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Cancer in Migrant and Seasonal Hired Farm Workers

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ABSTRACT. Studies of cancer among farm workers are difficult to conduct and interpret given the unique nature of this occupational group. The transitory nature of the work, high levels of poverty, and lack of legal documentation make epidemiologic studies difficult to accomplish. Nevertheless, this workforce in the United States, which numbers as much as 3 million persons, is a high isk population due to exposures to numerous toxic substances, including excessive sunlight, heat, dangerous machinery, fumes, fertizers, dust, and pesticides. We summarize characteristics of farm workers (i.e., demographics, health care) from the National Agricultural Workers Survey (NAWS) and the California Agricultural Workers Survey (CAWS) and present findings from a series of studies conducted among farm workers in California. The epidemiology literature was reviewed and methods for a unique farm worker union-based epidemiologic study are presented. Farm workers in California and the rest of the United States, many of whom are seasonal and migrant workers are at elevated risk for numerous forms of cancer compared to the general population and specific pesticides may be associated with this altered risk. Elevated risks have been found for lymphomas and prostate, brain, leukemia, cervix, and stomach cancers.

KEYWORDS. Cancer, epidemiology, migrant farm workers

INTRODUCTION

Studies of cancer among hired farm workers, many of whom are seasonal and migrant workers, are sparse and difficult to conduct given the transitory nature of farm work, the migration of the farm labor force, issues concerning immigration and legality of work status, and other associated difficulties, including tracing workers for health and vital status. The feasibility of conducting such studies has been reviewed[1] and different approaches for overcoming some of these issues have been attempted. Nevertheless, because farm workers are commonly exposed to such agents as toxic fumes, sunlight, fertilizers, and pesticides, as well as potentially dangerous farm machinery, it is logical to suspect that their risk for several forms of cancer may be elevated.

Some studies of cancer in this unique population have been conducted using resources such as death certificates, migrant health clinics, labor union records, and other administrative databases that can potentially support

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epidemiologic studies. In this review, we attempt to characterize farm workers in the United States, review those epidemiologic cancer studies that have been conducted among farm workers, and focus on some studies of cancer in the farm worker population in California. Thousands of farm workers have been represented by a labor union formed in California in the mid-1960s, where there is population-based cancer registry data dating back to the late 1980s. Pesticide reporting has been mandatory for most restricted use chemicals since 1970 and for all chemicals used in agriculture since 1990 and these resources have been used to conduct epidemiologic studies.

Who are Farm Workers in the United States?

The National Agriculture Workers Survey (NAWS), conducted by the United States Department of Labor, has interviewed nearly 50,000 farm workers in the United States since 1988.[2] Information on demographic characteristics including age, gender and ethnicity, earnings, housing characteristics, some health data, and disabilities have been collected. Findings from the NAWS indicate that farm workers in the United States are overwhelmingly Hispanic and male (72%) or Hispanic female (21%), relatively young (median age of 31 years), foreign born (84%), and working in the United States without documentation (53%). Although a sizable proportion have been working in the United States for relatively short periods of time (24% for 1 year or less), the largest proportion (36%) have been working in the United States for 10 years of longer. Indeed, nearly half of the farm workers interviewed in NAWS indicated that they are "settled" in the United States and only a small portion (22%) consider themselves newcomers to the United States. In addition, in California, where as many as 1 million farm workers labor, the California Agricultural Workers Survey (CAWS) provides information on these and other issues in the California farm worker population.[3] Based on interviews of 971 farm workers carefully selected in a sampling survey scheme, 70% of farm workers in California reported no health insurance, and more than half reported major health problems, including hypertension and diabetes. Many had never visited a physician in their entire lifetime.

However, neither the NAWS nor the CAWS provide information on cancer diagnosis in the farm worker population. There may be an excellent reason for not including cancer-related questions on these surveys, particularly because cancer is an age-related disease and most active farm workers are young men and women. Nevertheless, the exposures sustained by farm workers in their early years may increase cancer risk in later life.

Previous Studies of Hired Farm Workers

Studies of farm workers have been conducted in the United States dating back to the 1970s. These studies have been largely limited to mortality studies based on death certificates and the limitations of this approach are apparent, including the fact that many former farm workers are not identified as such on the death certificate.

However, many studies have been instructive and some consistent findings have emerged from various studies. For example, in the interview portion of the Third National Cancer Survey (TNCS), respondents were interviewed and queried about their "main lifetime occupation." Elevated risks for prostate cancer, esophagus cancer, oral cavity cancers, and others were found in those who reported farm working as their lifeline occupation.[4] Additionally, in the early 1980s, studies among farm workers in Iowa noted elevated proportionate mortality ratios (PMRs) for cancers of the lip, stomach, prostate, as well as for leukemia, non-Hodgkin's lymphoma, and multiple myeloma.[5] These forms of cancer have subsequently been labeled as "agricultural cancers."[6] Between 1978 and 1979, more than 7000 farm worker deaths (as recorded on the death certificate) were reviewed in California. Again, elevated mortality was found for stomach cancer, "other lymphatic cancer," as well as for cervical cancer.[7] Medical records of young men diagnosed with testis cancer (and controls) were reviewed for occupational history at the M.D. Anderson Cancer Center in Houston, Texas, and elevated risk of this form of cancer was found among

those with a history of farm working.[8] A review of death certificates in 24 states in the United States found elevations in deaths from buccal cavity, larynx, esophagus, stomach, and skin and cervix cancers. Unfortunately, many of the states with the largest concentration of farm workers were not included in this study, including Florida, Texas, and California.[9]

Studies of Cancer Mortality, Incidence, and Survival in California Farm Workers

Agriculture is a major industry in the state of California. Each year more than $25 billion in hundreds of different crops and commodities are produced, in particular in industries that require large amounts of manual labor. Crops such as grapes, row vegetables, tree fruit, and other crops require extensive treatment with chemicals (indeed about one-quarter of all pesticide sales in the United States occur in California) and the human contact with crops during planting, weeding, cultivating, and harvesting results in direct contact with these chemicals. Farm workers in California were organized by the late Caesar Chavez beginning in the mid-1960s and contracts with various growers were signed beginning in the early 1970s. Between 1973 and 1996, contracts had been signed with about 250 growers throughout the state and during that time about 140,000 farm workers had joined the United Farm Workers of America (UFW). Based on union membership, a roster of these workers was created by combining the listings of two benefits packages offered to all workers, namely the Robert F. Kennedy Medical Plan and the Juan De La Cruz Pension Program. Various epidemiologic studies have been conducted by the authors of this review based upon this roster of "ever" members of the UFW, including studies of mortality, cancer incidence, and cancer survival.

Cancer (and all cause mortality) was examined in this farm worker population by merging the listing of ever members of the UFW with the California Death Certificate Master File for the years 1973 to 2000. The result of this record linkage identified about 4000 deaths in the UFW membership during the linkage period. A proportional mortality analysis was conducted for all causes of death as well as for cancer deaths. The analyses revealed elevated risk of death from stomach cancer, cervix cancer, and cancer of the biliary passages, liver, and gallbladder. Lung and breast cancer deaths were decreased.[10]

A similar approach was taken to evaluate cancer incidence in the UFW membership between the years 1987 and 1997. A computerized record linkage was conducted between the UFW membership roster and the database of the California Cancer Registry (CCR), the population-based cancer registry that has monitored cancer in the population of California. During the period covered by the linkage, more than 1000 cancer diagnoses were detected in the UFW cohort and cancer morbidity odds ratios were calculated. Elevated risk of incident brain cancer, leukemia, and stomach, uterine cervix, and uterine corpus cancers were found. Results were statistically significant for leukemia and stomach, cervix, and uterine corpus cancers.[11] Also noteworthy was the finding of advanced stage of disease at diagnosis in the farm workers compared to other Hispanics in California. There was less early stage diagnosis in the farm workers for prostate, colorectal, and cervix cancers, which has implications for cancer survival.

When cancer survival was analyzed in this cohort, overall 5-year cancer survival was found to be shorter in the UFW members than in the general California Hispanic population (53.7% versus 57.7%), which was statistically significant. Interestingly, colorectal cancer survival was worse in male members of the cohort compared to California Hispanic males (48.1% versus 60.6%), but not in the females. Another paradoxical finding was that non-Hodgkin's lymphoma survival in men was actually better in the farm worker population than in the California Hispanic population at large (86.7% versus 56.7%).[12]

STUDIES OF ASSOCIATIONS BETWEEN PESTICIDE USE AND CANCER IN CALIFORNIA FARM WORKERS

A series of nested case-control studies have been conducted within the cohort focusing on breast, prostate, stomach, and lymphohematopoeitic

cancers. In each analysis, a standardized methodology was used for identifying cases and controls and for exposure assessment and for analysis. Briefly, these methods are described below as are the findings to date for several of these cancer sites.

Case Selection

These epidemiologic case-control studies of newly diagnosed cancer were conducted using the resources of the California Cancer Registry (CCR), the statewide population-based cancer registry that has monitored all newly diagnosed cancers and cancer related mortality since 1988. The methodology of the CCR has been fully described.[13] Currently, reporting to the statewide registry is complete and edited through 2006. The CCR collects information on all cancers except for nonmelanoma skin cancers and in situ cancers of the uterine cervix. Information on several demographic variables (e.g., age, race, sex, residence, place of birth), diagnostic variables (including stage at diagnosis, tumor size, histology, and grade of tumor), and first course of treatment are collected for all cases. Race and ethnicity are categorized into four mutually exclusive groups in the CCR database: White, non-Hispanic (NHW); Black, non-Hispanic; Hispanic; and Asian/Pacific Islander.

Cancer cases were identified by conducting electronic record linkages between the roster of "ever" members of the UFW, 1973 to 2000, and the database of the CCR for the years 1987 to 2001 using an automated record linkage program (INTEGRITY). Social security number, first and last names, date of birth, sex, city of residence, and vital status were used in the probabilistic linkage program. Only cases identified as Hispanic were used in these analyses.

Control Selection

For each case, five members of the UFW not diagnosed with any cancer as of the year of the case diagnosis and who were of the same attained age as the case at the time of diagnosis were selected after matching on gender, Hispanic ethnicity, and ± 1 year of birth. Controls may have developed cancer after the date of their matched case diagnosis. Controls were plentiful in that the UFW cohort includes approximately 139,000 "ever" (i.e., current and past) UFW members.

Exposure Data

For both cases and controls, information was available from the UFW on date of first union affiliation, duration of union membership, and by whom the worker was employed (i.e., the grower). The UFW has signed contracts with more than 250 individual growers during its existence and each grower has been characterized by the nature of the crops and commodities most commonly produced as well as by geographic location. Union records were reviewed to determine for which grower study participants worked, when they worked, and where they worked. These work histories are available on a month-to-month basis because the employers pay into health and pension funds (monthly) based on employee work status.

The California Department of Pesticide Regulation (DPR) has a publicly available statewide comprehensive pesticide usage database. Since 1970 all agricultural applications of restricted use pesticides have been reported to the state. In order to create a more complete and detailed system of pesticide use data, full use reporting was implemented in 1990. All pesticide information for 1974 to 1989 was obtained from the Pesticide Databank, which is a database of historical pesticide use records collected by the California Department of Food and Agriculture and maintained at the University of California, Davis. At the time of theses studies, pesticide use reports (PUR) from 1970 to 1973 were not available in computerized format. Pesticide data for 1990 to 1999 were obtained from the University of California, Davis Statewide Integrated Pest Management Project online summaries database (www.ipm.ucdavis.edu). The following variables were obtained from both data sources: county, crop, month and year of application, pesticide, number of acres treated, and pounds of active ingredient applied.

The UFW job histories were linked to DPR PUR such that employment in a given crop in a

given month/year in a given county was matched to the corresponding application of several pesticides on that crop in a given month and county location. These applications (in pounds of active ingredients applied) were summed and used as a proxy or surrogate measure of pesticide exposure for both cases and controls for the two- to three-decade period prior to diagnosis of the cancer.

Analysis

Cases and controls were stratified on age and sex and analyzed using the methods of Mantel and Haenszel[14] to calculate adjusted odds ratios associated with several occupational variables. Upon completion of the stratified analysis, unconditional logistic regression analyses[15] were conducted.

RESULTS OF THE CHEMICAL-SPECIFIC, CANCER-SPECIFIC ANALYSIS PRESENTED BY CANCER TYPE

Prostate

Prostate cancer has consistently been recognized as one of the agricultural related cancers and was the focus of one analysis in this study. Between 1988 and 2000, we identified 222 UFW members diagnosed with prostate cancer and 1110 healthy controls were selected. When specific chemicals were examined using the exposure assessment scenario described above, certain chemicals were found to be associated with elevated prostate cancer risk including the organochlorine pesticides heptachlor and lindane (odds ratio [OR] = 2.01 and 2.37, respectively) as well as the fungicide methyl bromide and the herbicide simazine, although the latter two chemicals were not statistically significant.[16]

Breast

Breast cancer has not traditionally been associated with farm working, yet it is difficult to untangle the effects of menstrual, reproductive, and screening issues in farm working women (which tend to lower breast cancer risk) from those factors that are found in the work site. Between 1988 and 1999, we identified 128 cases of breast cancer diagnosed in female farm workers; we also identified 640 age/ethnicity matched healthy control women. When various chemicals were analyzed, risk of breast cancer was increased in those areas of the state with heavy used of 2,4-D and chlordane. 2,4-D is a phenoxy acetic acid herbicide that is used abundantly in California, whereas chlordane is an organochlorine pesticide.[17]

Lymphohematopietic

Perhaps the most notable finding to date from these analyses concerns non-Hodgkin's lymphoma, which has consistently been associated with farm working in previous studies. Although there were only 45 cases of NHL available in the UFW cohort, risk of NHL was more than tripled (OR = 3.85) in those areas where 2,4-D is heavily used. In addition, leukemia risk was doubled in those areas where toxaphene and mancozeb were heavily applied.[18]

Stomach

Agricultural workers have commonly been reported to suffer excess risk of stomach cancer, but farm workers also are largely Hispanic, and Hispanic ethnicity seems to be associated with this disease. Nevertheless, when 100 case of gastric cancer were identified in the UFW cohort (as well as 648 healthy controls), working in heavy use areas of 2,4-D was once again associated with a 2-fold elevation in gastric cancer risk as was working in heavy use areas of chlordane and propargite.[19] Each of these findings was statistically significant.

These results are summarized in Table 1.

CONCLUSIONS

Farm workers in the United States and particularly in California are overwhelmingly Hispanic males, who are immigrants from Mexico, who live in substandard housing, who are impoverished, and who lack health insurance. Their work is transitory and regularly requires them to travel great distances to find

TABLE 1. Summary of Results from UFW Cancer Studies

Cancer site	No. Case/controls	Chemical	OR (95% CI)*	Comment
Prostate	222/1110	Heptachlor	2.01 (1.12–3.60)	pTrend = .003
		Lindane	2.37 (1.22–4.61)	pTrend = .003
		Methyl Bromide	1.59 (.77–3.30)	pTrend = .25
		Simazine	1.81 (.93–3.53)	pTrend = .03
Breast	128/640	2,4-D	2.14 (1.06–4.32)	Dx 1995–2001
		Chlordane	3.85 (1.22–12.2)	Dx 1988–1994
Stomach	100/210	2,4-D	1.85 (1.05–3.25)	
		Chlordane	2.96 (1.48–5.94)	
		propargite	2.86 (1.56–5.23)	
		triflurin	1.69 (.99–2.89)	
Leukemia	35/175	mancozeb	2.35 (1.12–4.95)	
		toxaphene	2.20 (1.04–4.65)	
Non-Hodgkin's lymphoma	45/225	2,4-D	3.80 (1.85–7.81)	

*Adjusted for age, gender, ethnicity, date of first union affiliation and duration of union affiliation.

work. Risk of cancer is difficult to measure because of the migratory nature of the population and because exposures relevant to cancer etiology occur years prior to the diagnosis and it is difficult to link exposure to disease outcome with any certainty. Yet the consensus of those epidemiologic studies that have been completed indicate that this population is at increased risk for several forms of cancer in comparison to the general population. In particular, the lymphatic and hematopoietic cancers are found to occur excessively in this population, as do prostate, stomach, and cervical cancers. In California, mortality studies indicate elevated risk of fatal disease for several of those same forms of cancer. Cancer survival appears to be poorer overall and specifically for colorectal cancer, which appears to be related to advanced stage of disease at diagnosis. Several chemicals appear to be associated with elevated cancer risk in farm workers, notably the use of the phenoxyacetic acid herbicide 2,4-D.

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