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Exposure of South Carolinians to commercial meats and fish within their meat and fish diet

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Abstract

There has been considerable interest in the public's exposure to a variety of contaminants through the consumption of wild fish and game, yet there is little information on consumption of commercial meats and fish, or the relationship between commercial and self-caught fish. We conducted a dietary survey in 1999 to estimate exposure levels of 464 individuals from people attending the Palmetto Sportsmen's Classic. Mean consumption was similar for beef, chicken/turkey, and wild-caught fish, and much lower for pork and store-bought fish, and still lower for restaurant fish. There were no ethnic differences in the consumption of most commercial fish and meats, although the differences for chicken approached significance. There were significant ethnic differences in consumption of wild-caught fish. Women ate significantly less of all meat types, except store-bought fish. People over 45 ate less beef than younger people, and people younger than 32 ate significantly more chicken than others. There were no significant differences in consumption patterns as a function of income, except for chicken and wild-caught fish; people with higher incomes ate more chicken than others, and people with lower incomes ate more wild-caught fish than others. When all wild-caught and commercial fish and meats are considered, there are significant differences only for ethnicity and gender. Blacks consume significantly more fish than Whites, and men consume significantly more than women.

Keywords: Commercial fish; Commercial meats; Human health; Recreationists; Consumption

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1. Introduction

There is considerable discussion about the safety of the foods that Americans consume, which range from mercury, PCBs, and contaminants in wild-caught fish and game, to pesticides and other contaminants on commercial fruits and vegetables. Much of the discussion about the safety of food has related to non-commercial fish, shellfish, and wildlife (Horn, 1992; ATSDR, 1996; IOM, 1991; Berti et al., 1998), although Price et al. (1994) have considered the risks from TCDD in beef. The discussion revolves around the increases in the number of the nation's water bodies that are under consumption advisories (EPA, 1996, 1998), and the relationship between some contaminant levels (mercury, PCBs), fish consumption, and neurobehavioral deficits in children (Jacobson et al., 1989, 1990; Ratcliffe et al., 1996; Weihe et al., 1996).

While risk assessors often examine the potential negative effects of the consumption of wild-caught fish, there are questions concerning the balancing of the risks of fish consumption against the benefits (Wahlqvist et al., 1989; Anderson and Wiener, 1995; Egeland and Middaugh, 1997; Hunter et al., 1998), as well as the risks from consumption of other sources of animal protein (such as red meat). Furthermore, the relative risks and benefits from the consumption of wild-caught vs. commercial fish are seldom examined, although Jacobs et al. (1998) examined consumption rates for different kinds of fish.

There are, however, issues about the safety and healthfulness of consumption of other sources of protein, such as commercial meats and fish. For example, there is concern about pesticides in eggs (Ibrahim et al., 1994) and in chicken (Lino and Silveira, 1994), PAHs in charcoal-broiled beef (Kang et al. 1995), and a variety of other contaminants in beef (Winters et al., 1996).

In this paper we present consumption data for 464 people interviewed at the Palmetto Sportsmen's Classic in Columbia, South Carolina, of commercial meats and fish. We were particularly interested in examining the relationship between self-caught fish and other fish obtained from supermarkets or in restaurants, and in the relationship between commercial meats and self-caught fish. This information will allow for a variety of risk assessments, including risk–risk balancing from different types of meats and fish, and for regulatory purposes (Bier, 1999). The study is part of a long-term investigation of human exposure and risk, stimulated by concerns over possible environmental pollution from the Department of Energy's Savannah River Site.

2. Methods

We conducted dietary surveys of 464 people interviewed while they attended the Palmetto Sportsmen's Classic in Columbia, South Carolina (27–29 March 1998). The event was attended by approximately 60 000 people. People were interviewed while they waited in lines, were eating, or were standing about. Our sample represents a population interested in hunting, fishing and other sports, and not the general public.

All interviewers started in different parts of the grounds, and randomly selected people for interviewing. Interviewers walked transects through the exhibit halls and grounds to ensure that people were interviewed from all areas of the show. We walked transects, interviewing a person, and then walking 2 m before interviewing the next person. Upon completing that interview, we interviewed the next person that was 2 m away along our transect (or the first person thereafter). This ensured that people were interviewed at all areas of the show.

All interviewers were experienced with similar surveys. We identified ourselves as researchers from Rutgers University who were interested in how much they ate of different types of meat and fish. Nearly everyone agreed to answer our interview, and those who declined ($N = 12$) were in a hurry, caring for small children, or about to leave the show. More details on methodology can be found in Burger and Gochfeld (in press).

The questionnaire contained three parts dealing with number of meals consumed of several different types of commercial meats and fish by month, information concerning serving size and cooking methods, and demographics. People were

prompted for each type of food and for each month. Information about the number of meals for each meat or fish type was placed in a table, and people were prompted for each type and for each month. We showed them fish models of different portion sizes to ensure accuracy. We also asked them whether they ate each item during particular hunting or fishing seasons.

Species of interest included wild-caught fish, store-bought fish, restaurant fish, beef, chicken/turkey, and pork/ham. Hereafter we use chicken to refer to both chicken and turkey, and pork to refer to pork/ham. This list of meats and fish was derived from interviews at a prior Sportsmen's Classic, and from interviews of hunters and fisherman along the Savannah River (Burger et al., 1997, 1998, 1999; Sanchez and Burger, 1998). Respondents were asked if they ate any other commercial foods.

Subjects were also asked about serving size, and what percent they ate of meat vs. stews. Subjects were provided with a three-dimensional model of fillets of fish, allowing them to think about how much they regularly eat. Interviewers mentioned the size of a small can of tuna as another reference. People are generally aware of how much beef they eat because many fast food stores sell hamburgers by weight, as do restaurants. Demographic information included ethnicity, gender, age, location of residence, occupation, and income. The length of the survey (20 min) is within the guidelines suggested for dietary surveys (Block et al., 1986). Additional details about the data collection and overview analyses can be found in Burger (2000). The sample sizes vary slightly in different tables because a few people did not give their age or ethnicity.

We computed individual consumption by determining the average number of meals eaten as meat per month, and the average number of meals eaten as stew per month. Each of these was then multiplied by the average serving size for each meat or fish type. These were summed across months to obtain the mean daily and total yearly consumption rate for each type of fish or meat. We used SAS (1994, 1996)) to compute the means and percentiles for the tables.

We used regression procedures to determine if age, ethnicity, income or gender contributed to differences in overall consumption of commercial meats and fish (PROC GLM, SAS, 1996). The procedure adds the variable that contributes the most to the R^2, then adds the next variable that increases the R^2 the most, continuing until all significant variables are added. Thus variables that vary co-linearly are entered only if they add independently to explaining the variation. The procedure also allows for interaction variables (i.e. income $\times$ ethnicity). We compared gender and age groups using a Kruskal–Wallis one-way analysis of variance.

3. Results

We interviewed 39 Blacks and 415 Whites, representative of the attendance at the event. There were no significant differences in the age composition or in whether they had ever worked at SRS (approx. 4%). Our sample was evenly divided between those under 32, those from 32 to 45, and those over 45 years of age. There were differences in mean income, with Blacks averaging lower ($\$20\,900 \pm 2620$) than Whites ($\$32\,800 \pm 3.080$, $\chi^2 = 11.8$, $P < 0.0006$).

There were no ethnic differences in the consumption of most commercial fish and meats, although the differences for chicken approach significance (Table 1). However, there were significant differences in the amount of self-caught fish consumed. In general mean consumption was similar for beef, chicken, and self-caught fish, much lower for pork and store-bought fish, and still lower for restaurant fish. We did not distinguish between restaurant and store-bought for the other categories. The ethnic differences are great when all types of fish are considered together (Fig. 1).

There were gender differences in consumption of all meat types except store-bought fish (Table 2). Women ate significantly less of all meat types. These differences persisted for all percentiles.

There were significant age differences in consumption of beef and chicken, but not for the other meat types (Table 3). In general, people over 45 ate less beef than younger people, and

Table 1
Univariate analysis of total daily consumption of five commercial meat types for Black and White people surveyed at the Palmetto Sportsman's Classic 1998 — for those who ate each category

Ethnicity	% Who eat	Grams/person per day					
		Mean (range)	Median	75th%	90th%	95th%	99th%
Beef							
Black	87	75.1 (5.63–211)	60.1	120	186	211	211
White	88	83.3 (9.39–1130)	28.6	78.9	169	218	457
Wilcoxon χ^2 (P)		0.01 (NS)					
Chicken/turkey							
Black	97	81.7 (7.51–225)	60.1	114	169	203	225
White	93	71.6 (3.76–526)	52.6	90.2	150.0	225	368
Wilcoxon χ^2 (P)		3.01 (0.08)					
Pork[a]							
Black	63	31.3 (1.88–135)	22.5	30.1	113	135	135
White	64	29.1 (1.25–113)	20.4	37.6	75.1	86.4	113
Wilcoxon χ^2 (P)		0.18 (NS)					
Restaurant fish							
Black	26	13.7 (4.69–60.1)	7.51	7.51	41.3	60.1	60.1
White	61	15.3 (0.47–158)	9.39	15.0	33.8	52.6	105.0
Wilcoxon χ^2 (P)		0.43 (NS)					
Store-bought fish							
Black	26	22.6 (3.76–67.6)	14.1	30.1	63.9	67.6	67.6
White	37	18.8 (2.50–75.1)	11.3	30.1	45.1	60.1	75.1
Wilcoxon χ^2 (P)		0.05 (NS)					
Wild-caught fish							
Black	79	171 (1.88–590)	137	240	446	557	590
White	78	38.8 (0.35–902)	15.3	37.6	93.0	129	286
Wilcoxon χ^2 (P)		29.2 (0.0001)					

Shown are a Kruskal–Wallis chi-square comparison for means for each meat type. ($N = 39$ Blacks, 415 Whites).
[a]A subset of only 114 people were questioned about pork, as pork questions were added as the survey progressed.

people under 32 ate significantly more chicken than older people.

There were no significant differences in consumption patterns as a function of income, except for chicken and self-caught fish (Table 4). People with higher incomes ate more chicken than those with incomes below $20 000 per year; people with lower incomes ate more self-caught fish than others.

We then examined daily and yearly consumption patterns for commercial meats and commercial fish in terms of ethnicity, gender, age and income. Overall, there were no gender differences in total commercial meats and fish consumed, although there were age and income differences (Table 5). Men consumed significantly more than women; consumption decreased with age, and consumption increased with income.

The best model examining commercial foods for the subjects interviewed explained 12% of the variation ($F = 4.8$, d.f. = 3,364, $P < 0.0001$) in terms of gender ($P < 0.0006$), ethnicity × location ($P < 0.03$), and ethnicity × age ($P < 0.03$). The best model for wild-caught fish and meat consumption explained 20% of the variation ($F = 6.2$, d.f. = 3,364, $P < 0.0001$) in terms of gender ($P <$

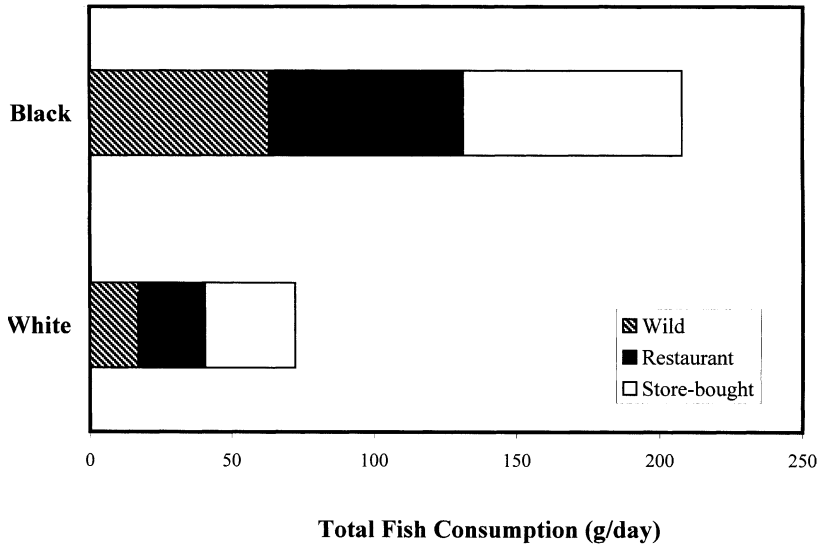

Fig. 1. Ethnic differences in mean consumption of different types of fish. Shown are yearly consumption for people interviewed in South Carolina.

0.0004), age ($P < 0.003$), ethnicity × age ($P < 0.006$), and ethnicity × location ($P < 0.009$).

In summary, the overall patterns indicate that the population examined ate similar amounts of beef, chicken/turkey, and self-caught fish (Fig. 2). These data illustrate that for some populations, in this case hunters/fishermen/recreationists, self-caught fish are an important part of the diet.

4. Discussion

4.1. Methodological considerations

The choice of food items to place on the questionnaire was derived from experience interviewing hunters and anglers in South Carolina (Burger, 1997, 1998; Burger et al., 1997, 1999). Dietary recall studies have been criticized because of: (1) reliability over time; and (2) recall bias. However, Smith (1993) reported that subjects have excellent relative judgements of frequency. In short-term studies of dietary intake, there is a fairly high and significant correlation in recall (repeated measures averaged correlations of 0.7–0.8 for fish and meat, Jarvinen et al., 1993). Foods that are never eaten are easy to remember (Krall et al., 1988), and foods which are eaten regularly are recalled reliably (Nomura et al., 1976).

We provided respondents with cues for all types of meat and fish they might have consumed. Recall of serving size could also be critical. In this study we showed subjects three-dimensional models of 8 ounces of fish, so that it was easier for them to estimate how much they ate of different food items. Finally, the results of this study apply to people who are interested in hunting and fishing as they were attending a sportsmen's show aimed at this audience. Thus the consumption rates for wild-caught fish and game might be higher than in the general population.

Finally, this population also hunts, particularly for deer and small game (Burger and Gochfeld, in press). Nearly 80% of the population eats deer meat, and their consumption is seasonal. Game accounts for 11% of the fish and meat diet of blacks, and 19% of the fish and meat diet of whites (Burger and Gochfeld, in press).

4.2. Comparative consumption

One important aspect of this study was to determine whether consumption of commercial

Table 2
Univariate analysis of total daily consumption of five commercial meat types for men and women surveyed at the Palmetto Sportsman's Classic 1998 — for those who ate

Gender	% Who eat	Grams/person per day					
		Mean (range)	Median	75th%	90th%	95th%	99th%
Beef							
Female	85	58.5 (0.94–395)	37.5	72.3	135	170	352
Male	89	94.5 (1.10–1.130)	60.4	120	225	282	451
Wilcoxon χ^2 (P)		18.2 (< 0.0001)					
All	88	83.3 (0.94–1.130)	60.1	106	186	257	421
Chicken							
Female	95	55.0 (3.76–298)	45.1	65.8	120	135	210
Male	92	82.1 (3.76–526)	60.1	102	180	248	376
Wilcoxon χ^2 (P)		13.0 (0.003)					
All	93	73.0 (3.76–526)	54.5	90.1	150	225	335
Pork[a]							
Female	71	20.9 (1.25–90.2)	15.6	27.4	38.8	45.1	90.2
Male	61	34.0 (1.25–135)	22.5	37.6	84.5	113	135
Wilcoxon χ^2 (P)		3.01 (0.08)					
All	64	29.7 (1.25–135)	22.5	37.6	75.1	90.2	135
Restaurant fish							
Female	57	11.1 (0.47–60.1)	7.51	15.0	22.5	30.1	60.1
Male	58	17.1 (0.62–158)	9.39	15.0	45.1	60.1	132
Wilcoxon χ^2 (P)		4.84 (0.03)					
All	57	15.2 (0.47–158)	8.77	15.0	33.8	52.6	105
Store-bought fish							
Female	38	18.0 (0.47–75.1)	7.51	30.1	45.1	71.4	75.1
Male	36	19.4 (1.10–67.6)	13.6	30.1	49.5	60.1	67.6
Wilcoxon χ^2 (P)		1.20 (NS)					
All	36	18.9 (0.47–75.1)	11.3	30.1	46.5	60.1	75.1

Shown are a Kruskal–Wallis chi-square comparison for means for each meat type. ($N = 149$ females, 308 males).
[a]A subset of only 114 people were questioned about pork, as pork questions were added as the survey progressed.

meats of the people attending the Sportsmens Classic in Columbia was similar to the US generally. This is particularly important given the relative importance of wild fish and game in their diet (see Burger, ms).

From 1909 to 1980, the consumption of beef, pork, poultry, and fish all increased in the United States (Welsh and Marston, 1982), while from 1980 until 1998 the consumption of beef declined and the consumption of poultry increased (Cattle and Beef Industry, 1999). This suggests that for risk assessments it is essential to report data by year, since there are yearly fluctuations.

In this study we found that the per capita consumption of beef was 83 g/day, which is very similar to that reported by the cattle and beef industry (1999; 64.7 lb/year = 29 kg/year = 81 g/day). People in this study also ate approximately the same amount of chicken (US = 63.5 lb/year = 28.9 kg/year = 79 g/day, compared to 73 g/day for this study). This is remarkable agreement. Pork consumption, however, was less; US consumption was 48.8 lb/year (= 22.2 kg/year = 61 g/day, Cattle and Beef Industry, 1999), compared to 29.7 g/day in this study. However, self-caught fish is seldom considered in stud-

Table 3
Univariate analysis of total yearly consumption of five commercial meat types for people surveyed at the Palmetto Sportsman's Classic 1998 — for those who ate each type

Age	% Who eat	Grams/person per day					
		Mean (range)	Median	75th%	90th%	95th%	99th%
Beef							
32 and under	88	99.8 (9.39–451)	60.1	150	257	310	451
33–45	89	86.9 (2.82–1.130)	60.2	115	169	225	406
Over 45	87	61.1 (1.25–305)	45.1	82.7	135	180	272
Wilcoxon χ^2 (P)		7.52 (0.02)					
Chicken							
32 and under	92	91.1 (7.05–526)	60.1	114	203	282	526
33–45	93	66.1 (7.51–376)	47.0	87.4	135	169	368
Over 45	94	36.9 (3.76–301)	45.1	75.1	127	180	298
Wilcoxon χ^2		11.0 (0.004)					
Pork[a]							
32 and under	59	29.8 (3.29–86.4)	22.5	37.6	60.1	84.5	86.4
33–45	68	31.2 (4.69–113)	22.5	37.6	75.1	90.2	113
Over 45	65	28.0 (1.25–135)	15.0	26.3	82.7	113.0	135.0
Wilcoxon χ^2 (P)		3.63 (NS)					
Restaurant fish							
32 and under	55	13.6 (0.47–90.2)	7.51	15.0	31.9	46.0	90.2
33–45	57	15.8 (0.63–132)	9.39	15.0	39.0	56.4	132.0
Over 45	60	14.5 (0.63–105)	9.39	15.0	33.8	58.6	105.0
Wilcoxon χ^2 (P)		0.70 (NS)					
Store-bought fish							
32 and under	31	17.4 (1.10–75.1)	9.39	16.9	45.1	60.1	75.1
33–45	36	18.5 (0.47–71.4)	11.3	25.4	50.7	60.1	71.4
Over 45	42	20.5 (0.94–67.6)	15.0	30.1	46.5	60.1	67.6
Wilcoxon χ^2 (P)		0.93 (NS)					

Shown are a Kruskal–Wallis chi-square comparison for means for each meat type. ($N = 145$, 32 and under; $N = 59$, 33–45; $N = 150$, over 45 years).

[a]A subset of only 114 people were questioned about pork, as pork questions were added as the survey progressed.

ies of consumption for Americans overall. The results of this study indicate that self-caught fish can be as important in the diets of some people as beef and chicken/turkey.

We calculated consumption, however, on the basis of those who ate a specific meat type, not on the basis of the whole population. Furthermore, people in this study ate a significant amount of fish (self-caught, restaurant and store-bought). Partly, the usefulness of the data lies in the information about median consumption and the consumption for different percentiles useful for probabilistic risk assessments. In this regard, consumption for the 95th percentile was quite high for beef, chicken/turkey, and self-caught fish, and intermediate for pork and commercial fish.

4.3. Consumption patterns and exposure

Obtaining relevant consumption data for a wide variety of foods that provide heath benefits or costs is an important part of risk assessment (Ebert et al., 1994). The data presented in the paper can be used for understanding exposure for sportsmen living in South Carolina if any of the foods, such as wild-caught fish, contain contami-

Table 4
Univariate analysis of total yearly consumption of five commercial meat types for people surveyed at the Palmetto Sportsman's Classic 1998 — for those who ate each type of food

Income	% Who eat	Grams/person per day					
		Mean (range)	Median	75th%	90th%	95th%	99th%
Beef							
$0–<20K	84	71.2 (0.94–451)	44.8	92.1	150	210	451
$20–30K	85	87.2 (1.10–451)	60.1	124	211	257	451
Over $30K	94	90.5 (6.58–1130)	60.1	113	208	269	406
Wilcoxon χ^2 (P)		4.55 (NS)					
Chicken							
$0–<20K	94	65.9 (3.76–335)	451	75.1	169	225	335
$20–30K	87	79.6 (7.51–368)	60.1	113	180	240	368
Over $30K	95	82.9 (3.76–526)	60.1	104	169	225	526
Wilcoxon χ^2 (P)		6.47 (0.04)					
Pork[a]							
$0–<20K	40	35.7 (1.25–135)	11.3	61.2	113	135	135
$20–30K	84	33.2 (3.29–113)	28.0	37.6	84.5	86.4	113
Over $30K	65	25.6 (3.75–75.1)	17.6	37.6	60.1	60.1	75.1
Wilcoxon χ^2 (P)		1.77 (NS)					
Restaurant fish							
$0–<20K	43	12.7 (0.47–60.1)	8.14	15.0	30.1	38.5	60.1
$20–30K	61	12.9 (0.63–60.1)	9.39	15.0	30.1	57.7	60.1
Over $30K	65	18.3 (1.25–158)	9.39	15.0	45.1	67.6	132.0
Wilcoxon χ^2 (P)		2.93 (NS)					
Store-bought fish							
$0–<20K	34	15.7 (0.47–60.1)	9.39	15.0	45.1	60.1	60.1
$20–30K	34	25.1 (0.63–75.1)	11.3	27.1	35.2	45.1	60.1
Over $30K	36	18.9 (0.47–75.1)	11.3	30.1	46.5	60.1	75.1
Wilcoxon χ^2 (P)		0.87 (NS)					

Shown are a Kruskal–Wallis chi-square comparison for means for each meat type. ($N = 98$, under $20K; $N = 95$, $20–30K; $N = 172$, over $30K).

[a] For only a subset (see Table 3).

nants. They are presented largely because of the importance of obtaining site-specific information for risk assessment in regions where there are consumption advisories for some foods from some locations (SCDHEC, 1996). While the amount of beef and chicken were similar to that of the overall US population, pork consumption was less. However, when the amount of wild-caught meat and fish consumed is added to the commercial foods, the overall amount of meat and fish consumed is quite high.

From a risk perspective, potential exposure to contaminants through wild-caught fish and game should be viewed in combination with information on commercial foods. Some commercial foods, such as tuna and some other fish, also are relatively high in contaminants (such as mercury), and thus total fish consumption should be considered when conducting potential risk assessments. Remarkably, the amount of wild-caught fish consumed was equal to beef and to chicken, suggesting that wild-caught foods are a very important food source for people in this sample. The percentage, however, was not similar as a

Table 5
Univariate analysis of total daily consumption of all commercial meat types for four demographics surveyed at the Palmetto Sportsman's Classic 1998 — for those who ate each type

	Sample size	% Who eat	Grams/person per day					
			Mean (range)	Median	75th%	90th%	95th%	99th%
All	449	98	165 (1.88–1140)	127	216	335	417	701
Ethnicity								
Black	39	100	170 (7.51–438)	162	284	411	417	437
White	415	98	164 (1.88–1140)	122	212	327	422	701
Wilcoxon χ^2 (P)			0.37 (NS)					
Gender								
Female	149	99	121 (5.63–492)	92.4	163	239	307	416
Male	308	98	187 (1.87–1140)	150	235	366	481	729
Wilcoxon χ^2 (P)			24.8 (< 0.0001)					
Age								
≤ 32	145	97	194 (7.51–826)	150	246	413	535	742
33–45	159	97	166 (7.51–1140)	142	224	297	362	729
Over 45	150	100	136 (1.88–481)	109	162	295	361	451
Wilcoxon χ^2 (P)			8.69 (0.01)					
Income								
\$0–< 20K	98	97	141 (7.51–826)	92.7	190	284	438	826
\$20–30K	95	98	171 (1.88–701)	143	235	355	413	701
Over \$30K	172	99	189 (7.51–1140)	150	240	377	481	729
Wilcoxon χ^2 (P)			13.3 (0.001)					

Shown are a Kruskal–Wallis chi-square comparison for means for each demographic.

function of income. Wild-caught foods accounted for less of consumption for the people with high incomes compared to those with low incomes.

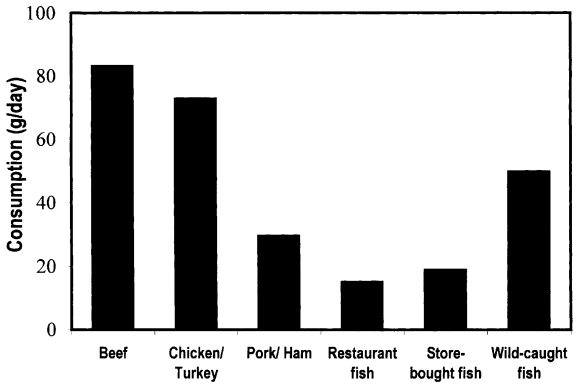

Fig. 2. Daily consumption of different types of meat and fish for people interviewed in South Carolina.

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