

Research Article

A Pilot Case-Cohort Study of Lung Cancer in Poultry and Control Workers: Non-Occupational Findings

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Abstract

The objective of this study was to obtain preliminary information on which non-occupational risk factors are responsible for the excess of lung cancer deaths seen in a cohort of workers in poultry slaughtering & processing plants, and to investigate whether established non-occupational risk factors for lung cancer mortality can be replicated. We conducted a pilot case-cohort study within a cohort of 43,904 poultry and non-poultry plant workers alive in 1990 and followed up to the end of 2003. Cases were 125 lung cancer deaths that occurred between 1990-2003 for whom interviews were successfully obtained. Controls (N=152) were derived from a random sample of the cohort in 1990. Statistical analysis was by logistic and Cox proportional hazards regression. The study successfully identified many of the established risk factors for lung cancer, and a few new ones were identified. The study demonstrates that valid case-cohort studies in this occupational group are feasible, and also successfully identified non-occupational risk factors that may need to be adjusted for in future planned large-scale studies of this occupational group.

Keywords: Chickens; meat; lung cancer; diet; non-occupational

Introduction

Workers in poultry slaughtering/processing plants have high exposures to oncogenic viruses that naturally infect and cause cancer in poultry. They also have exposures to chemical carcinogens at work. We initially performed three cohort mortality studies of 30,411 poultry workers and 16,405 non-poultry workers who were members of the United Food and Commercial Workers unions in the United States (N=46,816). An excess of lung cancer was consistently observed in the poultry workers [1-4]. We next conducted a pilot case-cohort study of lung cancer within a subset of 43,904 subjects of the 46,816 subjects that were alive in 1990, and followed them up to the end of 2003. The findings for occupational exposures have been published, [5] and the corresponding literature reviewed [6]. Here we present the results for non-occupational exposures. The study provides a unique opportunity for examining whether established non-occupational risk factors for lung cancer can be replicated in this group of workers who are among the lowest paid workers in industry. Also, if established risk factors for lung cancers are confirmed in this study, this will be strong evidence that future planned large full-scale studies to investigate lung cancer occurrence in this occupational group will give valid results.

Material & Methods

Cases were the first 125 lung cancer deaths out of 552 (23%) that occurred in the cohort between 1990 and 2003, for whom telephone interviews were obtained. Controls were similarly the first 152 subjects (10%) for whom telephone interviews were obtained. They

originate from a random sample of 1,516 persons in the cohort that were alive in 1990. A telephone questionnaire was administered to the next-of-kin of study subjects if they were deceased (all cases, and 13% of controls) or to live control subjects themselves. Statistical analyses were conducted using both logistic regression and Cox proportional hazards regression methods as previously described [5].

Ethics: The study was approved by the University of North Texas Health Science Center's Institutional Review Board

Results

The results are summarized in Tables 1&2.

Discussion

With regard to lifestyle, established associations in the literature with cigarette smoking, drinking of wine and exercise were confirmed [7-9]. The significant association with radiation exposure may be real and consistent with well-documented reports of this association [7,10]; but it is also likely that it reflects using radiation treatment for the lung cancer, since no significant associations were seen for treating other conditions with radiation. The elevated but not statistically significant risk for tuberculosis seen is consistent with the findings of a comprehensive review [11]. Protective effects were seen for history of cold sores, diabetes, and allergy to pollen and medications. These are consistent with reports of allergies being protective risk factors for the disease [12-14].

Table 1. Poultry associated non-occupational exposures: Associations with lung cancer mortality, 1990-2003

	Cases (n=125)	Controls (n=152)	Adjusted Logistic Regression ORs [†]	Adjusted Cox Proportional HRs [‡]
			OR (95% CI)	HR (95% CI)
LIFESTYLE				
Ever smoked tobacco	113	135	7.1 (2.8-18.0)	3.7 (1.8-7.4)
Mostly prepared own food	118	147	0.5 (0.2-1.1)	0.5 (0.3-0.9)
Ever drunk wine	113	146	0.4 (0.2-0.9)	0.6 (0.4-0.9)
Swam at least once a month for more than one year	115	147	0.4 (0.1-0.9)	0.5 (0.3-0.9)
Regularly performed any exercise	117	147	0.3 (0.1-0.5)	0.5 (0.3-0.7)
MEDICAL HISTORY				
Ever treated with radiation therapy	106	141	16.6 (6.8-40.8)	5.3 (3.5-8.1)
Ever treated with radiation therapy for cancer	67	21	1.6 (0.5-5.4)	1.1 (0.6-1.9)
Ever treated with radiation therapy for skin/scalp conditions	68	20	1.0 (0.1-11.9)	1.5 (0.6-3.9)
Ever treated with radiation therapy for arthritis	70	20	0.5 (0.1-1.9)	0.8 (0.4-1.5)
Tuberculosis	102	144	9.0 (0.3-304.9)	2.2 (0.9-5.4)
Cirrhosis	112	147	7.8 (0.7-82.6)	2.0 (0.8-5.0)
Pancreatic inflammation	111	146	6.2 (0.7-55.5)	1.2 (0.5-2.8)
Infectious mononucleosis	109	147	3.6 (0.3-51.5)	1.7 (0.4- 6.9)
Cold sores on lip	114	145	0.6 (0.3-1.2)	0.6 (0.4-0.9)
Diabetes	114	148	0.3 (0.1-0.8)	0.4 (0.2-0.9)
Allergic to pollen	113	145	0.2 (0.1-0.5)	0.3 (0.2-0.7)
Allergy to drug medications	110	144	0.1 (0.0-0.4)	0.2 (0.1-0.5)
FOOD CONSUMPTION				
Ate beef once every two weeks for most of life	114	144	14.9 (1.8-123.0)	9.6 (1.3-69.0)
Ate bacon every week for most of life	112	141	12.1 (4.2-35.1)	5.1 (2.4-11.2)
Ate uncooked fish/shellfish every week for most of life	111	142	2.0 (0.4-10.0)	1.4 (0.5-3.8)
Ate spicy foods every week for most of life	110	142	1.7 (0.9-3.4)	1.3 (0.9-1.9)
Ate chicken once every two weeks for most of life	116	144	1.7 (0.4-7.4)	1.5 (0.6-3.6)
Ate pork once every two weeks for most of life	114	144	1.6 (0.7-3.6)	1.4 (0.8-2.4)
Ate lamb once every two weeks for most of life	115	144	1.6 (0.5-5.2)	1.1 (0.6-2.2)
Ate turkey once every two weeks for most of life	115	144	1.0 (0.5-1.9)	1.0 (0.7-1.5)
Ate fruits every week for most of life	108	143	0.8 (0.3-2.0)	0.9 (0.5-1.5)
Ate freshwater fish at least once a month	115	142	0.7 (0.4-1.4)	0.8 (0.5-1.2)
Ate cheese every week for most of life	109	142	0.7 (0.3-1.7)	0.8 (0.5-1.4)
Ate raw eggs at least once every two weeks for most of life	114	143	0.6 (0.1-3.9)	0.7 (0.3-2.1)
Ate veggies every week for most of life	111	143	0.5 (0.3-1.1)	0.6 (0.2-1.7)
Ate seafood once every two weeks for most of life	111	144	0.5 (0.2-0.9)	0.7 (0.4-1.0)
Ever ingested herbal leaves, drinks, medications at least once a week for >1yr	111	140	0.3 (0.1-0.9)	0.4 (0.2-1.0)
Ever adhered to a vegetarian diet for more than a year	114	143	0.2 (0.0-3.8)	0.3 (0.0-2.1)
<i>Method of cooking meats</i>				
Ate meat fried at least once every two weeks for most of life	113	144	2.6 (1.0-6.6)	1.9 (1.0-3.8)
Ate meat salted at least once every two weeks for most of life	109	144	2.4 (1.2-4.8)	1.5 (1.0-2.2)
Ate meat raw at least once every two weeks for most of life	111	144	1.6 (0.2-11.3)	1.9 (0.7-5.3)
Ate meat barbequed at least once every two weeks for most of life	112	144	1.5 (0.8-2.9)	1.1 (0.7-1.6)
Ate meat smoked at least once every two weeks for most of life	110	144	1.3 (0.6-2.8)	1.0 (0.6-1.6)
DRUG USE				
Use vitamins at least every week for more than a year	103	140	0.4 (0.2-0.8)	0.6 (0.4-1.0)
Ever had general anesthesia during surgery	108	140	0.4 (0.2-0.7)	0.6 (0.4-0.9)
Ever used hormone replacement therapy continuously for at least a year	24	57	0.2 (0.0-0.8)	0.3 (0.1-0.9)

FAMILY HISTORY OF CONDITIONS				
Reported cancer in children	114	139	1.7 (0.5-6.4)	1.1 (0.6-1.9)
Reported cancer in parents	107	135	0.8 (0.4-1.6)	0.8 (0.5-1.2)
Reported cancer in spouse	113	139	0.8 (0.3-2.0)	1.1 (0.7-1.8)
IMMUNIZATIONS				
Typhoid	46	127	2.1 (0.8-5.5)	1.4 (0.7-2.7)
Pneumococcal infections	48	127	1.7 (0.6-4.3)	1.4 (0.7-2.7)
Yellow fever	41	127	1.7 (0.5-5.6)	0.9 (0.4-2.2)
Ever received gamma globulin	56	131	1.6 (0.3-8.7)	1.8 (0.6-6.0)
Measles	42	124	1.5 (0.6-3.5)	1.0 (0.5-2.0)
Small pox	64	128	1.4 (0.6-3.1)	1.0 (0.6-1.7)
Diphtheria	55	120	1.3 (0.6-3.2)	1.0 (0.5-1.8)
Mumps	43	123	1.3 (0.5-3.0)	0.9 (0.5-1.7)
OTHER				
Ever owned a cell phone	115	141	0.2 (0.1-0.4)	0.3 (0.1-0.6)

† Odds ratios (OR) were adjusted for smoking, gender, and age by the Logistic Regression Method

‡Hazard ratios (HR) were adjusted for smoking, gender, and age by the Cox Proportional Hazard Method

®For ever smoked tobacco, adjustment was for age and gender.

Table 2. Lung cancer mortality associated with frequent consumption of Beef and Bacon, adjusted for occupational exposures, meat preparation type, tobacco smoking, age, gender, and union site - (1990-2003)

	Ate a lot of Beef		Ate a lot of Bacon	
	Case/control	HR (95% CI)	Case/control	HR (95% CI)
OCCUPATIONAL EXPOSURES				
History of working in stockyard	56/99	---	56/98	2.7 (1.1-6.7)
Ever killed chickens at work	105/143	8.9 (1.2-64.6)	103/140	4.7 (2.1-10.3)
History of working in deli department	66/99	---	66/98	3.1 (1.3-7.4)
History of working in meat department	66/99	---	66/98	3.1 (1.3-7.1)
MEAT PREPARATION				
Ate a lot of meat raw	109/144	9.8 (1.3-71.1)	108/141	4.8 (2.2-10.5)
Ate a lot of meat fried	111/144	8.9 (1.2-64.8)	110/141	4.7 (2.1-10.3)
Ate a lot of meat BBQ	111/144	9.7 (1.3-70.4)	109/141	5.0 (2.3-10.9)
Ate a lot of meat smoked	109/144	9.5 (1.3-69.0)	109/141	5.1 (2.3-11.2)
Ate a lot of meat salted	107/144	8.5 (1.2-62.0)	106/141	4.5 (2.0-10.1)

*HR = hazard ratio; CI = confidence interval; NOTE: Questionnaire defined a lot as “once every two weeks for most of life”

Frequent consumption of beef and bacon were significantly associated with increased lung cancer risk, and the risks persisted after adjusting for occupational exposures that were associated with increased risks [5] Table 2. The risks also persisted irrespective of whether the beef or bacon was eaten raw, fried, barbecued, smoked, or salted – Table 2. The method of preparation of any of the different meats (beef, pork, poultry, etc.) was not an independent risk factor for lung cancer (data not shown) except for salted chicken, turkey and lamb for which the hazard ratios were 1.4 (95% CI, 1.0-2.2), 1.5 (95% CI, 1.0-2.2) and 1.5 (95% CI, 1.0-2.2), respectively. These associations with beef and bacon and salted meats are well documented in the literature [7,15-18], and mere consumption of these meats seem to be the most important factor.

Risk estimates for eating of seafood, ingestion of herbal leaves, drinks or medications, adherence to vegetarian diet, vitamin intake,

hormone replacement therapy, and history of diabetes and general anesthesia were all below the null. These protective associations have been previously reported [7,19-21], except for history of diabetes and general anesthesia for which we have no explanation. The results for cellphone use are likely due to systematic bias resulting from cases (all deceased) dying during earlier periods when cellphone use was not in existence or infrequent while controls most of whom were alive, lived long enough into the more recent period of popular use; moreover, this reduced risk was also seen for the other cancers (liver, pancreas, brain) investigated [22,23].

Conclusion

The findings in this study are important for three reasons: 1) in spite of its small size, the study remarkably was able to confirm many of the reported non-occupational risk factors in the literature

for lung cancer in this low-income population. This indicates that future planned case-cohort studies nested within occupational cohorts of workers in poultry slaughtering and processing plants that are assembled to investigate cancer occurrence in this industry, are feasible and capable of giving valid results. Such studies can provide valuable information on both occupational and non-occupational risk factors for various cancers. Secondly, this study has successfully identified non-occupational exposures that are risk factors for lung cancer in this specific population of poultry workers. These constitute some important potential confounding factors that may need to be adjusted for when investigating the role of occupational carcinogenic exposures (especially oncogenic viruses) in the occurrence of lung cancer in poultry slaughtering & processing plant workers in future full-scale large case-cohort studies. Finally, this small study indicates that established risk factors for lung cancer are equally applicable for this group of minimum-wage workers who belong to the lowest socio-economic group.

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Competing interests: None

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