MEAT, COOKING METHODS AND RISK OF COLORECTAL CANCER: A CASE - CONTROL STUDY IN ARMENIA.

Master of Public Health Thesis Project Utilizing Professional Publication Framework

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Abstract

Objectives: The study aimed to explore an association between meat consumption, its cooking methods and risk of colorectal cancer in Armenia. Colorectal cancer is the third most common cause of death among patients with neoplastic diseases and the sixth cause of death in Armenia.

Study Methods and Design: The study utilized a case-control design. Seventy-seven patients diagnosed with colorectal cancer during the study period from August 17, 2002 to August 20, 2003 were included in the study as cases. The control group was selected from healthy hospital visitors, who were free of the disease, and were not related to the patient. The controls were matched with the cases by age and gender. Information was collected using telephone or face-to-face interviews by means of interviewer-administered questionnaires.

Results: The analysis showed that the risk of having colorectal cancer increased with everyday meat use compared with not-daily meat use (adjusted for frequency of fried and boiled sausage use and preference of fried meat surface: OR=3.2; 95% CI 1.0- 18.5; p-value 0.044), with preference of heavily browned surface of fried meat compared with lightly browned (adjusted for daily meat use and frequency of fried and boiled sausage use: OR= 15.4; 95% CI 2.8-85.8; p-value 0.002). There was no statistically significant risk of having colorectal cancer across different types of meat as well as across preferred cooking methods for different meat types. The results of the study have also shown a protective effect of frequent use (more than once/week) of boiled and fried sausage use on risk of colorectal cancer (adjusted for daily meat use and preference of fried meat surface: OR=0.03; 95% CI 0.004-0.3; p-value 0.002, and OR=0.1; 95% CI 0.008-0.5; p-value 0.008, respectively).

Conclusions: The study has demonstrated evidence that there is a need for a nutrition educational program to make the information available for the public. Based on the results of the study, it is recommended to avoid use of heavily browned surface meat and shift from

daily to more rare meat use. However, more research is needed to obtain data that might serve for decision-making regarding nation-wide preventive programs. Further, protective effect of frequent use of boiled and fried sausages need to be proved by additional research, as the results are controversial compared with previous studies.

Introduction

General Overview. Burden of Disease.

Colorectal cancer is one of the leading causes of cancer mortality in the industrialized world (1). Colorectal cancer is the second most common cause of death among patients with neoplastic diseases in the United States, after lung and breast cancer in women, and lung and prostate cancer in men (1). According to the statistical data from the World Health Organization (WHO), colorectal cancer appears to be the third most common cause of death among patients with neoplastic diseases and the sixth cause of death in Armenia (2). In addition, colorectal cancer in Armenia has had a trend to increase during the last decade (2). The most common site for colorectal tumors is in the rectum (39%), followed by tumors in the descending and the sigmoid colon (35%). Only 17% of colorectal cancers are located in the ascending colon and 9% in the transverse colon (3). One of the important traits of this disease is that in 2/3 of cases it begins in people without obvious symptoms or complains, which leads to the late detection of the disease (1). As a result, about 38% of colorectal cancer cases are diagnosed after progressing into regional disease and 22% with already existing metastases (1). Survival beyond 5 years is high for patients diagnosed with localized forms of the cancer (94%), about 70% for those diagnosed with regional disease, and only 9% for metastatic cancer (1).

Literature Review.

Colorectal cancer is one of the most studied types of cancer. The risk factors for developing colorectal cancer include medical conditions, such as having inflammatory bowel diseases, a personal or family history of colorectal cancer or colorectal polyps, and certain hereditary syndromes (1, 4). The risk of developing colorectal cancer increases with advancing age (1). There are also some modifiable factors, which enhance the risk of colorectal cancer, such as lack of physical activity, incorrect nutrition and absence of regular

screening (1). Other factors, which might contribute to the risk of colorectal cancer, include obesity, alcohol consumption, and tobacco use, which increase the risk not only for related cancer, but also for adenomas (4). There are also studies, which find a positive influence of non-steroidal anti-inflammatory drug use on the initiation of the disease (5).

Polyps are one of the most important factors for the development of colorectal cancer. Although there are many types of colonic polyps, only adenomatous polyps have the potential to develop into invasive cancer (1). Adenomatous polyps are the most common type of polyp; they are found in approximately 25% of people by age 50, and their prevalence increases with age (1). There is evidence for an adenoma-carcinoma sequence. The average age of onset of adenomatous polyps precedes that of the carcinoma by several years, and few cancers arise in the absence of polyps (1). Many carcinomas contain the remnants of adenomatous polyps and adenomatous polyps and carcinomas share some genetic changes (1). Finally, adenomatous polyps and carcinomas have similar risk factors (1).

Some studies have shown the importance of inflammatory bowel diseases in the colorectal cancer development. Patients with ulcerative colitis are at higher risk of having colorectal cancer (6). The risk of colon cancer increases with the duration of inflammatory bowel disease; most cancers occur after 8 years of pancolitis (1).

The significance of genetic factors and mechanisms, and their role in the development of colorectal cancer, has become more obvious. The heritable and genetic factors contributing to colon cancer can be divided into three categories: inherited syndromes, genetic epidemiology, and molecular genetics (7). Inherited syndromes of colorectal cancer have been identified and include familial adenomatous polyposis, Gardner syndrome, Peutz-Jeghers syndrome, familial juvenile polyposis, and hereditary nonpolyposis colorectal cancer (7). Inherited syndromes of colorectal cancer can be separated into two categories. The first one consists of the polyposis syndromes, which are rare autosomal dominantly inherited

conditions expressed in intestinal polyposis and cancer (7). The second category consists of the "hereditary nonpolyposis colorectal cancer syndromes," which are also the dominantly inherited conditions characterized by a high genetic risk for colon cancer (7). Individuals with the nonpolyposis syndromes express only one or a few colonic polyps and have a tendency for having proximal colonic tumors (7). Genetic epidemiological studies have shown that first-degree relatives of persons with colon cancer have a two or three times greater risk of having colon malignancy (7). More recent studies have found a similar risk among the relatives of those with adenomatous polyps. Studies of colon cancer and adenomatous polyps in generations have demonstrated that this familial clustering probably is due to inherited susceptibilities (7). These inherited susceptibilities probably interact with environmental factors and cause the polyp growth and, finally, colon cancer (7). The familial clustering of colon cancer also occurs in the absence of a defined genetic syndrome. This may be explained by similar lifestyles and dietary factors within families (1). The first-degree relatives of colorectal cancer patients from families without heritable genetic syndromes still have two to three times higher risk of colorectal cancer than those without a positive family history (8).

In addition to the above-mentioned factors, there are some modifiable factors related to colon cancer. Some of the factors influence polyp development, while others influence neoplastic change. Obesity, physical inactivity, and consumption of a diet high in fat and low in fiber are associated with an increased risk of colorectal cancer (9). Among both men and women, high levels of physical activity may decrease the risk of colon cancer by as much as 50%. Physical activity also appears to reduce the risk of large adenomatous polyps (1). There is considerable evidence that the high intake of red meat increases the risk of colorectal cancer among both men and women (1). Despite the availability of numerous epidemiological studies on the association between meat consumption and risk of colorectal

cancer, only few have paid attention to cooking methods (10). Results from the study in Stockholm have demonstrated the association between meat consumption and its cooking methods and colorectal cancer (10). It was established that the total meat intake, frequent consumption of brown gravy, a preference for heavily browned meat surface increases the risk of colorectal cancer (10). Several mechanisms have been proposed to explain the relationship between red meat and colorectal cancer. Some researchers consider animal fat to exert a cancer-promoting effect due to carcinogenic effect of fatty acids; however it is impossible to exclude effects of some protein metabolites on cancer initiation (1,10). Other studies have considered also possible confounding effects of meat protein and fat (10). Another hypotheses assume that promoters of neoplastic change may be formed during meat cooking (1). Another hypothesis states that high consumption of red meat may increase concentrations of fecal iron thus influencing the risk of colorectal cancer by generation of hydroxyl radicals (1). Previous researches have suggested that high cholesterol intake may be a risk factor for colorectal cancer, as diets containing high amounts of animal fat also provide high amounts of cholesterol (11). Association of some supplements has also been studied. Several studies have demonstrated the inverse association between colorectal cancer and the intake of vegetables containing folate (1). Researchers have found that individuals inflicted with colon cancer had significantly lower levels of serum folate and higher levels of serum homocysteine than did controls (12). In populations with lowest level of serum folate, the risk of developing colon cancer was two times greater than in those with the highest levels of serum folate (12).

Various studies have tried to explore an association between alcohol and tobacco use and the risk of colorectal cancer. The risk of polyps has been demonstrated to be three times higher for drinkers who did not smoke, and twelve times more for drinkers who also smoked compared with those who did not use alcohol and did not smoke (13). It has been suggested

that alcohol has an indirect effect on colorectal cancer development (13). In patients with at least one carcinoma, the risk of having colorectal cancer increases with alcohol consumption (13). Smoking is also associated with colorectal cancer (14). The smoking and adenoma association has been demonstrated in several studies (14). The possible explanation was irreversible damage due to carcinogens in cigarette smoke (14).

During the last decades, some studies were conducted to determine the association between nonsteroidal anti-inflammatory drug use and reduced risk of colorectal cancer. Different studies have shown a lower risk among regular users of aspirin and nonsteroidal anti-inflammatory drugs, regardless of the treatment indications (5). The association was found among users of daily doses of 300 mg (14). The risk reduction disappeared one year after the treatment cessation (14).

Despite a very wide range of different epidemiological studies on the etiology of colorectal caner, few of them have paid attention to the cooking methods (10).

Objectives.

The incidence of colorectal cancer in Armenia has remained high over the past decade and has had an increasing trend. At the same time, colorectal cancer etiology research has been absent in the country. The current study was designed to explore an association between meat consumption and its cooking methods and colorectal cancer in Armenia. The research hypothesis was that risk of having colorectal cancer increases with increased meat consumption and the risk varies across different cooking methods.

Subjects and Methods

Research question and study design.

The research question to be answered by the study was to determine whether there was an association between meat consumption, its cooking methods, and risk of developing

colorectal cancer. The study was designed as a case-control study with one control for each case. Cases and controls were matched by age and gender to exclude possible effects of confounders. The target population was the population of Armenia. The study population included one case and one control group. The patients from the specialized proctology departments in four of the hospitals in Yerevan (Clinical hospital #8, Saint Nerses hospital, Oncology Institute, Clinical Hospital after Mikaelyan), who were hospitalized between August 17, 2002 and August 20, 2003, served as cases and were selected after review of the medical records. The total list of potential cases included 119 patients. Patients, being treated in the departments at the time of the study, were interviewed by means of face-to face interviews. Other patients were interviewed by phone using the same questionnaire. The control group included hospital visitors to other than proctology departments of the same hospitals, who were free of the disease, including any signs of bowel disorders, and not related to the patients. No more than one person from one family was selected as control to exclude the possibility of having the same nutritional habits. Selection of this control group was done mainly because of the time limitation. The main problem with controls was that they did not undergo the same diagnostic procedures as cases. In order to minimize bias, after discussion with specialists, it was decided to ask two orientation questions to all hospital visitors before selecting them as controls. The questions were about presence of any intestinal problems and a family history of colorectal cancer. Initially, the possibility of conducting an interview before a sigmoscopy procedure and the final diagnosis was also considered but excluded for two reasons: time-limitation and the fact that persons who undergo this procedure, probably have some symptoms of bowel diseases, and may share the same risk factors as colorectal cancer (1). Family members and friends of patients were excluded as possible controls as they could share similar nutritional habits. After identification of their eligibility, controls were matched with cases by age (5 year interval age

groups) and gender. Selected controls were asked to provide phone numbers for conducting an interview. Those who preferred to have a face-to-face interview were interviewed in hospital settings.

Study population.

Definition of cases

All patients, regardless of gender and age, who were diagnosed with colorectal cancer (proved both histologically and by colonoscopy) for the first time during the period from August 17, 2002 to August 20, 2003, and were residents of Armenia.

The cases were selected from Proctology Department at Clinical Hospital # 8, the Department of Coloproctology at Saint Nerses Hospital, the Proctology Department of the Oncology Institute and the Proctology Department of the Clinical Hospital after Mikaelyan.

Definition of controls

Healthy hospital visitors to other than the specialized proctology departments of the same hospitals, who did not have any gastrointestinal problems, were not related to the cases, and were residents of Armenia, were matched by age and gender to the cases.

Exclusion criteria

Persons unwilling to participate in the study, and those controls with self-reported bowel problems.

Main Variables.

The presence of the colorectal cancer was considered an outcome (dependent) variable of the study. Independent variables included different meat consumption levels and preference of different cooking methods. Summary of the study variables and their measurement scales are presented in the table 1 below.

Table 1. Proposed research variables by name and type

Variable type/name	Type	Measure
Outcome (dependent) Study group	Binary	Measured as 1 (cases) or 0 (control group)
Hypothesized determinants (independent) Meat type preference	Nominal	Measured as 1-poultry; 2-beef/pork; 3-sausages; 4 -bacon/smoked meat
Frequency of meat consumption	Ordinal	Measured by Likert-type scale as 1-more than once/week; 2-1-3 times/month; 3-less than once/month; 4-never
Preference of fried meat surface	Ordinal	Measured as 1-heavily browned; 2-medium browned; 3-lightly browned
Frequency of certain meat type use cooked in different ways	Ordinal	Measured by Likert-type scale as 1-more than once/week; 2-1-3 times/month; 3 - less than once/month; 4-never
Preference of certain cooking method for different meat types	Nominal	Measured as 1-fried, 2-oven-roasted; 3-boiled

Ethical Considerations.

The study was implemented after approval from the Institutional Review Board/Committee on Human Research (IRB) of the American University of Armenia. Permission for the implementation from the Ministry of Health was received before conducting the study. The permission of the hospital Department heads selected for participation in the study was obtained prior to the program implementation. All participants were provided with the oral consent form (see Appendix 1, 2). No identification information was included in the questionnaires. The personal information of the participants, obtained from the Departments, was not disclosed and was destroyed immediately after the completion of the data collection process. The questionnaires will be kept in the College of Health Sciences or Center for Health Services Research and Development of the AUA for 2 years after the study. The results are presented as aggregated data.

Sample size.

Taking into account the values of odd ratios from previous research (1.7- 2.8), the proportion of people consuming meat (29%), and power equal to 0.8, the cases and controls were calculated to include at least 75 participants each (2,3,6,15). The following formula was

used for sample size calculations (calculations by STATA for different values are presented in Appendix 3):

$$n = \frac{\left[z_{\frac{\alpha}{2}} \sqrt{2\overline{pq}} + z_{\beta} \sqrt{p_1 q_1 + p_2 q_2} \right]^2}{\Delta^2}$$

Where p_1-proportion in cases, p_2-proportion in controls, $\overline{p} = (x_1+x_2)/(n_1+n_2)$, $\Delta = p_1 - p_2$. Taking into account hypothesized refusal rate of 10%, the sample size was estimated to be no less than 85.

Totally 119 patients from the specialized proctology departments in four of the hospitals in Yerevan were selected as potential cases after reviewing their medical records. From those, 38 had died before the beginning of the study and were excluded from the list of potential cases, and 4 persons refused to participate. From 84 selected controls, 7 refused to participate. Selection for controls for age group 65 and older was changed to convenience sampling because of the absence of that age group among hospital visitors. This group was selected from relatives and neighbors of Master of Public Health program students.

Data Collection. Description of the Instrument.

Interviewer administered questionnaire, containing questions regarding meat consumption and cooking methods, was used for data collection (see Appendix 4,5). The questionnaire was elaborated on the basis of diet history questionnaires from Risk Factor Monitoring and Methods Branch of the National Cancer Institute (NIH), and a questionnaire used in "Meat, Cooking Methods and Colorectal Cancer: A case-referent study in Stockholm" after permission from the appropriate persons. It was adapted to the Armenian population.

The questionnaire items referred to the meat consumption and preferred cooking methods for different meat types during the previous 5 years. The questionnaire began with questions on daily diet composition. Meat questions included daily meat use (yes/no),

frequency of meat use (once/week and more, 1-3 times/month, less than once/month), preferred meat type (beef/pork, poultry, sausage, bacon/smoked meat). Questions regarding preferred meat cooking methods were asked separately for each meat type (fried, boiled, oven-roasted). These were followed by frequency questions for particular meat type and its cooking method (once/week and more, 1-3 times/month, less than once/month). Questionnaire did not contain any identification information. It was pre-tested internally (among MPH program students at AUA) and some changes were made in wording to avoid misunderstanding. Both phone and face-to-face interviews were used for data collection. Cases admitted to the hospital at the time of data collection were interviewed in their wards after permission from the Department Heads. Other cases were interviewed by phone. Each selected control was asked for her/his phone number for conducting a phone interview. Those persons who preferred face-to-face interviews were interviewed in the hospital setting.

Data Analysis.

Information from cases and controls was entered into the STATA data screen. Appropriate computations and recoding were performed for making possible further analysis. The data from the STATA screen were also imported into the STATA file for performing conditional logistic regression. Some additional variables were generated in the STATA file for correct analysis. The results from SPSS and STATA were compared. Statistical Analysis included descriptive statistics (frequency tables, cross-tabulations) and conditional logistic regression (17).

Results

The data were collected from 77 cases and 77 controls. Non-response rate was 5% among cases (4 out of 81 patients refused to participate), and 8% among controls (7 out of 84 persons refused to participate). No questionnaire was considered as incomplete (missing

responses for more than 16 questions). Composition of the samples according to gender and age are presented in the table 3 below:

Table 3. Age and gender composition of cases and controls.

Age group	Gender		Total
	Male	Female	
35-39	-	1	1
40-44	1	1	2
45-49	4	4	8
50-54	6	6	12
55-59	6	6	12
60-64	7	4	11
65-69	6	3	9
70-74	5	6	11
75-79	6	4	10
80-84	1	-	1
Total	42	35	77
Mean age	63	60	61

The results have shown that 87% of all cases and 74% of all controls used meat daily. From cases, 42.9% and 49.4% preferred heavily and medium browned surface of fried meat respectively. For controls, 19.5 % preferred heavily browned meat surface and 58.4% preferred medium browned. Fried poultry was used more than once a week by 46.8 % of cases and 22.08 % of controls. Only 32.5% of controls mentioned frying as a preferred cooking method for poultry in contrast to 58.4% of cases. Results for conditional logistic regression with different variables and corresponding 95% Confidence Intervals (CI) as well as the total number of responses for each item are summarized in the table 4 below:

Table 4. Unadjusted Odds Ratios and 95%Confidence Intervals for Different Meat Consumption and Cooking Methods Items.

Meat item	**Number (%) of**		**OR (95%CI)**
	Cases	Controls	
Bacon			
less than 1 time/month	73(94.81)	77(100)	*[1]
1-3 times/month	2(2.60)	0	
>once/week	2(2.60)	0	
Beef/pork fried			
less than 1 time/month	58(75.32)	54(70.13)	1.00[2]
1-3 times/month	11(14.29)	14(18.18)	0.76(0.33-1.74)
>once/week	8(10.39)	9(11.69)	0.84(0.28-2.5)
Beef/pork oven			
less than 1 time/month	73(94.81)	67(87.01)	1.00
1-3 times/month	2(2.60)	6(7.79)	0.29(0.07-1.5)
>once/week	2(2.60)	4(5.19)	0.398(0.67-2.34)

[1] **For these variables the data were insufficient to obtain interpretable results for conditional logistic regression**

[2] **Reference group**

Meat item	Number (%) of		OR (95%CI)
	Cases	Controls	
Beef/pork boiled			
less than 1 time/month	7(9.09)	0	*
1-3 times/month	14(18.18)	19(24.68)	
>once/week	56(72.73)	58(75.32)	
Sausage fried			
less than 1 time/month	65(84.42)	55(71.43)	1.00
1-3 times/month	9(11.69)	12(15.58)	0.48 (0.17-1.35)
>once/week	**3(3.90)**	**10(12.99)**	**0.22 (0.05-0.88)[3]**
Sausage oven			
less than 1 time/month	75(97.4)	71(92.21)	*
1-3 times/month	0	6(7.79)	
>once/week	2(2.60)	0	
Sausage boiled			
less than 1 time/month	24(31.17)	9(11.69)	1.00
1-3 times/month	**33(42.86)**	**39(50.65)**	**0.27(0.096-0.75)[3]**
>once/week	**20(25.97)**	**29(37.66)**	**0.23(0.08-0.66)[3]**
Poultry fried			
less than 1 time/month	17(22.08)	28(36.36)	1.00
1-3 times/month	24(31.17)	32(41.56)	1.72(0.67-4.42)
>once/week	**36(46.75)**	**17(22.08)**	**4.01(1.5-10.74)[3]**
Poultry oven			
less than 1 time/month	49(63.64)	53(68.83)	*
1-3 times/month	24(31.17)	20(25.97)	
>once/week	4(5.19)	4(5.19)	
Poultry boiled			
less than 1 time/month	16(20.78)	7(9.09)	1.00
1-3times/month	33(42.86)	34(44.16)	0.34(0.11-1.09)
>once/week	**28(36.36)**	**36(46.75)**	**0.27(0.08-0.89)[3]**
Meat type			
sausage	2(2.60)	4(5.19)	1.00
poultry	7(9.09)	18(23.38)	0.82(0.12-5.47)
beef/pork	68(88.31)	55(71.43)	2.44(0.43-13.97)
bacon/smoked meat	0	0	*
Meat frequency			
less than 1 time/month	2(2.60)	0	*
1-3 times/month	8(10.39)	10(12.99)	
>once/week	67(87.01)	67(87.01)	
Cooking methods			
beef			
boiled	64(83.12)	70(90.91)	*
fried	11(14.29)	7(9.09)	
oven-roasted	2(2.60)	0	
sausage			
boiled	75(97.4)	69(89.61)	*
fried	2(2.60)	0	
oven-roasted	0	8(10.39)	
poultry			
boiled	28(36.36)	41(53.25)	1.00
fried	**45(58.44)**	**25(32.47)**	**2.28-(1.18-4.43)[3]**
oven-roasted	4(5.19)	11(14.29)	0.45(0.12-1.71)
Meat surface			
lightly browned	6(7.79)	17(22.08)	1.00
moderately browned	38(49.35)	45(58.44)	2.36(0.83-6.69)
heavily browned	**33(42.86)**	**15(19.48)**	**6.05 (1.88-19.48)[3]**
Daily meat use			
no	10(12.99)	20(25.97)	1.00
yes	**67(87.01)**	**57(74.03)**	**3.00(1.09-8.25)[3]**

[3] **Statistically significant variables (p<0.05)**

According to the results of simple conditional logistic regression, statistically significant increases of risk for colorectal cancer were estimated for some variables. The risk of having colorectal cancer increased with daily meat consumption (OR=3.0 with 95 % confidence interval 1.1-8.3, p-value 0.033). There was a statistically significant association between preferences of heavily browned fried meat surface and the risk of developing colorectal cancer (OR=6.1; 95 % CI 1.9-19.9; p-value 0.003). The association also estimated between preference of fried poultry and colorectal cancer (OR=2.3; 95% CI 1.2-4.4; p-value 0.014). Frequent use of fried poultry (more than once/week) also increases the risk of developing colorectal cancer (OR=4.0; 95% CI 1.5-10.7; p-value 0.006).

The results of simple conditional logistic regression also demonstrated a protective effect of more frequent use of fried and boiled sausages (fried more than once/week: OR=0.2; 95% CI 0.1-0.9; p-value 0.033; boiled more than once/week: OR=0.2; 95% CI 0.1-0.7; p-value 0.007; boiled 1-3 times/month: OR=0.3; 95% CI 0.1-0.8; p-value 0.012) as well as for more frequent (more than once/week) use of boiled poultry (OR =0.3; 95% CI 0.1-0.9; p-value 0.031).

There was no statistically significant effect of meat type preference on the development of colorectal cancer (beef/pork-OR=2.4; 95% CI 0.4-14.0; p-value 0.315; poultry-OR=0.8; 95% CI 0.1-5.5; p-value 0.841). There were also no statistically significant associations between the frequency of fried or oven-roasted beef/pork use (OR=0.8; 95% CI 0.3-2.5; p-value 0.8 and OR=0.4; 95% CI 0.7-2.3; p-value 0.308 respectively) and colorectal cancer. Similar non-significant results were obtained for preference of oven-roasted poultry and preference of moderately browned surface of fried meat (OR=0.5; 95% CI 0.1-1.7; p-value 0.240 and OR=2.4; 95% CI 0.8-6.7; p-value 0.105 respectively). The data were insufficient to obtain interpretable results from conditional logistic regression for preference of cooking methods for beef and sausages, for frequency of bacon, boiled beef/pork, oven-

roasted sausage and oven-roasted poultry use. Such results were related to the small sample size and the absence of a sufficient number of responses for different response categories.

No statistically significant association was observed for variables on the daily composition of different products. Results of logistic regression for these variables are summarized in the table 6 below:

Table 6. Unadjusted Odds Ratios, p-value and 95% CI intervals for daily diet composition variables.

Variable Name	*Odds Ratio*	*p-value*	*95% Confidence Interval*
Butter	0.88	0.715	0.43-1.79
Dairy	0.59	0.080	0.32-1.07
Fruit	0.65	0.198	0.34-1.25
Vegetables	0.65	0.261	0.30-1.38
Greens	0.95	0.879	0.52-1.74
Beans	1	1.000	0.14-7.10
Rice	0.15	0.000	0.06-0.39
Bread	4.69e-16*	1.000	0*
Fish	0.33	0.341	0.03-3.19

***- the data were insufficient to obtain interpretable results for conditional logistic regression**

Possible interactions between different statistically significant risk factors were examined. No association between them was revealed. All the statistically significant variables were included in different multiple logistic regression models. Models were tested by Log Likelihood Ratio test to determine the best fitting model. Characteristics of different tested models are summarized in the table below:

Table 7. Results of Log Likelihood Ratio test for different multiple logistic regression models:

	Variable name	OR	SE	z	P (z)	95%CI	Log likelihood test
Model 1	Daily meat use	1.1	0.52	2.13	0.033	0.086- 2.111	_
Model 2	Daily meat use Heavily browned meat surface	2.8 5.7	1.56 3.44	1.96 2.84	0.050 0.004	0.998-8.379 1.711-18.671	Chi^2 11.3 p 0.0008 (compared with Model 1)
Model 3	Daily meat use Heavily browned meat surface Preference of fried poultry	3.0 5.9 1.8	1.74 3.99 0.68	1.93 2.60 1.51	0.054 0.009 0.131	0.980-9.330 1.548 -22.258 0.843- 3.744	Chi^2 2.33 p 0.1272 (compared with Model 2)

	Variable name	OR	SE	z	P (z)	95%CI	Log likelihood test
Model 4	Daily meat use	2.4	1.42	1.47	0.141	0.749- 7.628	Chi^2 2.68
	Heavily browned meat surface	4.0	2.57	2.16	0.031	1.138- 14.075	p 0.1017
	Fried poultry use more than once/week	2.3	1.34	1.43	0.152	0.735- 7.205	(compared with Model 2)
Model 5	Daily meat use	3.7	2.46	2.01	0.045	1.032- 13.629	Chi^2 13.59
	Heavily browned meat surface	13.9	10.79	3.37	0.001	3.009- 63.796	p 0.0002
	Boiled sausage use more than once/week	0.1	5.07	-3.27	0.001	0.022-0.385	(compared with Model 2)
Model 6	**Daily meat use**	**3.2**	**4.39**	**2.02**	**0.044**	**1.042- 18.509**	**Chi^2 8.82**
	Heavily browned meat surface	**15.4**	**13.48**	**3.11**	**0.002**	**2.752-85.770**	**p 0.0030**
	Boiled sausage use more than once/week	**0.03**	**0.03**	**-3.15**	**0.002**	**0.004-0.271**	(compared with
	Fried sausage use more than once/week	**0.1**	**0.07**	**-2.64**	**0.008**	**0.008-0.494**	Model 5)
Model 7	Daily meat use	5.49	4.23	2.21	0.027	1.209- 24.880	Chi^2 0.45
	Heavily browned meat surface	14.06	12.65	2.94	0.003	2.412- 82.014	p 0.5008
	Boiled sausage use more than once/week	0.03	0.04	-2.94	0.003	0.004-0.324	(compared with
	Fried sausage use more than once/week	0.06	0.06	-2.56	0.010	0.007-0.513	Model 6)
	Boiled poultry use more than once/week	0.39	0.35	-1.05	0.295	0.065- 2.289	

Based on the results of likelihood ratio test, the best fitting (parsimonious) model includes variables of daily meat use, preference of fried meat surface, frequency of boiled sausage use, frequency of fried sausage use. The model was tested with goodness-of-fit test to compare with saturated model. There was no significant difference between selected model and saturated model (Hosmer-Lemeshow chi^2 =1.88; Prob > chi2 = 0.8653), which support the assumption that the model is the best fitting model. According to the model, risk of having colorectal cancer is higher in case of daily meat use versus not-daily meat use after controlling for other variables (OR=3.2; 95% CI 1.0- 18.5; p-value 0.044). Preference of heavily browned meat surface versus lightly browned also increases risk of having colorectal cancer after controlling for other variables (OR= 15.4; 95% CI 2.8-85.8; p-value 0.002). There is a protective effect of frequent use (more than once/week) of boiled and fried sausage use on risk of colorectal cancer (OR=0.03; 95% CI 0.004-0.3; p-value 0.002 and OR=0.1; 95% CI 0.008-0.5; p-value 0.008 respectively). In addition, there might be a confounding

effect of boiled sausage use (values for OR of meat surface preference change in the fitting model).

Discussion and recommendations

The main findings demonstrated by the study were statistically significant associations between daily meat consumption, preference of browned surface of fried meat, and the risk of developing colorectal cancer as well as protective effects of frequent use (more than once/week) of boiled and fried sausage.

The findings of the current study regarding an association between fried foods and cancer were consistent with previous reports from other studies that examined the relationship between fried food and colorectal cancer (10). The results of previous studies indicated higher risk for preference of heavily browned meat surface with OR 2.8 and 6.0 for colon and rectum cancers respectively (10). The results of the current study also indicated higher colorectal cancer risk with preference of heavily browned meat surface (OR=15.0). Meat intake was associated with higher risk of colorectal cancer in other studies, which reported OR 1.5-2.8 (1, 10). Possible explanations of the association of meat intake with colorectal cancer risk include carcinogenic effects of fatty acids or protein metabolites as well as formation of some cancer-promoting substances during cooking (1,10).

Previous researches also reported the association between frequent use of boiled (OR=1.2-1.7 for colon and OR=3-3.2 for rectum cancer) and fried (OR=1.0-1.2 for colon and OR=1.5-1.8 for rectum cancer) sausages and the risk of colorectal cancer in contrast to the results of this case-control study, which showed protective effect with OR=0.39 and 0.06 for boiled and fried sausages, respectively (10). Such discrepancy might be the result of small sample size in the current study.

The majority of the study limitations were the result of lack of time and resources. The most serious limitation was that controls did not undergo the same diagnostic procedure

as cases. After discussion with professionals, it was decided to minimize this bias by asking potential controls about the presence of bowel dysfunction symptoms. This might reduce possibility of having persons with latent forms of colorectal cancer among controls. In the beginning of the study, the possibility of selecting cases and controls after sigmoscopy was also considered. It was decided not to use this method because those who underwent sigmoscopy already had bowel problems. As some of the bowel diseases share common risk factors with colorectal cancer, such methodology could create a source of bias. Selection of healthy visitors as controls was done for the following reasons. First of all, they were easily accessible and their selection was less time-consuming. Selection of the healthy hospital visitors as controls instead of family members or friends avoided the possibility of having similar nutritional habits between cases and controls. Initially, it was planned to select the controls among randomly selected departments at the same hospitals and use RANDI command of calculator for randomization of controls (0-non-eligible, 1-eligible). But taking into account time feasibility and smaller number of visitors in hospitals during the summer period (as the result of smaller number of patients), when the data collection took place, it was decided not to use randomization.

The next limitation dealt with questions in the study instrument referring to 5-year period. Etiology of the cancer requires long period for the development of the disease. For the best results, it would be better to recall nutritional habits of the participants for the past 10-15 years period. On the other hand, the social and economic conditions in Armenia had changed drastically during the last 10-15 years, which was associated with varying exposure to meat and changes in nutritional habits. For these reasons, it is recommended to separate the questions for nutrition into three periods in subsequent studies. Those periods should be the following: before 1991-1996, during 1991-1996 and after 1996. It is also possible that not only the products themselves, but also their low quality may contribute to the increased

risk of colorectal cancer. It would be useful to include questions on food quality in the next study. The next serious limitation was the absence of distinct exposure measurement. The questions do not refer to the specific amounts of used products. Another problem with the instrument was that reliability and validity of the instrument were not determined.

There were difficulties with selection of healthy visitors for age group 65 and above. Initially, it was considered an option to include all the people above 65 years of age in one group. Later it was decided that age might have a crucial role (for example, absence of teeth may result in less consumption of meat). This assumption was the reason for selecting controls for these age groups among relatives and neighbors of classmates. However, selected persons may belong to a certain social group, which may introduce some bias. Further, the study instrument did not contain questions, which might serve for detecting differences between groups of hospital visitors and relatives/neighbors of MPH students with regards to some characteristics.

There were some problems with potential intervening variables. Family history was not included in the questionnaire and might serve as an intervening variable. It is better to exclude people with a family history of colorectal cancer from both cases and controls in the next study. However, none of the cases mentioned family history of colorectal cancer. One person from potential controls mentioned the family history of the disease and was excluded from the study.

Another possible intervening variable was the presence of hereditary syndromes. Because of the variety of such syndromes and lack of diagnostics of those syndromes in Armenia today, they were not taken into account. Physical activity and regular screening may also be considered intervening variables. It is possible to include some questions on physical activity in the next studies or match cases and controls by the level of their physical activity. According to the specialists, regular screening does not exist as prevention strategy

in Armenia, so regular screening methodology does not appear to be a serious problem for the study. However, there are two options to improve the study in the future in regards to intervening variables. One possible way is to match cases and controls on intervening variable. This is more complicated and time-consuming method. Another strategy is to include these variables in the questionnaire and make adjustments during the analysis.

The results of conditional logistic regression were not interpretable for some variables, which could be explained by the absence, or very small number of observations for a particular item and certain group (cases or controls). It could be explained as the result of small sample size. It is recommended to increase the sample size in a future study. Inclusion of patients diagnosed within more than one-year period will not increase sample size substantially because of the low survival rate among colorectal cancer patients. Another more acceptable way of increasing the sample size is to recruit colorectal cancer patients from other health care facilities.

The study demonstrated evidence that there was a need for a nutrition educational program to make the information available for the public. Based on the results of the study, the public educational program should recommend avoiding use of heavily browned surface meat and shifting from daily to more rare meat use. It could be possible to organize separate educational programs for health care professionals, especially family physicians, as well as for residents at the departments of Clinical Oncology and Internal Medicine of Yerevan State Medical University and National Institute of Health.

However, the results of the study analysis demonstrated the need for further and comprehensive investigations taking into account the listed limitations. Further, protective effect of frequent use of boiled and fried sausages need to be confirmed by additional research, as the results were controversial compared with previous studies. Additional information is needed to make conclusions regarding other variables, which did not

demonstrate interpretable results during the analysis. The results of a comprehensive research may serve as a basis for decision-making and implementation of nation-wide prevention programs in the future.

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List of Potential Journals for Publication

1. Cancer Epidemiology
2. British Journal of Cancer
3. Cancer Causes and Control
4. International Journal of Cancer

APPENDIXES

APPENDIX 1. English Version of Study Consent Form.

American University of Armenia
College of Health Sciences
Master of Public Health Program
CONSENT FORM

Title of Research Project:
Exploratory study to determine role of meat consumption and cooking methods in development of colorectal disease in Armenia.

Explanation of Research Project:
A student enrolled in the MPH program at the AUA is conducting a study to determine factors, which may have contributed to the development of colorectal disease. The purpose is to identify factors, which could be used in the future to assist other people to reduce their chances of developing the disease. All that is required of you is the one time completion of a questionnaire. The time required for completion is approximately 20-30 minutes. You will not undergo any further examination or procedures. You were selected as a patient already diagnosed with colorectal disease during last 12 months regardless of gender.

Your involvement in the study: Your name was obtained from records maintained by the Department of Proctology. Patients selected for inclusion are all of those diagnosed within the previous twelve-months of the study.

Risk/Benefit:
You are not at physical risk during the study. The questionnaire does not contain any questions, which might cause inconvenience for you.
Although you may receive no direct benefit through your participation, your answers may be used to design educational programs, which could benefit other people.

Rights to refuse participation:
You have the right to refuse participation any time during the study. If you decide not to participate, there will be no reprisal or detrimental effect. It is your voluntary choice to participate in the study and to complete the questionnaire.
Privacy and confidentiality:
Although the researcher will collect the name and contact information from the Department in order to obtain an interview, your name will not be recorded on the instrument. A code or number will be assigned to the questionnaire. No individual can be identified from the information provided in the questionnaire. Identification information, obtained from the Department, will be destroyed just after completion of the research. All information obtained from the study will be reported as aggregate data. However, it should be stressed that information on the questionnaire is not of a sensitive nature. It contains questions regarding your meat consumption and cooking methods.

Identification of researcher:
The name of the researcher is Doctor Lusine Yaghjyan, a student at the AUA. You may ask her any question regarding the study. The outcome of the study will be publicly available and stored in the Soghikian Library at the AUA. Doctor Yaghjyan may be reached at the following telephone number: 51 26 22, or 51 26 21.

In addition, if you believe you have not been treated fairly, you may contact Dr. Yelena Amirkhanyan (51 25 68) or Dr. Michael Thompson (51 25 92), AUA.

Thank you very much for participation.

APPENDIX 2. Armenian Version of Study Consent Form.

Հայաստանի Ամերիկյան Համալսարան
Հանրային Առողջապահության Բաժին
Կրթական Վերանայման Խորհուրդ
Համաձայնագիր

Հետազոտության անվանումը
Մսի օգտագործման և նրա պատրաստման եղանակների դերը ուղիղ և հաստ աղիների հիվանդության զարգացման ընթացքում

Հետազոտության բացատրությունը
Հայաստանի Ամերիկյան Համալսարանի Հանրային Առողջապահության Ծրագրում ընգրկված ուսանողը իրականացնում է հետազոտություն Հայաստանում մսամթերքի և նրա պատրաստման եղանակների դերը հաստ և ուղիղ աղիների հիվանդությունների զարգացման գործում: Դրա նպատակն է որոշել այն գործոնները, որոնք հետագայում կարող են օգտագործվել ուրիշ անձանց մոտ այդ հիվանդության զարգացման հավանականությունը նվազեցնելու նպատակով: Մասնակցից պահանջվում է միայն մեկ անգամ լրացնել հարցաթերթիկը: Լրացնելու համար անհրաժեշտ ժամանակը կազմում է 20-30 րոպե: Դուք չեք ենթարկվելու ոչ մի հետագա հետազոտությանը կամ միջամտությանը: Այս հետազոտության մասնակիցները ընտրվել են վերջին 12 ամսվա ընթացքում հաստ և ուղիղ աղիների հիվանդություններով հայտնաբերված հիվանդների ցուցակից՝ անկախ սեռից:

Ձեր մասնակցությունը հետազոտությանը: Ձեր անունը վերցվել է Պրոկտոլոգիայի բաժանմունքում պահպանված բժշկական գրառումներից: Վերջին տասներկու ամսվա ընթացքում ախտորոշված հիվանդները ընտրվել են որպես մասնակից:

Ծանույթ:
Դուք չեք ենթարկվում վտանգի հետազոտությոն ընթացքում: Հարցաթերթիկը չի պարունակում հարցեր, որոնք կարող են անհարմարության պատճառ դառնալ Ձեր համար:
Չնայած Դուք հավանական է որ չունենաք անմիջական օգուտ Ձեր մասնակցությունից, հնարավոր է, որ Ձեր պատասխանները կօգնեն մշակել կրթական ծրագրեր, որոնք օգուտ կբերեն այլ մարդկանց:

Մասնակցությունից հրաժարվելու իրավունքը:
Դուք իրավունք ունեք հրաժարվելու մասնակցությունից հետազոտուցյան ցանկացած պահին: Եթե Դուք որոշեք չմասնակցել, Ձեզ չի սպասում ոչ մի պատիժ: Դա Ձեր կամայական ընտրությունն է մասնակցել հետազոտությանը և լրացնել հարցաթերթիկը:
Գաղտնիությունը:
Չնայած որ հետազոտողը վերցրել է Ձեր անունը բաժանմունքից հարցազրույց վարելու նպատակով, Ձեր անունը չի գրանցվելու է հարցաթերթիկում: Հարցաթերթիկին տրվելու է համար կամ կոդ: Ձեր անձը չի կարող որոշվել հարցաթերթիկի տվյալների հիման

վրա: Հիվանդանոցից ստացած Ձեր անձին վերաբերվող տվյալները ոչնչացվելու են անմիջապես հետազոտության ավարտից հետո: Բոլոր տվյալները ներկայացվելու են ամփոփիչ տվյալների Ձևով: Այնուամենայնիվ, պետք է նշել, որ հարցաթերթիկներում տեղ գտած ինֆորմացիան չի կրում զգայուն բնույթ: Հարցաթերթիկը պարունակում է հարցեր մսի օգտագործման և նրա պատրաստման եղանակների վերաբերյալ:

Հետազոտողի տվյալները:
Հետազոտողի անունը բժիշկ Լուսինե Յաղջյան է, Հայաստանի Ամերիկյան Համալսարանի ուսանող: Դուք կարող եք իրենց ցանկացած հարց տալ՝ հետազոտության վերաբերյալ: Ուսումնասիրության տվյալները լինելու են հասանելի հադսարակությանը և պահվելու են Հայաստանի Ամերիկյան Համալսարանի Սողիկյանի անվան գրադարանում: Հնարավոր է դրանք նաև տպագրվեն մասնագիտական ամսագրում: Բժիշկ Յաղջյանի հեռախոսի համարները հետևյալն են՝ 51 26 22, կամ 51 26 21:
Բացի այդ, եթե Դուք գտնում եք, որ Ձեզ հետ անարդարն են վարվել, դուք կարող եք հայտնել այդ մասին Դոկտոր Ելենա Ամիրխանյանին (51 25 68) կամ Դոկտոր Մայքլ Տոմփսոնին ՝ 51 25 92, ՀԱՀ.

Շնորհակալություն Ձեր մասնակցության համար:

APPENDIX 3. Estimated sample size for two-sample comparison of proportions (equal samples). STATA results.

Test Ho	Assumptions	Estimated required sample sizes
$p_1 = p_2$, where p_1 is the proportion in population 1 and p_2 is the proportion in population 2	OR= 2 alpha = 0.05 (two-sided) power = 0.80 $p_1 = 0.45$ $p_2 = 0.29$	$n_1 = 154$ $n_2 = 154$
$p_1 = p_2$, where p_1 is the proportion in population 1 and p_2 is the proportion in population 2	OR=1.7 alpha = 0.05 (two-sided) power = 0.80 $p_1 = 0.41$ $p_2 = 0.29$	$n_1 = 264$ $n_2 = 264$
$p_1 = p_2$, where p_1 is the proportion in population 1 and p_2 is the proportion in population 2	OR=2.8 alpha = 0.05 (two-sided) power = 0.80 $p_1 = 0.53$ $p_2 = 0.29$	$n_1 = 73$ $n_2 = 73$
$p_1 = p_2$, where p_1 is the proportion in population 1 and p_2 is the proportion in population 2	OR=2.5 alpha = 0.05 (two-sided) power = 0.80 $p_1 = 0.51$ $p_2 = 0.29$	$n_1 = 86$ $n_2 = 86$

APPENDIX 4. English Version of the Questionnaire.

1. **Date of interview _____**
2. **Questionnaire ID _____**
3. **Date of birth _____**
4. **Gender ٱ male ٱ female**
5. **Weight _____**

6. **Your typical daily diet during last 5 years included all of the following products:**

a. Meat	ٱ
b. Butter	ٱ
c. Dairy products	ٱ
d. Fruit	ٱ
e. Vegetables	ٱ
f. Greens	ٱ
g. Beans	ٱ
h. Rice and other grains	ٱ
i. Bread	ٱ
j. Fish	ٱ

7. **How often did you use meat of any kind during last 5 years?**

>once /week	**1**
1-3 times month	**2**
Less than once/month	**3**
Never (do not continue the questionnaire)	**4**

8. **Which type of meat did you use at most of the time during last 5 years?**

a. Poultry	**1**
b. Beef/pork	**2**
c. Sausage	**3**
d. Bacon/smoked meat	**4**

9. Please choose an appropriate answer

	Fried	Oven-roasted	Boiled
a. During last 5 years I used beef/pork mainly as	1	2	3
b. During last 5 years I used sausage mainly as	1	2	3
c. During last 5 years I used poultry mainly as	1	2	3

10. How often did you use the following meat types (during last 5 years)?

Meat type	>once /week	1-3 times month	less than once/week
a. Bacon/smoked meat	1	2	3
b. Beef/pork fried	1	2	3
c. Beef/pork oven/roasted	1	2	3
d. Beef/pork boiled	1	2	3
e. Sausage fried	1	2	3
f. Sausage oven/roasted	1	2	3
g. Sausage boiled	1	2	3
h. Poultry fried	1	2	3
i. Poultry over/roasted	1	2	3
j. Poultry boiled	1	2	3

11. Which fried meat surface did you prefer (during last 5 years)?

Heavily browned	1
Moderately browned	2
Lightly browned	3

APPENDIX 5. Armenian Version of the Questionnaire

1. Հարցազրույցի ամսաթիվը _____
2. Հարցաթերթիկի համարը _____
3. Ծննդյան թիվ _____
4. Սեռ արական իգական
5. Մարմնի քաշը _____

6. Ամենօրյա Ձեր սովորական սննդակարգը վերջին 5 տարվա մեջ ընդգրկել է սննդամթերքի հետևյալ տեսակները՝

a. Միս	
b. Կարագ	
c. Կաթնամթերք	
d. Միրգ	
e. Բանջարեղեն	
f. Կանաչեղեն	
g. Լոբազգիներ	
h. Բրինձ և այլ հատիկեղեն	
i. Հաց	
j. Ձուկ	

7. Ինչ հաճախականությամբ եք Դուք օգտագործել միս վերջին 5 տարվա ընթացքում ՝ անկախ մսի տեսակից

շաբաթական մեկ անգամից ավելի	1
ամիսը 1-3 անգամ	2
ավելի հազվադեպ	3
Երբեք (մի շարունակեք հարցաթերթիկը)	4

8. Մսի ինչպիսի տեսակ եք Դուք օգտագործել սոցորաբար վերջին 5 տարվա ընթացքում

a. Թռչնի միս	1
b. Տավար/խոզի միս	2
c. Երշիկեղեն	3
d. Ապրտած միս	4

9. Խնդրում եմ ընտրեք ամենահարմար պատասխանը

	Տապակած	Ջեռոցում պատրաստված	Եփած
a. Վերջին 2 տարվա մեջ ես օգտագործել եմ տավարի/խոզի միս մեծ մասամբ որպես	1	2	3
b. Վերջին 2 տարվա մեջ ես օգտագործել եմ երշիկեղեն միս մեծ մասամբ որպես	1	2	3
c. Վերջին 2 տարվա մեջ ես օգտագործել եմ թռչնեղեն միս մեծ մասամբ որպես	1	2	3

10. Ինչ հաճախականությամբ եք Դուք օգտագործել հետևյալ մսի տեսակները վերջին 5 տարվա ընթացքում

Մսի տեսակ	>շաբաթը մեկ անգամ	ամսեկան 1-3 անգամ	ավելի հազվադեպ
a. Ապխտած միս	1	2	3
b. Տավար/խոզ տապակած	1	2	3
c. Տավար/խոզ ջեռոցում	1	2	3
d. Տավար/խոզ տապակած	1	2	3
e. Երշիկեղեն տապակած	1	2	3
f. Երշիկեղեն ջեռոցում	1	2	3
g. Երշիկեղեն եփած	1	2	3
h. Թռչնի միս տապակած	1	2	3
i. Թռչնի միս ջեռոցում	1	2	3
j. Թռչնի միս եփած	1	2	3

11. Տապակած մսի ինչպիսի մակերես եք նախընտրել (վերջին 5 տարվա ընթացքում)

Մուգ կարմրացրած	1
Միգին աստիճանի կարմրացրած	2
Թեթև կարմրացրած	3

APPENDIX 6. STATA output for conditional logistic regression.

Variables used:

Name	Interpretation	Coding
meat	Daily meat use	1-yes, 0-no
meat_sur_new	Preference of meat surface	0-lightly browned, 1-medium browned, 2-heavily browned
p_cook_new	Preferred cooking method for poultry	0- boiled, 1-oven-roasted, 2-fried
poultry_fried_new	Frequency of fried poultry use	0-less than 1 time/month; 1-1-3times/month; 2-> once/week

Statistically significant variables.

```
xi: clogit disease meat, group (ID) or

Iteration 0:   log likelihood = -52.444307
Iteration 1:   log likelihood = -50.771281
Iteration 2:   log likelihood = -50.756099
Iteration 3:   log likelihood = -50.756092

Conditional (fixed-effects) logistic regression   Number of obs   =        154
                                                  LR chi2(1)      =       5.23
                                                  Prob > chi2     =     0.0222
Log likelihood = -50.756092                       Pseudo R2       =     0.0490

------------------------------------------------------------------------------
     disease | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        meat |          3   1.549193     2.13   0.033     1.090342     8.25429
```

```
xi: clogit disease i.meat_sur_new, group (ID) or
i.meat_sur_new    _Imeat_sur__0-2     (naturally coded; _Imeat_sur__0 omitted)

Iteration 0:   log likelihood = -50.649826
Iteration 1:   log likelihood = -47.271063
Iteration 2:   log likelihood = -47.212619
Iteration 3:   log likelihood = -47.212547

Conditional (fixed-effects) logistic regression   Number of obs   =        154
                                                  LR chi2(2)      =      12.32
                                                  Prob > chi2     =     0.0021
Log likelihood = -47.212547                       Pseudo R2       =     0.1154

------------------------------------------------------------------------------
     disease | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Imeat_sur~1 |   2.363306   1.254882     1.62   0.105     .8347259    6.691074
_Imeat_sur~2 |    6.04998   3.609959     3.02   0.003     1.878672    19.48305
```

```
xi: clogit disease i.p_cook_new, group(ID) or
i.p_cook_new      _Ip_cook_ne_0-2     (naturally coded; _Ip_cook_ne_0 omitted)

Iteration 0:   log likelihood = -50.925712
Iteration 1:   log likelihood = -48.145994
Iteration 2:   log likelihood =   -48.1117
Iteration 3:   log likelihood = -48.111664

Conditional (fixed-effects) logistic regression   Number of obs   =        154
```

```
                                                  LR chi2(2)      =      10.52
                                                  Prob > chi2     =     0.0052
Log likelihood = -48.111664                       Pseudo R2       =     0.0986

------------------------------------------------------------------------------
     disease | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Ip_cook_n~1 |   .4476294   .3060238    -1.18   0.240     .1172171     1.70941
_Ip_cook_n~2 |    2.28967    .771867     2.46   0.014     1.182567    4.433228
------------------------------------------------------------------------------

xi: clogit disease i.poultry_fried_new, group (ID) or
i.poultry_fri~w   _Ipoultry_f_0-2     (naturally coded; _Ipoultry_f_0 omitted)

Iteration 0:   log likelihood = -51.081922
Iteration 1:   log likelihood =  -48.16118
Iteration 2:   log likelihood =   -48.1309
Iteration 3:   log likelihood = -48.130886

Conditional (fixed-effects) logistic regression   Number of obs   =        154
                                                  LR chi2(2)      =      10.48
                                                  Prob > chi2     =     0.0053
Log likelihood = -48.130886                       Pseudo R2       =     0.0982

------------------------------------------------------------------------------
     disease | Odds Ratio   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
_Ipoultry_~1 |   1.722649   .8285327     1.13   0.258     .6711186    4.421752
_Ipoultry_~2 |   4.014411   2.015439     2.77   0.006     1.500636    10.73911
------------------------------------------------------------------------------
```

APPENDIX 7. Interviewer Journal Form.

Attempt #	Date	Outcome*	Comments
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
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23.			
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25.			
26.			
27.			
28.			
29.			

*0-ineligible respondent

1-completed interview

2- refused

3-other (please specify in provided column)