

Exponent<sup>®</sup>

*Center for Chemical Regulation & Food  
Safety*

**Assessment of the Potential  
Human Exposure to  
Heterocyclic Amines from  
Cooked Meat Products**



# **Assessment of the Potential Human Exposure to Heterocyclic Amines from Cooked Meat Products**

Prepared for:  
Susan Backus  
Director of Research  
American Meat Institute Foundation  
1150 Connecticut Ave, NW, 12<sup>th</sup> Floor  
Washington, DC 20036

Prepared by:  
  
Exponent  
1150 Connecticut Ave., NW, Suite 1100  
Washington, DC 20036

August 15, 2009

© Exponent, Inc.

# Contents

---

	<u>Page</u>
<b>Contents</b>	<b>3</b>
<b>List of Tables</b>	<b>4</b>
<b>List of Acronyms</b>	<b>6</b>
<b>1 EXECUTIVE SUMMARY</b>	<b>7</b>
<b>2 PROJECT OVERVIEW</b>	<b>8</b>
<b>3 DATA SOURCES</b>	<b>9</b>
3.1 Consumption Data	9
3.2 Consumers' Consumption Preference Survey (IPSOS Survey)	10
3.2.1 Survey Instrument	11
3.3 HCA Levels in Foods	11
<b>4 METHODS OF ESTIMATING DIETARY EXPOSURE</b>	<b>14</b>
4.1 Estimating Food Intake	14
4.1.1 Bridging NHANES Food Consumption with IPSOS Survey Data	15
4.2 Estimating Exposure to HCA	16
<b>5 RESULTS AND DISCUSSION</b>	<b>18</b>
5.1 IPSOS Survey	18
5.2 Meat Intake by Method of Cooking and Degree of Doneness	19
5.3 Dietary Exposure to HCA	22
5.4 Discussion	26
<b>6 REFERENCES</b>	<b>31</b>
<b>APPENDIX A. CONSUMER SURVEY</b>	<b>33</b>
<b>APPENDIX B. RESIDUE DATA AVAILABILITY</b>	<b>46</b>
<b>APPENDIX C. FOOD INTAKE BY SPECIFIC MEAT TYPE</b>	<b>77</b>

## List of Tables

---

	<u>Page</u>
Table 1. Frequency of Consumer's Preference for Degree of Doneness	18
Table 2. U.S. Population Estimated Consumption of Meat (Mean <i>per Capita</i> , g/day, NHANES 2003-2006)	19
Table 3. Estimated Meat Consumption by Cut (Mean per Capita, g/day); US Population, NHANES 2003-2006	20
Table 4. Estimated Meat Consumption by Degree of Doneness (Mean per Capita, g/day); US Population, NHANES 2003-2006	21
Table 5-A. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Meat, Chicken, and Fish ( $\mu\text{g}/\text{day}$ , Mean <i>per Capita</i> , NHANES 2003-2006)	22
Table 5-B. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Meat, Chicken, and Fish ( $\mu\text{g}/\text{kg-BW}/\text{day}$ , Mean <i>per Capita</i> , NHANES 2003-2006)	22
Table 6-A. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Chicken by Degree of Doneness ( $\mu\text{g}/\text{day}$ , Mean <i>per Capita</i> , NHANES 2003-2006)	23
Table 6-B. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Chicken by Cooking Method( $\mu\text{g}/\text{day}$ , Mean <i>per Capita</i> , NHANES 2003-2006)	23
Table 7-A. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Beef and Hamburgers ( $\mu\text{g}/\text{day}$ , Mean <i>per Capita</i> , NHANES 2003-2006)	24
Table 7-B. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Beef and Hamburgers by Degree of Doneness( $\mu\text{g}/\text{day}$ , Mean <i>per Capita</i> , NHANES 2003-2006)	24
Table 7-C. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Beef and Hamburgers by Method of Cooking( $\mu\text{g}/\text{day}$ , Mean <i>per Capita</i> , NHANES 2003-2006)	25
Table 8-A. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Pork and Bacon( $\mu\text{g}/\text{day}$ , Mean <i>per Capita</i> , NHANES 2003-2006)	25
Table 8-B. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Pork and Bacon by Degree of Doneness( $\mu\text{g}/\text{day}$ , Mean <i>per Capita</i> , NHANES 2003-2006)	26
Table 8-C. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Pork and Bacon by Method of Cooking( $\mu\text{g}/\text{day}$ , Mean <i>per Capita</i> , NHANES 2003-2006)	26
Table A-1. Summary Results From the IPSOS Observer Survey: Percent Consumers and Degree of Doneness Preference	41
Table A-2. Summary Results From the IPSOS Observer Survey: Percent Consuming Marinated Meat Products	45

Table B-1. HCA Data Availability – Beef	47
Table B-2. HCA Data Availability – Hamburger	52
Table B-3. HCA Data Availability – Chicken	54
Table B-4. HCA Data Availability – Pork	62
Table B-5. HCA Data Availability – Bacon Slices	70
Table B-6. HCA Data Availability – Hot Dogs	72
Table B-7. HCA Data Availability – Fish	74
Table C-1. Beef Consumption by Method of Cooking and Degree of Doneness (Mean <i>per Capita</i> , US Population, NHANES 03-06)	77
Table C-2. Hamburgers Consumption by Method of Cooking and Degree of Doneness (Mean <i>per Capita</i> , US Population, NHANES 03-06)	80
Table C-3. Chicken Consumption by Method of Cooking and Degree of Doneness (Mean <i>per Capita</i> , US Population, NHANES 03-06)	81
Table C-4. Pork Consumption by Method of Cooking and Degree of Doneness (Mean <i>per Capita</i> , US Population, NHANES 03-06)	85
Table C-5. Bacon Slice Consumption by Method of Cooking and Degree of Doneness (Mean <i>per Capita</i> , US Population, NHANES 03-06)	89
Table C-6. Hot Dog Consumption by Method of Cooking and Degree of Doneness (Mean <i>per Capita</i> , US Population, NHANES 03-06)	90
Table C-7. Fish Consumption by Method of Cooking and Degree of Doneness (Mean <i>per Capita</i> , US Population, NHANES 03-06)	91

## List of Acronyms

---

AC	1-amino-9-H-pyrido (2,3,b) Indole
AMI	American Meat Institute
AMIF	American Meat Institute Foundation
B(a)P	Benzo(a)pyrene
CDC	Centers for Disease Control
CFSII	Continuing Survey of Food Intakes by Individuals
CHARRED	Computerized Heterocyclic Amines Resource for Research in Epidemiology of Disease
DiMeIQx	2-amino-3,4,8 trimethylimidazo (4,5,f) quinoxiline
FDA	Food and Drug Administration
FFQ	Food Frequency Questionnaire
FSIS	Food Safety and Inspection Service
HCA	Heterocyclic Amines
IQ	2-amino-3,4 dimethylimidazo (4,5,f) quinoline
MeIQ	2-amino-3-methylimidazo (4,5,f) quinoline
MeIQx	2-amino-3,8 dimethylimidazo (4,5,f) quinoxiline
NAS NRC	National Academy of Sciences National Research Council
NHANES	National Health and Nutrition Examination Survey
PAH	Polycyclic aromatic hydrocarbon
PhIP	2-amino-1-methyl-6-phenylimidazo (4,5,b) pyridine
USDA	United States Department of Agriculture

# 1 EXECUTIVE SUMMARY

---

The main objectives of this study are to review of the major categories of fresh and processed meat products that are candidates for heterocyclic amine (HCA) formation and develop a matrix of levels of HCA among the major consumed meat categories (based on data in the published literature); and to conduct an exposure assessment based on known dietary consumption patterns. The project was comprised of three parts, including: 1) literature review and data compilation, 2) a consumer behavior/preference survey, and 3) a dietary exposure assessment. In phase 1, data on HCA formation based on different methods of cooking/processing were reviewed and compiled. In phase 2, an internet survey was conducted to ascertain the prevalence of various meat cooking methods that are preferred among U.S. meat consumers. In phase 3 of the study, data from phases 1 and 2 were combined with food consumption data from the National Health and Nutrition Examination Survey 2003-2006 (NHANES 03-06), to derive estimates of exposure to HAs from meat consumption.

Based on the available published data, Exponent created an Excel database of HCA and B[a]P levels for 83 types of meat cuts by cooking method and degree of doneness that were included in the consumer behavior/preference survey. Based on NHANES 2003-2006 consumption data and the consumer's behavior/preference internet survey, food intake estimates for the 83 meat cuts by methods of cooking and degree of doneness were tabulated and summarized. In this report, we summarize the data and methods that were applied to develop dietary exposure estimates for PhIP, MeIQx, DiMeIQx, and B[a]P.

Uncertainties associated with the dietary exposure estimates, particularly those associated with the existing data gaps in HCA levels in foods are also described. For the 83 meat cut/degree of doneness, the existing data gaps for PhIP, MeIQx, DiMeIQx and B[a]P are indicated.

Overall, the existing data gaps and the extrapolation/surrogating from the available HCA level data present significant uncertainty in the exposure estimates and thus these results should be carefully interpreted. If it is possible in the future to fill the HCA data gaps (described in this report), then it would be recommended to re-estimate HCA exposure based on these improved data.

## 2 PROJECT OVERVIEW

---

The objectives of this project are to:

- Review of the major categories of fresh and processed meat products that are candidates for heterocyclic amine (HCA) formation and develop a matrix of levels of HCA among the major meat categories that are consumed.
- Conduct an exposure assessment based on the likelihood of HCA formation during normal processing and handling, and the likelihood and degree of human exposure based upon known dietary consumption patterns of major meat categories.

The project was comprised of three parts, including: 1) literature review and data compilation, 2) a consumer behavior survey, and 3) a dietary exposure assessment. In phase 1, data on HCA formation based on different methods of cooking/processing are reviewed and compiled. In phase 2, an Internet survey was conducted by IPSOS Observer to ascertain the prevalence of various meat cooking methods that are preferred among U.S. meat consumers. In phase 3 of the study, data from phases 1 and 2 were combined with food consumption data from the National Health and Nutrition Examination Survey 2003-2006 (NHANES 03-06), to derive estimates of exposure to HAs from meat consumption.

The goals were to assess dietary exposure to 3 major HCAs in meat/fish: PhIP, MeIQx, DiMeIQx, and B[a]P. In this report, we summarized the data and methods that were applied to develop dietary exposure estimates. Food intake estimates for the various meat cuts, methods of cooking and degree of doneness based on NHANES consumption data and the IPSOS consumer's behavior/preference survey were tabulated and summarized. For these meat cut/degree of doneness, the available concentration data for PhIP, MeIQx, DiMeIQx and B[a]P are also summarized in this report. Uncertainties associated with the HCA and B[a]P exposure estimates particularly those associated with the existing data gap in HCA levels in foods are also described.



## 3 DATA SOURCES

---

### 3.1 Consumption Data

The major publicly available consumption surveys (e.g., USDA’s Continuing Survey of Food Intakes by Individuals (CSFII), and CDC’s NHANES) that are typically used to assess potential dietary exposures to food additives or contaminants include very limited information about factors likely to affect HCA formation. Such factors include: the cut of meat and the degree of doneness (correlates of temperature and duration) associated with the cooking method used to prepare the various meat cuts. Based on an analysis of the types of foods included in the NHANES 2003-2006 food consumption survey, intake assessment based solely on the U.S. national consumption survey would be limited to following combination of meat/fish types and cooking methods:

<b><u>Broad Meat Groups</u></b>	<b><u>Meat Types Reported in NHANES</u></b>	<b><u>Cooking Method Reported in NHANES</u></b>
<b>Beef</b>	Steak, Brisket, Roast/Pot roast Ribs, Stew meat, Jerky, Liver, Other	Boiled, cooked, dried, fried, grilled/barbecued, roasted
<b>Bacon</b>	Pork, Turkey, Beef	Smoked
<b>Burger</b>	Ground beef	Cooked
<b>Fish</b>	Various fish species	Baked, baked or broiled, boiled, cooked, dried, dried, raw, smoked
<b>Pork</b>	Ground, patty, ham, liver, chop, jerky, roast, steak, ribs, tenderloins	Baked, baked or broiled, boiled, cooked, fried, Grilled/barbecued, smoked
<b>Hotdog</b>	Hotdogs	(blank)
<b>Lunchmeat</b>		Canned, cooked
<b>Other meats</b>	Ribs, ground or patty, chop, , roast, cutlet or steak, jerky	Baked, boiled, broiled, cooked, fried Roasted
<b>Poultry</b>	Breast w/ skin, breast, w/o skin, drumstick, w/ skin, drumstick, w/o skin, fillet, ground, leg (drumstick and thigh), w/ skin	baked or broiled, baked or fried, boiled, broiled, cooked, fried, roasted

leg (drumstick and thigh), w/o skin,  
nuggets, patty, wing w/ skin, wing w/o  
skin, dark meat w/ skin, dark meat w/o  
skin

<b>Sausage</b>	Beef, bratwurst, chicken and beef, Italian, polish, pork, pork and beef, link pork, link pork and beef, turkey, turkey and pork, Vienna, turkey, pork, beef	Canned, cooked, smoked
----------------	--	------------------------

This study utilized the latest food consumption dataset to estimate meat/fish intake. The NHANES 2003-2006 (NCHS, 2008) is a complex multistage probability sample designed to be representative of the civilian U.S. population. The survey collects two days of food intake data, in addition to nutrition, demographic, and health information. The NHANES survey over-samples minorities, low-income groups, adolescents (12-19 years), and adults 60 years of age and older, and statistical weights are provided by the National Center for Health Statistics (NCHS) to adjust for the differential probabilities of selection. Participants included 10,122 subjects in 2003-2004 and 10,348 subjects in 2005-2006. Only individuals with complete and reliable 2-day dietary records were included in the analysis (N=16,783).

Given the limited descriptors for the method of cooking and degree of doneness for foods with reported consumption in NHANES, Exponent also conducted an internet-based survey to obtain data on consumers' preference for method of cooking and degree of doneness of the meat/fish that they consume. The development, implementation and application of the consumer's survey are described in the next section.

### **3.2 Consumers' Consumption Preference Survey (IPSOS Survey)**

Exponent contracted with a market research survey company, IPSOS Observer, to conduct a specially designed survey to collect supplemental information on meat cut and cooking method preferences and data on degree of doneness preference. (Refer to Appendix A for more details)

### 3.2.1 Survey Instrument

Meat cooking behavior and meat consumption frequency have been ascertained using a validated FFQ developed by Sinha et al (2005), however, most of the data were gathered for specific cohort of individuals in an epidemiologic study (e.g. Martinez et al, 2007) and are not representative of meat cooking behavior among all US consumers. Exponent, along with its contractor IPSOS Observer, developed a survey questionnaire with close-ended questions to collect information on preferred cooking methods for home and restaurant prepared meat/fish products to supplement the food and method of cooking information extractable from the NHANES food consumption survey with degree of doneness preference and usual intake information. As such the purpose of the current survey is to ascertain the consumer preference and usual consumption as it relates to the degree of doneness of various cooked meat/fish products.

The cooking temperature and time have been shown to be correlated with HA formation. However, according to a 2006 FDA/FSIS survey<sup>1</sup>, 67 % of the population owns a food thermometer, and while 54% always or often use a thermometer when cooking roasts or large cuts of meat, only 26% do so when cooking chicken parts, and 13% when cooking hamburgers. Sinha et al. (2005) report that the cooking technique and doneness level “serve as a reasonable proxy” for cooking temperature and time, the two most important elements in HA formation. Thus, for practical reasons the survey questionnaire relies on visual aids and description of degrees of doneness rather than on temperature measurements.

More details about the survey instrument and results are summarized in **Appendix A** of this report.

### 3.3 HCA Levels in Foods

A comprehensive review of the published literature was conducted to compile the readily available information on HCA levels in meat and fish products and associated method of cooking

---

<sup>1</sup> <http://www.cfsan.fda.gov/~comm/crnutri7.html>

and degree of doneness. There are two publicly available databases on HCA levels in meat and fish products:

*NCI (National Cancer Institute) CHARRED (Computerized Heterocyclic Amines Resource for Research in Epidemiology of Disease) database:*<sup>2</sup>

An excel spreadsheet of HCAs and benzo(a)pyrene (BaP) levels data is available from NCI. The data for MeIQx (ng/g meat), PhIP (ng/g meat), DiMeIQx (ng/g meat), and B[a]P (ng/g meat) are available for the following meat, cooking method and degree of doneness

➤ Meat types:

- |                      |                   |
|----------------------|-------------------|
| - Bacon              | - Ham slice       |
| - Bacon fat          | - Hamburger       |
| - Chicken            | - Pork chop       |
| - Chicken (both)     | - Sausage         |
| - Chicken (skin)     | - Sausage links   |
| - Chicken (skinless) | - Sausage patties |
| - Chicken            | - Steak           |
| - Gravy              |                   |

➤ Cooking method:

- |                     |   |
|---------------------|---|
| - Baked             | Cooked in an oven with very little or no added liquid       |
| - Boiled            | Cooked in large amount of boiling liquid.                   |
| - Deep-fat fried    | Cooked by immersing completely in hot fat                   |
| - Grilled/Barbecued | Cooked over a charcoal or gas grill.                        |
| - Microwaved        | Cooked completely in a microwave oven.                      |
| - Oven-broiled      | Cooked by direct exposure to the heat source in the oven.   |
| - Pan-fried         | Cooked in a small amount of hot fat in an open shallow pan. |
| - Stewed            | Cooked by simmering in liquid in                            |

➤ Degree of doneness: “just”, “rare”, “medium”, “well”, “very well”.

*Jakszyn et al (2004) Food Database of Nitrosamines, Heterocyclic amines, and Polycyclic Aromatic Hydrocarbons*

This database is a compilation of available published data on food concentration on nitrosamines, HCAs and PAHs (polycyclic aromatic hydrocarbons) developed by the Catalan Institute of Oncology. The database contains information on HCA levels for 297 food items and PAH levels for 313 food items. The database is based on 139 references (1982 and 2003) from 23 different

---

<sup>2</sup> <http://www.charred.cancer.gov>

countries (including the US). HCAs included in the database are MeIQx, DiMeIQx, MeIQ, PhIP, AC, and IQ. Data on HCA and PAH levels are available for the following combinations of meat and fish products, cooking methods and degree of doneness:

<b>Meat and Fish Products:</b>	<b>Cooking Methods:</b>	<b>Degree of Doneness:</b>
- Bacon (bacon, bacon fat, or pan residues)	- BA/GR: barbequed	- Uncooked
- Beef (beef, hamburger, patty, minced, extract, minute steak, steak, stock cube)	- BK/ROA: baked	- Rare
- Chicken (breast, breast w skin, breast no skin, fast food sandwich, gravy, nuggets, thigh/leg, wings, white meat, liver)	- BO: boiled	- Medium
- Duck	- BR: broiled	- Well-done
- Turkey breast	- FR: fried	- Very well done
- Pork (ham, steak, chop, belly, rib, cubes, rinds)	- MW: microwaved	- Extra well done
- Hotdog	- NE: cooked	- Not available
- Lamb (chops)	- RA: raw	
- Meat loaf	- SM: smoked	
- Sausage	- STW: stewed	
- Fish (fast food, herring, mackerel, pike-perch, salmon, swordfish, trout, tuna, whitefish, lobster, mussel, shrimp)		

In addition to these two datasets, there are other published papers that provide more limited compilation of published studies, such as a publication by Keating and Bogen (2001). Although this compilation is not as extensive as that in the CHARRED and Jakszyn 2004 databases, Keating and Bogen (2004) updated this database in 2004 and provided HA concentration data for beef and chicken based on method of cooking, cooking temperature, duration and internal temperature. Toribio et al (2007) also measured concentrations of 15 HAs in different samples of griddled beef steak.

Based on the available data, Exponent created an Excel database of HCA levels for the meat cuts and cooking method and degree of doneness combinations that were included in the IPSOS survey. The database is summarized in **Appendix B, Tables B-1 to B-7**.

## 4 METHODS OF ESTIMATING DIETARY EXPOSURE

---

### 4.1 Estimating Food Intake

Detailed food consumption data from the NHANES 2003-2006 were used in conjunction with the IPSOS survey data to estimate food intake.

Each NHANES subject provided 2 days of food consumption information. Intakes for various meat/fish cuts by cooking method and degree of doneness were estimated using Exponent's Foods and Residue Evaluation Program (FARE™ 8.42) software. We identified each individual who reported consuming a food on either of the survey days, and we used that individual's responses for both survey days. Zero consumption days are included in calculating that individual's average daily intake. Provided the ingredient/contaminant of interest is not an acute toxicant, it is appropriate to average exposures over a longer period than one day. Therefore, Exponent® used each respondent's food consumption averaged over the two days of the NHANES 2003-2006 surveys. For example, if someone reported consuming 100 grams of steak on day 1 and 150 grams of steak on day 2, his/her 2-day average steak consumption would be 125 grams  $([100+150]/2)$ .

Exponent uses the statistically weighted values from the survey in its analyses. The statistical weights compensate for variable probabilities of selection, adjust for non-response, and provide intake estimates that are representative of the U.S. population and the selected age-gender subgroups.

A 2-day average typically overestimates long-term (chronic) daily intake; however, only two nonconsecutive days' worth of food consumption data are available in the most recent NHANES 2003-2006 survey. Although the 1989-91 CSFII included food consumption diaries on three nonconsecutive days, Exponent believes that rapidly evolving trends in diet and the pace of introduction of new foods call into question the representativeness of the older data for today's consumers. Therefore, Exponent used the best publicly available dietary intake data for this analysis. Further, since chronic health effect (cancer) is the toxicity endpoint of interest in the

case of HCA, the appropriate exposure metric is mean *per capita*. In the estimation of the mean *per capita*, NHANES respondents who did not report consumption of a food are assumed as having zero intakes (assumed to be true non-eaters) and the reported consumption from the “eaters” of that food are averaged over all eaters and non-eaters. As such, it is unlikely that intakes are overestimated when expressed as mean *per capita*.

#### **4.1.1 Bridging NHANES Food Consumption with IPSOS Survey Data**

As previously described, NHANES food descriptors are limited in terms of method of cooking and the information on degree of doneness is not indicated. To develop intake for meat/fish by cuts, method of cooking and degree of doneness, Exponent developed a Monte Carlo sampling model to integrate the prevalence of type of meat cut consumed, cooking method, and degree of doneness preference among US consumers from the IPSOS survey with the NHANES 2003-2006 food consumption data. The following general approach was followed:

- When meat cut and cooking method were specified for a food of interest in the NHANES survey data, we applied the IPSOS survey’s data on consumers’ preference on the degree of doneness
- When meat cut was specified but cooking method was not specified for a food of interest in the NHANES survey data, we applied the IPSOS survey’s data on consumers’ preference on method of cooking and degree of doneness.
- When a meat/fish food was not further specified in terms of cut and cooking method in the NHANES survey data, we applied the IPSOS survey’s data on consumption frequency for types of cuts, cooking method and degree of doneness.

Overall, NHANES food codes for meat/fish were mapped into 83 food groups based on type of meat, cut, and cooking method. Each of these was then classified into categories based on degree of doneness.

## 4.2 Estimating Exposure to HCA

The HCA intakes for each survey participant were derived by multiplying the amount of food consumed by concentration of the HCA in that food and then summing that information over all the foods reported consumed by that individual. Per capita estimates were derived by averaging the estimated HCA intakes over the population. Relative to the food intake database, the PhIP, MeIQx, DiMeIQx and B[a]P data were much less robust. Of the 83 foods classified based on meat cut and cooking method, concentration data were not available for 34 foods (41%). They include:

### **Beef Products**

- Oven Baked Beef Steak
- Grilled/BBQ Beef Ribs
- Oven Broiled Beef Ribs
- Fried Beef Ribs
- Oven Baked Beef Ribs
- Microwave Baked Beef Ribs
- Grilled/BBQ Beef Brisket
- Oven Broiled Beef Brisket
- Fried Beef Brisket
- Oven Baked Beef Brisket
- Microwave Baked Beef Brisket
- Microwave Baked Beef Roast
- Oven Baked Hamburgers/Beef patties

### **Pork Products**

- Oven Broiled Pork Ribs
- Fried Pork Ribs
- Microwave Baked Pork Ribs
- Oven Broiled Pork Tenderloins
- Fried Pork Tenderloins
- Oven Baked Pork Tenderloins
- Microwave Baked Pork Tenderloins
- Oven Broiled Pork Roast
- Fried Pork Roast
- Oven Baked Pork Roast
- Microwave Baked Pork Roast
- Oven Baked Ham Slices
- Microwave Baked Ham Slices

### **Other Meats (bacon, hotdog, and sausages)**

- Oven Baked Bacon
- Grilled/BBQ Bacon
- Microwaved Baked Hot Dogs

### **Chicken Products**

- Rotisserie Chicken

### **Fish Products**

- Fried fish
- Oven broiled fish
- Oven baked fish
- Microwave baked fish

The B[a]P data are non-existent for all fish types. In order to carry out the exposure assessment, the following data treatment approach was applied to the foods with missing HCA information:

- When concentration data are not available for a specific meat cut or cooking method, values for a similar meat/cooking method were used as surrogate. For example, PhIP data were not available for oven baked beef steak, but data were available for oven broiled beef steaks and grilled/BBQ beef steaks. Since oven baking is more similar to oven broiling than grilling/BBQing, oven baked beef steak was assumed to have the same PhIP levels as oven broiled beef steak.
- When concentration data are not available for a degree of doneness, interpolation from levels reported for the lesser and higher degree of doneness was carried out. For instance if data were not available for the “Well done” category, but were available for the



“Medium well” and “Very well done” categories, linear interpolation between the two categories was used to estimate levels for the “Well done” category.

Overall, the existing data gaps in the HCA levels in meat/fish and the extrapolation/surrogating from the available data as described above present significant uncertainty in the exposure assessment. Dietary exposure estimates based on the extant HCA and B[a]P data should be carefully interpreted.

## 5 RESULTS AND DISCUSSION

---

### 5.1 IPSOS Survey

Consumers' preferences for degree of doneness by meat types are summarized in table 1. Based on the survey results, most consumers prefer their beef (cuts) just done (28.38%), medium well (20.10%), and well done (24.44%). The majority of consumers also prefer their hamburgers, chicken, pork, bacon and fish to be well done (32.73%, 56.29%, 46.59%, 50.07%, and 41.08%, respectively) and their hotdogs to be medium well (40.23%).

**Table 1. Frequency of Consumer's Preference for Degree of Doneness**

Meat/Fish Types	Degree of Doneness (Frequency %)					
	Rare	Medium rare	Just done	Medium well	Well done	Very well done
<b>Beef</b>	4.15%	16.86%	28.38%	20.10%	24.44%	6.08%
<b>Hamburgers</b>	2.79%	10.20%	24.27%	24.08%	32.73%	5.94%
<b>Chicken</b>	-	-	9.17%	23.40%	56.29%	11.14%
<b>Pork</b>	-	-	16.32%	29.26%	46.59%	7.82%
<b>Bacon</b>	-	-	10.41%	21.33%	50.07%	18.19%
<b>Hot dogs</b>	-	-	13.18%	40.23%	38.63%	7.96%
<b>Fish</b>	0.67%	2.49%	22.38%	28.13%	41.08%	5.25%

## 5.2 Meat Intake by Method of Cooking and Degree of Doneness

Since meat dishes can be either: (i) mostly meat (e.g., fried chicken) or (ii) mixed dishes (e.g., chicken fried rice), meat consumption from foods that are mostly meat captures a portion of total meat consumption. Table 2 provides a summary of per capita meat intakes when mixed dishes are included and when they are not. With the exception of chicken, consumption of non-mixed dishes, i.e., consumption of the mostly meat dishes, captured >75% of the overall meat/fish intake among US consumers. The current study focuses on non-mixed dishes and the intake results presented here are based on non-mixed (excluding mixed) dishes.

Based on NHANES 2003-2006 data, the mean *per capita* intake in g/day for the foods that were captured in this study was the highest for chicken (26.23 g/day) and the lowest for pork (7.57 g/day). Beef intake was second highest (mean *per capita* 19.76 g/day). Fish intake was slightly above pork consumption (mean *per capita* 8.81 g/day). Bacon and hotdogs combined mean *per capita* intake was 11.14 g/day

**Table 2. U.S. Population Estimated Consumption of Meat (Mean *per Capita*, g/day, NHANES 2003-2006**

Meat Type	Excluding Mixed Dishes	Including Mixed Dishes	% of Total
Beef	19.76	26.1	76%
Pork	7.57	9.8	77%
Chicken	26.23	35.8	73%
Bacon and hotdogs*	11.14	14.7	76%
Fish	8.81	9.03	95%

\*include sausages

Consumption of meat and fish based on cut type are summarized in Table 3. In beef group, steak and hamburger have the highest consumption (mean per capita 8.52 g/day and 8.38 g/day, respectively). In the chicken meat group, skinless chicken breast has the highest intake (mean

per capita 9.57 g/day), and in the pork meat group, pork chops have the highest intake (mean per capita 2.89 g/day).

**Table 3. Estimated Meat Consumption by Cut (Mean per Capita, g/day); US Population, NHANES 2003-2006**

<b>Meat Type</b>	<b>Cut Type</b>	<b>g/day</b>	<b>g/kg-bw/day</b>
Beef	Brisket	0.14	0.002
	Ribs	0.42	0.007
	Roast	1.86	0.027
	Steak	8.52	0.123
	NFS	0.45	0.007
Beef (Hamburger)	NA	8.38	0.131
Pork	Ham	1.87	0.028
	Pork chops	2.89	0.045
	Ribs	1.35	0.018
	Roast	0.81	0.011
	Tenderloins	0.24	0.004
	NFS	0.41	0.007
Chicken	Breast skin	2.22	0.031
	Breast skinless	9.57	0.162
	Other pieces skin	5.76	0.093
	Other pieces skinless	4.46	0.109
	NFS	4.22	0.063
Bacon	NA	1.39	0.022
Hot dog	NA	9.75	0.176
Fish	NA	8.54	0.129

Consumption of meat and fish based on degree of doneness are summarized in Table 4. Medium rare, just done and medium well done beef and hamburger have the highest consumption.

Consumption for all other meat and fish are highest in the medium and well done categories.

**Table 4. Estimated Meat Consumption by Degree of Doneness (Mean per Capita, g/day); US Population, NHANES 2003-2006**

	<b>Doneness Degree</b>	<b>g/day</b>	<b>g/kg-bw/day</b>
Beef	Rare	0.737	0.011
	Medium rare	2.937	0.043
	Just done	2.912	0.042
	Medium well	2.264	0.033
	Well done	2.065	0.030
	Very well done	0.469	0.007
Hamburgers	Rare	0.226	0.004
	Medium rare	0.894	0.014
	Just done	2.112	0.033
	Medium well	2.060	0.032
	Well done	2.634	0.041
	Very well done	0.452	0.007
Chicken	Rare	0.000	0.000
	Medium rare	0.000	0.000
	Just done	2.301	0.040
	Medium well	6.178	0.109
	Well done	14.818	0.258
	Very well done	2.931	0.051
Pork	Rare	0.000	0.000
	Medium rare	0.000	0.000
	Just done	1.247	0.019
	Medium well	2.254	0.034
	Well done	3.576	0.053
	Very well done	0.495	0.007
Bacon	Rare	0.000	0.000
	Medium rare	0.000	0.000
	Just done	0.123	0.002
	Medium well	0.275	0.004
	Well done	0.718	0.011
	Very well done	0.276	0.004
Hot dogs	Rare	0.000	0.000
	Medium rare	0.000	0.000
	Just done	1.256	0.023
	Medium well	3.953	0.071
	Well done	3.848	0.069
	Very well done	0.695	0.013
Fish	Rare	0.040	0.001
	Medium rare	0.162	0.002
	Just done	1.838	0.028
	Medium well	2.429	0.037
	Well done	3.600	0.054
	Very well done	0.470	0.007

### 5.3 Dietary Exposure to HCA

Tables 5-A and 5-B summarize the intake of HCA and B[a]P from meat and fish by the U.S. population. Data are expressed in  $\mu\text{g}/\text{day}$  (Table 5-A) and  $\mu\text{g}/\text{kg}\text{-bw}/\text{day}$  (Table 5-B) on the mean *per capita* basis. Overall, on a  $\mu\text{g}/\text{day}$  basis, chicken contribution to the total dietary exposure to PhIP and DiMeIQx and B[a]P were the highest, at 81% (0.82  $\mu\text{g}/\text{day}$ ) and 74% (0.0078  $\mu\text{g}/\text{day}$ ) respectively; fish contributes the most to total MeIQx dietary exposure (35% or 0.023  $\mu\text{g}/\text{day}$ ); and beef contributes the most to total B[a]P exposure (52% or 0.014  $\mu\text{g}/\text{day}$ ). On a  $\mu\text{g}/\text{kg}\text{-bw}/\text{day}$  basis, a similar pattern was observed.

**Table 5-A. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Meat, Chicken, and Fish ( $\mu\text{g}/\text{day}$ , Mean *per Capita*, NHANES 2003-2006)**

Meat Types	PhIP	% of total	MeIQx	% of total	DiMeIQx	% of total	B[a]P	% of total
Beef	6.7E-02	7%	1.2E-02	19%	1.2E-03	12%	1.4E-02	52%
Hamburgers	6.5E-03	1%	8.0E-03	12%	4.3E-04	4%	1.3E-03	5%
Chicken	8.2E-01	81%	1.6E-02	25%	7.8E-03	74%	1.2E-02	43%
Pork	3.0E-03	0%	3.2E-03	5%	3.0E-04	3%	4.6E-05	0%
Bacon Slides	7.7E-03	1%	2.3E-03	3%	1.7E-04	2%	1.5E-05	0%
Hot Dogs	8.7E-04	0%	1.0E-03	2%	0.0E+00	0%	4.3E-05	0%
Fish	1.0E-01	10%	2.3E-02	35%	6.1E-04	6%	0.0E+00	0%
TOTAL	1.0E+00	100%	6.6E-02	100%	1.1E-02	100%	2.7E-02	100%

**Table 5-B. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Meat, Chicken, and Fish ( $\mu\text{g}/\text{kg}\text{-BW}/\text{day}$ , Mean *per Capita*, NHANES 2003-2006)**

Meat Types	PhIP	% of total	MeIQx	% of total	DiMeIQx	% of total	B[a]P	% of total
Beef	9.7E-04	6%	1.8E-04	17%	1.8E-05	10%	2.0E-04	49%
Hamburgers	1.0E-04	1%	1.2E-04	12%	6.7E-06	4%	2.0E-05	5%
Chicken	1.4E-02	83%	2.7E-04	27%	1.3E-04	76%	1.9E-04	45%
Pork	4.2E-05	0%	4.9E-05	5%	4.7E-06	3%	6.8E-07	0%
Bacon Slices	1.2E-04	1%	3.6E-05	3%	2.7E-06	2%	2.4E-07	0%
Hot Dogs	1.6E-05	0%	1.8E-05	2%	0.0E+00	0%	7.8E-07	0%
Fish	1.6E-03	10%	3.5E-04	34%	9.2E-06	5%	0.0E+00	0%
TOTAL	1.6E-02	100%	1.0E-03	100%	1.7E-04	100%	4.1E-04	100%

Tables 6-A and 6-B summarize the dietary exposure to HCA and B[a]P from chicken consumption alone by the U.S. population in  $\mu\text{g}/\text{day}$  and  $\mu\text{g}/\text{kg}\text{-bw}/\text{day}$ . Table 6-A provides exposure estimates by degree of doneness while Table 6-B provides exposure estimates by cooking method. Well done chicken consumption provide the highest exposure to HCA and B[a]P (PhIP = 0.46  $\mu\text{g}/\text{day}$ , MeIQx = 0.0088  $\mu\text{g}/\text{day}$ , DiMeIQx = 0.0049  $\mu\text{g}/\text{day}$ , and B[a]P = 0.0075  $\mu\text{g}/\text{day}$ ) (Table 6-A). Consumption of grilled/BBQ chicken resulted in the highest exposure to PhIP (0.54  $\mu\text{g}/\text{day}$ ), MeIQx (0.0083  $\mu\text{g}/\text{day}$ ) and B[a]P (0.01  $\mu\text{g}/\text{day}$ ), while consumption of fried chicken resulted in the highest exposure to DiMeIQx (0.005  $\mu\text{g}/\text{day}$ ) (Table 6-B).

**Table 6-A. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Chicken by Degree of Doneness ( $\mu\text{g}/\text{day}$ , Mean *per Capita*, NHANES 2003-2006)**

Doneness	$\mu\text{g}/\text{day}$				$\mu\text{g}/\text{kg}\text{-BW}/\text{day}$			
	PhIP	MeIQx	DiMeIQx	B[a]P	PhIP	MeIQx	DiMeIQx	B[a]P
Rare	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Medium rare	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Just done	9.4E-03	1.1E-04	1.4E-05	2.5E-04	1.6E-04	1.9E-06	2.2E-07	4.0E-06
Medium well	1.2E-01	2.0E-03	1.1E-03	2.2E-03	1.9E-03	3.4E-05	1.8E-05	3.5E-05
Well done	4.6E-01	8.8E-03	4.9E-03	7.5E-03	7.6E-03	1.5E-04	8.2E-05	1.2E-04
Very well done	2.3E-01	5.3E-03	1.8E-03	1.7E-03	3.9E-03	8.8E-05	3.0E-05	2.7E-05
<b>Sub-Total</b>	8.2E-01	1.6E-02	7.8E-03	1.2E-02	1.4E-02	2.7E-04	1.3E-04	1.9E-04

**Table 6-B. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Chicken by Cooking Method(  $\mu\text{g}/\text{day}$ , Mean *per Capita*, NHANES 2003-2006)**

Cooking Method	$\mu\text{g}/\text{day}$				$\mu\text{g}/\text{kg}/\text{day}$			
	PhIP	MeIQx	DiMeIQx	B[a]P	PhIP	MeIQx	DiMeIQx	B[a]P
Fried	1.5E-01	6.9E-03	5.0E-03	7.2E-04	2.4E-03	1.2E-04	8.3E-05	1.2E-05
Grilled/BBQ	5.4E-01	8.3E-03	2.8E-03	1.0E-02	8.9E-03	1.4E-04	4.7E-05	1.6E-04
Microwaved Baked	0.0E+00	8.2E-05	0.0E+00	1.0E-05	0.0E+00	1.5E-06	0.0E+00	1.8E-07
Oven Baked	0.0E+00	4.4E-04	0.0E+00	5.4E-05	0.0E+00	7.6E-06	0.0E+00	9.5E-07
Oven Broiled	1.3E-01	5.2E-04	3.1E-05	4.4E-04	2.1E-03	8.9E-06	5.7E-07	8.0E-06
Rotisserie Chicken	6.3E-03	1.6E-05	2.8E-06	2.3E-05	9.7E-05	2.5E-07	4.3E-08	3.5E-07
<b>Sub-Total</b>	8.2E-01	1.6E-02	7.8E-03	1.2E-02	1.4E-02	2.7E-04	1.3E-04	1.9E-04

Tables 7-A, 7-B, and 7-C summarize the dietary exposure to HCA and B[a]P from beef and hamburger consumption by the U.S. population in  $\mu\text{g}/\text{day}$  and  $\mu\text{g}/\text{kg}\text{-bw}/\text{day}$ . Table 7-A provides exposure estimates by beef types while Table 7-B provides exposure estimates by degree of doneness and Table 7-C provides exposure estimates by cooking method. Consistent with steak having high intake, the exposure estimates for HCA and B[a]P were the highest for steak (PhIP =  $0.06 \mu\text{g}/\text{day}$ , MeIQx =  $0.011 \mu\text{g}/\text{day}$ , DiMeIQx =  $0.00098 \mu\text{g}/\text{day}$ , and B[a]P =  $0.012 \mu\text{g}/\text{day}$ ) (Table 7-A). Most of the exposure to HCA and B[a]P were from consumption of just done, medium well, and well done meat and hamburgers (Table 7-B). Consumption of grilled/BBQ beef and hamburgers resulted in the highest exposure to PhIP ( $0.049 \mu\text{g}/\text{day}$ ) and B[a]P ( $0.015 \mu\text{g}/\text{day}$ ), while consumption of fried beef and hamburgers resulted in the highest exposure to MeIQx ( $0.01 \mu\text{g}/\text{day}$ ) and DiMeIQx ( $0.00071 \mu\text{g}/\text{day}$ ) (Table 7-C).

**Table 7-A. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Beef and Hamburgers ( $\mu\text{g}/\text{day}$ , Mean *per Capita*, NHANES 2003-2006)**

Beef Types	$\mu\text{g}/\text{day}$				$\mu\text{g}/\text{kg}/\text{day}$			
	PhIP	MeIQx	DiMeIQx	B[a]P	PhIP	MeIQx	DiMeIQx	B[a]P
Steak	6.0E-02	1.1E-02	9.8E-04	1.2E-02	8.7E-04	1.6E-04	1.4E-05	1.8E-04
Beef Brisket	1.4E-03	2.3E-04	2.0E-05	3.0E-04	2.1E-05	3.4E-06	2.9E-07	4.4E-06
Beef Ribs	4.7E-03	7.7E-04	6.1E-05	1.1E-03	7.6E-05	1.3E-05	9.9E-07	1.8E-05
Beef Roast	1.8E-04	1.8E-04	1.8E-04	1.6E-05	2.6E-06	2.6E-06	2.6E-06	2.3E-07
Hamburgers	6.5E-03	8.0E-03	4.3E-04	1.3E-03	1.0E-04	1.2E-04	6.7E-06	2.0E-05
Sub-Total	7.3E-02	2.0E-02	1.7E-03	1.5E-02	1.1E-03	3.0E-04	2.5E-05	2.2E-04

**Table 7-B. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Beef and Hamburgers by Degree of Doneness ( $\mu\text{g}/\text{day}$ , Mean *per Capita*, NHANES 2003-2006)**

Degree of Doneness	$\mu\text{g}/\text{day}$				$\mu\text{g}/\text{kg}/\text{day}$			
	PhIP	MeIQx	DiMeIQx	B[a]P	PhIP	MeIQx	DiMeIQx	B[a]P
Rare	2.4E-03	2.2E-04	6.3E-06	0.0E+00	3.4E-05	3.3E-06	9.2E-08	0.0E+00
Medium rare	1.4E-02	1.8E-03	1.2E-04	2.8E-03	2.0E-04	2.6E-05	1.8E-06	4.1E-05
Just done	1.6E-02	2.8E-03	3.0E-04	4.5E-03	2.3E-04	4.2E-05	4.4E-06	6.6E-05
Medium well	1.5E-02	4.7E-03	3.5E-04	3.7E-03	2.2E-04	7.0E-05	5.2E-06	5.4E-05
Well done	1.5E-02	7.5E-03	4.5E-04	3.2E-03	2.3E-04	1.1E-04	6.8E-06	4.8E-05
Very well done	1.1E-02	3.2E-03	4.3E-04	9.3E-04	1.6E-04	4.8E-05	6.4E-06	1.4E-05
Sub-Total	7.3E-02	2.0E-02	1.7E-03	1.5E-02	1.1E-03	3.0E-04	2.5E-05	2.2E-04



**Table 7-C. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Beef and Hamburgers by Method of Cooking(  $\mu\text{g/day}$ , Mean *per Capita*, NHANES 2003-2006)**

Cooking method	$\mu\text{g/day}$				$\mu\text{g/kg/day}$			
	PhIP	MeIQx	DiMeIQx	B[a]P	PhIP	MeIQx	DiMeIQx	B[a]P
Fried	1.2E-02	1.0E-02	7.1E-04	4.6E-05	1.7E-04	1.5E-04	1.0E-05	7.2E-07
Grilled/BBQ	4.9E-02	8.1E-03	6.5E-04	1.5E-02	7.2E-04	1.2E-04	9.8E-06	2.2E-04
Microwaved Baked	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Oven Baked	5.2E-03	1.2E-03	2.5E-04	3.3E-05	7.7E-05	1.8E-05	3.6E-06	4.9E-07
Oven Broiled	7.0E-03	8.5E-04	5.8E-05	2.2E-05	1.0E-04	1.3E-05	8.5E-07	3.4E-07
Sub-Total	7.3E-02	2.0E-02	1.7E-03	1.5E-02	1.1E-03	3.0E-04	2.5E-05	2.2E-04

Tables 8-A, 8-B, and 8-C summarize the dietary exposure to HCA and B[a]P from pork and bacon consumption by the U.S. population in  $\mu\text{g/day}$  and  $\mu\text{g/kg-bw/day}$ . Table 8-A provides exposure estimates by pork types, while Table 8-B provides exposure estimates by degree of doneness and Table 8-C provides exposure estimates by cooking method. Bacon consumption contributed the highest exposure to PhIP and MeIQx (0.0077  $\mu\text{g/day}$  and 0.0023  $\mu\text{g/day}$ , respectively) (Table 8-A). Pork chops intake lead to the highest exposure to DiMeIQx (0.00025  $\mu\text{g/day}$ ) and B[a]P (0.000022  $\mu\text{g/day}$ ). Well done pork consumption lead to the highest exposure estimates for all three HCA and B[a]P (PhIP = 0.0051  $\mu\text{g/day}$ , MeIQx = 0.0028  $\mu\text{g/day}$ , DiMeIQx = 0.00024  $\mu\text{g/day}$ , and B[a]P = 0.000041  $\mu\text{g/day}$ ) (Table 8-B). Consumption of fried pork meats resulted in the highest exposure to MeIQx (0.003  $\mu\text{g/day}$ ), DiMeIQx (0.00023  $\mu\text{g/day}$ ) and B[a]P (0.000024  $\mu\text{g/day}$ ), while consumption of grilled/BBQ pork resulted in the highest exposure to PhIP (0.0037  $\mu\text{g/day}$ ) (Table 8-C).

**Table 8-A. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Pork and Bacon( $\mu\text{g/day}$ , Mean *per Capita*, NHANES 2003-2006)**

Pork Type	$\mu\text{g/day}$				$\mu\text{g/kg/day}$			
	PhIP	MeIQx	DiMeIQx	B[a]P	PhIP	MeIQx	DiMeIQx	B[a]P
Bacon	7.7E-03	2.3E-03	1.7E-04	1.5E-05	1.2E-04	3.6E-05	2.7E-06	2.4E-07
Ham Slices	3.0E-04	4.0E-04	4.3E-06	5.7E-06	4.4E-06	6.0E-06	6.5E-08	8.6E-08
Pork Chop	7.0E-04	2.1E-03	2.5E-04	2.2E-05	1.1E-05	3.2E-05	3.9E-06	3.4E-07
Pork Ribs	1.8E-03	4.7E-04	3.0E-05	1.1E-05	2.4E-05	6.3E-06	4.0E-07	1.4E-07
Pork Roast	1.2E-04	1.8E-04	8.6E-06	6.2E-06	1.6E-06	2.5E-06	1.2E-07	8.6E-08
Pork Tenderloins	6.9E-05	1.2E-04	8.7E-06	2.0E-06	1.1E-06	2.0E-06	1.4E-07	3.3E-08
Sub-Total	1.1E-02	5.5E-03	4.8E-04	6.1E-05	1.6E-04	8.5E-05	7.4E-06	9.3E-07

**Table 8-B. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Pork and Bacon by Degree of Doneness( $\mu\text{g}/\text{day}$ , Mean *per Capita*, NHANES 2003-2006)**

Doneness	$\mu\text{g}/\text{day}$				$\mu\text{g}/\text{kg}/\text{day}$			
	PhIP	MeIQx	DiMeIQx	B[a]P	PhIP	MeIQx	DiMeIQx	B[a]P
Rare	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Medium rare	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
Just done	2.2E-04	1.2E-04	2.8E-06	5.8E-07	3.4E-06	3.8E-08	9.2E-09	1.9E-06
Medium well	1.5E-03	8.3E-04	6.8E-05	1.2E-05	2.3E-05	1.1E-06	1.8E-07	1.3E-05
Well done	5.1E-03	2.8E-03	2.4E-04	4.1E-05	7.7E-05	3.7E-06	6.2E-07	4.3E-05
Very well done	3.9E-03	1.8E-03	1.7E-04	7.9E-06	6.1E-05	2.6E-06	1.2E-07	2.8E-05
Sub-Total	1.1E-02	5.5E-03	4.8E-04	6.1E-05	1.6E-04	7.4E-06	9.3E-07	8.5E-05

**Table 8-C. U.S. Population Estimated Intake of PhIP, MeIQx, DiMeIQx, and B[a]P from Consumption of Pork and Bacon by Method of Cooking( $\mu\text{g}/\text{day}$ , Mean *per Capita*, NHANES 2003-2006)**

Cooking Method	$\mu\text{g}/\text{day}$				$\mu\text{g}/\text{kg}/\text{day}$			
	PhIP	MeIQx	DiMeIQx	B[a]P	PhIP	MeIQx	DiMeIQx	B[a]P
Fried	1.3E-03	3.0E-03	2.3E-04	2.4E-05	2.1E-05	4.7E-05	3.7E-06	3.7E-07
Grilled/BBQ	3.7E-03	1.8E-03	1.4E-04	1.4E-05	5.7E-05	2.7E-05	2.2E-06	2.0E-07
Micro waved Baked	2.1E-04	1.8E-04	1.4E-05	3.3E-06	3.4E-06	2.9E-06	2.2E-07	5.2E-08
Microwaved Baked	0.0E+00	1.4E-05	0.0E+00	1.3E-06	0.0E+00	2.1E-07	0.0E+00	1.9E-08
Oven Baked	3.1E-03	3.0E-04	5.0E-05	1.3E-05	4.8E-05	4.6E-06	7.4E-07	1.9E-07
Oven Broiled	2.3E-03	2.1E-04	3.5E-05	6.5E-06	3.5E-05	3.2E-06	5.3E-07	9.6E-08
Sub-Total	1.1E-02	5.5E-03	4.8E-04	6.1E-05	1.6E-04	8.5E-05	7.4E-06	9.3E-07

## 5.4 Discussion

Representative and up-to-date food consumption rates can be readily obtained from national food consumption survey such as NHANES 2003-06. However, food descriptors are limited in terms of information about method of cooking and degree of doneness, which highly correlate with the formation of HCA and B[a]P in meat and fish. A survey was therefore conducted for Exponent by IPSOS Observer to collect information on the degree of doneness preference for 84 types of

meats and cooking methods combinations among US adult consumers. The IPSOS survey collected information via a targeted internet survey of a representative sample of subjects ages 18 year or more. Further, data on levels of PhIP, MeIQx, DiMeIQx and B[a]P in meat and fish were obtained from the published literature. When such data were not available for a specific {meat cut X cooking method X degree of doneness} combination, they were imputed from the existing data.

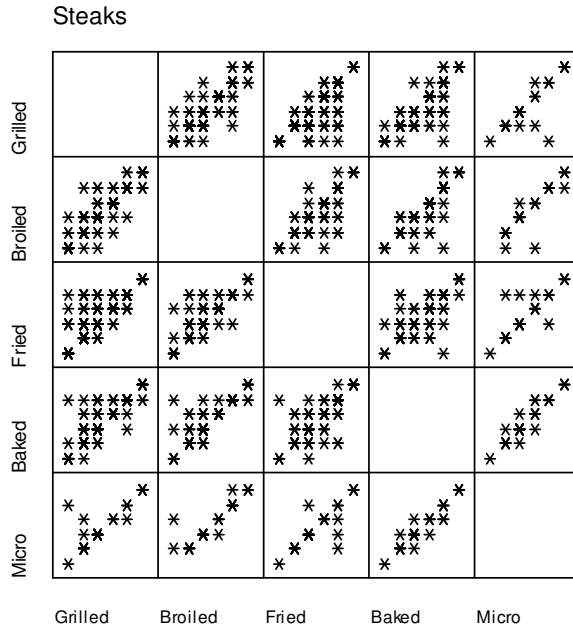
In the current study we developed intake for meat/fish by cuts, method of cooking and degree of doneness by applying the Monte Carlo sampling model to integrate the prevalence of type of meat cut consumed, cooking method, and degree of doneness preference among US consumers from the IPSOS survey with the NHANES 2003-2006 food consumption data. The approach used to integrate the data from both surveys randomly allocated a degree of doneness preference to each meat eating occasion in the NHANES survey. The Monte Carlo model used did not assume any correlation in the doneness preference across meat cut types and cooking methods for a given individual. A graphical examination of the IPSOS data indicates that there may be some correlation in the doneness preference across cooking methods for some products, e.g., steaks (Figure 1) or beef ribs (Figure 2), but that this may not necessarily apply to all products, e.g., pork chops (Figure 3). Further, an examination of the data to determine if subjects tend to prefer similar doneness levels for given cooking methods (across multiple meats and cuts) indicates that this assumption may not be true (Figure 4). If correlations were accounted for the extreme percentile estimates (i.e. 5<sup>th</sup>, 95<sup>th</sup> percentiles) would be lower (at the 5<sup>th</sup> percentile) or higher (at the 95<sup>th</sup> percentile) than when correlations were not accounted for. However, these effects are not likely to be observed at the mean, which is the focus of this study analysis.

Relative to the robust food consumption and the consumer's preference data obtained from NHANES 2003-2006 and the IPSOS survey, respectively, the data on levels of PhIP, MeIQx, DiMeIQx and B[a]P in meat and fish were more limited. Of the 83 foods classified based on meat cut, cooking method and degree of doneness included in the current study, concentration data were not available for 34 foods (41%), most of which are beef and pork types. The B[a]P data were non-existent for all fish types. Further, since the concentration data were published compilation of existing studies, the quality of the data (and original studies) is unknown.

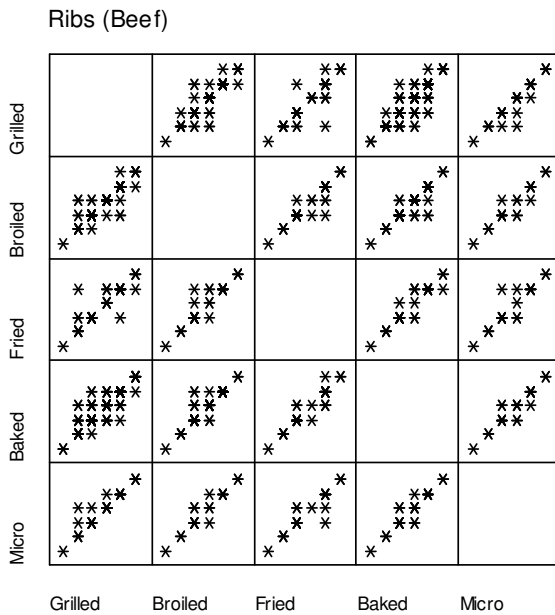
In assessing dietary exposure, values for the missing data were extrapolated based on the concentration data that are available for similar meat/fish types, cut and degree of doneness. Since the imputed data may not be representative of levels expected to occur in these meat cuts and degree of doneness the conclusions reached on the relative ranking of exposures for various products should be viewed with caution. For instance, data from the IPSOS survey indicate that Grilled/BBQ steak are among the most frequently consumed beef foods of interest (percent consumers: 67.9%), and that the most preferred doneness level for Grilled/BBQ steak is “Medium rare” (33.9% of consumers of the food). However, no PhIP data were available for that combination of beef cut and degree of doneness, and the exposure assessment used a value interpolated between the levels reported for the “Rare” and “Just Done” categories. Since there is a large difference in levels reported for these two categories (2.53 ng/g vs. 12.0 ng/g), the impact of the linear assumption used in the derivation of the assumed level for the “Medium rare” category may be significant. Similar potential uncertainties exist for several meat cuts. In some instances, the published levels for the less done categories were higher than for the more done ones. For instance, in the case of oven broiled steaks, the levels reported in the published literature for the “Rare” and “Just done” categories were: 6.14 ng/g and 2.08 ng/g, respectively

Overall, the existing data gaps in the HCA levels in meat/fish and the extrapolation/surrogating from the available data as described in this report present significant uncertainty in the exposure estimates. Dietary exposure estimates for HCA and B[a]P based on the extant concentration data should be carefully interpreted.

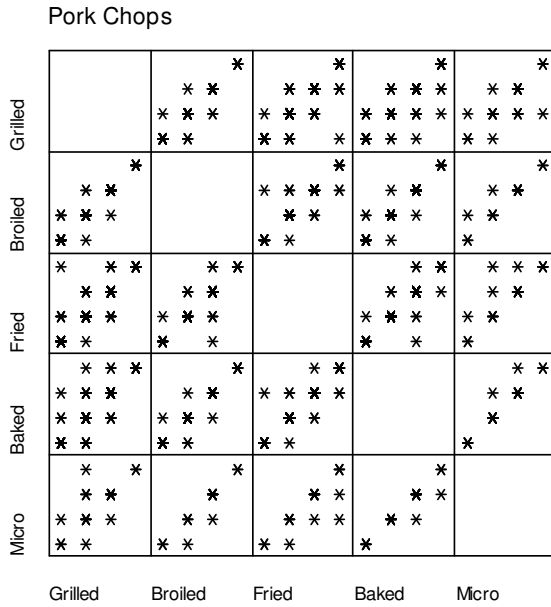
**FIGURE 1. CORRELATION IN DONENESS LEVEL PREFERENCE FOR BEEF STEAKS**



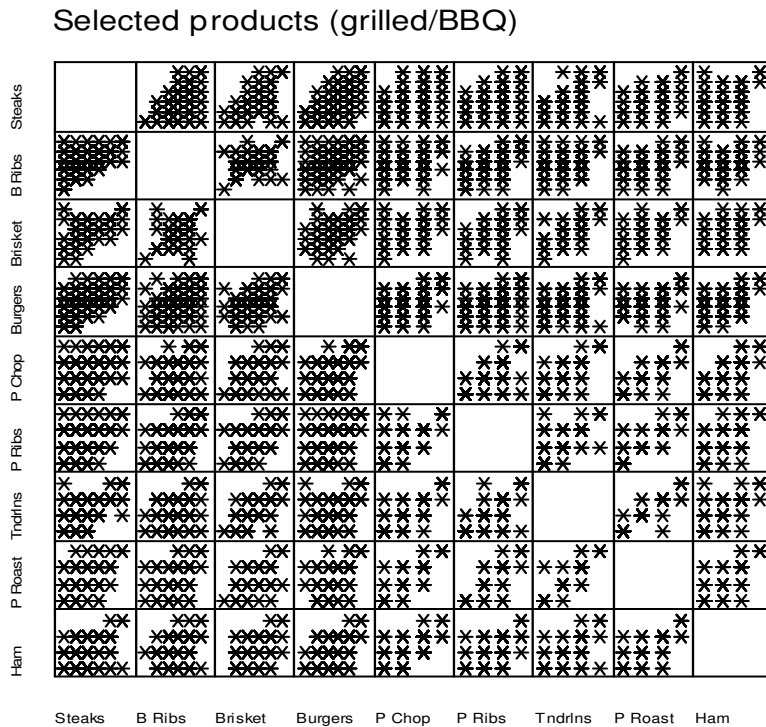
**FIGURE 2. CORRELATION IN DONENESS LEVEL PREFERENCE FOR BEEF RIBS**



**FIGURE 3. CORRELATION IN DONENESS LEVEL PREFERENCE FOR PORK CHOPS**



**FIGURE 4. CORRELATION IN DONENESS LEVEL PREFERENCE FOR GRILLED PRODUCTS**



## 6 REFERENCES

---

- Busquets R, Puignou L, Galceran MT, Skog K. 2006. Effects of red wine marinades on the formation of heterocyclic amines in fried chicken breast. *J Agric Food Chemistry*, 54(21):8376- 384.
- Butler, L.M., R. Sinha, R.C. Millikan, C.F. Martin, B. Newman, M.D. Gammon, A.S. Ammerman, R.S. Sandler, 2003. Heterocyclic amines, meat intake, and association with colon cancer in a population-based study. *Am J Epidemiol*. 157(5):434-45
- Jakszyn, P., A. Agudo, R. Ibanez, R. Garcia-Closas, G. Pera, P. Amiano, C.A. Gonzalez, 2004. Development of a food database of nitrosamines, heterocyclic amines, and polycyclic aromatic hydrocarbons *J Nutr*. 134:2011-14
- Knize, MG, Felton, JS. 2005. Formation and human risk of carcinogenic heterocyclic amines formed from natural precursors in meat. *Nutrition Reviews*, 63(5):158-165.
- Keating, G.A. and K.T. Bogen, 2004. Estimates of heterocyclic amines intake in the US population. *J Chromatogr B*. 802:127-133
- Keating, G.A. and K.T. Bogen, 2001. Methods for estimating heterocyclic amine concentrations in cooked meats in the US diet. *Food and Chemical Toxicology*. 39:29-43
- Lan CM, Kao TH and Chen BH. 2004. Effects of heating time and antioxidants on the formation of heterocyclic amines in marinated foods. *J Chromatogr B Analyt Technol Biomed Life Sci*. 802:27-37
- Martinez, M.E., E.T. Jacobs, E.L. Ashbeck, R. Sinha, P. Lance, D.S. Alberts, P.A. Thompson, 2007. Meat intake, preparation methods, mutagens and colorectal adenoma recurrence. *Carcinogenesis*. 28(9):2019-27
- Salmon, C.P. Knize, M.G. Felton, J.S. 1997. Effects of Marinating on Heterocyclic Amine Carcinogen Formation in Grilled Chicken. *Food Chem. Tox.* 35: 433-441
- Sinha R, Corss A, Curtin J, Zimmerman T, McNutt S, Risch A, Holden J. 2005. Development of a food frequency questionnaire module and databases for compounds in cooked and processed meats. *Mol. Nutr Food Res*, 49:648-655.
- Sinha, R, Rothman N, Salmon CP, Knize MG et al, 1998 (a). Heterocyclic amine content in beef cooked by different methods to varying degrees of doneness in gravy made from meat drippings. *Food Chemical Toxicology*, 36: 279-287.
- Sinha R, Knize MG, Salmon CP, Brown ED, et al, 1998 (b). Heterocyclic amine content of pork products cooked by different methods and to varying degrees of doneness. *Food Chem Tox*, 36: 289-297

Toribio F, Busquets R, Puignou L, Galceran MT. 2007. Heterocyclic amines in griddled beefsteak analyzed using a single extract clean-up procedure. Food Chem Tox. 45(4):667-675.

USDA-FSIS. The Food Safety Educator. Volume 6. (2001).



## **APPENDIX A. CONSUMER SURVEY**

---

Exponent contracted with a market research survey company, IPSOS Observer, to conduct a specially designed survey to collect supplemental information on meat cut and cooking method preferences and data on degree of doneness preference. The IPSOS survey was a custom online survey conducted via the World Wide Web with data collected electronically on IPSOS secure servers. IPSOS Observer contacted a nationally representative sample of adults age 18 years and over to complete this survey. Respondents received an initial screen and only those who had reported consuming at least one of the following eight types of meat in the past 6 months: Beef, Ground Beef, Pork, Ham, Bacon, Hotdog, Chicken or Fish were included. A total of 1,086 subjects (498 male/588 female) completed the survey. Interviewing took place from November 19 – December 1, 2008

The questionnaire used to collect the information is provided below. The subjects were asked whether they had consumed any of the products of interest in the past six months. The web-based survey automatically guided respondents across follow-up questions regarding the cooking methods and doneness degree preferences. In addition, since different subjects may have different interpretation of the definition of the doneness levels, the questionnaire provided respondents with pictures illustrating the various doneness levels to ensure some level of consistency.

**Figure A-1. Questionnaire used in the IPSOS survey: selected sections**

**EXPONENT MEAT PREPARATION SURVEY**  
Online Custom Survey  
**Ipsos Observer Job #: I10AVG100-1**

**Q.1**  
Please indicate the types of meat that you have eaten in the past 6 months.  
(Select all that apply)

Beef  
Ground Beef  
Pork  
Ham  
Bacon  
Hotdog  
Chicken  
Fish  
None

**[IF Q.1=NONE, THANK AND TERMINATE, OTHERWISE CONTINUE.]**

**SEGMENT BREAK-----**

**[IF Q.1=BEEF CONTINUE. OTHERWISE SKIP TO Q.4.]**

**Q.2**  
Which of the following types of beef have you eaten either at home or away from home in the past 6 months?  
(Select all that apply)

Grilled/BBQ Steak  
Oven Broiled Steak  
Fried Steak  
Oven Baked Steak  
Microwave Baked Steak  
Grilled/BBQ Ribs  
Oven Broiled Ribs  
Fried Ribs  
Oven Baked Ribs  
Microwave Baked Ribs  
Grilled/BBQ Brisket  
Oven Broiled Brisket  
Fried Brisket  
Oven Baked Brisket  
Microwave Baked Brisket  
Oven Baked Roast  
Microwave Baked Roast  
None of the above

**SEGMENT BREAK-----**

**[IF Q.2=NONE OF THE ABOVE SKIP TO Q.4. OTHERWISE CONTINUE.]**

**Q.3**

Please indicate how you typically consume each of the following. If needed, you can click on each photo to enlarge it.  
(Select One for each)

**[BANNER WITH THUMBNAIL PICTURES. ALLOW RESPONDENTS TO ENLARGE PHOTO IF DESIRED]**

- Rare
- Medium Rare
- Just done (Medium)
- Medium Well (Medium Well is in between Just Done and Well Done)
- Well Done
- Very Well Done

**[STUB]**  
**[PIPE-IN TYPES SELECTED IN Q2]**

**SEGMENT BREAK-----**

**[IF Q.1=GROUND BEEF CONTINUE. OTHERWISE SKIP TO Q.6.]**

**Q.4**

Which of the following types of ground beef have you eaten either at home or away from home in the past 6 months?

(Select all that apply)

- Grilled/BBQ Hamburgers/Beef patties
- Oven Broiled Hamburgers/Beef patties
- Fried Hamburgers/Beef patties
- Oven Baked Hamburgers/Beef patties
- Microwave Baked Hamburgers/Beef patties
- None of the above

**SEGMENT BREAK-----**

**[IF Q.4=NONE OF THE ABOVE SKIP TO Q.6. OTHERWISE CONTINUE.]**

**Q.5**

Please indicate how you typically consume each of the following. If needed, you can click on each photo to enlarge it.

(Select One for each)

**[BANNER WITH THUMBNAIL PICTURES. ALLOW RESPONDENTS TO ENLARGE PHOTO IF DESIRED]**

- Rare
- Medium Rare (Medium Rare is in between Rare and Just Done)
- Just done (Medium)
- Medium Well (Medium Well is in between Just Done and Well Done)
- Well Done
- Very Well Done

**[STUB]**  
**[PIPE-IN TYPES SELECTED IN Q.4]**

**SEGMENT BREAK-----**

**[IF Q.1=PORK CONTINUE. OTHERWISE SKIP TO Q.8.]**

**Q.6**

Which of the following types of pork have you eaten either at home or away from home in the past 6 months?

(Select all that apply)

- Grilled/BBQ Pork Chop
- Oven Broiled Pork Chop
- Fried Pork Chop
- Oven Baked Pork Chop
- Microwave Baked Pork Chop
- Grilled/BBQ Ribs
- Oven Broiled Ribs
- Fried Ribs
- Oven Baked Ribs
- Microwave Baked Ribs
- Grilled/BBQ Tenderloins
- Oven Broiled Tenderloins
- Fried Tenderloins
- Oven Baked Tenderloins
- Microwave Baked Tenderloins
- Grilled/BBQ Pork Roast
- Oven Broiled Pork Roast
- Fried Pork Roast
- Oven Baked Pork Roast
- Microwave Baked Pork Roast
- None of the above

**SEGMENT BREAK-----**

**[IF Q.6=NONE OF THE ABOVE SKIP TO Q.8. OTHERWISE CONTINUE.]**

**Q.7**

Please indicate how you typically consume each of the following. If needed, you can click on each photo to enlarge it.

(Select One for each)

**[BANNER WITH THUMBNAIL PICTURES. ALLOW RESPONDENTS TO ENLARGE PHOTO IF DESIRED]**

- Just done (Medium)
- Medium Well (Medium Well is in between Just Done and Well Done)
- Well Done
- Very Well Done

**[STUB]**

**[PIPE-IN TYPES SELECTED IN Q.6]**

**SEGMENT BREAK-----**

**[IF Q.1=HAM CONTINUE. OTHERWISE SKIP TO Q.10.]**

**Q.8**

Which of the following types of ham have you eaten either at home or away from home in the past 6 months?

(Select all that apply)

Grilled/BBQ Ham Slices  
Oven Broiled Ham Slices  
Fried Ham Slices  
Oven Baked Ham Slices  
Microwave Baked Ham Slices  
None of the above

**SEGMENT BREAK-----**

**[IF Q.8=NONE OF THE ABOVE SKIP TO Q.10. OTHERWISE CONTINUE.]**

**Q.9**

Please indicate how you typically consume each of the following. If needed, you can click on each photo to enlarge it.

(Select One for each)

**[BANNER WITH THUMBNAIL PICTURES. ALLOW RESPONDENTS TO ENLARGE PHOTO IF DESIRED]**

Just done (Medium)

Medium Well (Medium Well is in between Just Done and Well Done)

Well Done

Very Well Done

**[STUB]**

**[PIPE-IN TYPES SELECTED IN Q.8]**

**SEGMENT BREAK-----**

**[IF Q.1=BACON CONTINUE. OTHERWISE SKIP TO Q.12.]**

**Q.10**

Which of the following types of bacon have you eaten either at home or away from home in the past 6 months?

(Select all that apply)

Grilled/BBQ Bacon Slices  
Oven Broiled Bacon Slices  
Fried Bacon Slices  
Oven Baked Bacon Slices  
Microwave Baked Bacon Slices  
None of the above

**SEGMENT BREAK-----**

**[IF Q.10=NONE OF THE ABOVE SKIP TO Q.12. OTHERWISE CONTINUE.]**

**Q.11**

Please indicate how you typically consume each of the following. If needed, you can click on each photo to enlarge it.

(Select One for each)

**[BANNER WITH THUMBNAIL PICTURES. ALLOW RESPONDENTS TO ENLARGE PHOTO IF DESIRED]**

Just done (Medium)

Medium Well (Medium Well is in between Just Done and Well Done)

Well Done

Very Well Done

**[STUB]**

**[PIPE-IN TYPES SELECTED IN Q.10]**

**SEGMENT BREAK**-----

**[IF Q.1=HOTDOG CONTINUE. OTHERWISE SKIP TO Q.14.]**

**Q.12**

Which of the following types of hotdog have you eaten either at home or away from home in the past 6 months?

(Select all that apply)

- Grilled/BBQ Hotdog
- Oven Broiled Hotdog
- Fried Hotdog
- Oven Baked Hotdog
- Microwave Baked Hotdog
- None of the above

**SEGMENT BREAK**-----

**[IF Q.12=NONE OF THE ABOVE SKIP TO Q.14. OTHERWISE CONTINUE.]**

**Q.13**

Please indicate how you typically consume each of the following. If needed, you can click on each photo to enlarge it.

(Select One for each)

**[BANNER WITH THUMBNAIL PICTURES. ALLOW RESPONDENTS TO ENLARGE PHOTO IF DESIRED]**

Just done (Medium)

Medium Well (Medium Well is in between Just Done and Well Done)

Well Done

Very Well Done

**[STUB]**

**[PIPE-IN TYPES SELECTED IN Q.12]**

**SEGMENT BREAK**-----

**[IF Q.1=CHICKEN CONTINUE. OTHERWISE SKIP TO Q.16.]**

**Q.14**

Which of the following types of chicken have you eaten either at home or away from home in the past 6 months?

(Select all that apply)

- Rotisserie Chicken
- Grilled/BBQ Chicken Breasts, Skinless
- Oven Broiled Chicken Breasts, Skinless
- Fried Chicken Breasts, Skinless
- Oven Baked Chicken Breasts, Skinless
- Microwave Baked Chicken Breasts, Skinless
- Grilled/BBQ Chicken Breasts, With Skin
- Oven Broiled Chicken Breasts, With Skin
- Fried Chicken Breasts, With Skin
- Oven Baked Chicken Breasts, With Skin
- Microwave Baked Chicken Breasts, With Skin

Grilled/BBQ Other Chicken Pieces, Skinless  
Oven Broiled Other Chicken Pieces, Skinless  
Fried Other Chicken Pieces, Skinless  
Oven Baked Other Chicken Pieces, Skinless  
Microwave Baked Other Chicken Pieces, Skinless  
Grilled/BBQ Other Chicken Pieces, With Skin  
Oven Broiled Other Chicken Pieces, With Skin  
Fried Other Chicken Pieces, With Skin  
Oven Baked Other Chicken Pieces, With Skin  
Microwave Baked Other Chicken Pieces, With Skin  
None of the above

**SEGMENT BREAK-----**

**[IF Q.14=NONE OF THE ABOVE SKIP TO Q.16. OTHERWISE CONTINUE.]**

**Q.15**

Please indicate how you typically consume each of the following. If needed, you can click on each photo to enlarge it.

(Select One for each)

**[BANNER WITH THUMBNAIL PICTURES. ALLOW RESPONDENTS TO ENLARGE PHOTO IF DESIRED]**

Just done (Medium)

Medium Well (Medium Well is in between Just Done and Well Done)

Well Done

Very Well Done

**[STUB]**

**[PIPE-IN TYPES SELECTED IN Q14]**

**SEGMENT BREAK-----**

**[IF Q.1=FISH CONTINUE. OTHERWISE SKIP TO Q.18.]**

**Q.16**

Which of the following types of fish have you eaten either at home or away from home in the past 6 months?

(Select all that apply)

Grilled/BBQ Fish

Oven Broiled Fish

Fried Fish

Oven Baked Fish

Microwave Baked Fish

None of the above

**SEGMENT BREAK-----**

**[IF Q.16=NONE OF THE ABOVE SKIP TO Q.18. OTHERWISE CONTINUE.]**

**Q.17**

Please indicate how you typically consume each of the following. If needed, you can click on each photo to enlarge it.

(Select One for each)

**[BANNER WITH THUMBNAIL PICTURES. ALLOW RESPONDENTS TO ENLARGE PHOTO IF DESIRED]**

Rare  
Medium Rare  
Just done (Medium)  
Medium Well (Medium Well is in between Just Done and Well Done)  
Well Done  
Very Well Done

**[STUB]**  
**[PIPE-IN TYPES SELECTED IN Q16]**

**SEGMENT BREAK-----**

**Q.18**  
When you ate any of the following meat products, were they usually marinated before cooking?  
(Select all that apply)

**[BANNER]**  
Yes  
No  
Don't know  
Did Not Eat

**[STUB]**  
Beef Steak  
Beef Ribs  
Beef Brisket  
Pork Chop  
Pork Rib  
Pork Tenderloins  
Chicken  
Fish



**Table A-1. Summary Results From the IPSOS Observer Survey: Percent Consumers and Degree of Doneness Preference**

Meat type	Meat, Cut and Method of Cooking	Percent consumers	Preferred Degree of Doneness (%)					
			Rare	Medium Rare	Just done (Medium)	Medium Well	Well Done	Very Well Done
Beef		92.8						
	Grilled/BBQ Steak	67.9	8.9	33.9	25.4	17.3	11.4	3.1
	Oven Broiled Steak	30.7	8.7	30.4	27.2	18.8	11.0	3.9
	Fried Steak	31.7	5.3	25.3	25.3	20.0	20.6	3.4
	Oven Baked Steak	19.8	4.5	20.5	21.0	21.5	27.5	5.0
	Microwave Baked Steak	3.6	2.8	19.4	33.3	19.4	13.9	11.1
	Grilled/BBQ Beef Ribs	47.1	1.5	9.3	24.8	26.1	33.7	4.6
	Oven Broiled Beef Ribs	14.8	1.3	6.7	30.2	23.5	32.9	5.4
	Fried Beef Ribs	5.5	1.8	10.9	38.2	10.9	0.0	0.0
	Oven Baked Beef Ribs	25.7	1.5	5.0	23.6	27.8	37.5	4.6
	Microwave Baked Beef Ribs	3.7	5.4	10.8	21.6	27.0	27.0	8.1
	Grilled/BBQ Brisket	18.3	1.6	19.0	27.7	26.6	20.7	4.3
	Oven Broiled Brisket	9.9	4.0	19.0	38.0	15.0	17.0	7.0
	Fried Brisket	4.6	4.3	17.4	26.1	21.7	23.9	6.5
	Oven Baked Brisket	11.5	2.6	13.8	34.5	15.5	26.7	6.9
	Microwave Baked Brisket	3.8	5.3	13.2	34.2	13.2	26.3	7.9
	Oven Baked Roast	55.5	3.6	15.6	25.8	24.7	25.4	5.0
	Microwave Baked Roast	5.5	7.3	16.4	25.5	12.7	29.1	9.1
	None of the Above	6.1						
Ground Beef		92.5						
	Grilled/BBQ Hamburgers/Beef patties	77.8	2.8	13.2	26.5	25.1	27.6	4.9
	Oven Broiled Hamburgers/Beef patties	18.9	2.1	14.7	24.7	24.7	28.9	4.7
	Fried Hamburgers/Beef patties	60.0	2.5	7.3	24.7	24.4	35.5	5.6
	Oven Baked Hamburgers/Beef patties	13.4	3.7	5.9	21.5	23.7	37.8	7.4
	Microwave Baked Hamburgers/Beef patties	7.1	2.8	9.9	23.9	22.5	33.8	7.0

Meat type	Meat, Cut and Method of Cooking	Percent consumers	Preferred Degree of Doneness (%)					
			Rare	Medium Rare	Just done (Medium)	Medium Well	Well Done	Very Well Done
	None of the Above	3.2						
<b>Pork</b>		84.3						
	Grilled/BBQ Pork Chop	44.4	0.0	0.0	18.2	28.6	47.3	5.9
	Oven Broiled Pork Chop	25.5	0.0	0.0	13.7	31.8	49.4	5.2
	Fried Pork Chop	46.8	0.0	0.0	11.0	26.9	53.0	9.1
	Oven Baked Pork Chop	43.2	0.0	0.0	14.2	27.6	51.1	7.1
	Microwave Baked Pork Chop	3.8	0.0	0.0	17.1	28.6	42.9	11.4
	Grilled/BBQ Pork Ribs	41.4	0.0	0.0	12.9	28.8	51.5	6.9
	Oven Broiled Pork Ribs	13.3	0.0	0.0	11.5	32.0	48.4	8.2
	Fried Pork Ribs	5.1	0.0	0.0	10.6	25.5	55.3	8.5
	Oven Baked Pork Ribs	22.7	0.0	0.0	8.2	28.8	52.4	10.6
	Microwave Baked Pork Ribs	3.5	0.0	0.0	15.6	18.8	53.1	12.5
	Grilled/BBQ Tenderloins	23.7	0.0	0.0	24.9	34.6	36.4	4.1
	Oven Broiled Tenderloins	13.8	0.0	0.0	15.9	35.7	44.4	4.0
	Fried Tenderloins	14.3	0.0	0.0	11.5	26.7	55.0	6.9
	Oven Baked Tenderloins	22.3	0.0	0.0	14.2	31.4	46.1	8.3
	Microwave Baked Tenderloins	2.8	0.0	0.0	7.7	23.1	53.8	15.4
	Grilled/BBQ Pork Roast	14.1	0.0	0.0	20.2	31.0	40.3	8.5
	Oven Broiled Pork Roast	15.8	0.0	0.0	15.9	31.0	46.9	6.2
	Fried Pork Roast	5.1	0.0	0.0	12.8	27.7	44.7	14.9
	Oven Baked Pork Roast	43.6	0.0	0.0	14.3	23.6	53.6	8.5
	Microwave Baked Pork Roast	3.1	0.0	0.0	17.9	25.0	42.9	14.3
	None of the Above	2.5						
<b>Ham</b>		77.0						
	Grilled/BBQ Ham Slices	18.9	0.0	0.0	27.2	31.6	38.6	2.5
	Oven Broiled Ham Slices	18.7	0.0	0.0	24.4	37.8	34.6	3.2
	Fried Ham Slices	38.9	0.0	0.0	21.2	31.4	43.7	3.7
	Oven Baked Ham Slices	54.2	0.0	0.0	23.8	36.4	36.9	2.9

Meat type	Meat, Cut and Method of Cooking	Percent consumers	Preferred Degree of Doneness (%)					
			Rare	Medium Rare	Just done (Medium)	Medium Well	Well Done	Very Well Done
	Microwave Baked Ham Slices	8.7	0.0	0.0	23.3	27.4	42.5	6.8
	None of the Above	15.4						
<b>Bacon</b>		84.1						
	Grilled/BBQ Bacon Slices	12.2	0.0	0.0	10.8	20.7	49.5	18.9
	Oven Broiled Bacon Slices	11.7	0.0	0.0	13.1	27.1	45.8	14.0
	Fried Bacon Slices	83.4	0.0	0.0	7.9	18.9	52.7	20.5
	Oven Baked Bacon Slices	14.2	0.0	0.0	13.1	21.5	50.0	15.4
	Microwave Baked Bacon Slices	35.2	0.0	0.0	7.2	18.4	52.3	22.1
	None of the Above	1.8						
<b>Hotdog</b>		76.2						
	Grilled/BBQ Hotdog	64.0	0.0	0.0	7.5	37.5	46.8	8.1
	Oven Broiled Hotdog	17.0	0.0	0.0	11.3	44.7	37.6	6.4
	Fried Hotdog	25.2	0.0	0.0	7.7	32.1	50.7	9.6
	Oven Baked Hotdog	11.8	0.0	0.0	14.3	36.7	35.7	13.3
	Microwave Baked Hotdog	39.5	0.0	0.0	25.1	50.2	22.3	2.4
	None of the Above	10.6						
<b>Chicken</b>		97.6						
	Rotisserie Chicken	49.3	0.0	0.0	9.0	24.9	55.1	11.1
	Grilled/BBQ Chicken Breasts, Skinless	50.9	0.0	0.0	8.0	25.7	55.6	10.7
	Oven Broiled Chicken Breasts, Skinless	27.1	0.0	0.0	10.5	23.0	59.9	6.6
	Fried Chicken Breasts, Skinless	39.3	0.0	0.0	8.2	23.0	56.1	12.7
	Oven Baked Chicken Breasts, Skinless	50.3	0.0	0.0	9.8	22.9	57.4	9.9
	Microwave Baked Chicken Breasts, Skinless	8.4	0.0	0.0	9.0	21.3	58.4	11.2
	Grilled/BBQ Chicken Breasts, With Skin	26.2	0.0	0.0	8.3	23.4	56.5	11.9
	Oven Broiled Chicken Breasts, With Skin	14.2	0.0	0.0	7.9	20.5	63.6	7.9
	Fried Chicken Breasts, With Skin	33.6	0.0	0.0	6.2	21.1	59.8	12.9
	Oven Baked Chicken Breasts, With Skin	25.8	0.0	0.0	10.3	23.1	54.6	12.1
	Microwave Baked Chicken Breasts, With	3.9	0.0	0.0	12.2	24.4	53.7	9.8

Meat type	Meat, Cut and Method of Cooking	Percent consumers	Preferred Degree of Doneness (%)					
			Rare	Medium Rare	Just done (Medium)	Medium Well	Well Done	Very Well Done
	Skin							
	Grilled/BBQ Other Chicken Pieces, Skinless	19.2	0.0	0.0	8.8	27.0	53.4	10.8
	Oven Broiled Other Chicken Pieces, Skinless	11.5	0.0	0.0	9.8	25.4	51.6	13.1
	Fried Other Chicken Pieces, Skinless	20.4	0.0	0.0	8.8	22.7	57.9	10.6
	Oven Baked Other Chicken Pieces, Skinless	19.4	0.0	0.0	8.7	26.7	53.4	11.2
	Microwave Baked Other Chicken Pieces, Skinless	5.0	0.0	0.0	11.3	22.6	54.7	11.3
	Grilled/BBQ Other Chicken Pieces, With Skin	21.1	0.0	0.0	8.5	27.7	53.1	10.7
	Oven Broiled Other Chicken Pieces, With Skin	11.3	0.0	0.0	7.5	25.8	54.2	12.5
	Fried Other Chicken Pieces, With Skin	31.5	0.0	0.0	7.5	20.1	59.3	13.2
	Oven Baked Other Chicken Pieces, With Skin	22.5	0.0	0.0	9.6	20.9	56.5	13.0
	Microwave Baked Other Chicken Pieces, With Skin	4.4	0.0	0.0	12.8	19.1	57.4	10.6
	None of the Above	1.4						
<b>Fish</b>		<b>79.1</b>						
	Grilled/BBQ Fish	33.6	1.0	4.5	23.2	31.5	36.0	3.8
	Oven Broiled Fish	39.5	0.6	2.1	25.4	30.4	37.2	4.4
	Fried Fish	60.3	0.2	0.4	16.6	24.1	51.5	7.1
	Oven Baked Fish	54.7	0.2	1.5	22.8	30.6	39.4	5.5
	Microwave Baked Fish	8.7	1.3	4.0	24.0	24.0	41.3	5.3
	None of the Above	4.5						

**Table A-2. Summary Results From the IPSOS Observer Survey: Percent Consuming Marinated Meat Products**

<b>Product</b>	<b>When you ate the following meat products, were they marinated?</b>			
	<b>Yes</b>	<b>No</b>	<b>Don't know</b>	<b>Did Not Eat Product</b>
Beef Steak	45.0	41.3	5.4	8.3
Beef Ribs	39.7	29.2	7.0	24.1
Beef Brisket	26.5	29.2	8.2	36.1
Pork Chop	28.0	52.9	6.1	13.0
Pork Rib	30.9	35.7	8.1	25.2
Pork Tenderloins	30.6	38.4	7.0	24.0
Chicken	45.9	46.9	5.6	1.7
Fish	20.6	58.0	6.5	14.8

## APPENDIX B. RESIDUE DATA AVAILABILITY

---

The following tables (B-1 to B-7) summarize the concentration data that are publicly available for the specific meat types, by cut, cooking method and degree of doneness or that were imputed from the available data. The sources for the data presented in this appendix are listed below. The {meat cut X cooking method X degree of doneness} combinations are the same as those included in the consumer internet-based survey and that were mapped to intakes (g/day) from the NHANES 2003-2006 and presented in this report. When the data for for PHiP, MeIQx, DiMeIQx and B[a]P for a given {meat cut X cooking method X degree of doneness} combination were not available in the published literature, the approach used to extrapolate the missing data is also noted in the comment field. This extrapolation represents a major source of uncertainty associated with the HCA intake estimates presented in this report.

### Sources:

- Gross, GA and A Gruter. 1992. Quantitation of mutagenic/carcinogenic heterocyclic aromatic amines in food products. *J Chrom.*, 592: 271-78.
- Gu, YS, IS Kim, JK Ahn, DM Yeum, CI Ji, and SB Kim. 2002. Mutagenic and carcinogenic heterocyclic amines as affected by muscle types/skin and cooking in pan-roasted mackerel. *Mutat Res.*, 515(1-2): 189-95.
- Jakszyn, P., A. Agudo, R. Ibanez, R. Garcia-Closas, G. Pera, P. Amiano, C.A. Gonzalez, 2004. Development of a food database of nitrosamines, heterocyclic amines, and polycyclic aromatic hydrocarbons *J Nutr.* 134:2011-14
- Keating, G.A. and K.T. Bogen, 2001. Methods for estimating heterocyclic amine concentrations in cooked meats in the US diet. *Food and Chemical Toxicology.* 39:29-43
- National Cancer Institute (NCI). 2006. Computerized Heterocyclic Amines Resource for Research in Epidemiology of Disease (CHARRED) version 1.7. Available via <http://charred.cancer.gov>. Accessed 17 October 2007.
- Sinha, R, Rothman N, Salmon CP, Knize MG et al, 1998. Heterocyclic amine content in beef cooked by different methods to varying degrees of doneness in gravy made from meat drippings. *Food Chemical Toxicology*, 36: 279-287.

**Table B-1. HCA Data Availability – Beef**

Cut	Cooking Method	Doneness	PhIP (ng/g)	Comment	MeIQx (ng/g)	Comment	DiMeIQx (ng/g)	Comment	B[a]P (ng/g)	Comment
Steak	Grilled/ BBQ	Rare	2.53		0.21		0.00		0.00	
		Medium rare	7.27	Calculated - from doneness value above and below	0.66	Calculated - from doneness value above and below	0.03	Calculated - from doneness value above and below	2.08	Calculated - from doneness value above and below
		Just done	12.00		1.10		0.05		4.15	
		Medium well	13.50	Calculated - from doneness value above and below	1.64	Calculated - from doneness value above and below	0.05	Calculated - from doneness value above and below	4.45	Calculated - from doneness value above and below
		Well done	15.00		2.17		0.05		4.75	
		Very well done	33.30		5.78		1.90		4.86	
Steak	Oven Broiled	Rare	6.14		0.00		0.00		0.00	
		Medium rare	4.11	Calculated - from doneness value above and below	0.00	Calculated - from doneness value above and below	0.00	Calculated - from doneness value above and below	0.01	Calculated - from doneness value above and below
		Just done	2.08		0.00		0.00		0.01	
		Medium well	3.33	Calculated - from doneness value above and below	0.84	Calculated - from doneness value above and below	0.06	Calculated - from doneness value above and below	0.01	Calculated - from doneness value above and below
		Well done	4.57		1.67		0.11		0.01	
		Very well done	7.08		1.51		0.19		0.01	

Steak	Fried	Rare	1.89		1.25		0.00		0.00	
		Medium rare		Calculated - from doneness value above and below		Calculated - from doneness value above and below		Calculated - from doneness value above and below		Calculated - from doneness value above and below
			2.21		1.60		0.11		0.00	
		Just done	2.53		1.94		0.21		0.00	
		Medium well		Calculated - from doneness value above and below		Calculated - from doneness value above and below		Calculated - from doneness value above and below		Calculated - from doneness value above and below
			4.53		3.01		0.33		0.01	
		Well done	6.53		4.07		0.45		0.01	
	Very well done	23.22		8.19		1.30		0.01		
Steak	Oven Baked	Rare	6.14	Surrogate - from oven broiled steak	0.00	Surrogate - from oven broiled steak	0.00	Surrogate - from oven broiled steak	0.00	Surrogate - from oven broiled steak
		Medium rare	4.11		0.00		0.00		0.01	
		Just done	2.08		0.00		0.00		0.01	
		Medium well	3.33		0.84		0.06		0.01	
		Well done	4.57		1.67		0.11		0.01	
		Very well done	7.08		1.51		0.19		0.01	
Steak	Microw aved	Rare	0.00		0.00		0.00		0.00	
		Medium rare		Assumed to be same as levels above and below		Assumed to be same as levels above and below		Assumed to be same as levels above and below		Assumed to be same as levels above and below
			0.00		0.00		0.00		0.00	
		Just done	0.00		0.00		0.00		0.00	
		Medium well		Assumed to be same as levels above and below		Assumed to be same as levels above and below		Assumed to be same as levels above and below		Assumed to be same as levels above and below
			0.00		0.00		0.00		0.00	
	Well done	0.00		0.00		0.00		0.00		
	Very well done	0.00		0.00		0.00		0.00		



Beef Ribs	Grilled/ BBQ	Rare	2.53	Surrogate - from grilled/bbq steak	0.21	Surrogate - from grilled/bbq steak	0.00	Surrogate - from grilled/bbq steak	0.00	Surrogate - from grilled/bbq steak
		Medium rare	7.27		0.66		0.03		2.08	
		Just done	12.00		1.10		0.05		4.15	
		Medium well	13.50		1.64		0.05		4.45	
		Well done	15.00		2.17		0.05		4.75	
		Very well done	33.30		5.78		1.90		4.86	
Beef Ribs	Oven Broiled	Rare	6.14	Surrogate - from oven broiled steak	0.00	Surrogate - from oven broiled steak	0.00	Surrogate - value taken from oven broiled steak	0.00	Surrogate - from oven broiled steak
		Medium rare	4.11		0.00		0.00		0.01	
		Just done	2.08		0.00		0.00		0.01	
		Medium well	3.33		0.84		0.06		0.01	
		Well done	4.57		1.67		0.11		0.01	
		Very well done	7.08		1.51		0.19		0.01	
Beef Ribs	Fried	Rare	1.89	Surrogate - from fried steak	1.25	Surrogate - from fried steak	0.00	Surrogate - value taken from fried steak	0.00	Surrogate - from fried steak
		Medium rare	2.21		1.60		0.11		0.00	
		Just done	2.53		1.94		0.21		0.00	
		Medium well	4.53		3.01		0.33		0.01	
		Well done	6.53		4.07		0.45		0.01	
		Very well done	23.22		8.19		1.30		0.01	
Beef Ribs	Oven Baked	Rare	6.14	Surrogate - from oven baked steak	0.00	Surrogate - from oven baked steak	0.00	Surrogate - from oven baked steak	0.00	Surrogate - from oven baked steak
		Medium rare	4.11		0.00		0.00		0.01	
		Just done	2.08		0.00		0.00		0.01	
		Medium well	3.33		0.84		0.06		0.01	
		Well done	4.57		1.67		0.11		0.01	
		Very well done	7.08		1.51		0.19		0.01	
Beef Ribs	Microwaved	Rare	0.00	Surrogate - from microwaved steak	0.00	Surrogate - from microwaved steak	0.00	Surrogate - from microwaved steak	0.00	Surrogate - from microwaved steak
		Medium rare	0.00		0.00		0.00		0.00	
		Just done	0.00		0.00		0.00		0.00	
		Medium well	0.00		0.00		0.00		0.00	
		Well done	0.00		0.00		0.00		0.00	
		Very well done	0.00		0.00		0.00		0.00	

Beef Brisket	Grilled/ BBQ	Rare	2.53	Surrogate - from grilled/bbq steak	0.21	Surrogate - from grilled/bbq steak	0.00	Surrogate - from grilled/bbq steak	0.00	Surrogate - from grilled/bbq steak
		Medium rare	7.27		0.66		0.03		2.08	
		Just done	12.00		1.10		0.05		4.15	
		Medium well	13.50		1.64		0.05		4.45	
		Well done	15.00		2.17		0.05		4.75	
		Very well done	33.30		5.78		1.90		4.86	
Beef Brisket	Oven Broiled	Rare	6.14	Surrogate - from oven broiled steak	0.00	Surrogate - from oven broiled steak	0.00	Surrogate - from oven broiled steak	0.00	Surrogate - from oven broiled steak
		Medium rare	4.11		0.00		0.00		0.01	
		Just done	2.08		0.00		0.00		0.01	
		Medium well	3.33		0.84		0.06		0.01	
		Well done	4.57		1.67		0.11		0.01	
		Very well done	7.08		1.51		0.19		0.01	
Beef Brisket	Fried	Rare	1.89	Surrogate - from fried steak	1.25	Surrogate - from fried steak	0.00	Surrogate - from fried steak	0.00	Surrogate - from fried steak
		Medium rare	2.21		1.60		0.11		0.00	
		Just done	2.53		1.94		0.21		0.00	
		Medium well	4.53		3.01		0.33		0.01	
		Well done	6.53		4.07		0.45		0.01	
		Very well done	23.22		8.19		1.30		0.01	
Beef Brisket	Oven Baked	Rare	6.14	Surrogate - from oven baked steak	0.00	Surrogate - from oven baked steak	0.00	Surrogate - from oven baked steak	0.00	Surrogate - from oven baked steak
		Medium rare	4.11		0.00		0.00		0.01	
		Just done	2.08		0.00		0.00		0.01	
		Medium well	3.33		0.84		0.06		0.01	
		Well done	4.57		1.67		0.11		0.01	
		Very well done	7.08		1.51		0.19		0.01	
Beef Brisket	Microwaved	Rare	0.00	Surrogate from microwaved steak	0.00	Surrogate from microwaved steak	0.00	Surrogate from microwaved steak	0.00	Surrogate from microwaved steak
		Medium rare	0.00		0.00		0.00		0.00	
		Just done	0.00		0.00		0.00		0.00	
		Medium well	0.00		0.00		0.00		0.00	
		Well done	0.00		0.00		0.00		0.00	
		Very well done	0.00		0.00		0.00		0.00	

Beef Roast	Oven Baked	Rare	0.10		0.10		0.10		0.00	Surrogate from oven baked steak
		Medium rare	0.10	Assumed to be same as levels above and below	0.10	Assumed to be same as levels above and below	0.10	Assumed to be same as levels above and below	0.01	
		Just done	0.10		0.10		0.10		0.01	
		Medium well	0.10	Assumed to be same as levels above and below	0.10	Assumed to be same as levels above and below	0.10	Assumed to be same as levels above and below	0.01	
		Well done	0.10		0.10		0.10		0.01	
		Very well done	0.10	Assumed to be same as levels above and below	0.10	Assumed to be same as levels above and below	0.10	Assumed to be same as levels above and below	0.01	
Beef Roast	Microwaved	Rare	0.00	Surrogate from microwaved steak	0.00	Surrogate from microwaved steak	0.00	Surrogate from microwaved steak	0.00	Surrogate from microwaved steak
		Medium rare	0.00		0.00		0.00			
		Just done	0.00		0.00		0.00			
		Medium well	0.00		0.00		0.00			
		Well done	0.00		0.00		0.00			
		Very well done	0.00		0.00		0.00			

**Table B-2. HCA Data Availability – Hamburger**

<b>Cooking Method</b>	<b>Doneness</b>	<b>PhIP (ng/g)</b>	<b>Comment</b>	<b>MeIQx (ng/g)</b>	<b>Comment</b>	<b>DiMeIQx (ng/g)</b>	<b>Comment</b>	<b>B[a]P (ng/g)</b>	<b>Comment</b>
Grilled/ BBQ	Rare	0.00		0.00		0.00		0.00	
	Medium rare	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	0.05	Calculated - from doneness value above and below
	Just done	0.00		0.00		0.00		0.09	
	Medium well	0.00	Assumed to be same as levels above and below	0.66	Calculated - from doneness value above and below	0.07	Calculated - from doneness value above and below	0.33	Calculated - from doneness value above and below
	Well done	0.00		1.31		0.13		0.56	
	Very well done	16.79		4.55		0.31		1.52	
Oven Broiled	Rare	0.00		0.00		0.00		0.00	
	Medium rare	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	0.01	Calculated - from doneness value above and below
	Just done	0.00		0.00		0.00		0.01	
	Medium well	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	0.01	Calculated - from doneness value above and below
	Well done	0.00		0.00		0.00		0.01	
	Very well done	0.00		1.61		0.00		0.01	
Fried	Rare	0.00		0.34		0.00		0.00	
	Medium rare	0.00	Assumed to be same as levels above and below	0.67	Calculated - from doneness value above and below	0.07	Calculated - from doneness value above and below	0.01	Calculated - from doneness value above and below
	Just done	0.00		1.00		0.14		0.01	
	Medium well	0.97	Calculated - from doneness value above and below	1.68	Calculated - from doneness value above and below	0.08	Calculated - from doneness value above and below	0.02	Calculated - from doneness value above and below
	Well done	1.94		2.35		0.01		0.02	
	Very well done	5.18		4.25		0.03		0.01	

<b>Cooking Method</b>	<b>Doneness</b>	<b>PhIP (ng/g)</b>	<b>Comment</b>	<b>MeIQx (ng/g)</b>	<b>Comment</b>	<b>DiMeIQx (ng/g)</b>	<b>Comment</b>	<b>B[a]P (ng/g)</b>	<b>Comment</b>
Oven Baked	Rare	0.00	Surrogate - value taken from oven broiled hamburger	0.00	Surrogate - value taken from oven broiled hamburger	0.00	Surrogate - value taken from oven broiled hamburger	0.00	Surrogate - value taken from oven broiled hamburger
	Medium rare	0.00		0.00		0.00		0.01	
	Just done	0.00		0.00		0.00		0.01	
	Medium well	0.00		0.00		0.00		0.01	
	Well done	0.00		0.00		0.00		0.01	
	Very well done	0.00		1.61		0.00		0.01	
Microwaved	Rare	0.00		0.00		0.00		0.00	
	Medium rare	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below
	Just done	0.00		0.00		0.00		0.00	
	Medium well	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below
	Well done	0.00		0.00		0.00		0.00	
	Very well done	0.00		0.00		0.00		0.00	

**Table B-3. HCA Data Availability – Chicken**

Cut	Cooking Method	Doneness	PhIP (ng/g)	Comment	MeIQx (ng/g)	Comment	DiMeIQx (ng/g)	Comment	B[a]P (ng/g)	Comment
Chicken, with skin	Rotisserie	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	2.61	Surrogate - from oven broiled breasts with skin	0.04	Surrogate - from oven broiled breasts with skin	0.00	Surrogate - from oven broiled breasts with skin	0.04	Surrogate - from oven broiled breasts with skin
		Medium well	5.34 66.8		0.03		0.06			
		Well done	8.06 131		0.02		0.08			
		Very well done	22.87		0.32		0.16			
Breasts, skinless	Grilled/ BBQ	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	27.00		0.00		0.00		0.06	
		Medium well	83.50	Calculated - from doneness value above and below	1.00	Calculated - from doneness value above and below	0.50	Calculated - from doneness value above and below	0.23	Calculated - from doneness value above and below
		Well done	140.0		2.00		1.00		0.39	
		Very well done	480.0		9.00		1.00		0.40	

Breasts, skinless	Oven Broiled	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.24		0.00		0.00		0.06	
		Medium well	32.12	Calculated - from doneness value above and below	0.02	Calculated - from doneness value above and below	0.00	Assumed to be same as levels above and below	0.09	Calculated - from doneness value above and below
		Well done	64.00		0.04		0.00		0.12	
		Very well done	150.00		3.00		0.09		0.48	
Breasts, skinless	Fried	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.96		0.11		0.00		0.00	
		Medium well	18.98	Calculated - from doneness value above and below	1.06	Calculated - from doneness value above and below	1.00	Calculated - from doneness value above and below	0.05	Calculated - from doneness value above and below
		Well done	37.00		2.00		2.00		0.10	
		Very well done	70.00		3.00		4.00		0.10	
Breasts, skinless	Oven Baked	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00		0.00		0.00		0.00	
		Medium well	0.00	Assume to contain no levels	0.04	Calculated - from doneness value above and below	0.00	Assume to contain no levels	0.01	Calculated - from doneness value above and below
		Well done	0.00		0.08		0.00		0.01	
		Very well done	0.00		0.08		0.00		0.01	

Breasts, skinless	Microwav ed	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00		0.00		0.00		0.00	
		Medium well	0.00	Assume to contain no levels	0.04	Calculated - from doneness value above and below	0.00	Assume to contain no levels	0.01	Calculated - from doneness value above and below
		Well done	0.00		0.08		0.00		0.01	
		Very well done	0.00		0.08		0.00		0.01	
Breasts, with skin	Grilled/ BBQ	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	5.12		0.07		0.00		1.00	
		Medium well	7.68 20.56	Calculated - from doneness value above and below	0.09	Calculated - from doneness value above and below	0.00	Assume to contain no levels	2.79	Calculated - from doneness value above and below
		Well done	10.24 36.0		0.11		0.00		4.57	
		Very well done	10.24		0.55		0.00		4.57	
Breasts, with skin	Oven Broiled	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	2.61		0.04		0.00		0.04	
		Medium well	5.335 66.80 5	Calculated - from doneness value above and below	0.03	Calculated - from doneness value above and below	0.00	Assume to contain no levels	0.06	Calculated - from doneness value above and below
		Well done	8.06 131		0.02		0.00		0.08	
		Very well done	22.87		0.32		0.09		0.16	



Breasts, with skin	Fried	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	2.43		0.25		0.06		0.06	
		Medium well	13.72	Calculated - from doneness value above and below	0.45	Calculated - from doneness value above and below	0.06	Calculated - from doneness value above and below	0.09	Calculated - from doneness value above and below
		Well done	25.00		0.65		0.06		0.12	
		Very well done	30.90		0.72		0.13		0.24	
Breasts, with skin	Oven Baked	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00		0.00		0.00		0.00	
		Medium well	0.00	Assume to contain no levels	0.04	Calculated - from doneness value above and below	0.00	Assume to contain no levels	0.01	Calculated - from doneness value above and below
		Well done	0.00		0.08		0.00		0.01	
		Very well done	0.00		0.08		0.00		0.01	
Breasts, with skin	Microwav ed	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00		0.00		0.00		0.00	
		Medium well	0.00	Assume to contain no levels	0.04	Calculated - from doneness value above and below	0.00	Assume to contain no levels	0.01	Calculated - from doneness value above and below
		Well done	0.00		0.08		0.00		0.01	
		Very well done	0.00		0.08		0.00		0.01	

Other Pieces, skinless	Grilled/ BBQ	Rare	-		-		-		-		
		Medium rare	-		-		-		-		
		Just done	1.52		0.00		0.00		0.06		
		Medium well	5.03	Calculated - from doneness value above and below	0.12		Calculated - from doneness value above and below	0.09		Calculated - from doneness value above and below	0.23
		Well done	8.54		0.24		0.18		0.39		
		Very well done	8.54		0.76		0.22		0.40		
Other Pieces, skinless	Oven Broiled	Rare	-		-		-		-		
		Medium rare	-		-		-		-		
		Just done	0.24		0.00		0.00		0.06		
		Medium well	1.10	Calculated - from doneness value above and below	0.02		Calculated - from doneness value above and below	0.00		Calculated - from doneness value above and below	0.09
		Well done	1.96		0.04		0.00		0.12		
		Very well done	14.78		0.34		0.09		0.48		
Other Pieces, skinless	Fried	Rare	-		-		-		-		
		Medium rare	-		-		-		-		
		Just done	0.96		0.11		0.00		0.00		
		Medium well	4.90	Calculated - from doneness value above and below	0.27		Calculated - from doneness value above and below	0.02		Calculated - from doneness value above and below	0.05
		Well done	8.84		0.42		0.04		0.10		
		Very well done	30.90		0.64		0.25		0.10		

Other Pieces, skinless	Oven Baked	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00		0.00		0.00		0.00	
		Medium well	0.00	Assume to contain no levels	0.04	Calculated - from doneness value above and below	0.00	Assume to contain no levels	0.01	Calculated - from doneness value above and below
		Well done	0.00		0.08		0.00		0.01	
		Very well done	0.00		0.08		0.00		0.01	
Other Pieces, skinless	Microwaved Baked	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00		0.00		0.00		0.00	
		Medium well	0.00	Assume to contain no levels	0.04	Calculated - from doneness value above and below	0.00	Assume to contain no levels	0.01	Calculated - from doneness value above and below
		Well done	0.00		0.08		0.00		0.01	
		Very well done	0.00		0.08		0.00		0.01	
Other Pieces, with skin	Grilled/ BBQ	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	5.12		0.07		0.00		1.00	
		Medium well	7.68	Calculated - from doneness value above and below	0.09	Calculated - from doneness value above and below	0.00	Assume to contain no levels	2.79	Calculated - from doneness value above and below
		Well done	10.24		0.11		0.00		4.57	
		Very well done	10.24		0.55		0.00		4.57	

Other Pieces, with skin	Oven Broiled	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	2.61		0.04		0.00		0.04	
		Medium well	5.34	Calculated - from doneness value above and below	0.03	Calculated - from doneness value above and below	0.00	Assume to contain no levels	0.06	Calculated - from doneness value above and below
		Well done	8.06		0.02		0.00		0.08	
		Very well done	22.87		0.32		0.09		0.16	
Other Pieces, with skin	Fried	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	2.43		0.25		0.06		0.06	
		Medium well	5.64	Calculated - from doneness value above and below	0.45	Calculated - from doneness value above and below	0.06	Calculated - from doneness value above and below	0.09	Calculated - from doneness value above and below
		Well done	8.84		0.65		0.06		0.12	
		Very well done	30.90		0.72		0.13		0.24	
Other Pieces, with skin	Oven Baked	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00		0.00		0.00		0.00	
		Medium well	0.00	Assume to contain no levels	0.04	Calculated - from doneness value above and below	0.00	Assume to contain no levels	0.01	Calculated - from doneness value above and below
		Well done	0.00		0.08		0.00		0.01	
		Very well done	0.00		0.08		0.00		0.01	

Other Pieces, with skin	Microwaved Baked	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00		0.00		0.00		0.00	
		Medium well	0.00	Assume to contain no levels	0.04	Calculated - from doneness value above and below	0.00	Assume to contain no levels	0.01	Calculated - from doneness value above and below
		Well done	0.00		0.08		0.00		0.01	
		Very well done	0.00		0.08		0.00		0.01	

**Table B-4. HCA Data Availability – Pork**

Cut	Cooking Method	Doneness	PhIP (ng/g)	Comment	MeIQx (ng/g)	Comment	DiMeIQx (ng/g)	Comment	B[a]P (ng/g)	Comment
Pork Chop	Grilled/ BBQ	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.32		0.23		0.00		0.00	
		Medium well	0.62	Calculated - from doneness value above and below	0.79	Calculated - from doneness value above and below	0.10	Calculated - from doneness value above and below	0.01	Calculated - from doneness value above and below
		Well done	0.91		1.34		0.20		0.01	
		Very well done	1.50		3.83		0.28		0.01	
Pork Chop	Oven Broiled	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00		0.00		0.00		0.00	
		Medium well	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	0.01	Calculated - from doneness value above and below
		Well done	0.00		0.00		0.00		0.01	
		Very well done	0.00		0.52		0.00		0.01	
Pork Chop	Fried	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.10		0.10		0.00		0.00	
		Medium well	0.10	Calculated - from doneness value above and below	0.72	Calculated - from doneness value above and below	0.10	Calculated - from doneness value above and below	0.01	Calculated - from doneness value above and below
		Well done	0.10		1.34		0.20		0.01	
		Very well done	0.10		3.83		0.28		0.01	

Pork Chop	Oven Baked	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00		0.00		0.00		0.00	
		Medium well	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	0.01	Calculated - from doneness value above and below
		Well done	0.00		0.00		0.00		0.01	
		Very well done	0.00		0.52		0.00		0.01	
Pork Chop	Microwaved	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00		0.00		0.00		0.00	
		Medium well	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	0.01	Calculated - from doneness value above and below
		Well done	0.00		0.00		0.00		0.01	
		Very well done	0.00		0.52		0.00		0.01	
Pork Ribs	Grilled/BBQ	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.32		0.23		0.00		0.00	Surrogate - value taken from grilled/bbq pork chop
		Medium well	0.62	Calculated - from doneness value above and below	0.44	Calculated - from doneness value above and below	0.00	Assumed to be same as levels above and below	0.01	
		Well done	0.91		0.65		0.00		0.01	
		Very well done	1.50		1.07		0.00		0.01	

Pork Ribs	Oven Broiled	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.50	Surrogate - from oven baked ribs	0.05	Surrogate - from oven baked ribs	0.05	Surrogate - from oven baked ribs	0.00	Surrogate - from oven broiled pork chop
		Medium well	1.40		0.05		0.05			
		Well done	2.30		0.05		0.05			
		Very well done	3.79		0.05		0.05			
Pork Ribs	Fried	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.32	Surrogate - value taken from grilled/bbq ribs	0.23	Surrogate - value taken from grilled/bbq ribs	0.00	Surrogate - value taken from grilled/bbq ribs	0.00	Surrogate - value taken from prok chop
		Medium well	0.62		0.44		0.00			
		Well done	0.91		0.65		0.00			
		Very well done	1.50		1.07		0.00			
Pork Ribs	Oven Baked	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.50		0.05		0.05		0.00	Surrogate - value taken from oven baked pork chop
		Medium well	1.40	Calculated - from doneness value above and below	0.05	Assumed to be same as levels above and below	0.05	Assumed to be same as levels above and below	0.01	
		Well done	2.30		0.05		0.05		0.01	
		Very well done	3.79	Calculated - from grilled/bbq tenderloins ratio of well done to very well done	0.05	Assumed to be same as level below	0.05	Assumed to be same as level below	0.01	
Pork Ribs	Microwaved	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00	Surrogate - value taken from microwaved steak	0.00	Surrogate - value taken from microwaved baked pork chop	0.00	Surrogate - value taken from microwaved steak	0.00	Surrogate - value taken from microwaved baked pork chop
		Medium well	0.00		0.00		0.00			
		Well done	0.00		0.00		0.00			
		Very well done	0.00		0.52		0.00			



Pork Tenderloins	Grilled/BBQ	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.32		0.23		0.00		0.00	Surrogate - from grilled/bbq pork chop
		Medium well	0.62	Calculated - from doneness value above and below	0.44	Calculated - from doneness value above and below	0.00	Assumed to be same as level below	0.01	
		Well done	0.91		0.65		0.00		0.01	
		Very well done	1.50		1.07		0.00		0.01	
Pork Tenderloins	Oven Broiled	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00	Surrogate - value taken from oven broiled pork chop	0.00	Surrogate - value taken from oven broiled pork chop	0.00	Surrogate - value taken from oven broiled pork chop	0.00	Surrogate - value taken from oven broiled pork chop
		Medium well	0.00		0.00		0.00		0.01	
		Well done	0.00		0.00		0.00		0.01	
Very well done	0.00	0.52	0.00		0.01					
Pork Tenderloins	Fried	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.10	Surrogate - value taken from fried pork chop	0.10	Surrogate - value taken from fried pork chop	0.00	Surrogate - value taken from fried pork chop	0.00	Surrogate - value taken from fried pork chop
		Medium well	0.10		0.72		0.10		0.01	
		Well done	0.10		1.34		0.20		0.01	
		Very well done	0.10		3.83		0.28		0.01	
Pork Tenderloins	Oven Baked	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00	Surrogate - value taken from oven baked pork chop	0.00	Surrogate - value taken from oven baked pork chop	0.00	Surrogate - value taken from oven baked pork chop	0.00	Surrogate - value taken from oven baked pork chop
		Medium well	0.00		0.00		0.00		0.01	
		Well done	0.00		0.00		0.00		0.01	
		Very well done	0.00		0.52		0.00		0.01	

Pork Tenderloins	Microwaved	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00	Surrogate - value taken from microwaved pork chop	0.00	Surrogate - value taken from microwaved pork chop	0.00	Surrogate - value taken from microwaved pork chop	0.00	Surrogate - value taken from microwaved pork chop
		Medium well	0.00		0.00		0.00			
		Well done	0.00		0.00		0.00			
		Very well done	0.00		0.52		0.00			
Pork Roast	Grilled/BBQ	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.32		0.23		0.00		0.00	Surrogate - value taken from grilled/bbq pork chop
		Medium well	0.62	Calculated - from doneness value above and below	0.44	Calculated - from doneness value above and below	0.00	Calculated - from doneness value above and below	0.01	
		Well done	0.91		0.65		0.00		0.01	
		Very well done	1.50		1.07		0.00		0.01	
Pork Roast	Oven Broiled	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00	Surrogate - from oven broiled pork chop	0.00	Surrogate - from oven broiled pork chop	0.00	Surrogate - from oven broiled pork chop	0.00	Surrogate - from oven broiled pork chop
		Medium well	0.00		0.00		0.00			
		Well done	0.00		0.00		0.00			
		Very well done	0.00		0.52		0.00			
Pork Roast	Fried	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.10	Surrogate - value taken from fried pork chop	0.10	Surrogate - value taken from fried pork chop	0.00	Surrogate - value taken from fried pork chop	0.00	Surrogate - value taken from fried pork chop
		Medium well	0.10		0.72		0.10			
		Well done	0.10		1.34		0.20			
		Very well done	0.10		3.83		0.28			

Pork Roast	Oven Baked	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00	Surrogate - value taken from oven baked pork chop	0.00	Surrogate - value taken from oven baked pork chop	0.00	Surrogate - value taken from oven baked pork chop	0.00	Surrogate - value taken from oven baked pork chop
		Medium well	0.00		0.00		0.00			
		Well done	0.00		0.00		0.00			
Very well done	0.00	0.52	0.00							
Pork Roast	Microwaved	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00	Surrogate - value taken from microwaved pork chop	0.00	Surrogate - value taken from microwaved pork chop	0.00	Surrogate - value taken from microwaved pork chop	0.00	Surrogate - value taken from microwaved baked pork chop
		Medium well	0.00		0.00		0.00			
		Well done	0.00		0.00		0.00			
Very well done	0.00	0.52	0.00							
Ham Slices	Grilled/ BBQ	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.32		0.23		0.00		0.00	Surrogate - value taken from fried ham slices
		Medium well	0.62	Calculated - from doneness value above and below	0.44	Calculated - from doneness value above and below	0.00	Calculated - from doneness value above and below	0.01	
		Well done	0.91		0.65		0.00		0.01	
		Very well done	1.50		1.07		0.00		0.01	

Ham Slices	Oven Broiled	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00		0.00		0.00		0.00	
		Medium well	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	0.00	Calculated - from doneness value above and below	0.00	Assumed to be same as level below
		Well done	0.00		0.00		0.00		0.00	
		Very well done	0.00		0.35		0.00		0.01	
Ham Slices	Fried	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00		0.00		0.00		0.00	
		Medium well	0.15	Calculated - from doneness value above and below	0.30	Calculated - from doneness value above and below	0.00	Calculated - from doneness value above and below	0.01	Calculated - from doneness value above and below
		Well done	0.30		0.60		0.00		0.01	
		Very well done	0.00		1.80		0.20		0.01	
Ham Slices	Oven Baked	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00	Surrogate - value taken from oven broiled ham	0.00	Surrogate - value taken from oven broiled ham	0.00	Surrogate - value taken from oven broiled ham	0.00	Surrogate - value taken from oven broiled ham
		Medium well	0.00		0.00		0.00			
		Well done	0.00		0.00		0.00			
		Very well done	0.00		0.35		0.00			

Ham Slices	Microwaved Baked	Rare	-		-		-		-	
		Medium rare	-		-		-		-	
		Just done	0.00	Surrogate - value taken from oven broiled ham	0.00	Surrogate - value taken from oven broiled ham	0.00	Surrogate - value taken from oven broiled ham	0.00	Surrogate - value taken from oven broiled ham
		Medium well	0.00		0.00		0.00			
		Well done	0.00		0.00		0.00			
		Very well done	0.00		0.35		0.00			

**Table B-5.HCA Data Availability – Bacon Slices**

Cooking Method	Doneness	PhIP (ng/g)	Comment	MeIQx (ng/g)	Comment	DiMeIQx (ng/g)	Comment	B[a]P (ng/g)	Comment
Grilled/BBQ	Rare	-		-		-		-	
	Medium rare	-		-		-		-	
	Just done	1.39	Surrogate - value taken from oven broiled values	0.10	Surrogate - value taken from oven broiled values	0.00	Surrogate - value taken from oven broiled values	0.00	Surrogate - value taken from oven broiled values
	Medium well	10.01		0.85		0.13		0.00	
	Well done	18.62		1.60		0.26		0.00	
	Very well done	46.20		4.84		0.57		0.00	
Oven Broiled	Rare	-		-		-		-	
	Medium rare	-		-		-		-	
	Just done	1.39		0.10		0.00		0.00	
	Medium well	10.01	Calculated - from doneness value above and below	0.85	Calculated - from doneness value above and below	0.13	Calculated - from doneness value above and below	0.00	Assumed to be same as levels above and below
	Well done	18.62		1.60		0.26		0.00	
	Very well done	46.20		4.84		0.57		0.00	
Fried	Rare	-		-		-		-	
	Medium rare	-		-		-		-	
	Just done	0.10		0.35		0.00		0.01	
	Medium well	0.41	Calculated - from doneness value above and below	1.03	Calculated - from doneness value above and below	0.00	Assumed to be same as levels above and below	0.02	Calculated - from doneness value above and below
	Well done	0.71		1.71		0.00		0.02	
	Very well done	4.80		4.30		0.50		0.01	

Oven Baked	Rare	-		-		-		-	
	Medium rare	-		-		-		-	
	Just done	1.39	Surrogate - value taken from oven broiled values	0.10	Surrogate - value taken from oven broiled values	0.00	Surrogate - value taken from oven broiled values	0.00	Surrogate - value taken from oven broiled values
	Medium well	10.01		0.85		0.13		0.00	
	Well done	18.62		1.60		0.26		0.00	
Very well done	46.20	4.84		0.57		0.00			
Micro waved	Rare	-		-		-		-	
	Medium rare	-		-		-		-	
	Just done	0.00		0.00		0.00		0.00	
	Medium well	0.00		0.20	Calculated - from doneness value above and below	0.00	Assumed to be same as levels above and below	0.01	Calculated - from doneness value above and below
	Well done	0.00		0.40		0.00		0.01	
Very well done	3.10		1.50		0.20		0.02		

**Table B-6. HCA Data Availability – Hot Dogs**

Cooking Method	Doneness	PhiP (ng/g)	Comment	MelQx (ng/g)	Comment	DiMelQx (ng/g)	Comment	B[a]P (ng/g)	Comment
Grilled/BBQ	Rare	-		-		-		-	
	Medium rare	-		-		-		-	
	Just done	0.10		0.10		0.00	Assume to contain no levels	0.00	Surrogate - value taken from ham slice values
	Medium well	0.10	Assumed to be same as levels above and below	0.10	Assumed to be same as levels above and below	0.00	Assume to contain no levels	0.01	
	Well done	0.10		0.10		0.00		0.01	
	Very well done	0.10		0.10		0.00		0.01	
Oven Broiled	Rare	-		-		-		-	
	Medium rare	-		-		-		-	
	Just done	0.00	Assumed to be same as level below	0.10	Surrogate - value taken from oven baked values	0.00	Assume to contain no levels	0.00	Surrogate - value taken from ham slice values
	Medium well	0.00	Assumed to be same as levels above and below	0.10		0.00	Assume to contain no levels	0.00	
	Well done	0.00		0.19		0.00		0.00	
	Very well done	0.00		0.10	Surrogate - value taken from oven baked values	0.00		0.01	



Fried	Rare	-		-		-		-	
	Medium rare	-		-		-		-	
	Just done	0.10		0.10		0.00	Assume to contain no levels	0.00	Surrogate - value taken from ham slice values
	Medium well	0.10	Assumed to be same as levels above and below	0.10	Assumed to be same as levels above and below	0.00	Assume to contain no levels	0.01	
	Well done	0.10		0.10		0.00		0.01	
	Very well done	0.10		0.10		0.00		0.01	
Oven Baked	Rare	-		-		-		-	
	Medium rare	-		-		-		-	
	Just done	0.10		0.10		0.00	Surrogate - value taken from oven broiled hot dog values	0.00	Surrogate - value taken from ham slice values
	Medium well	0.10	Assumed to be same as levels above and below	0.10	Assumed to be same as levels above and below	0.00		0.00	
	Well done	0.10		0.10		0.00		0.00	
	Very well done	0.10		0.10		0.00		0.01	
Micro waved	Rare	-		-		-		-	
	Medium rare	-		-		-		-	
	Just done	0.10	Surrogate - value taken from oven baked values	0.10	Surrogate - value taken from oven baked values	0.00	Surrogate - value taken from oven baked hot dog values	0.00	Surrogate - value taken from ham slice values
	Medium well	0.10		0.10		0.00		0.00	
	Well done	0.10		0.10		0.00		0.00	
	Very well done	0.10		0.10		0.00		0.01	

**Table B-7. HCA Data Availability – Fish**

Cooking Method	Doneness	PhiP (ng/g)	Comment	MeIQx (ng/g)	Comment	DiMeIQx (ng/g)	Comment	B[a]P (ng/g)	Comment
Grilled/BBQ	Rare	0.00		0.00	Assume to contain no levels	0.00	Assume to contain no levels	NA	No data available
	Medium rare	2.00		0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	NA	No data available
	Just done	0.066 6.2		0.00		0.00		NA	No data available
	Medium well	2.688 37.6	Calculated - from doneness value above and below	0.00	Assumed to be same as levels above and below	0.00	Assumed to be same as levels above and below	NA	No data available
	Well done	5.31 69		0.00		0.00		NA	No data available
	Very well done	28.55 73		0.00		0.00		NA	No data available
Oven Broiled	Rare	0.00	Assume to contain no levels	0.00	Assume to contain no levels	0.00	Surrogate - value taken from grilled/bbq fish	NA	No data available
	Medium rare	1.70	Calculated - from doneness value above and below	1.40		0.00		NA	No data available
	Just done	23.00		5.00		0.00		NA	No data available
	Medium well	18.50	Calculated - from doneness value above and below	4.85	Calculated - from doneness value above and below	0.00		NA	No data available
	Well done	14.00		4.70		0.00		NA	No data available
	Very well done	17.00		3.70		0.00		NA	No data available

Fried	Rare	0.00	Assume to contain no levels	0.00	Assume to contain no levels	0.00	Assume to contain no levels	NA	No data available
	Medium rare	0.80	Calculated - from doneness value above and below	0.10	Calculated - from doneness value above and below	0.03	Calculated - from doneness value above and below	NA	No data available
	Just done	1.60		0.20		0.05		NA	No data available
	Medium well	3.80	Calculated - from doneness value above and below	1.85	Calculated - from doneness value above and below	0.18	Calculated - from doneness value above and below	NA	No data available
	Well done	6.00		3.50		0.30		NA	No data available
	Very well done	12.80		5.80		0.40		NA	No data available
Oven Baked	Rare	0.00	Assume to contain no levels	0.00	Assume to contain no levels	0.00	Surrogate - value taken from grilled/bbq fish	NA	No data available
	Medium rare	0.25	Calculated - from doneness value above and below	0.25	Calculated - from doneness value above and below	0.00		NA	No data available
	Just done	0.50		0.50		0.00		NA	No data available
	Medium well	9.25	Calculated - from doneness value above and below	2.55	Calculated - from doneness value above and below	0.00		NA	No data available
	Well done	18.00		4.60		0.00		NA	No data available
	Very well done	5.90		3.40		0.00		NA	No data available

Microwaved	Rare	0.00	Surrogate - value taken from oven baked values	0.00	Surrogate - value taken from oven baked values	0.00	Surrogate - value taken from grilled/bbq fish	NA	No data available
	Medium rare	0.25		0.25		0.00		NA	No data available
	Just done	0.50		0.50		0.00		NA	No data available
	Medium well	9.25		2.55		0.00		NA	No data available
	Well done	18.00		4.60		0.00		NA	No data available
	Very well done	5.90		3.40		0.00		NA	No data available

## APPENDIX C. FOOD INTAKE BY SPECIFIC MEAT TYPE

Intakes based on cooking method and degree of doneness for the 7 meat types (beef cuts, hamburgers, chicken, pork, bacon, hotdogs, and fish) included in this study are summarized in this section, see Tables C-1 to C-7

**Table C-1. Beef Consumption by Method of Cooking and Degree of Doneness (Mean *per Capita*, US Population, NHANES 03-06)**

Beef Cuts	Cooking Method	Doneness Degree	g/day	g/kg/day
Steak	Grilled/BBQ	Rare	0.343	0.0050
		Medium rare	1.305	0.0189
		Just done	0.978	0.0142
		Medium well	0.664	0.0096
		Well done	0.439	0.0063
		Very well done	0.118	0.0017
Steak	Oven Broiled	Rare	0.152	0.0022
		Medium rare	0.529	0.0077
		Just done	0.473	0.0068
		Medium well	0.326	0.0047
		Well done	0.191	0.0028
		Very well done	0.068	0.0010
Steak	Fried	Rare	0.095	0.0014
		Medium rare	0.455	0.0066
		Just done	0.455	0.0066
		Medium well	0.359	0.0052
		Well done	0.370	0.0054
		Very well done	0.062	0.0009
Steak	Oven Baked	Rare	0.050	0.0007
		Medium rare	0.230	0.0033
		Just done	0.236	0.0034
		Medium well	0.241	0.0035
		Well done	0.308	0.0045
		Very well done	0.056	0.0008
Steak	Microwaved Baked	Rare	0.006	0.0001
		Medium rare	0.040	0.0006
		Just done	0.068	0.0010
		Medium well	0.040	0.0006
		Well done	0.028	0.0004
		Very well done	0.023	0.0003

<b>Beef Cuts</b>	<b>Cooking Method</b>	<b>Doneness Degree</b>	<b>g/day</b>	<b>g/kg/day</b>
Beef Ribs	Grilled/BBQ	Rare	0.004	0.0001
		Medium rare	0.025	0.0004
		Just done	0.066	0.0011
		Medium well	0.069	0.0011
		Well done	0.089	0.0015
		Very well done	0.012	0.0002
Beef Ribs	Oven Broiled	Rare	0.001	0.0000
		Medium rare	0.006	0.0001
		Just done	0.025	0.0004
		Medium well	0.020	0.0003
		Well done	0.027	0.0004
		Very well done	0.004	0.0001
Beef Ribs	Fried	Rare	0.001	0.0000
		Medium rare	0.003	0.0001
		Just done	0.012	0.0002
		Medium well	0.003	0.0001
		Well done	0.010	0.0002
		Very well done	0.002	0.0000
Beef Ribs	Oven Baked	Rare	0.002	0.0000
		Medium rare	0.007	0.0001
		Just done	0.034	0.0006
		Medium well	0.040	0.0007
		Well done	0.054	0.0009
		Very well done	0.007	0.0001
Beef Ribs	Microwaved Baked	Rare	0.001	0.0000
		Medium rare	0.002	0.0000
		Just done	0.004	0.0001
		Medium well	0.006	0.0001
		Well done	0.006	0.0001
		Very well done	0.002	0.0000
Beef Brisket	Grilled/BBQ	Rare	0.001	0.0000
		Medium rare	0.015	0.0002
		Just done	0.021	0.0003
		Medium well	0.020	0.0003
		Well done	0.016	0.0002
		Very well done	0.003	0.0000
Beef Brisket	Oven Broiled	Rare	0.002	0.0000
		Medium rare	0.008	0.0001
		Just done	0.016	0.0002
		Medium well	0.006	0.0001
		Well done	0.007	0.0001
		Very well done	0.003	0.0000

<b>Beef Cuts</b>	<b>Cooking Method</b>	<b>Doneness Degree</b>	<b>g/day</b>	<b>g/kg/day</b>
Beef Brisket	Fried	Rare	0.001	0.0000
		Medium rare	0.003	0.0000
		Just done	0.005	0.0001
		Medium well	0.004	0.0001
		Well done	0.005	0.0001
		Very well done	0.001	0.0000
Beef Brisket	Oven Baked	Rare	0.001	0.0000
		Medium rare	0.007	0.0001
		Just done	0.017	0.0002
		Medium well	0.007	0.0001
		Well done	0.013	0.0002
		Very well done	0.003	0.0000
Beef Brisket	Microwaved Baked	Rare	0.001	0.0000
		Medium rare	0.002	0.0000
		Just done	0.005	0.0001
		Medium well	0.002	0.0000
		Well done	0.004	0.0001
		Very well done	0.001	0.0000
Beef Roast	Oven Baked	Rare	0.063	0.0009
		Medium rare	0.274	0.0040
		Just done	0.453	0.0066
		Medium well	0.434	0.0063
		Well done	0.447	0.0065
		Very well done	0.088	0.0013
Beef Roast	Microwaved Baked	Rare	0.013	0.0002
		Medium rare	0.029	0.0004
		Just done	0.044	0.0006
		Medium well	0.022	0.0003
		Well done	0.051	0.0007
		Very well done	0.016	0.0002
<b>Total Beef intake</b>			<b>11.384</b>	<b>0.166</b>

**Table C-2. Hamburgers Consumption by Method of Cooking and Degree of Doneness  
(Mean *per Capita*, US Population, NHANES 03-06)**

<b>Cooking Method</b>	<b>Doneness</b>	<b>g/day</b>	<b>g/kg-bw/day</b>
Grilled/BBQ	Rare	0.103	0.0016
	Medium rare	0.484	0.0076
	Just done	0.974	0.0153
	Medium well	0.922	0.0145
	Well done	1.016	0.0159
	Very well done	0.179	0.0028
Oven Broiled	Rare	0.019	0.0003
	Medium rare	0.132	0.0021
	Just done	0.221	0.0035
	Medium well	0.221	0.0035
	Well done	0.259	0.0041
	Very well done	0.042	0.0007
Fried	Rare	0.071	0.0011
	Medium rare	0.207	0.0032
	Just done	0.701	0.0110
	Medium well	0.691	0.0108
	Well done	1.007	0.0158
	Very well done	0.160	0.0025
Oven Baked	Rare	0.023	0.0004
	Medium rare	0.038	0.0006
	Just done	0.136	0.0021
	Medium well	0.150	0.0024
	Well done	0.239	0.0038
	Very well done	0.047	0.0007
Microwaved	Rare	0.009	0.0001
	Medium rare	0.033	0.0005
	Just done	0.080	0.0013
	Medium well	0.076	0.0012
	Well done	0.113	0.0018
	Very well done	0.024	0.0004
<b>Total Hamburger Intake</b>		<b>8.377</b>	<b>0.131</b>



**Table C-3. Chicken Consumption by Method of Cooking and Degree of Doneness (Mean per Capita, US Population, NHANES 03-06)**

CHICKEN CUT	Cooking Method	Doneness	g/day	g/kg-bw/day
Rotisserie Chicken, with skin	Rotisserie Chicken	Rare	-	-
		Medium rare	-	-
		Just done	0.025	0.0004
		Medium well	0.070	0.0011
		Well done	0.155	0.0024
		Very well done	0.031	0.0005
Breasts, skinless	Grilled/BBQ	Rare	-	-
		Medium rare	-	-
		Just done	0.260	0.0043
		Medium well	0.839	0.0139
		Well done	1.812	0.0300
		Very well done	0.350	0.0058
Breasts, skinless	Oven Broiled	Rare	-	-
		Medium rare	-	-
		Just done	0.181	0.0030
		Medium well	0.399	0.0066
		Well done	1.041	0.0172
		Very well done	0.115	0.0019
Breasts, skinless	Fried	Rare	-	-
		Medium rare	-	-
		Just done	0.205	0.0034
		Medium well	0.580	0.0096
		Well done	1.413	0.0234
		Very well done	0.320	0.0053
Breasts, skinless	Oven Baked	Rare	-	-
		Medium rare	-	-
		Just done	0.314	0.0052
		Medium well	0.738	0.0122
		Well done	1.850	0.0307
		Very well done	0.320	0.0053
Breasts, skinless	Microwaved Baked	Rare	-	-
		Medium rare	-	-
		Just done	0.048	0.0008
		Medium well	0.115	0.0019
		Well done	0.314	0.0052
		Very well done	0.060	0.0010
Breasts, with skin	Grilled/BBQ	Rare	-	-
		Medium rare	-	-
		Just done	0.071	0.0010

<b>CHICKEN CUT</b>	<b>Cooking Method</b>	<b>Doneness</b>	<b>g/day</b>	<b>g/kg-bw/day</b>
		Medium well	0.200	0.0028
		Well done	0.484	0.0068
		Very well done	0.102	0.0014
Breasts, with skin	Oven Broiled	Rare	-	-
		Medium rare	-	-
		Just done	0.037	0.0005
		Medium well	0.095	0.0013
		Well done	0.295	0.0042
		Very well done	0.037	0.0005
Breasts, with skin	Fried	Rare	-	-
		Medium rare	-	-
		Just done	0.068	0.0010
		Medium well	0.231	0.0033
		Well done	0.657	0.0093
		Very well done	0.142	0.0020
Breasts, with skin	Oven Baked	Rare	-	-
		Medium rare	-	-
		Just done	0.086	0.0012
		Medium well	0.195	0.0027
		Well done	0.460	0.0065
		Very well done	0.102	0.0014
Breasts, with skin	Microwaved Baked	Rare	-	-
		Medium rare	-	-
		Just done	0.016	0.0002
		Medium well	0.031	0.0004
		Well done	0.068	0.0010
		Very well done	0.012	0.0002
Other Pieces, skinless	Grilled/BBQ	Rare	-	-
		Medium rare	-	-
		Just done	0.109	0.0026
		Medium well	0.334	0.0079
		Well done	0.663	0.0157
		Very well done	0.134	0.0032
Other Pieces, skinless	Oven Broiled	Rare	-	-
		Medium rare	-	-
		Just done	0.073	0.0017
		Medium well	0.189	0.0045
		Well done	0.384	0.0091
		Very well done	0.097	0.0023
Other Pieces,	Fried	Rare	-	-

<b>CHICKEN CUT</b>	<b>Cooking Method</b>	<b>Doneness</b>	<b>g/day</b>	<b>g/kg-bw/day</b>
skinless		Medium rare	-	-
		Just done	0.116	0.0028
		Medium well	0.299	0.0071
		Well done	0.762	0.0181
		Very well done	0.140	0.0033
Other Pieces, skinless	Oven Baked	Rare	-	-
		Medium rare	-	-
		Just done	0.109	0.0026
		Medium well	0.335	0.0079
		Well done	0.669	0.0159
Other Pieces, skinless	Microwaved Baked	Very well done	0.140	0.0033
		Rare	-	-
		Medium rare	-	-
		Just done	0.037	0.0009
		Medium well	0.073	0.0017
Other Pieces, with skin	Grilled/BBQ	Well done	0.177	0.0042
		Very well done	0.037	0.0009
		Rare	-	-
		Medium rare	-	-
		Just done	0.126	0.0020
Other Pieces, with skin	Oven Broiled	Medium well	0.412	0.0066
		Well done	0.791	0.0127
		Very well done	0.159	0.0026
		Rare	-	-
		Medium rare	-	-
Other Pieces, with skin	Fried	Just done	0.060	0.0010
		Medium well	0.206	0.0033
		Well done	0.432	0.0070
		Very well done	0.100	0.0016
		Rare	-	-
Other Pieces, with skin	Oven Baked	Medium rare	-	-
		Just done	0.166	0.0027
		Medium well	0.446	0.0072
		Well done	1.317	0.0212
		Very well done	0.293	0.0047
Other Pieces, with skin	Oven Baked	Rare	-	-

<b>CHICKEN CUT</b>	<b>Cooking Method</b>	<b>Doneness</b>	<b>g/day</b>	<b>g/kg-bw/day</b>
		Medium rare	-	-
		Just done	0.153	0.0025
		Medium well	0.332	0.0053
		Well done	0.896	0.0144
		Very well done	0.206	0.0033
Other Pieces, with skin	Microwaved Baked	Rare	-	-
		Medium rare	-	-
		Just done	0.040	0.0006
		Medium well	0.059	0.0010
		Well done	0.178	0.0029
		Very well done	0.033	0.0005
<b>Total Chicken Intake</b>			<b>26.228</b>	<b>0.458</b>

**Table C-4. Pork Consumption by Method of Cooking and Degree of Doneness (Mean per Capita, US Population, NHANES 03-06)**

PORK CUT	Cooking Method	Doneness	g/day	g/kg-bw/day
Pork Chop	Grilled/BBQ	Rare	-	-
		Medium rare	-	-
		Just done	0.149	0.0023
		Medium well	0.233	0.0037
		Well done	0.386	0.0060
		Very well done	0.048	0.0008
Pork Chop	Oven Broiled	Rare	-	-
		Medium rare	-	-
		Just done	0.064	0.0010
		Medium well	0.149	0.0023
		Well done	0.231	0.0036
		Very well done	0.024	0.0004
Pork Chop	Fried	Rare	-	-
		Medium rare	-	-
		Just done	0.094	0.0015
		Medium well	0.231	0.0036
		Well done	0.456	0.0071
		Very well done	0.078	0.0012
Pork Chop	Oven Baked	Rare	-	-
		Medium rare	-	-
		Just done	0.113	0.0018
		Medium well	0.219	0.0034
		Well done	0.406	0.0064
		Very well done	0.056	0.0009
Pork Chop	Microwaved Baked	Rare	-	-
		Medium rare	-	-
		Just done	0.012	0.0002
		Medium well	0.020	0.0003
		Well done	0.030	0.0005
		Very well done	0.008	0.0001
Pork Ribs	Grilled/BBQ	Rare	-	-
		Medium rare	-	-
		Just done	0.088	0.0012
		Medium well	0.196	0.0026
		Well done	0.351	0.0047
		Very well done	0.047	0.0006
Pork Ribs	Oven Broiled	Rare	-	-
		Medium rare	-	-
		Just done	0.025	0.0003
		Medium well	0.070	0.0009

<b>PORK CUT</b>	<b>Cooking Method</b>	<b>Doneness</b>	<b>g/day</b>	<b>g/kg-bw/day</b>
		Well done	0.106	0.0014
		Very well done	0.018	0.0002
Pork Ribs	Fried	Rare	-	-
		Medium rare	-	-
		Just done	0.009	0.0001
		Medium well	0.021	0.0003
		Well done	0.047	0.0006
		Very well done	0.007	0.0001
Pork Ribs	Oven Baked	Rare	-	-
		Medium rare	-	-
		Just done	0.031	0.0004
		Medium well	0.108	0.0015
		Well done	0.196	0.0026
		Very well done	0.040	0.0005
Pork Ribs	Microwaved Baked	Rare	-	-
		Medium rare	-	-
		Just done	0.009	0.0001
		Medium well	0.011	0.0001
		Well done	0.031	0.0004
		Very well done	0.007	0.0001
Pork Tenderloins	Grilled/BBQ	Rare	-	-
		Medium rare	-	-
		Just done	0.023	0.0004
		Medium well	0.032	0.0005
		Well done	0.034	0.0006
		Very well done	0.004	0.0001
Pork Tenderloins	Oven Broiled	Rare	-	-
		Medium rare	-	-
		Just done	0.009	0.0001
		Medium well	0.019	0.0003
		Well done	0.024	0.0004
		Very well done	0.002	0.0000
Pork Tenderloins	Fried	Rare	-	-
		Medium rare	-	-
		Just done	0.006	0.0001
		Medium well	0.015	0.0002
		Well done	0.031	0.0005
		Very well done	0.004	0.0001
Pork Tenderloins	Oven Baked	Rare	-	-
		Medium rare	-	-
		Just done	0.012	0.0002
		Medium well	0.027	0.0005

<b>PORK CUT</b>	<b>Cooking Method</b>	<b>Doneness</b>	<b>g/day</b>	<b>g/kg-bw/day</b>
Pork Tenderloins	Microwaved Baked	Well done	0.040	0.0007
		Very well done	0.007	0.0001
		Rare	-	-
		Medium rare	-	-
		Just done	0.001	0.0000
		Medium well	0.003	0.0000
		Well done	0.006	0.0001
		Very well done	0.002	0.0000
Pork Roast	Grilled/BBQ	Rare	-	-
		Medium rare	-	-
		Just done	0.030	0.0004
		Medium well	0.047	0.0006
		Well done	0.061	0.0008
		Very well done	0.013	0.0002
Pork Roast	Oven Broiled	Rare	-	-
		Medium rare	-	-
		Just done	0.027	0.0004
		Medium well	0.052	0.0007
		Well done	0.079	0.0011
		Very well done	0.010	0.0001
Pork Roast	Fried	Rare	-	-
		Medium rare	-	-
		Just done	0.007	0.0001
		Medium well	0.015	0.0002
		Well done	0.024	0.0003
		Very well done	0.008	0.0001
Pork Roast	Oven Baked	Rare	-	-
		Medium rare	-	-
		Just done	0.067	0.0009
		Medium well	0.110	0.0015
		Well done	0.250	0.0035
		Very well done	0.040	0.0005
Pork Roast	Microwaved Baked	Rare	-	-
		Medium rare	-	-
		Just done	0.006	0.0001
		Medium well	0.008	0.0001
		Well done	0.014	0.0002
		Very well done	0.005	0.0001
Ham Slices	Grilled/BBQ	Rare	-	-
		Medium rare	-	-
		Just done	0.077	0.0012
		Medium well	0.090	0.0014

<b>PORK CUT</b>	<b>Cooking Method</b>	<b>Doneness</b>	<b>g/day</b>	<b>g/kg-bw/day</b>
		Well done	0.110	0.0017
		Very well done	0.007	0.0001
Ham Slices	Oven Broiled	Rare	-	-
		Medium rare	-	-
		Just done	0.069	0.0010
		Medium well	0.106	0.0016
		Well done	0.097	0.0015
		Very well done	0.009	0.0001
Ham Slices	Fried	Rare	-	-
		Medium rare	-	-
		Just done	0.124	0.0019
		Medium well	0.184	0.0028
		Well done	0.256	0.0039
		Very well done	0.022	0.0003
Ham Slices	Oven Baked	Rare	-	-
		Medium rare	-	-
		Just done	0.164	0.0025
		Medium well	0.251	0.0038
		Well done	0.254	0.0038
		Very well done	0.020	0.0003
Ham Slices	Microwaved Baked	Rare	-	-
		Medium rare	-	-
		Just done	0.030	0.0005
		Medium well	0.036	0.0005
		Well done	0.056	0.0008
		Very well done	0.009	0.0001
<b>Total Pork Intake</b>			<b>7.572</b>	<b>0.113</b>



**Table C-5. Bacon Slice Consumption by Method of Cooking and Degree of Doneness  
(Mean *per Capita*, US Population, NHANES 03-06)**

<b>Cooking Method</b>	<b>Doneness</b>	<b>g/day</b>	<b>g/kg-bw/day</b>
Grilled/BBQ	Rare	-	-
	Medium rare	-	-
	Just done	0.012	0.0002
	Medium well	0.022	0.0004
	Well done	0.054	0.0008
	Very well done	0.021	0.0003
Oven Broiled	Rare	-	-
	Medium rare	-	-
	Just done	0.014	0.0002
	Medium well	0.028	0.0004
	Well done	0.048	0.0008
	Very well done	0.015	0.0002
Fried	Rare	-	-
	Medium rare	-	-
	Just done	0.058	0.0009
	Medium well	0.140	0.0022
	Well done	0.390	0.0062
	Very well done	0.152	0.0024
Oven Baked	Rare	-	-
	Medium rare	-	-
	Just done	0.017	0.0003
	Medium well	0.027	0.0004
	Well done	0.063	0.0010
	Very well done	0.019	0.0003
Micro waved	Rare	-	-
	Medium rare	-	-
	Just done	0.022	0.0004
	Medium well	0.057	0.0009
	Well done	0.164	0.0026
	Very well done	0.069	0.0011
<b>Total Bacon Slices Intake</b>		<b>1.392</b>	<b>0.022</b>

**Table C-6. Hot Dog Consumption by Method of Cooking and Degree of Doneness (Mean per Capita, US Population, NHANES 03-06)**

<b>Cooking Method</b>	<b>Doneness</b>	<b>g/day</b>	<b>g/kg-bw/day</b>
Grilled/BBQ	Rare	-	-
	Medium rare	-	-
	Just done	0.299	0.0054
	Medium well	1.488	0.0269
	Well done	1.854	0.0335
	Very well done	0.321	0.0058
Oven Broiled	Rare	-	-
	Medium rare	-	-
	Just done	0.119	0.0022
	Medium well	0.470	0.0085
	Well done	0.396	0.0071
	Very well done	0.067	0.0012
Fried	Rare	-	-
	Medium rare	-	-
	Just done	0.119	0.0022
	Medium well	0.500	0.0090
	Well done	0.791	0.0143
	Very well done	0.149	0.0027
Oven Baked	Rare	-	-
	Medium rare	-	-
	Just done	0.104	0.0019
	Medium well	0.268	0.0048
	Well done	0.261	0.0047
	Very well done	0.097	0.0017
Micro waved Baked	Rare	-	-
	Medium rare	-	-
	Just done	0.613	0.0111
	Medium well	1.226	0.0221
	Well done	0.546	0.0099
	Very well done	0.060	0.0011
<b>Total Hog Dog Intake</b>		<b>9.751</b>	<b>0.176</b>

**Table C-7. Fish Consumption by Method of Cooking and Degree of Doneness (Mean per Capita, US Population, NHANES 03-06)**

<b>Cooking Method</b>	<b>Doneness</b>	<b>g/day</b>	<b>g/kg-bw/day</b>
Grilled/BBQ	Rare	0.015	0.0002
	Medium rare	0.066	0.0010
	Just done	0.338	0.0051
	Medium well	0.459	0.0069
	Well done	0.525	0.0079
	Very well done	0.055	0.0008
Oven Broiled	Rare	0.010	0.0002
	Medium rare	0.035	0.0005
	Just done	0.435	0.0066
	Medium well	0.521	0.0079
	Well done	0.637	0.0096
	Very well done	0.076	0.0011
Fried	Rare	0.005	0.0001
	Medium rare	0.010	0.0002
	Just done	0.434	0.0066
	Medium well	0.631	0.0095
	Well done	1.349	0.0204
	Very well done	0.187	0.0028
Oven Baked	Rare	0.005	0.0001
	Medium rare	0.035	0.0005
	Just done	0.540	0.0082
	Medium well	0.727	0.0110
	Well done	0.934	0.0141
	Very well done	0.131	0.0020
Microwaved Baked	Rare	0.005	0.0001
	Medium rare	0.015	0.0002
	Just done	0.091	0.0014
	Medium well	0.091	0.0014
	Well done	0.156	0.0024
	Very well done	0.020	0.0003
<b>Total Fish Intake</b>		<b>8.539</b>	<b>0.129</b>