in Figures 7 & 8. There were no significant differences among tribes for carbohydrates, protein or fat. However, differences between men and women were significant ($p<0.001$).

Table 38. Mean intakes of selected nutrients of the four Columbia River Basin tribes.

Nutrient	Mean	SD
Energy (kcal)	1690.0	744.4
Carbohydrate (g)	193	105
Energy from Carb (%)	45	13
Protein (g)	77	41
Energy from Protein (%)	18	7
Total Fat (g)	70	37
Energy from fat (%)	36	10
Cholesterol (g)	323	235
Fiber (g)	6.9	2.5
Vitamin C (mg)	26	4
Vitamin E (mg)	5	4
Sodium (mg)	2696	1744
Omega 3 (g)	1.06	1.02
Omega 6 (g)	8.69	7.20

Figure 7. Total calorie intake and its major sources for four Northwest tribes

Male

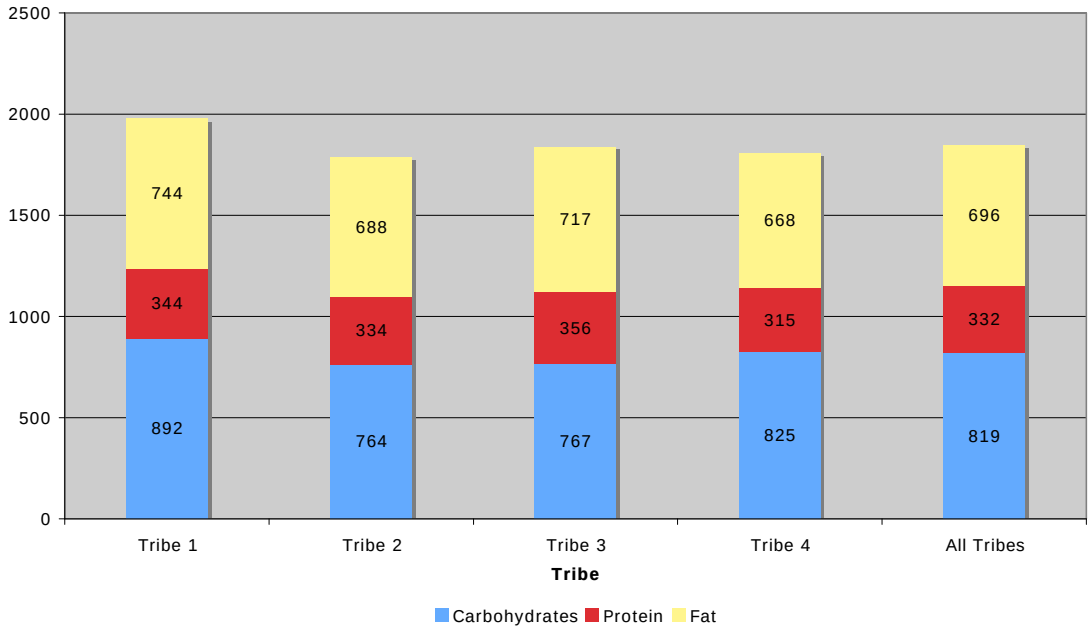
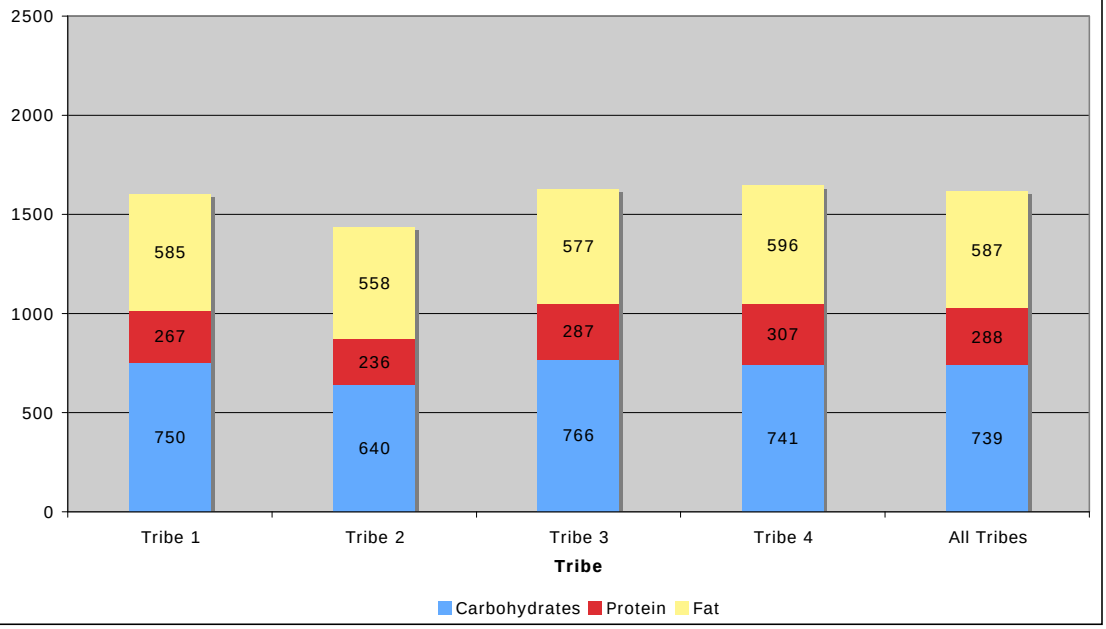


Figure 8. Total calorie intake and its major sources for four Northwest tribes

Female



Comparisons of mean daily nutrient intake were compared across gender while adjusted for tribes and age quartiles. Age was set up in quartiles based on the frequency

distribution of age: 18-26, 27-35, 36-48.7 and ≥ 48.8 years. Due to error of variance, vitamin C and fiber were log transformed for analysis. Data are presented in the anti-log of those mean values. Men consumed more total energy, macronutrients, and sodium (Table 39). Women had a significantly denser diet in energy from carbohydrates and vitamin C.

Table 39. Mean intakes of selected nutrients of the four Columbia River Basin Tribes grouped gender.

	Male (n=229)		Female (n=283)	
Nutrient	**Mean**	**SD**	**Mean**	**SD**
Energy (kcal) *	1823.3	732.2	1591.6	738.5
Carbohydrate (g) *	205	105	184	104
Energy from Carb (%) *	44	14	46	13
Protein (g) *	83	41	72	41
Energy from Protein (%)	19	8	18	7
Total Fat (g) *	78	41	64	33
Energy from fat (%) *	37	11	36	10
Cholesterol (mg) *	347	250	305	222
Fiber (g)	7.2	2.7	6.7	2.5
Vitamin C (mg) *	22	5	27	5
Vitamin E (mg)	5	4	5	4
Sodium (mg) *	2999	2016	2471	1471
Omega 3 (g) *	1.15	1.13	0.99	0.93
Omega 6 (g) *	9.26	7.31	8.28	7.09

* Gender differences significant ($p<.05$) by ANOVA, controlling for age groups and tribe

At the level of tribes, adjusted for age and gender, no significant differences were observed in total caloric intake, protein, total fat, cholesterol, vitamin C, and omega 3- and 6-fatty acids (Table 40). However, differences were observed for intake of carbohydrates, fiber, vitamin E, and sodium. Tribes 1 and 3 both had diets that were higher in fiber than tribe 4. The diet of tribe 3 was significantly higher in vitamin E than the diet of tribe 4. The tribe 1 diet was higher in carbohydrates than that of tribe 2. Tribes 3 and 4 had diets that were higher in energy from protein than tribe 1. Tribes 1 and 3 both had significantly higher diets in sodium than tribes 2 and 4, but were not statistically different between each other.

Table 40. Mean intakes of selected nutrients among four Columbia River Basin tribes.

	Tribe 1 (n=133)		Tribe 2 (n=132)		Tribe 3 (125)		Tribe 4 (n=123)		Total	
Nutrient	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Energy (kcal)	1729	646	1598	789	1707	665	1686	802	1690.0	744.4
Carbohydrate (g)$	202	86	175	105	192	89	194	117	193	105
Energy from Carb (%)	46	11	44	14	44	14	45	14	45	13
Protein (g)	75	36	72	45	80	37	78	44	77	41
Energy from Protein (%)	17	6	18	8	19	8	19	8	18	7
Total Fat (g)	72	34	70	42	72	37	68	38	70	37
Energy from fat (%)	37	9	38	11	37	11	36	11	36	10
Cholesterol (g)	313	220	277	260	344	244	329	232	323	235
Fiber (g)$	7.65	2.18	6.30	2.45	7.85	2.28	6.35	2.80	6.9	2.5
Vitamin C (mg)	27	4	26	4	26	4	26	4	26	4
Vitamin E (mg)$	4	3	4	4	5	5	4	4	5	4
Sodium (mg)$	2910	1447	2359	1421	3302	2387	2429	1530	2696	1744
Omega 3 (g)	1.06	0.89	1.02	0.99	1.04	0.91	1.07	1.11	1.06	1.02
Omega 6 (g)	8.96	6.13	7.78	7.07	9.45	7.59	8.47	7.47	8.69	7.20

$ Tribe differences Sig. $p<.05$ by ANOVA, controlling for age groups and gender

Mean intake of sodium, percent calories from saturated fat, and cholesterol, each known to influence the risk of developing cardiovascular disease were examined by tribe and gender. Overall, males for each tribe consumed more than the recommended intake

for each category. When tribes are combined, both genders consumed more than the recommended intake for each category although females were close to recommended intake for sodium and cholesterol. Sodium intake was highest in Tribe 3, and for both genders (Figure 9). Total percent of energy from saturated fat exceeded recommended levels in each tribe (Figure 10).[45] Males in tribe 3 had diets with the most cholesterol, and in tribe 4, women had higher cholesterol intake than males (Figure 11).

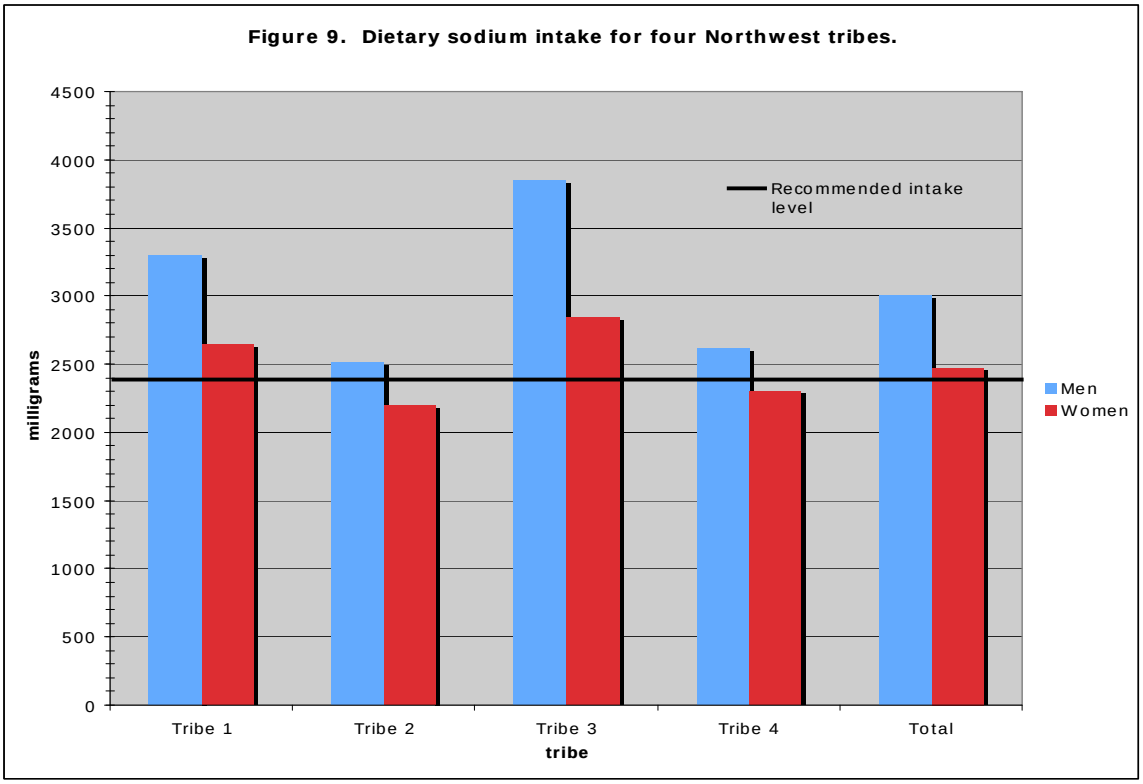


Figure 10. Saturated fat intake as percent of total calories for four Northwest tribes.

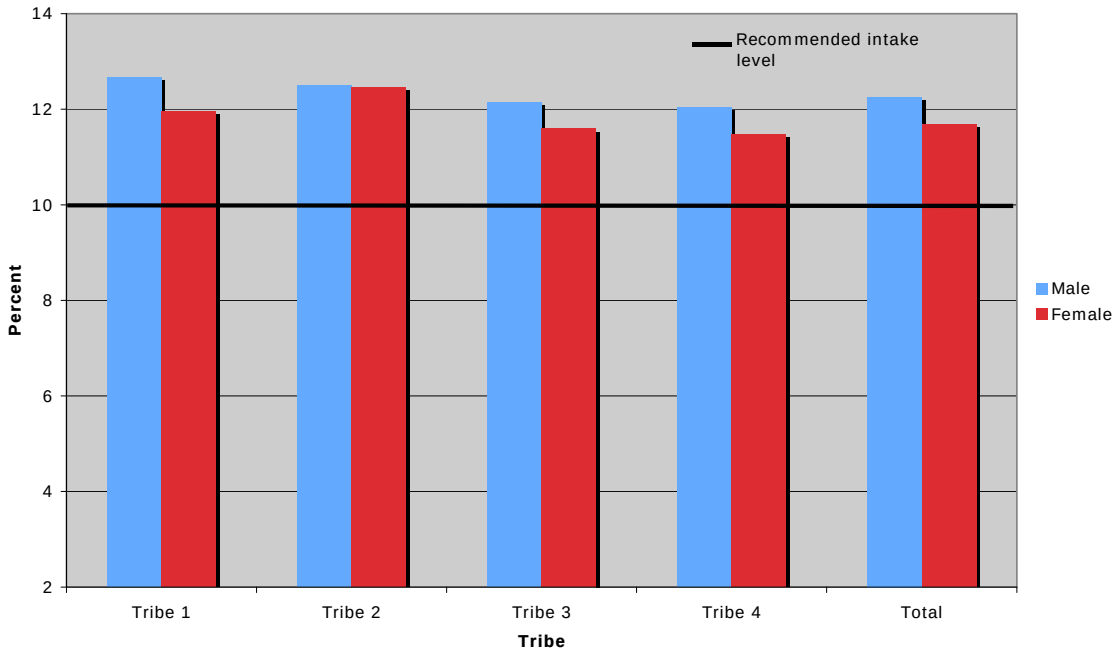
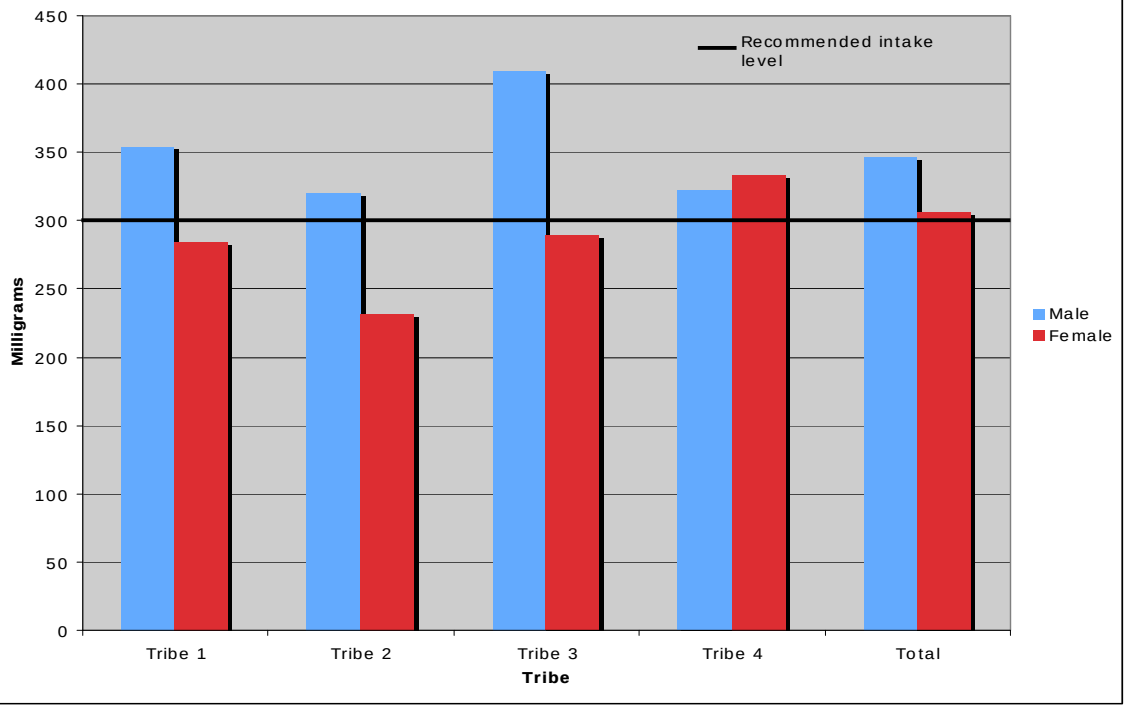


Figure 11. Dietary cholestrol intake for four Northwest tribes.



Discussion

A. Main findings

The technical report created by CRITFC in 1994 outlined consumption patterns for four tribal groups of the Columbia River Basin.[6] Our secondary analysis builds upon existing knowledge to provide specific descriptions of the fish consumption patterns of women who have recently given birth, elders (55 years and older) and children, including factors associated with consumption of fish, characteristics associated with consuming non-fillet parts, and preparing fish. Our dietary recall analysis provides information on the nutritional intake of Northwest tribes previously undocumented in scientific literature.

1. Women who have recently given birth

Fish consumption

The mean amount of fish consumption (gpd) was higher than the all fish consumers (69.3 vs. 63.2 gpd). Furthermore, the highest amount of fish consumption per day among women who recently gave birth is comparable to all participants (99^{th} percentiles, 340 to 389 gpd).[6]

In examining factors associated with fish consumption, univariate analysis showed a much higher consumption in women who recently gave birth and had breast fed their most recent child (92 vs. 51 gpd, Table 10) and was supported by the multivariate linear regression model as well. In the multivariable linear regression model for all women, having given birth in the past 5 years in addition to having breast fed their most recent child was positively associated with fish consumption. These results are

significant since studies in other tribal populations in the U.S. have documented contaminants in fetal cord blood at birth, and in breast milk.[36, 46] As mentioned previously, chemicals such as PCBs are associated with neurodevelopmental delays.[16, 34, 47, 48] In our analysis, we do not know whether fish consumption was modified during the months of pregnancy or during breastfeeding. Almost half of this group breast fed their most recent child and there is high likelihood that lipid soluble chemicals originating from fish tissues were passed through breast milk to children. Given this potential among women who recently gave birth to expose themselves and their child to higher amounts of contaminants and increase the likelihood of experiencing adverse health effects, continued efforts should be taken to educate women during pregnancy and nursing periods on the importance of safe methods of fish consumption. In doing so, women and children will benefit from the nutritional value of fish while limiting the exposure and associated effects of contaminants.

Fish parts

Women who recently gave birth consumed all fish species and at least half of those who eat a particular species also consume parts of the fish body in addition to the fillet. The most commonly reported non-fillet part reported was skin, especially for salmon, trout and whitefish. The original CRITFC technical report also showed that skin was the most consumed non-fillet fish part among adults and children.

It is an interesting finding that those who recently gave birth are less likely to consume non-fillet parts for the most commonly consumed species (salmon and trout) but more likely for whitefish and sucker. Specifically, they consumed less skin, head and eggs for salmon and trout (in addition to bones), but consumed more skin of sturgeon and

sucker (Table 7). Sturgeon and sucker spend their life cycle primarily in freshwater where they able to accumulate higher concentrations of chemical contaminants. Consumption of skin, internal organs, and heads increases the potential for exposure to contaminants that tend to accumulate in fatty tissues, such as organochlorines (DDT and its breakdown products, PCBs, and dioxins).

Whitefish have been shown to contain high concentrations of contaminants in the Columbia River Basin.[34] Our analysis showed that women who consumed whitefish and salmon non-fillet parts were more likely to breastfeed their most recent child. Given that this occurs 5-fold for whitefish non-fillet consumers, this presents a high level of potential exposure to mothers and their unborn babies and infants.

Cooking methods

The cooking methods frequently employed by those who recently gave birth were similar to the CRITFC technical report. If fat is allowed to drip off, baking is an efficient method of removing tissue contaminants. Baking was reported most frequently, and was associated with higher amounts of fish consumption than those who do not frequently bake.[49-52] However, higher fish consumption was also noted for those who frequently boil and pan fry fish, both tied as the second most frequent methods of preparing fish. Pan frying may retain fat during the cooking process, but boiling may cause the separation of fat from the fish meat.[49-52]

Comparisons according to recent childbirth status showed that those who recently gave birth were more likely to bake in addition to other less recommended methods such as pan and deep frying, boiling and poaching. The important products in fish for fetal and infant neurodevelopment (n-3 fatty acids) are fortunately not modified or removed

when deep or pan fried, but do introduce more of the frying medium (oils) into the fish.[53] Unfortunately, these types of cooking methods do little to remove contaminants present in tissues. However, one study of Japanese fish cooking methods showed that any type of cooking reduced PCBs in mackerel fish.[54] In the Columbia River Basin tribes, it is not known how traditional cooking methods contribute to changes in contaminant levels in fish foods.

While there is no evidence that some cooking methods retain n-3 fatty acid concentrations, other methods add unhealthy fats to the tissues and reduce the nutritional value of the meal. Additionally, it is unknown how local cooking methods affect fish tissue contaminant concentrations. Despite this gap in knowledge, we have identified frequently used cooking methods that introduce unhealthy fats into tissues and to our knowledge, may not effectively remove contaminants. This provides an opportunity to promote cooking methods that improve diets and maximize contaminant removal.

2. Elders

Fish consumption

Much like women who recently gave birth, levels of fish consumption were comparable to those previously reported for all adult respondents in the CRITFC survey (65 vs. 63 gpd), with a higher 99th percentile of consumption (486 to 389 gpd). Frequent attendance at community events or ceremonies was positively associated with fish consumption. For the four Columbia River Basin tribes, some events and ceremonies occur at the beginning and end of fish harvesting seasons and other celebrations of culture and life often involve the consumption of a variety of species at different points through the year.[55] For some individuals, these harvesting seasons may contribute to

the bulk of fish consumption throughout the year. The CRITFC technical report noted that there are over 40 community events and feasts and often involve fish consumption.[6] Elders in most tribes, considered to have the most knowledge of their culture and history, are an important presence at ceremonies. It is therefore not surprising that their frequent attendance at ceremonies is associated with higher amounts of fish consumption. Elders, perhaps having less opportunity to regularly fish for their own food, may instead rely on younger family or friends and community events for fish. This data suggest that interventions designed to educate individuals about safe fish consumption must not only include the elders, but perhaps the larger community that conduct community festivals, events and ceremonies.

Interestingly, living on the reservation was negatively associated with fish consumption. Many of the traditional locations for fish harvesting are located off the reservation near the larger waterways of the Columbia River, and those who live off the reservation may have closer access, and therefore more opportunity for harvesting and consumption of fish. There was a small sample size of individuals who lived off the reservation in the survey. Further exploration among these individuals, who may live in places such as Celilo Falls, OR, which abuts the Columbia River and is not on a reservation, may reveal that they may not only consume more fish, but also a wider variety of fish and fish parts.

Finally, having a child in the household was negatively associated with fish consumption. This association may be the result of a larger family sharing fish and subsequently each individual having smaller and less frequent meals, especially in years that salmon runs along the Columbia River Basin have been small.

Fish parts

Elders commonly consumed fish parts in addition to the fillets for salmon and trout, and almost 80% for whitefish. Elders were more likely to consume eggs of salmon, trout, whitefish, sturgeon and sucker species than non-elders. It is notable that the EPA fish tissue contaminant study found elevated levels of dioxins in fish eggs collected from female fish sampled in the Columbia River Basin.[34] Elders were approximately twice as likely to consume non-fillet parts of trout, whitefish and sturgeon, the last two of which have been shown to have higher concentrations of PCBs and dioxins in the Columbia River Basin.[34] Elders are consuming a wider variety of fish parts, some of which belong to species that have some of the highest concentrations of contaminants and therefore are potentially being exposed to higher amounts of contaminants.

Cooking methods

It is encouraging to find that baking is the predominant method of preparing fish among elders. The benefits of baking fish go beyond efficient reduction of chemical contaminants. Regular consumption of baked or broiled fish is associated with better cardiac parameters (systemic vascular resistance, blood pressure, cardiac stroke volume) and lower ischemic heart disease-related death (IHD), while conversely, regular consumption of fried fish was associated with worse cardiac parameters and IHD.[56, 57] These findings point out consuming fish on a regular basis and preparing it in a healthy manner can provide cardio-protective benefits and becomes especially important for tribes that have a high prevalence risk factors for cardiovascular disease.

3. Children

Fish consumption and fish parts

The mean level of fish consumption per day among children under the age of 5 years, reported by CRITFC's technical report, was 19.6 gpd, which is lower than we calculated in this analysis (26.7 gpd). In the analysis, we found that there were a variety of responses to the average size of fish meals that may not have been coded correctly or at all in the original analysis. The 99th percentile in fish consumption was 162 gpd. The EPA stated that the general child population (age less than 14 years) consume approximately 2.8 grams of fish/day with the 99th percentile consuming 78 grams/day.[58] These data show that children among the Northwest Columbia River Basin consume more fish than the national average.

We determined that increases in age were positively associated with fish consumption. However, this may solely be a function of growth, as larger children are able to consume higher amounts of fish. We were unable to investigate many factors that may be associated with fish consumption in children since there are few questions relating to personal characteristics of children in the survey.

We found at least half of children who consume a particular species only consume the fillet. As noted in the original report, the most commonly consumed non-fillet part was skin. Consumption of non-fillet parts was higher for trout than salmon. Additionally, male children consumed more trout non-fillet parts than females.

4. Dietary recall

In 1988, the American Heart Association published guidelines for reducing risk to cardiovascular disease that include total fat intake of less than 30% of total calories, saturated fat intake equaling less than 10% of total calories, cholesterol intake less than 300 mg/day, sodium intake less than 3 grams/day, and fiber intake of at

least 20 g/day.[59] Using these guidelines and Healthy People 2000 for sodium intake (2400 mg/day), we examined the proportion of individuals who met these recommendations by tribe, and for all males (Figure 12) and females (Figure 13) combined across the 4 tribes.[45, 59] Overall, less than 10% of both genders obtain recommended amounts of fiber. Higher proportions of females than males meet recommendations for cholesterol and sodium intake.

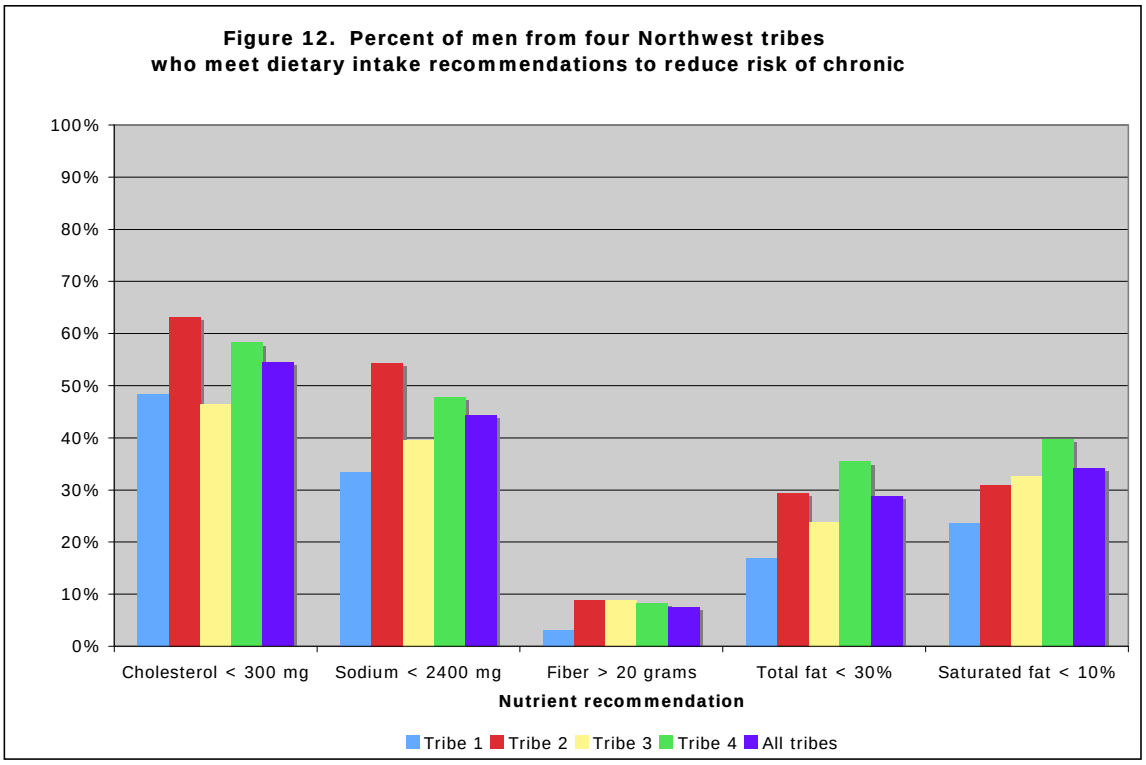
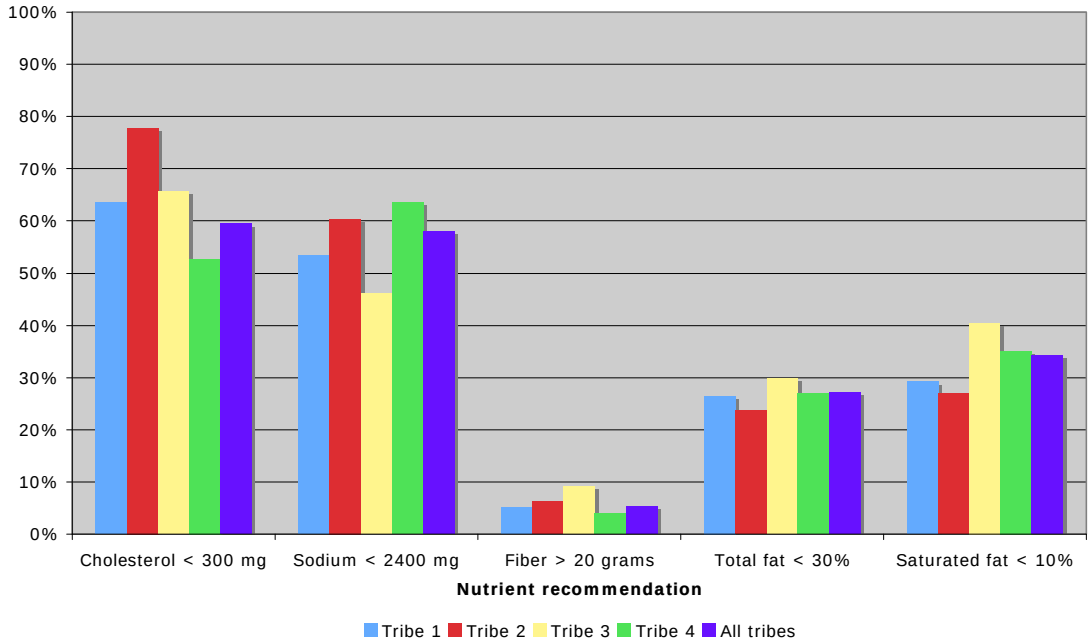


Figure 13. Percent of women from four Northwest tribes who meet dietary intake recommendations to reduce risk of chronic disease.



We found significant differences in some mean nutrient intakes across gender and tribes. In most cases men had higher mean levels of nutrients. Mean levels of nutrients thought to be important for modifying chronic diseases such as hypertension, diabetes, and cardiovascular disease were above the recommended levels. Additionally, very few individuals met recommendations for reducing this risk, particularly fiber and percent energy from saturated and total fat.

There were notable differences in mean dietary intake when Northwest tribes were qualitatively compared to the general population using NHANES III data obtained during the same time period as the CRITFC survey and other Native American diets (Table 41).[23, 25] Among men, Northwest tribes consume less total energy than the Pima tribe but are comparable to Plains tribes of Oklahoma, North Dakota and South Dakota and the U.S. population. Additionally, Pima men and women have diets higher in cholesterol than the Columbia River Basin tribes.

Table 41. Mean intakes of selected nutrients among different tribal groups and from data from NHANES III stratified by gender.

Men

	Tribe 1		Tribe 2		Tribe 3		Tribe 4		PIMA +		AZ *		OK *		ND/SD *		NHANES III *	
Nutrient	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Energy (kcal)	1949	743	1776	855	1819	743	1783	683	2234	1157	1958	987	1931	1015	1873	1183	2254	1143
Carbohydrate (g)	223	97	191	123	192	97	206	105	276	132	235	123	210	111	209	127	265	163
Energy from Carb (%)	45	10	43	15	40	15	45	14	49	10	49	11	47	10	45	11	48	16
Protein (g)	86	45	84	50	89	38	79	37	84	41	73	34	68	36	74	47	88	44
Energy from Protein (	17	5	19	9	21	9	18	8	15	3	16	4	16	3	16	3	16	4
Total Fat (g)	83	39	76	46	81	40	74	41	89	51	74	45	76	54	78	57	88	64
Energy from fat (%)	38	9	37	12	39	12	36	12	34	8	34	10	37	8	37	10	34	20
Cholesterol (g)	354	229	320	278	409	257	322	244	517	380	447	331	306	202	383	232	313	326
Fiber (g)	7.73	2.28	6.64	2.44	7.29	2.37	7.00	3.01	29.2	19.8	20	15	15	9	14	9	18	12
Vitamin C (mg)	29	4	17	4	23	5	20	6	112	162	102	126	109	102	84	70	110	163
Vitamin E (mg)	5	3	5	5	6	5	4	3	-	-	6.9	7.2	8.3	9.7	7	7.7	10.3	11.9
Sodium (mg)	3298	1520	2507	1617	3842	2905	2610	1633	3315	1785	2819	1536	3085	1909	3252	2232	3551	2009
Omega 3 (g)	1.22	0.95	1.19	1.16	1.22	1.02	1.08	1.24	-	-	-	-	-	-	-	-	-	-
Omega 6 (g)	10.62	7.44	8.58	7.84	11.26	8.74	7.92	5.99	-	-	-	-	-	-	-	-	-	-

Women

	Tribe 1		Tribe 2		Tribe 3		Tribe 4		PIMA +		AZ *		OK *		ND/SD *		NHANES III *	
Nutrient	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Energy (kcal)	1578	522	1406	666	1611	578	1622	867	1813	764.6	1574	564	1431	718	1651	881	1609	809
Carbohydrate (g)	188	74	158	81	192	81	185	124	216	86.8	192	77	175	96	202	103	201	108
Energy from Carb (%)	47	11	46	12	47	12	45	13	49	12.2	50	11	49	11	49	9	51	15
Protein (g)	67	27	59	34	72	35	77	48	70	34.8	62	26	55	26	62	33	64	39
Energy from Protein (	17	7	17	6	18	7	19	8	16	3.5	16	4	16	3	16	3	16	4
Total Fat (g)	65	28	62	36	64	33	64	35	75	40	63	29	59	37	66	41	61	39
Energy from fat (%)	36	9	38	9	35	10	36	10	36	8.68	35	9	39	6	36	7	33	15
Cholesterol (mg)	284	210	232	233	289	219	333	223	430	347.6	404	344	233	173	276	170	211	212
Fiber (g)	7.59	2.11	5.95	2.46	8.35	2.20	5.93	2.64	23.2	13.9	17	11	12	7	14	8	14	8
Vitamin C (mg)	26	4	20	4	30	5	28	5	97	113	108	124	112	134	100	79	98	131
Vitamin E (mg)	4	4	4	3	5	5	5	4	-	-	8.7	23.7	8	10.1	6.9	6.2	7.8	11.6
Sodium (mg)	2645	1336	2199	1167	2843	1716	2307	1447	2787	1338	2530	1234	2859	1808	2886	1572	2623	1902
Omega 3 (g)	0.95	0.83	0.84	0.74	0.89	0.79	1.06	1.03	-	-	-	-	-	-	-	-	-	-
Omega 6 (g)	7.83	4.74	6.93	6.11	7.91	6.08	8.83	8.29	-	-	-	-	-	-	-	-	-	-

+ Data obtained from Smith et al
* Data published by Zephier et al

Both genders from Northwest tribes consume diets lower in fiber and vitamin C than either the Pima or Plains area tribes. Considering dietary factors associated with cardiovascular mortality, Plains tribes from Indian Health Service (IHS) areas like Aberdeen had much higher rates than Northwest tribes from the Portland area (289 to 158 per 100,000 population).[60] The Portland Area was third in gastrointestinal disease mortality during 1990 and was almost twice that of the U.S. population (2.2 to 1.3 per 100,000 population). Due to problems with death certificate misclassification, these data from IHS may under-represent the true rate and account for the discrepancy in rates despite similar or worse diets among Portland Area tribes. This survey data suggests that the 1991 diet placed tribal members at risk for developing cardiovascular and gastrointestinal disease. Certainly risk factors other than diet were also prevalent among Northwest tribes that may account for differing mortality rates.

Barriers to consumption of fruits and vegetables among Plains tribes included cost, quality and availability.[61] Additionally, there have been documentation of groups of people adapting to Western diets which ultimately leads to decreasing consumption of fruits and vegetables and more of convenience foods low in fiber and high in fat.[22] What is appealing is the fact that adhering to traditional diets has been shown to be associated with healthier metabolic profiles for diabetes and cardiovascular disease.[62, 63] Dietary modification among Northwest tribes that includes increasing fiber, fruit and vegetable intake, reducing total and saturated fat and sodium intake as well as adhering to traditional diets will help tribes prevent and manage diabetes, hypertension and cardiovascular diseases.

Significance

Fish consumption patterns among women, elders and to some extent, children among the Columbia River Basin tribes had previously not been examined from either the CRITFC fish consumption survey or any other study of which we are aware. These data fills a gap in knowledge of subgroup fish consumption patterns, most of which provide a very nutritious source of protein, essential fatty acids for fetal and child development, and modification of cardiovascular, neurologic and other chronic diseases.

However, we have also found that there are consumption patterns that increase exposure to chemical contaminants found in the Columbia River Basin. Studies have shown fish consumption is positively associated with serum PCB levels in other Native American populations.[4]

Steps should be taken to enhance awareness of preparation and cooking methods that reduce and minimize exposure and the health risks associated with contaminants such as PCBs. This analysis provides an opportunity to tailor interventions and policies towards these groups to reinforce the benefits of consuming fish species that contain lower concentrations of contaminants, avoiding all fish parts except the fillet, and cooking fish in a manner that effectively minimizes the chemicals found in fat.

In addition to fish consumption patterns, this analysis also provides information on dietary intake of a group of Native American tribes that has not been previously described. We have found that very few individuals are following diets that will help prevent or modify chronic diseases. Opportunities are abound for educating the tribes on the importance of healthy fish consumption in a diet that should include foods that provide adequate fiber and other antioxidant vitamins.

C. Public health implications

The risk of developing cancer as a result of cumulative exposure to contaminants, such as dioxins, PCBs, and furans, have been estimated (7 in 10,000 to 2 in 100) depending on the fish species, and the location along the river where it was caught.[34] The lowest risks were for salmon, rainbow trout and smelt, and the highest for whitefish and sturgeon. Despite this spectrum of risk, it is notable that the most popular and culturally significant species of fish consumed, salmon and trout, are also the least contaminated species. Given the high prevalence of diabetes, hypertension, and cardiovascular disease, it is safe to assume that the benefits of consuming fish outweigh the currently estimated cancer risks. However public health efforts should be directed to enhance awareness of pollutants present in fish and knowledge of how to safely choose and prepare fish. Our analysis identified factors that may be applied to promote healthy diets that include fish and reduce exposure to contaminants.

Opportunities exist to teach pregnant women the health benefits of breast feeding while incorporating messages on simple ways to continue to eat fish and reduce exposures to toxins for themselves and their nursing babies. Among elders, interventions should be designed to inform the safest methods of preparing and cooking fish and that their continued consumption will contribute to a more healthy life. These interventions should take place at community events such as pow wows and festivals where elders are associated with consuming higher amounts of fish. Because children also consume fish, culturally appropriate in-school demonstrations of healthy preparation and cooking methods may help create a knowledgebase for the children to build upon in their future.

Dietary factors are thought to play a role in the risk of developing cardiovascular disease. Health professionals within IHS and tribal health programs must continue to advocate for consuming recommended diets in the prevention of chronic diseases in addition to stressing the importance and unique benefits of traditional diets that include fish.

D. Limitations

This secondary analysis examined fish consumption habits in three groups of individuals considered to be most susceptible to adverse effects of exposure to chemical contaminants. The sample sizes selected for the original survey design did not consider subgroup analysis, and were intended to determine overall fish consumption patterns in all 500 adults. Therefore, small numbers were encountered for women who recently gave birth and elders. Despite this, there appeared to be adequate power in the linear regression models to identify meaningful associations between personal characteristics and fish consumption in these groups.

This survey was conducted on a large and apparently representative sample of tribal members from the four Columbia River Basin tribes. The 1994 CRITFC report describes the multiple attempts to contact and interview adults who where randomly selected from IHS clinic patient lists. A response rate of 70% was achieved. One measure of representativeness is provided through the comparison of the age distribution of adult respondents at Warm Springs to the 1990 data from the U.S. Census.[64] The Warm Springs reservation is the only geographically distinct population among the four tribes in the Census. Adults over 55 years of age make up approximately ten percent of participants in both the CRITFC and 1990 Census.

The dietary recalls represents only one day of food consumption and may not be an accurate representation of an individuals' long-term diet. Other methods, such as food frequency questionnaires may provide a better insight into overall diet. Despite this limitation, these data represent the only known dietary record of Northwest tribes with an as large sample size and allows comparison of diets to other tribes and the general U.S. population that utilized 24-hour dietary recalls during the same time period.

The primary intent of the survey and original analysis was to document the extent of fish consumption among adult tribal members. It is possible that individuals who were aware of the intent of the survey may have been more likely to over-report the frequency and the size of fish portions consumed. Over-estimation of number of fish meals and portion size, as a product term, could result in an upward bias. Similarly for the dietary recall interview method, it has been shown that those who consume very little food tend to overestimate the amounts of foods consumed.[44] The size of this bias should not be judged using the 24-hour recall data. Few individuals reported consuming fish during the 24-hours prior to the interview, which is not surprising given the spring-summer-fall availability of fish, and the fact that the survey was conducted during the winter months. The fish consumption questions requested information on amounts of fish consumed across the year.

We did not adjust the linear regression model for women who recently gave birth to account for potential changes in caloric intake, and thus fish consumption, associated with pregnancy or breast feeding. It is plausible that women who breast fed their most recent child had a relative increase in daily fish consumption concomitant with increases in total calories. Women who are pregnant or breastfeed are advised to consume more

calories and have been reported to consume increased levels of a variety of food groups.[65, 66] Total food frequency questions were not asked of respondents, and therefore it is not possible to adjust multivariate models for total caloric intake. (Although the survey included the dietary recall that could be used to adjust for caloric intake in women, this type of data recorded for one day out of the year is not representative of an individuals' overall diet.)

E. Future Studies

There data are reflective of fish and food consumption from the 1990's. Because this survey was carefully conducted on a large sample of adults, with careful attention to quality control, it provides a reliable point of reference for fish consumption and to a limited extent, diet, at that time. New surveys may demonstrate whether changes have occurred in the setting of increasing reliance on convenience food and/or tribal health initiatives that have highlighted the nutritional value of fish and practices to reduce the ingestion of contaminants in fish foods. Further, in 1991, the salmon runs were at historic lows. Salmon runs during 2000-2004 were abundant, and harvests by tribal commercial fisherman were high. It is reasonable to expect that fish consumption increased during this period of abundance, but this change may have gone undocumented. Diet surveys conducted over several years are needed to describe year-to-year changes in the role of fish in the tribal diet.

It is known that fish species are uniquely prepared and cooked by the tribal members.[55] Determining unique cooking methods often employed for each species will provide a better insight on how individuals are exposed to higher or lower amounts of contaminants. While studies in other countries have shown that local popular cooking

methods affect contaminant concentrations in fish and meat, it is unknown how local preparation methods affect tissue concentrations.[54, 67] Measuring chemical contaminants in fish prepared by unique tribal cooking methods will allow us to determine the extent of potential contaminant exposure.

It will be important to consider using a different dietary assessment tool, such as a food frequency questionnaire that asks individuals to estimate their consumption of food items over a longer period of time than one day and provides a more accurate picture of an individuals' total diet.[44] Another alternative to consider is conducting dietary recalls at multiple periods over the course of a year to obtain a better estimate of an overall diet.

The associations in univariate and multivariate analyses of fish consumption represented as a continuous variable of grams per day generally agreed with univariate ordinal analyses. This agreement increased our confidence in the use of gpd as a continuous independent variable. However, further multivariable modeling, using logistic regression and ordinal regression methods should be performed.

F. Conclusions

This secondary analysis describes for the first time personal characteristics associated with fish consumption practices among women who recently gave birth, elders, provides more detailed information on children, and documents the diets of Northwest tribes. This information will be useful to tribal leaders to better assess the policy and health-related implications of regulatory decisions related to water quality standards and environmental cleanup as specifically related to the most susceptible tribal groups. The tribes will be able to compare their dietary patterns to other Native

American populations and thus put into context the importance of a healthy balanced diet and regular fish consumption.

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Appendix I – Analyses for Women Who Have Given Birth in Past 5 Years

Table I-1. Potential determinants of salmon/steelhead ln(gpd) among women who have given birth in past 5 years using univariate linear regression.

Determinant	Beta	95% CI	P-value
Age	0.0066	(.001,.012)	0.016
Tribe			
1	-0.517	(-.72,-.313)	0
2	-0.122	(-.393,.149)	0.377
3	-0.134	(-.35,.078)	0.215
4	0	-	-
Residence			
Off the reservation	0	-	-
On the reservation	0.575	(.311,.84)	<.001
Weekly event/ceremony attendance			
No	0	-	-
Yes	0.322	(.13,.52)	0.001
Catch own fish			
No	0	-	-
Yes	0.333	(.168,.498)	<.001
Regularly prepare meals			
No	0	-	-
Yes	0.476	(.26,.69)	<.001
Percent fish obtained non-commercially	0.0012	(-.002,.004)	0.471
Breast fed most recent child			
No	0	-	-
Yes	0.272	(.11,.43)	0.001

Table I-2. Determinants of Salmon/Steelhead Ln(gpd) among women who have given birth in past 5 years using multivariable linear regression.

Determinant	Beta	95% CI	P-value
Constant	2.49	(2.22, 2.76)	<.001
Age	0.004	(-.002,.01)	0.175
Tribe			
1	-0.561	(-.77,-.36)	0
2	-0.184	(-.45,.08)	0.172
3	-0.2	(-.41,.01)	0.065
4	0	-	-
Catch own fish			
No	0	-	-
Yes	0.322	(.15,.49)	<.001
Breast fed most recent child			
No	0	-	-
Yes	0.358	(.20,.51)	<.001

Model:Tribes, Age (years) $r^2 = .038$

Model: Tribes, Age (years), Last child breast fed $r^2 = .08$

Model: Tribes, Age (years), Last child breast fed, catch your own fish $r^2 = .105$

Table I-3. Potential determinants of resident trout ln(gpd) among women who gave birth in past 5 years using univariate linear regression.

Determinant	Beta	95% CI	P-value
Age	-0.06	(-.09,-.02	0.001
Tribe			
1	-0.599	(-1.16,-.03)	0.038
2	-1.081	(-1.82,-.35)	0.004
3	0.776	(-1.82,-.35)	0.004
4	0	-	-
Residence			
Off the reservation	0	-	-
On the reservation	0.401	(-.46,1.26)	0.36
Weekly event/ceremony attendance			
No	0	-	-
Yes	0.833	(.24,1.43)	0.007
Catch own fish			
No	0	-	-
Yes	0.09	(-.37,.54)	0.704
Regularly prepare meals			
No	0	-	-
Yes	-0.83	(-1.69,.04)	0.062
Percent fish obtained non-commercially	0.013	(.003,.023)	0.013
Breast fed most recent child			
No	0	-	-
Yes	0.079	(-.37,.53)	0.73

Table I-4. Determinants of resident trout ln(gpd) among women who have given birth in past 5 years using multivariable linear regression.

Determinant	Beta	95% CI	P-value
Constant	1.785	(.51,3.06)	0.007
Age	-0.05	(-.083,-.02)	0.002
Tribe			
1	-0.04705	(-.59,.50)	0.865
2	-1.529	(-2.25,-.81)	0
3	0.639	(.145,1.13)	0.012
4	0	-	-
Percent fish obtained non-commercially	0.014	(.005,.023)	0.003

Model:Tribes, Age (years) $r^2 = .331$

Model: Tribes, Age (years),Percent non-commercial source $r^2 = .388$

Table I-5. Comparison of personal and consumption characteristics according to consumption of non-fillet salmon/steelhead parts among women gave birth within 5 years.

Characteristic	Consume any non-fillet parts?		P-value	Odds Ratio
	No	*Yes*		(95% CI)
Weighted n	*74*	*115*	-	
Age (mean, se)	26.4 (.69)	29 (.65)	0.008	
Fish meals/week	1.4 (.11)	2.5 (.18)	<.001	
Grams per day	43.3 (4.4)	89 (7.5)	<.001	
Source of consumed fish (Mean %, SD)				
Caught by family/self	57.5% (4.1)	43.1% (3.5)	0.009	
Grocery stores	12.2% (3.1)	22.6% (2.4)	0.261	
Friends	7.5% (1.7)	22.6% (2.5)	<.001	
Ceremonies	10.2% (2)	8.6% (1.3)	0.51	
Tribal distributions	11.2% (2)	16.5% (2.2)	0.08	
Non-commercial*	86.4% (3.2)	90.8% (1.7)	0.238	
Residence on the reservation - No. (%)	68 (91.9)	110 (96.5)	.195$	
Consume Salmon/Steelhead fillet - No. (%)	74 (100)	108 (93.9)	0.044$	N/A
Tribe[#]				
1	14 (18.9)	9 (8)	0.023	0.36 (.15,.89)
2	8 (11)	7 (6)	0.241	0.54 (.19,1.54)
3	12 (16)	24 (21)	0.427	1.36 (.63,2.93)
4	40 (54)	76 (66)	0.097	1.66 (.91,3.01)
Weekly event/ceremony attendance - No. (%)	10 (15)	15 (13)	0.722	
Catch own fish - No. (%)	21 (28)	36 (31)	0.669	
Regularly prepare meals - No. (%)	65 (88)	96 (83.5)	0.41	
Breastfeed most recent child - No. (%)	20(27)	63(55)	<.001	3.27(1.74,6.15)

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

$ Fisher's Exact Test

Table I-6. Comparison of personal and consumption characteristics according to consumption of non-fillet resident trout parts among women who gave birth within 5 years.

Characteristic	Consume any non-fillet parts?		P-value	Odds Ratio
	No	*Yes*		(95% CI)
Weighted n	*48*	*65*	-	
Age (mean, se)	27 (.73)	30.8 (.98)	0.002	
Fish meals/week	1.7 (.13)	3 (.3)	<.001	
Grams per day	56.4 (4.7)	116.7 (12.1)	<.001	
Source of consumed fish (Mean %, SD)				
Caught by family/self	48.7% (5.7)	48% (4.5)	0.926	
Grocery stores	11.7% (3.6)	6% (2)	0.166	
Friends	8.3% (2.1)	19.6% (3.1)	0.003	
Ceremonies	10.6% (2.6)	9% (1.8)	0.596	
Tribal distributions	19.6% (4.2)	16.9% (2.4)	0.582	
Non-commercial*	87.2% (3.9)	93.5% (2)	0.155	
Residence on the reservation - No. (%)	44 (91.7)	61 (93.8)	.721$	
Consume Resident Trout fillet - No. (%)	48 (100)	60 (92.3)	0.071	
Tribe#				
1	7 (14.6)	12 (18.5)	0.586	
2	5 (10)	5 (8)	0.741	
3	16 (33)	8 (12)	0.006	0.28 (.11,.72)
4	20 (42)	40 (61.5)	0.036	2.24 (1.05,4.79)
Weekly event/ceremony attendance - No. (%)	11 (23)	13 (22)	0.831	
Catch own fish - No. (%)	23 (48)	18 (28)	0.027	0.42(.19,.91)
Regularly prepare meals - No. (%)	44 (92)	61 (94)	0.721	
Breastfeed most recent child - No. (%)	30 (64)	32 (49)	0.125	

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

Table I-7. Comparison of personal and consumption characteristics according to consumption of non-fillet whitefish parts among women who gave birth within 5 years.

Characteristic	Consume any non-fillet parts?		P-value	Odds Ratio (95% CI)
	No	*Yes*		
Weighted n	*14*	*17*	-	
Age (mean, se)	29.2 (1.7)	36.5 (2.1)	0.011	
Fish meals/week	.93 (.15)	4.1 (.81)	0.001	
Grams per day	36.2 (5.4)	177 (34.4)	0.001	
Source of consumed fish (Mean %, SD)				
Caught by family/self	33.8 (8.9)	60.8 (8.8)	0.041	
Grocery stores	23.4 (9.5)	6.7 (2.9)	0.115	
Friends	8.7 (2)	13 (3.5)	0.269	
Ceremonies	24.7 (5.9)	.91 (.9)	0.001	
Tribal distributions	9.4 (2.5)	18.4 (5.9)	0.174	
Non-commercial*	76.6 (9.5)	93.3 (2.9)	0.115	
Residence on the reservation - No. (%)	12 (86)	17 (100)	0.2$	
Consume Whitefish fillet - No. (%)	100	100	N/A	
Tribe#				
1	9 (64)	3 (19)	0.011	0.13 (.02,.68)
2	0 (0)	1 (6)	1$	
3	0	2 (12)	0.49$	
4	5 (36)	10 (62.5)	0.143	
Weekly event/ceremony attendance - No. (%)	7 (50)	5 (31)	0.296	
Catch own fish - No. (%)	5 (36)	5 (29)	1$	
Regularly prepare meals - No. (%)	100	100	N/A	
Breastfeed most recent child - No. (%)	3 (23)	10 (62.5)	0.034	5.56 (1.08,28.64)

* Cumulation of all sources except grocery stores.
# Comparisons made to the rest of the study sample.
$ Fisher's Exact Test

Table I-8. Comparison of characteristics to frequent pan-frying among women who gave birth within 5 years.

Characteristic	Use at least weekly		P-value
	No	*Yes*	
n	*97*	*37*	-
Age (Mean, SD)	28.3 (6.6)	26.5 (5.6)	0.148
Fish meals/wk (Mean, SD)	2.13 (1.8)	2.84 (2.07)	0.053
Average grams/meal (Mean, SD)	240.7 (71.9)	250.2 (62)	0.476
Grams of fish/day (Mean, SD)	72.4 (63.7)	108.5 (101)	0.048
Source of consumed fish (Mean %, SD)			
Caught by family/self	36.9 (36.9)	67.2 (28.5)	<.001
Grocery stores	10.8 (22.8)	2.9 (6.9)	0.002
Friends	7.5% (1.7)	22.6% (2.5)	<.001
Ceremonies	8.6 (14)	11.9 (19.4)	0.347
Tribal distributions	18.8 (25.6)	7.9 (9.3)	<.001
Non-commercial*	85.1 (24.7)	97.1 (6.9)	<.001
Residence on the reservation - No. (%)	88 (90.7)	37 (100)	.18$
Tribe[#] - No. (%)			
1	16 (16)	2 (5.4)	0.154$
2	9 (9.3)	2 (5.4)	0.283$
3	27 (28)	4 (10.8)	0.037
4	45 (46.6)	30 (81.1)	<.001
Weekly event/ceremony attendance - No. (%)	9 (9.7)	9 (24.3)	0.029
Catch own fish - No. (%)	34 (35)	8 (21.6)	0.134
Regularly prepare meals - No. (%)	90 (91.8)	29 (78.4)	.04#
Breastfeed most recent child - No. (%)	52 (53.1)	13 (35.1)	0.063

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

$ Fisher's Exact Test

Table I-9. Comparison of Characteristics to Frequent Baking among women who gave birth within 5 years.

Characteristic	Use at least weekly		P-value
	No	*Yes*	
n	*102*	*80*	-
Age (Mean, SD)	28.4 (7.2)	27.8 (6.3)	0.551
Fish meals/wk (Mean, SD)	1.7 (1.4)	2.4 (2)	0.006
Average grams/meal (Mean, SD)	232 (79.8)	248.2 (60.6)	0.133
Grams of fish/day (Mean, SD)	54.3 (47)	92.3 (89.5)	0.001
Source of consumed fish (Mean %, SD)			
Caught by family/self	43 (39)	54 (31.9)	0.039
Grocery stores	12 (21.9)	6.1 (20)	0.058
Friends	23.2 (28)	9.9 (14.4)	<.001
Ceremonies	9.2 (16.6)	9.6 (14.4)	0.845
Tribal distributions	11.8 (20.3)	18.9 (23)	0.028
Non-commercial*	87.1 (23.1)	92.4 (20.5)	0.106
Residence on the reservation - No. (%)	97 (95.1)	75 (93.8)	0.751
Tribe# - No. (%)			
1	9 (9)	12 (15)	0.195
2	10 (10)	5 (6)	0.387
3	18 (18)	18 (22)	0.439
4	66 (65)	45 (56)	0.246
Weekly event/ceremony attendance - No. (%)	14 (14.6)	12 (15)	0.938
Catch own fish - No. (%)	22 (21.8)	34 (42.5)	0.003
Regularly prepare meals - No. (%)	84 (82.4)	70 (87.5)	0.339
Breastfeed most recent child - No. (%)	43 (42.2)	38 (47.5)	0.472

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

$ Fisher's Exact Test

Table I-10. Comparison of characteristics to frequent canning preparation among women who gave birth within 5 years.

Characteristic	Use at least weekly		P-value
	No	*Yes*	
n	*105*	*39*	-
Age (Mean, SD)	28.4 (6.9)	27.4 (6.3)	0.439
Fish meals/wk (Mean, SD)	1.83 (1.4)	2.9 (1.9)	0.003
Average grams/meal (Mean, SD)	232.6 (68.6)	249.8 (70)	0.188
Grams of fish/day (Mean, SD)	59.6 (48.3)	113.9 (101.7)	0.003
Source of consumed fish (Mean %, SD)			
Caught by family/self	50.4 (38.2)	48.8 (34)	0.816
Grocery stores	7 (15.9)	5 (10.1)	0.48
Friends	19.1 (26.6)	20.1 (19.3)	0.837
Ceremonies	11.2 (17.5)	8 (12.8)	0.298
Tribal distributions	11.2 (17.2)	17.5 (23.1)	0.081
Non-commercial*	91.9 (17.8)	94.3 (11.2)	0.437
Residence on the reservation - No. (%)	103 (98.1)	37 (95)	0.296
Tribe[#] - No. (%)			
1	5 (5)	2 (5)	1$
2	10 (10)	2 (5)	0.514
3	14 (13)	10 (26)	0.078
4	76 (72)	25 (64)	0.335
Weekly event/ceremony attendance - No. (%)	17 (17)	4 (10.3)	0.319
Catch own fish - No. (%)	17 (16.2)	14 (36)	0.011
Regularly prepare meals - No. (%)	85 (81)	37 (95)	0.039
Breastfeed most recent child - No. (%)	37 (36)	24 (61.5)	0.005

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

$ Fisher's Exact Test

Table I-11. Comparison of characteristics to frequent boiling among women who gave birth within 5 years.

Characteristic	Use at least weekly		P-value
	No	*Yes*	
n	*102*	*42*	-
Age (Mean, SD)	27 (6.6)	29.9 (6.7)	0.015
Fish meals/wk (Mean, SD)	2.1 (1.9)	2.2 (1.5)	0.614
Average grams/meal (Mean, SD)	243 (73)	248 (57.1)	0.68
Grams of fish/day (Mean, SD)	74 (80)	81.7 (60)	0.572
Source of consumed fish (Mean %, SD)			
Caught by family/self	49.3 (38.8)	50.7 (32.7)	0.84
Grocery stores	8.7 (18.4)	2.5 (6.5)	0.003
Friends	15.8 (26.7)	19 (20.5)	0.479
Ceremonies	8.9 (16)	18 (16.9)	0.003
Tribal distributions	18.2 (25)	9.2 (9.5)	0.002
Non-commercial*	92.2 (17)	96.9 (6.5)	0.016
Residence on the reservation - No. (%)	99 (96)	42 (100)	.671$
Tribe# - No. (%)			
1	10 (10)	0	.11$
2	11 (11)	0	.109$
3	25 (25)	2 (5)	0.006
4	56 (54)	40 (95)	<.001
Weekly event/ceremony attendance - No. (%)	13 (13.4)	7 (16.7)	0.615
Catch own fish - No. (%)	30 (29)	15 (35.7)	0.437
Regularly prepare meals - No. (%)	88 (85.4)	37 (88.1)	0.674
Breastfeed most recent child - No. (%)	45 (43.7)	15 (35.7)	0.376

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

$ Fisher's Exact Test

Table I-12. Potential Determinants of fish consumption [ln(gpd)] in all women, using univariate linear regression.

Determinant	Beta	95% CI	P-value
Age	0.0016	(-.003, .007)	0.538
Age quartiles			
18-28	0	-	-
29-36	0.0021	(-.209, .213)	0.984
36-50	0.159	(-.049, .367)	0.133
> 50	0.048	(-.257, .161)	0.654
Recent childbirth (<5 years)			
No	0	-	-
Yes	0.171	(.007, .336)	0.042
Residence			
Off the reservation	0	-	-
On the reservation	0.411	(.156, .665)	0.002
Tribe			
1	-0.114	(-.310, .083)	0.256
2	-0.343	(-.531, -.155)	<.001
3	-0.884	(-1.136, -.632)	<.001
4	0	-	-
Weekly event/ceremony attendance			
No	0	-	-
Yes	0.249	(.059, .439)	0.01
Catch own fish			
No	0	-	-
Yes	0.171	(.014, .328)	0.033
Regularly prepare meals			
No	0	-	-
Yes	0.103	(-.105, .311)	0.331
Percent fish obtained non-commercially	0.0042	(.001, .007)	0.005
Breastfeed most recent child			
No	0	-	-
Yes	0.172	(.013, .331)	0.034

Table I-13. Comparison of characteristics according to recent childbirth status among those who consume salmon/steelhead non-fillet parts.

Characteristic	Recently Given Birth (within 5 years)		P-value	Odds Ratio (95% CI)
	No	*Yes*		
Age (mean, se)	48(11.9)	29(7)	<.001	
Grams of fish/day (Mean, SD)	61.5(58.5)	89(80.5)	0.001	
Source of consumed fish (Mean %, SD)				
Caught by family/self	38(33.5)	43(37)	0.204	
Grocery stores	7.5(15.6)	8.2(17.9)	0.675	
Friends	15.3(23.9)	22.6(26.3)	0.011	
Ceremonies	12.9(17.4)	8.6(14.1)	0.013	
Tribal distributions	22.4(25.3)	16.5(23.7)	0.036	
Non-commercial*	88.5(23.5)	90.8(15.6)	0.343	
Residence on the reservation - No. (%)	231(91)	110(97)	0.059	2.74(.92,8.11)
Tribe# - No. (%)				
1	52(20)	9(8)	0.002	.33(.16,.70)
2	26(10)	7(6)	0.196	.57(.24,1.35)
3	45(18)	24(21)	0.472	1.23(.70,2.13)
4	131(52)	76(66)	0.009	1.83(1.16,2.90)
Weekly event/ceremony attendance - No. (%)	54(22)	15(13)	0.05	0.54(.29,1.01)
Catch own fish - No. (%)	79(31)	36(31)	0.969	1.01(.71,1.38)
Regularly prepare meals - No. (%)	226(89)	96(84)	0.172	0.65(.35,1.21)
Breast fed most recent child - No. (%)	120(48)	63(55)	0.203	1.33(.86,2.08)

* Cumulation of all sources except grocery stores.
\# Comparisons made to the rest of the study sample.

Table I-14. Comparison of characteristics according to recent childbirth status among those who consume resident trout non-fillet parts.

Characteristic	Recently Given Birth (within 5 years)		P-value	Odds Ratio (95% CI)
	No	*Yes*		
Age (mean, se)	49(11.8)	30.8(7.9)	<.001	
Grams of fish/day (Mean, SD)	54.5(42.4)	116.7(98)	<.001	
Source of consumed fish (Mean %, SD)				
Caught by family/self	42(34.1)	48(36.5)	0.232	
Grocery stores	10.3(18.6)	6(16.1)	0.08	
Friends	12.4(20.4)	19.6(25.2)	0.041	
Ceremonies	10.8(15.9)	9(14.7)	0.42	
Tribal distributions	18.9(23.4)	16.9(19.7)	0.543	
Non-commercial*	84.1(27.6)	93.5(16.2)	0.001	
Residence on the reservation - No. (%)	159(92)	61(94)	.786$	1.34(.43,4.24)
Tribe# - No. (%)				
1	52(30)	12(18.5)	0.076	0.53(.26,1.08)
2	19(11)	5(8)	0.46	0.68(.24,1.90)
3	12(7)	8(12)	0.191	1.86(.73,4.78)
4	91(52)	40(62)	0.202	1.46(0.82,2.61)
Weekly event/ceremony attendance - No. (%)	42(25)	13(22)	0.604	0.83(.41,1.68)
Catch own fish - No. (%)	59(34)	18(28)	0.36	0.75(.4,1.40)
Regularly prepare meals - No. (%)	154(89)	61(94)	0.261	1.88(.62,5.76)
Breast fed most recent child - No. (%)	89(51)	32(49)	0.792	0.93(.52,1.64)

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

$ Fisher's Exact Test

Table I-15. Comparison of characteristics of those who frequently pan fry according to recent childbirth status.

Characteristic	Childbirth within 5 years?		P-value	Odds Ratio (95% CI)
	No	*Yes*		
n	*41*	*37*		
Age (Mean, SD)	49(11.3)	26.5(5.6)	<.001	
Grams of fish/day (Mean, SD)	86.2(60)	108.5(101)	0.234	
Source of consumed fish (Mean %, SD)				
Caught by family/self	52.1(37.1)	67.2(28.6)	0.047	
Grocery stores	14.6(24.5)	2.9(7)	<.005	
Friends	12.5(19.2)	10.2(14)	0.556	
Ceremonies	4.3(7.7)	11.9(19.4)	0.03	
Tribal distributions	15.2(22)	7.9(9.3)	0.056	
Non-commercial*	84(26)	97(6.9)	0.003	
Residence on the reservation - No. (%)	32(78)	37(100)	.003$	N/A
Tribe# - No. (%)				
1	14(34)	2(5)	0.002	0.11(.02,.53)
2	3(7)	1(3)	.62$	.35(.04,3.54)
3	4(10)	4(11)	1$	1.12(.26,4.84)
4	20(49)	30(81)	0.003	4.5(1.61,12.55)
Weekly event/ceremony attendance - No. (%)	7(18)	9(24)	0.533	1.42(.47,4.33)
Catch own fish - No. (%)	26(63)	8 (22)	<.001	0.16(0.06,.44)
Regularly prepare meals - No. (%)	39(95)	29(78)	.041$	0.19(.04,.94)
Breastfeed most recent child - No. (%)	15(37)	13(35)	1$	0.94(.37,.2.37)

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

$ Fisher's Exact Test

Table I-16. Comparison of characteristics of those who frequently boil fish for soup/stew according to recent childbirth status.

Characteristic	Childbirth within 5 years?		P-value	Odds Ratio (95% CI)
	No	*Yes*		
n	*33*	*42*	-	
Age (Mean, SD)	52.2(10.6)	29.9(6.7)	<.001	
Grams of fish/day (Mean, SD)	83.4(60.9)	81.7(60.1)	0.906	
Source of consumed fish (Mean %, SD)				
Caught by family/self	16.8(23.7)	50.7(32.7)	<.001	
Grocery stores	39.7(36.3)	2.5(6.5)	<.001	
Friends	9.5(11.9)	19(20.5)	0.014	
Ceremonies	8.8(9.2)	18(16.9)	0.004	
Tribal distributions	19.4(20.3)	9.2(9.5)	0.01	
Non-commercial*	54.5(37.9)	96.9(6.5)	<.001	
Residence on the reservation - No. (%)	32(97)	42(100)	.44$	N/A
Tribe# - No. (%)				
1	5(15)	0(0)	.014$	N/A
2	4 (12)	0(0)	0.034$	N/A
3	4(12)	2(5)	0.395	0.36(.06,2.11)
4	20(61)	40(95)	<.001	13.0(2.67,63.27)
Weekly event/ceremony attendance - No. (%)	0(0)	7(17)	.016$	N/A
Catch own fish - No. (%)	4(12)	15(36)	0.017	4.17(1.23,14.10)
Regularly prepare meals - No. (%)	31(91)	37(88)	.725$	0.72(.16,3.24)
Breastfeed most recent child - No. (%)	21(64)	14(36)	0.016	0.32(.12,.82)

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

$ Fisher's Exact Test

Table I-17. Comparison of characteristics of those who frequently bake according to recent childbirth status.

Characteristic	Childbirth within 5 years?		P-value	Odds Ratio (95% CI)
	No	*Yes*		
n	*110*	*80*	-	
Age (Mean, SD)	46.5(12)	27.8(6.3)	<.001	
Grams of fish/day (Mean, SD)	68.2(58.7)	92.3(89.5)	0.038	
Source of consumed fish (Mean %, SD)				
Caught by family/self	34.2(32.2)	54(31.9)	<.001	
Grocery stores	13(22.3)	6.1(19.7)	0.024	
Friends	15.7(23.7)	9.9(13.9)	0.033	
Ceremonies	9.7(13.1)	9.6(14.4)	0.983	
Tribal distributions	23.8(28.7)	18.9(23)	0.192	
Non-commercial*	83.4(27.3)	92.4(20.5)	0.011	
Residence on the reservation - No. (%)	103(93)	75(94)	0.796	1.17(.37,3.70)
Tribe# - No. (%)				
1	42(38)	12(15)	0.001	0.29(.14,.60)
2	5(4.5)	5(6.3)	.745$	1.4(.39,5.01)
3	24(22)	18(22)	0.921	1.04(.52,2.07)
4	40(36)	45(56)	0.006	2.25(1.25,4.05)
Weekly event/ceremony attendance - No. (%)	22(20)	12(15)	0.39	0.71(.33,1.54)
Catch own fish - No. (%)	37(34)	34(43)	0.212	1.46(.81,2.64)
Regularly prepare meals - No. (%)	100(91)	70(88)	0.45	0.7(.28,1.77)
Breastfeed most recent child - No. (%)	48(43)	38(37.5)	0.56	1.19(.67,2.11)

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

$ Fisher's Exact Test

Table I-18. Comparison of characteristics of those who frequently use canned preparations according to recent childbirth status.

Characteristic	Childbirth within 5 years?		P-value	Odds Ratio (95% CI)
	No	*Yes*		
n	*66*	*39*	-	
Age (Mean, SD)	47.6(12)	27.4(6.3)	**<.001**	
Grams of fish/day (Mean, SD)	69.8(52.3)	113.9(101.7)	**0.015**	
Source of consumed fish (Mean %, SD)				
Caught by family/self	35.6(33.8)	48.8(34)	0.057	
Grocery stores	9.9(20.9)	5(10.1)	0.115	
Friends	20.7(27.6)	20.1(19.3)	0.9	
Ceremonies	11.3(12.4)	8(12.8)	0.196	
Tribal distributions	21.4(27.7)	17.5(23.1)	0.46	
Non-commercial*	88.9(22.1)	94.3(11.2)	0.104	
Residence on the reservation - No. (%)	60(91)	37(95)	.707$	1.85(.36,9.65)
Tribe# - No. (%)				
1	7(11)	2(5)	.479$	0.46(.09,2.31)
2	6(9)	2(5)	.707$	0.54(.10,2.82)
3	18(27)	10(26)	0.855	0.92(.37,2.26)
4	35(53)	25(64)	0.268	1.58(0.7,3.57)
Weekly event/ceremony attendance - No. (%)	19(29)	4(10)	0.024	0.28(.09,.89)
Catch own fish - No. (%)	21(32)	14(36)	0.668	1.2(.52,2.76)
Regularly prepare meals - No. (%)	62(94)	37(95)	1$	1.19(.21,6.84)
Breastfeed most recent child - No. (%)	25(38)	24(62)	0.019	2.62(1.16,5.93)

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

$ Fisher's Exact Test

Appendix II – Analyses for Seniors Ages 55 Years and Older

Table II-1. Potential Determinants of salmon/steelhead ln(gpd) in Elders using univariate linear regression.

Determinant	Beta	95% CI	P-value
Age	-0.017	(-.04,.004)	0.113
Gender			
Female	0	-	-
Male	0.259	(-.024,.543)	0.073
Child Living in House			
No	0	-	-
Yes	-0.278	(-.603,.048)	0.094
Residence			
Off the reservation	0	-	-
On the reservation	-0.635	(-1.03,0.239)	0.002
Tribe			
1	-0.729	(-1.05,-.41)	<.001
2	-0.243	(-.603,.117)	0.184
3	-0.732	(-1.202,-.262)	0.002
4	0	-	-
Weekly event/ceremony attendance			
No	0	-	-
Yes	0.193	(-.222, .61)	0.36
Catch own fish			
No	0	-	-
Yes	0.539	(.264,.813)	<.001
Regularly prepare meals			
No	0	-	-
Yes	-0.052	(-.392,.288)	0.762
Percent fish obtained non-commercially	0.0015	(-.005,.008)	0.665

Table II-2. Determinants of salmon/steelhead ln(gpd) in elders using multivariate linear regression.

Determinant	Beta	95% CI	P-value
Constant	4.09	(2.87,5.32)	<.001
Age	-0.016	(-.035,.003)	0.094
Tribe			
1	-0.679	(-0.983,-.38)	<.001
2	-0.252	(-0.598,.094)	0.153
3	-0.618	(-1.07,-.169)	0.007
4	0	-	-
Catch own fish			
No	0	-	-
Yes	0.54	(.213, .868)	0.001

Model: Age, Tribes $r^2 = .138$

Model: Age, Tribes, Catch own fish $r^2 = .191$

Table II-3. Potential determinants of resident trout ln(gpd) in elders using univariate linear regression.

Determinant	Beta	95% CI	P-value
Age	-0.0075	(-.04,.026)	0.661
Gender			
Female	0	-	-
Male	0.362	(-.079,.802)	0.107
Child Living in House			
No	0	-	-
Yes	0.487	(-.073,1.05)	0.088
Residence			
Off the reservation	0	-	-
On the reservation	-0.607	(-1.21,-.001)	0.05
Tribe			
1	-0.255	(-.76,.25)	0.318
2	-0.691	(-1.26,-.12)	0.018
3	0.567	(-.179,1.31)	0.135
4	0	-	-
Weekly event/ceremony attendance			
No	0	-	-
Yes	0.192	(-.43,.812)	0.542
Catch own fish			
No	0	-	-
Yes	0.788	(.37,1.21)	<.001
Regularly prepare meals			
No	0	-	-
Yes	-0.42	(-.91,.08)	0.099
Percent fish obtained non-commercially	0.011	(.002,.02)	0.015

Table II-4. Determinants of resident trout ln(gpd) in elders using multivariate linear regression.

Determinant	Beta	95% CI	P-value
Constant	1.488	(-.53,3.5)	0.148
Age	-0.02	(-.05,.003)	0.003
Gender	-1.092	(-1.6,-.582)	<.001
Child Living in House			
No	0	-	-
Yes	0.84	(.367,1.31)	0.001
Residence			
Off the reservation	0	-	-
On the reservation	-1.2	(-1.77,-.644)	0.05
Tribe			
1	-0.343	(-.76,.25)	0.127
2	-0.983	(-1.26,-.12)	<.001
3	0.583	(-.179,1.31)	0.063
4	0	-	-
Catch own fish			
No	0	-	-
Yes	1.41	(.95,1.87)	<.001
Percent fish obtained non-commercially	0.009	(.001,.016)	0.03

Model: Age (years), Tribes r^2 = .104

Model: Age (years), Tribes, catch your own fish r^2 = .238

Model: Age (years), Tribes, catch your own fish, Residence r^2 = .299

Model: Age (years), Tribes, catch your own fish, Residence, Gender r^2 = .349

Model: Age (years), Tribes, catch your own fish, Residence, Gender, children under age 5 living in house r^2 = .399

Model: Age (years),Tribes, catch your own fish, Residence, Gender, children under age 5 living in house, % non-commercial fish source r^2 = .421

Table II-5 Comparison of characteristics to salmon/steelhead non-fillet consumption status among elders.

Characteristic	Consume any non-fillet parts?		P-value	Odds Ratio
	No	*Yes*		(95% CI)
n (total = 169)	*28*	*141*	-	
Age (mean, sd)	64.6 (7.5)	63.5 (6.6)	0.415	
Male Gender - No. (%)	10(35)	57(40)	0.551	
Grams of fish/day (Mean, sd)	96.7 (236.2)	62.8 (83.5)	0.47	
Source of fish - (Mean %, sd)				
Caught by family/self	43 (34)	41 (35.8)	0.791	
Grocery stores	7.5 (20)	7.3 (15.8)	0.943	
Friends	5.3 (11)	11.9 (22.3)	0.02	
Ceremonies	4.1 (11)	7.8 (11.9)	0.099	
Tribal distributions	31.6 (34.1)	29.6 (31.9)	0.764	
Non-commercial*	83.9 (29.3)	90 (19.8)	0.148	
Tribe# - No. (%)				
1	17 (61)	35 (25)	<.001	.214 (.091, .499)
2	6(21)	30 (21)	0.986	.991 (.369, 2.66)
3	0 (0)	16 (11)	0.077$	N/A
4	5(18)	61(43)	0.012	3.51 (1.26, 9.76)
Residence on the reservation - No. (%)	26(93)	118(84)	0.259	.395 (.09, 1.78)
Weekly event/ceremony attendance - No. (%)	2(8)	15(11)	1$	1.44 (.31, 6.72)
Catch own fish - No. (%)	9(32)	53(38)	0.585	1.27 (.54, 3.01)
Regularly prepare meals - No. (%)	24(86)	108(77)	0.287	.545 (.18, 1.69)

* Cumulation of all sources except grocery stores.

Comparisons made to the other tribes.

$ 2-sided Fisher's Exact Test

Table II-6. Comparison of characteristics to resident trout non-fillet consumption status among elders .

Characteristic	Consume any non-fillet parts?		P-value	Odds Ratio (95% CI)
	No	*Yes*		
n (total = 135)	*23*	*112*		
Age (mean, sd)	62.7 (5.6)	63.7 (6.7)	0.497	
Male Gender - No. (%)	2(9)	52(46)	<.001	9.1 (2.04,40.7)
Grams of fish/day (Mean, sd)	89.1 (165.7)	53.4 (48.8)	0.316	
Source of fish - (Mean %, sd)				
Caught by family/self	32.1 (30.2)	47.3 (35.7)	0.058	
Grocery stores	5.4 (12)	9.6 (19)	0.315	
Friends	7.1 (12.3)	11.4 (20.6)	0.328	
Ceremonies	6.6 (9.6)	5.9 (10.5)	0.797	
Tribal distributions	38.6 (31)	22.7 (28.7)	0.019	
Non-commercial*	84.3 (28.2)	87.4 (22.7)	0.563	
Tribe# - No. (%)				
1	12(52)	36(32)	0.072	.44 (.18, 1.09)
2	7(30)	22(20)	0.27$	.56 (.21, 1.52)
3	4(17)	8(7)	0.123$	.365 (.1, 1.34)
4	0(0)	45(41)	<.001$	N/A
Residence on the reservation - No. (%)	21(91)	94(84)	0.525	.497 (.11, 2.31)
Weekly event/ceremony attendance - No. (%)	2(10)	9(8.6)	.689$	0.84 (0.17, 4.23)
Catch own fish - No. (%)	4(17)	46(41)	0.03	3.36 (1.07, 10.54)
Regularly prepare meals - No. (%)	20(87)	83(74)	0.187	0.43 (0.12, 1.55)

* Cumulation of all sources except grocery stores.
# Comparisons made to the other tribes.
$ 2-sided Fisher's Exact Test

Table II-7. Comparison of participant characteristics to whitefish non-fillet consumption status among elders.

Characteristic	Consume any non-fillet parts?		P-value	Odds Ratio
	No	*Yes*		(95% CI)
n (total = 135)	*13*	*47*		
Age (mean, sd)	64.4(6.5)	63.3(5)	0.51	
Male Gender - No. (%)	3(23)	27(57.4)	0.028	4.5 (1.09,18.5)
Grams of fish/day (Mean, sd)	145(226.7)	61.3(45.5)	0.207	
Source of fish - (Mean %, sd)				
Caught by family/self	41.7(30.4)	44(31.9)	0.818	
Grocery stores	11.9(15.6)	9.9(22.1)	0.761	
Friends	7.1(10.4)	13.1(16.1)	0.114	
Ceremonies	2.2(5.6)	7.6(10.7)	0.019	
Tribal distributions	34.4(36.8)	23.7(25.8)	0.338	
Non-commercial*	85.4(15.7)	88.4(22)	0.649	
Tribe# - No. (%)				
1	5(39)	3(7)	.01$	.112 (.02,.563)
2	4(31)	14(30)	1$	.955(.25,3.62)
3	4(31)	4(9)	.059$	.209 (.04,1.0)
4	0(0)	25(54)	<.001	32.0 (N/A)
Residence on the reservation - No. (%)	9(69)	44(94)	.034$	6.5 (1.24,34.28)
Weekly event/ceremony attendance - No. (%)	2(18)	4(9)	.318$	.419 (.07, 2.64)
Catch own fish - No. (%)	6(46)	20(43)	0.817	.86 (.25, 3.0)
Regularly prepare meals - No. (%)	12(92)	39(83)	.668$	.41 (.05,3.58)

* Cumulation of all sources except grocery stores.
# Comparisons made to the other tribes.
$ 2-sided Fisher's Exact Test

Table II-8. Comparison of characteristics according to frequent baking among elders.

Characteristic	Bake fish at least weekly		P-value	OR (95%CI)
	No	*Yes*		
n	*104*	*64*	-	
Age (Mean, SD)	63.7(6.8)	63.3(6.5)	0.698	
Male Gender - No. (%)	40(39)	26(41)	0.78	1.1(.58,2.07)
Grams of fish/day (Mean, SD)	55.2(87.4)	94.2(160.7)	0.082	
Source of consumed fish (Mean %, SD)				
Caught by family/self	43(38)	41(31)	0.684	
Grocery stores	6.4(11.7)	8.9(22.4)	0.416	
Friends	10.3(20.8)	11.2(15.5)	0.746	
Ceremonies	8.7(12.6)	4.6(6.6)	0.007	
Tribal distributions	28.8(32.7)	29.9(32)	0.831	
Non-commercial*	90.8(18.1)	86.6(26.6)	0.273	
Residence on the reservation - No. (%)	86(83)	57(89)	0.26	1.7(.67,4.34)
Tribe# - No. (%)				
1	29(28)	21(33)	0.523	1.25(.63,2.45)
2	28(27)	7(11)	0.013	.33(.14,.82)
3	6(6)	6(9)	.377$	1.69(.52,5.48)
4	40(39)	30(47)	0.306	(1.39(.74,2.61)
Weekly event/ceremony attendance - No. (%)	9(10)	11(18)	0.139	2.02(.79,5.2)
Catch own fish - No. (%)	33(32)	34(53)	0.006	2.44(1.28,4.63)
Regularly prepare meals - No. (%)	78(75)	55(86)	0.09	2.04(.89,4.69)

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

$ Fisher's Exact Test

Table II-9. Comparison of characteristics according to frequent boiling among elders .

Characteristic	Boiling at least weekly		P-value	OR (95%CI)
	No	*Yes*		
n	*103*	*39*	-	
Age (Mean, SD)	63.6(7.4)	64(4.5)	0.681	
Male Gender - No. (%)	40(39)	17(44)	0.606	1.22(.57,2.57)
Grams of fish/day (Mean, SD)	58.6(87.7)	67.6(47.2)	0.544	
Source of consumed fish (Mean %, SD)				
Caught by family/self	46.7(37.7)	38.7(27.7)	0.173	
Grocery stores	6.5(14.5)	9.9(23.7)	0.41	
Friends	11.9(24.8)	17(15.4)	0.241	
Ceremonies	8.2(11.5)	7.2(9)	0.629	
Tribal distributions	22.2(28.4)	26.9(25.3)	0.375	
Non-commercial*	89(22.4)	89.7(23.8)	0.875	
Residence on the reservation - No. (%)	82(80)	39(100)	.001$	N/A
Tribe# - No. (%)				
1	24(24)	9(23)	0.955	.975(.41,2.34)
2	25(25)	3(8)	0.027	.26 (.07,.92)
3	8(8)	2(5)	.727$	.64 (.13,3.17)
4	45(44)	25(64)	0.034	2.26(1.06,4.85)
Weekly event/ceremony attendance - No. (%)	14(14)	7(18)	0.608	1.3 (.48,3.51)
Catch own fish - No. (%)	29(28)	23(59)	0.001	3.62 (1.67,7.8)
Regularly prepare meals - No. (%)	78(77)	34(87)	0.159	2.09(.74, 5.95)

* Cumulation of all sources except grocery stores.
# Comparisons made to the rest of the study sample.
$ Fisher's Exact Test

Table II-10. Comparison of characteristics according to frequent canned preparation among elders.

Characteristic	Use Canned fish at least weekly		P-value	OR (95%CI)
	No	*Yes*		
n	*116*	*33*	-	
Age (Mean, SD)	64.2(6.5)	62.5(5.8)	0.145	
Male Gender - No. (%)	38(33)	13(38)	0.553	1.27(.58,2.81)
Grams of fish/day (Mean, SD)	66.5(136.6)	79.7(73.6)	0.592	
Source of consumed fish (Mean %, SD)				
Caught by family/self	46.8(34.1)	38.4(35.8)	0.219	
Grocery stores	4.5(9.6)	14.9(25.7)	0.028	
Friends	10.4(17.6)	7.6(12.9)	0.394	
Ceremonies	8(12.2)	7.1(8.9)	0.695	
Tribal distributions	28.2(31.1)	28.8(30.2)	0.927	
Non-commercial*	93.4(15.8)	81.9(25)	0.016	
Residence on the reservation - No. (%)	96(83)	32(97)	.046$	6.67(.86,51.67)
Tribe# - No. (%)				
1	36(31)	3(9)	0.011	.22(.06,.77)
2	19(17.5)	9(27)	0.158	1.91(.77,4.76)
3	10(9)	6(18)	202$	2.27(.76,6.79)
4	50(44.5)	15(46)	0.84	1.08(.5,2.36)
Weekly event/ceremony attendance - No. (%)	9(8)	12(35)	<.001$	6.12(2.3,16.3)
Catch own fish - No. (%)	52(45)	7(21)	0.01	.32(.13,.79)
Regularly prepare meals - No. (%)	91(79)	27(82)	0.735	1.19(.44,3.2)

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

$ Fisher's Exact Test

Table II-11. Comparison of characteristics according to dried preparation use among elders.

Characteristic	Use dried fish at least weekly		P-value	OR (95%CI)
	No	*Yes*		
n	*93*	*27*	-	
Age (Mean, SD)	63.9(6.6)	63.6(6.9)	0.802	
Male Gender - No. (%)	35(38)	14(52)	0.186	1.79(.75,4.23)
Grams of fish/day (Mean, SD)	42.2(24.7)	51.7(29.3)	0.101	
Source of consumed fish (Mean %, SD)				
Caught by family/self	42.4(35)	65.8(26.9)	<.001	
Grocery stores	4.8(9.8)	1.8(6.3)	0.06	
Friends	10.6(19.2)	5.6(8.1)	0.049	
Ceremonies	9.3(12)	4(7.7)	0.008	
Tribal distributions	30(32.3)	21(26.1)	0.142	
Non-commercial*	92.2(16.9)	96.3(6.9)	0.065	
Residence on the reservation - No. (%)	75(82)	25(93)	.236$	2.83(.61,13.13)
Tribe# - No. (%)				
1	22(24)	7(26)	0.83	1.11(.42,2.99)
2	18(20)	1(4)	.07$	.16(.02,1.26)
3	12(13)	4(15)	.755$	1.17(.35,3.99)
4	40(44)	15(56)	0.268	1.63(.69,3.86)
Weekly event/ceremony attendance - No. (%)	8(9)	8(30)	.011$	4.32(1.44,12.96)
Catch own fish - No. (%)	34(37)	12(44)	0.482	1.37(.57,3.26)
Regularly prepare meals - No. (%)	75(82)	18(67)	0.1	.453(.17,1.18)

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

$ Fisher's Exact Test

Table II-12. Comparison of characteristics to elder status among those who consume salmon/steelhead non-fillet parts.

Characteristic	Elder?		P-value	Odds Ratio
	No	*Yes*		(95% CI)
n	*670*	*141*	-	
Male Gender - No. (%)	339(50)	57(40)	0.036	0.68(.47,.98)
Grams of fish/day (Mean, sd)	72.1(81.7)	62.8(84)	0.222	
Source of fish - (Mean %, sd)				
Caught by family/self	48.5(35.7)	41(35.7)	0.024	
Grocery stores	5.8(15)	7.3(15.8)	0.29	
Friends	16.2(23)	11.9(22.3)	0.039	
Ceremonies	10.6(17.6)	7.8(10.9)	0.015	
Tribal distributions	15.4(22.6)	29.6(31.9)	<.001	
Non-commercial*	90.8(20.9)	90.4(19.8)	0.846	
Residence on the reservation - No. (%)	613(91)	118(84)	0.014	0.53(.32,.88)
Tribe# - No. (%)				
1	88(13)	35(25)	<.001	2.21(1.42,3.44)
2	53(8)	30(21)	<.001	3.18(1.94,5.19)
3	151(22)	16(11)	0.003	0.45(.26,.77)
4	384(57)	61(43)	0.003	0.58(.4,.84)
Weekly event/ceremony attendance - No. (%)	123(19)	15(11)	0.034	0.54(.31,.96)
Catch own fish - No. (%)	387(57)	88(62)	<.001	0.45(.31,.65)
Regularly prepare meals - No. (%)	470(70)	108(77)	0.093	1.43(.94,2.19)

* Cumulation of all sources except grocery stores.

Comparisons made to the other tribes.

$ 2-sided Fisher's Exact Test

Table II-13. Comparison of characteristics to elder status among those who consume resident trout non-fillet parts.

Characteristic	Elder?		P-value	Odds Ratio
	No	*Yes*		(95% CI)
n	*439*	*110*		
Male Gender - No. (%)	233(52)	52(46)	0.271	0.79(.52,1.2)
Grams of fish/day (Mean, sd)	78(91.9)	53.4(48.8)	<.001	
Source of fish - (Mean %, sd)				
Caught by family/self	50.5(34.7)	47.3(35.7)	0.389	
Grocery stores	5.4(13.3)	9.6(19.1)	0.032	
Friends	14.6(20.2)	11.4(20.6)	0.143	
Ceremonies	10.7(17)	5.9(10.5)	<.001	
Tribal distributions	16(22.3)	22.7(28.7)	0.023	
Non-commercial*	91.7(18.8)	87.4(22.7)	0.065	
Residence on the reservation - No. (%)	407(91.5)	94(84)	0.018	0.49(.27,.89)
Tribe# - No. (%)				
1	95(21)	36(32)	0.013	1.77(1.12,2.8)
2	45(10)	22(20)	0.005	2.18(1.25,3.81)
3	78(18)	8(7)	0.007	0.36(.17,.77)
4	227(51)	45(40.5)	0.051	0.66(.43,1.0)
Weekly event/ceremony attendance - No. (%)	88(21)	9(9)	0.004	0.36(.18,.74)
Catch own fish - No. (%)	264(59)	46(41)	0.001	0.49(.32,.74)
Regularly prepare meals - No. (%)	308(69)	83(74)	0.297	1.28(.80,2.05)

* Cumulation of all sources except grocery stores.

Comparisons made to the other tribes.

$ 2-sided Fisher's Exact Test

Table II-14. Comparison of characteristics to elder status among those who consume whitefish non-fillet parts.

Characteristic	Elder?		P-value	Odds Ratio
	No	*Yes*		(95% CI)
n	*114*	*47*	-	
Male Gender - No. (%)	70(61)	27(57)	0.687	0.87(.44,1.73)
Grams of fish/day (Mean, sd)	73.9(74.7)	61.3(45.5)	0.283	
Source of fish - (Mean %, sd)				
Caught by family/self	56.5(33.9)	44(31.9)	0.033	
Grocery stores	6.5(12.8)	10(22.1)	0.318	
Friends	10(15)	13.1(16)	0.25	
Ceremonies	8.1(15)	7.6(10.7)	0.839	
Tribal distributions	16.7(21.4)	23.7(25.8)	0.078	
Non-commercial*	91.3(17.6)	88.4(22)	0.385	
Residence on the reservation - No. (%)	106(93)	44(94)	0.885	1.11(.28,4.37)
Tribe# - No. (%)				
1	21(18)	3(6.5)	0.056	0.31(.09,1.09)
2	14(12)	14(30)	0.008	3.03(1.31,7.01)
3	14(12)	4(8.5)	0.49	0.66(.21,2.14)
4	66(58)	25(54)	0.682	0.87(.44,1.73)
Weekly event/ceremony attendance - No. (%)	30(28)	4(8.5)	0.008	.24(.08,.73)
Catch own fish - No. (%)	83(73)	20(43)	<.001	0.27(.14,.56)
Regularly prepare meals - No. (%)	89(78)	39(83)	0.483	1.37(.57,3.30)

* Cumulation of all sources except grocery stores.
# Comparisons made to the other tribes.
$ 2-sided Fisher's Exact Test

Table II-15. Comparison of characteristics according to elder status among those who frequently pan-fry fish.

Characteristic	Elder?		P-value	OR (95%CI)
	No	*Yes*		
n	*165*	*27*	-	
Male Gender - No. (%)	83(50)	13(45)	0.587	.8(.36,1.77)
Grams of fish/day (Mean, SD)	99.6(119.9)	89.9 (79)	0.686	
Source of consumed fish (Mean %, SD)				
Caught by family/self	61.8(28.8)	53.1(31.1)	0.139	
Grocery stores	4.3(8.6)	15.9(26.6)	0.029	
Friends	12.7(16.3)	13.1(13.3)	0.886	
Ceremonies	7.9(12.8)	2.7(3.1)	<.001	
Tribal distributions	11.1(17)	14(18)	0.381	
Non-commercial*	93.5(12.9)	83(26.7)	0.048	
Residence on the reservation - No. (%)	141(86)	24(83)	.777$	.82(.28,2.35)
Tribe# - No. (%)				
1	24(15)	9(31)	0.056	2.64(1.08,6.49)
2	9(6)	5(17)	.04$	3.61(1.12,11.69)
3	25(15)	0(0)	.017$	N/A
4	106(65)	15(52)	0.199	6(.27,1.32)
Weekly event/ceremony attendance - No. (%)	28(18)	9(32)	0.088	2.15(.88,5.25)
Catch own fish - No. (%)	117(71)	22(76)	0.585	1.29(.52,3.22)
Regularly prepare meals - No. (%)	127(77)	24(83)	0.489	1.44(.51,4.02)

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

$ Fisher's Exact Test

Table II-16. Comparison of characteristics according to elder status among those who frequently use canned fish preparations.

Characteristic	Elder?		P-value	OR (95%CI)
	No	*Yes*		
n	*177*	*33*	-	
Male Gender - No. (%)	76(43)	13(38)	0.611	.82(.39,1.75)
Grams of fish/day (Mean, SD)	79(76.6)	79.7(73.6)	0.958	
Source of consumed fish (Mean %, SD)				
Caught by family/self	53.9(34.6)	38.4(35.8)	0.029	
Grocery stores	3.6(9.4)	14.9(25.7)	0.017	
Friends	18.3(23.9)	7.6(12.9)	<.001	
Ceremonies	11.4(18.1)	7.11(8.9)	0.039	
Tribal distributions	11.9(21.1)	28.8(30.2)	0.004	
Non-commercial*	94.5(13)	81.9(25)	0.007	
Residence on the reservation - No. (%)	158(89)	32(97)	.212$	3.85(.50,29.79)
Tribe# - No. (%)				
1	10(6)	3(9)	.437$	1.66(.43,6.39)
2	10(6)	9(27)	.001$	6.26(2.31,16.97)
3	35(20)	6(18)	0.774	.87(.33,2.26)
4	121(69)	15(46)	0.011	.39(.18,.82)
Weekly event/ceremony attendance - No. (%)	34(19)	12(35)	0.04	2.26(1.02,5.02)
Catch own fish - No. (%)	114(64)	7(21)	<.001	.14(.06,.35)
Regularly prepare meals - No. (%)	142(81)	27(82)	0.879	1.08(.41,2.82)

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

$ Fisher's Exact Test

Table II-17. Comparison of characteristics according to elder status among those who frequently bake fish.

Characteristic	Elder?		P-value	OR (95%CI)
	No	*Yes*		
n	*310*	*62*	-	
Male Gender - No. (%)	124(40)	26(41)	0.926	1.03(.59,1.78)
Grams of fish/day (Mean, SD)	84.4(106.7)	94.2(160.7)	0.55	
Source of consumed fish (Mean %, SD)				
Caught by family/self	50.2(34.2)	40.9(31)	0.043	
Grocery stores	6(15)	8.9(22.4)	0.335	
Friends	12.9(19.7)	11.2(15.5)	0.537	
Ceremonies	11(16.5)	4.6(6.6)	<.001	
Tribal distributions	16.5(23.8)	29.9(32)	0.002	
Non-commercial*	90.6(19.8)	86.6(26.6)	0.257	
Residence on the reservation - No. (%)	289(93)	57(89)	.293$	.59(.24,1.46)
Tribe# - No. (%)				
1	69(22)	21(33)	0.072	1.71(.95,3.07)
2	16(5)	7(11)	.089$	2.26(.89,5.73)
3	53(17)	6(9)	0.123	.50(.21,1.22)
4	172(56)	30(47)	0.208	.71(.41,1.21)
Weekly event/ceremony attendance - No. (%)	67(22)	11(18)	0.446	.76(.28,1.54)
Catch own fish - No. (%)	176(57)	34(53)	0.592	.86(.5,1.48)
Regularly prepare meals - No. (%)	246(80)	55(86)	0.243	1.57(.73,3.34)

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

$ Fisher's Exact Test

Table II-18. Comparison of characteristics according to elder status among those who frequently boil fish.

Characteristic	Elder?		P-value	OR (95%CI)
	No	*Yes*		
n	*134*	*39*	-	
Male Gender - No. (%)	60(45)	17(44)	0.89	.95(.46,1.96)
Grams of fish/day (Mean, SD)	81.3(52)	67.6(47.2)	0.142	
Source of consumed fish (Mean %, SD)				
Caught by family/self	51.3(34.8)	38.7(27.7)	0.021	
Grocery stores	9.3(21.8)	9.87(23.7)	0.89	
Friends	15.8(21.4)	16.9(15.4)	0.77	
Ceremonies	12.1(13.5)	7.2(9)	0.01	
Tribal distributions	8.7(11.1)	26.9(25.3)	<.001	
Non-commercial*	88(25)	89.7(23.8)	0.708	
Residence on the reservation - No. (%)	128(96)	39(100)	.339$	N/A
Tribe# - No. (%)				
1	5(4)	9(23)	.001$	7.74(2.42,24.77)
2	6(5)	3(8)	.423$	1.78(.42,7.46)
3	12(9)	2(5)	.739$	.55(.12,2.57)
4	111(83)	25(64)	0.012	.37(.17,.82)
Weekly event/ceremony attendance - No. (%)	29(22)	7(18)	0.617	.79(.32,1.98)
Catch own fish - No. (%)	74(55)	23(59)	0.678	1.17(.57,2.4)
Regularly prepare meals - No. (%)	98(73)	34(87)	0.069	2.5(.91,6.88)

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

$ Fisher's Exact Test

Appendix III – Analyses for Children Ages Less than 5 Years

Table III-1. Comparison of characteristics according to salmon/steelhead non-fillet consumption among children.

Characteristic	Consume any non-fillet parts?		P-value	OR (95%CI)
	No	*Yes*		
Age at first fish meal(mean, sd)	12(13)	12.9(16.3)	0.56	
Gender - No. (%)				
Female	119(50)	75(48)		
Male	120(50)	80(52)	0.79	1.06(0.71,1.59)
Weight (Mean, sd)	35.7(14.6)	38.8(11.5)	0.02	
Fish meals/week (mean, sd)	1.75(2.2)	1.7(1.2)	0.66	
Grams per day (mean, sd)	27.8(30)	33(31)	0.11	
Percent Source from: - (mean %, sd)				
Caught	42.5(34.4)	46.5(38)	0.3	
Grocery store	6.2(16.3)	5(13.8)	0.45	
Friends	14.6(19.4)	17.6(23.8)	0.19	
Ceremonies	10.7(16.6)	12.8(18)	0.24	
Tribal distribution	21.8(26.6)	17.6(26.8)	0.13	
Non-commercial*	89.6(22)	94.5(14.5)	0.009	
Residence on the reservation - No. (%)	215(90)	146(91)	0.67	1.16(0.58,2.33)
Enrolled in Tribe:#				
1 - No	199(83)	148(92.5)		
1 - Yes	40(17)	12(7.5)	0.007	0.4 (0.21,0.8)
2 - No	212(89)	148(92)		
2 - Yes	27(11)	13(8)	0.3	0.7 (.34,1.38)
3 - No	163 (68)	131 (82)		
3 - Yes	76(32)	29(18)	0.002	0.48 (0.29,0.77)
4 - No	143(60)	55(34)		
4 - Yes	96(40)	106(66)	<0.001	2.87 (1.89,4.35)
Catch own fish - No (%)	119 (50)	73(45)	0.38	0.84(.56,1.25)
Regularly prepare meals - No. (%)	178(75)	124(77)	0.56	1.15(.72,1.84)

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.

Table III-2. Comparison of characteristics according to resident trout non-fillet consumption among children.

Characteristic	Consume any non-fillet parts?		P-value	OR (95%CI)
	No	*Yes*		
Age at first fish meal(mean, sd)	11.4(10)	13(18.6)	0.48	
Gender - No. (%)				
Female	58(63)	40(42)		
Male	34(37)	56(58)	0.003	2.39(1.33,4.29)
Weight (Mean, sd)	35(13)	38(13)	0.16	
Fish meals/week (mean, sd)	1.5(1.6)	1.6(1.1)	0.75	
Grams per day (mean, sd)	25.5(30)	32.8(35.9)	0.142	
Percent Source from: - (mean %, sd)				
Caught	46(33)	45(37)	0.81	
Grocery store	7.9(16.7)	6.3(15.4)	0.495	
Friends	11(14)	19(27)	0.016	
Ceremonies	9(14)	11(18)	0.31	
Tribal distribution	24(28)	17(24)	0.08	
Non-commercial*	90(19)	92(17)	0.44	
Residence on the reservation - No. (%)	85 (92)	83 (87)	0.19	0.53(.2,1.38)
Enrolled in Tribe:#				
1 - No	68(74)	82(85)		
1 - Yes	24(26)	14(15)	0.05	0.48(.23,1.01
2 - No	77(84)	88(92)		
2 - Yes	15(16)	8(8)	0.095	0.47 (.19,1.16)
3 - No	64(70)	72(75)		
3 - Yes	27(30)	24(25)	0.47	0.79(.42,1.5)
4 - No	67(73)	45(47)		
4 - Yes	25(27)	50(53)	<0.001	2.98(1.62,5.49)
Catch own fish - No (%)	70 (76)	7 (75)	0.86	0.94(.49,1.83)
Regularly prepare meals - No. (%)	70 (76)	72 (75)	0.86	0.94 (.48,1.83)

* Cumulation of all sources except grocery stores.

Comparisons made to the rest of the study sample.