Wisconsin Farmer Cancer Mortality, 1981 to 1990: Selected Malignancies

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ABSTRACT: *Cancer mortality risks for Wisconsin white male farmers were examined during the years 1981 to 1990. Four malignancies were studied: Non-Hodgkin's lymphoma, melanoma, colon cancer, and rectal cancer. Occupation coded deaths were segmented into farmer and nonfarmer groups and population counts for the groups were estimated from 1980 and 1990 Bureau of the Census data. Standardized mortality ratios (SMRs) were constructed from the ratio of observed farmer deaths and the expected number of farmer deaths. Expected deaths were generated from the underlying statewide nonfarmer rate for the malignancy multiplied into the farmer population at risk. Farmers had significantly lower mortality risks for melanoma (SMR: 0.659; 95% CI: 0.993-0.326) and colon cancer (SMR: 0.763; 95% CI: 0.928-0.599). Farmers also exhibited a nonsignificant decrement for non-Hodgkin's lymphoma (SMR: 0.930; 95% CI: 1.214-0.645). For rectal cancer, farmers experienced a slightly higher but essentially the same risk as nonfarmers (SMR: 1.013; 95% CI: 1.418-0.608)—the SMR was not significant. This study corroborates a number of cancer incidence and mortality investigations demonstrating that farmers generally experience the same or lower mortality risks for these malignancies.*

The agricultural industry plays an important economic role in Wisconsin: cash receipts for all farm commodities produced in the state accounted for more than $5.4 billion in 1993 (Wisconsin Department of Agriculture, 1994), and as a group, farmers represent over 3 percent of employed population in Wisconsin. Approximately 240,000 persons are employed on 79,000 farms, and in terms of agricultural production, Wisconsin ranks ninth in the nation (Wisconsin Department of Agriculture, 1994).

As a socioeconomic group however, farmers, farm managers, and farmworkers are often at the lower end of the scale because they tend to have lower incomes and a lower average level of educational attainment when compared to many nonfarmer occupational groups (Kitagawa & Hauser, 1973). In general, while mortality risk inversely correlates with socioeconomic status, farmers paradoxically experience a lower all cause mortality risk.

Two analyses of the mortality experience of a U.S. national sample from a socioeconomic and occupational perspective both demonstrated that all-cause mortality for farmers was lower (Kitagawa & Hauser, 1973; Rogot, Sorlie, Johnson, Glover, & Treasure, 1988). The all-cause standardized mortality ratio (SMR) for farmers was 0.76 for white males aged 25-64 in 1960 and 0.73 during the years 1979 through 1981. Thus, in 1960 the all-cause mortality rate was 24 percent lower for farmers, while from 1979 to 1981 it

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was 27 percent lower for farmers when compared to nonfarmers. This trend of lowered mortality risk for farmers is true for all-cause cancer risk as well (Blair & Hoar-Zahm, 1991; Blair, Hoar-Zahm, Pearce, Heineman, & Fraumeni, 1992). A review of four mortality studies and one incidence study of all cancer risk in agricultural workers found that each study reported lower mortality risks (Pierce & Reif, 1990).

Although farmers experience a favorable all-cause and all-cancer cause mortality risk, this study was done to discover if Wisconsin farmers experience adverse risks for specific cancers. Four cancer types were examined: colon (ICD9 153), rectal (ICD9 154), melanoma (ICD9 172), and non-Hodgkin's lymphoma (NHL-ICD9 159.1, 200 and 202). Colon cancer and rectal cancer were studied because they are frequently occurring cancers that may be detected by screening and are subject to successful management if diagnosed early (Newcomb, Norfleet, Storer, Surawicz, & Marcus, 1992). Any observed excess mortality risks in farmers would therefore be amenable to reduction by targeting preventive screening services to the rural farm community. Malignant melanoma and non-Hodgkin's lymphoma were selected because of their possible occupational relationship to farming hazards such as excessive sunlight exposure (Elwood, 1992) and working with pesticides (Cantor, et. al., 1992), respectively. However a number of SMR, standardized incidence ratio (SIR), and case-referent studies have demonstrated lower or no different farmer cancer risks overall for colon and rectal cancer, non-Hodgkins lymphoma, and melanoma (Blair, Malker, Cantor, Burmeister, & Wiklund, 1985; Kizer, 1987; Pierce & Reif, 1990; Vagero, Swerdlow, & Beral, 1990).

Methods

An epidemiologic assessment of farmer and nonfarmer cancer mortality was done using Wisconsin occupation coded death certificates. Cancer death frequencies for 1981 through 1990 were enumerated for farmers and nonfarmers. Age-specific cancer death rates were constructed for the nonfarm population. Four age groups were used (ages 16 to 44, 45 to 54, 55 to 59, and 60 to 64) and six 1980 and 1990 Bureau of the Census occupation codes were employed to group farmers. The census codes for farmers included: 473, farmers; 474, horticultural specialty farmers; 475, farm managers; 476, horticultural specialty farm managers; 477, farmworker supervisors; and 479, farmworkers. All of the other occupation codes were combined to form the nonfarmer reference group. Employment population data from the 1980 and 1990 censuses was used. The 1980 and 1990 population totals were averaged and multiplied by 10 to provide annualized denominator estimates for the decade observed. Only white males were studied in this investigation because of the dearth of females and minorities employed in the agricultural sector in Wisconsin, and because only a few female or minority death certificates were found to be coded to the farming occupations. Thus, reliable risk estimates could not be obtained for these populations.

SMRs were constructed for the farming group (Kahn & Sempos, 1989) and observed farm cancer cases were arrayed by type into each of the four age groups. Cancer rates were estimated for the balance of the statewide population using the remaining malignancy and population totals. These age-specific nonfarmer cancer rates were multiplied into the farm population estimates to generate the expected number of cancers for farmers. The SMRs were generated by dividing the sum total of the observed events in farmers by the sum total of expected cancers based on the underlying balance-of-state rates. The estimated SMRs were then bounded by 95% confidence intervals (CIs) (Kahn & Sempos, 1989).

Results

Statewide, from 1981 to 1990, there were a total of 1,261 colon, 282 rectal, 316 melanoma, and 550 non-Hodgkin's lymphoma cancers for Wisconsin white males aged 16 to 64. Table 1 displays the corresponding death frequencies for farmers and nonfarmers. Overall, 6.77 percent of the selected malignancy deaths had a farming occupation code listed as the usual occupation. The percent of deaths for farmers varied by cancer type, from a low of 4.75 percent (melanoma) to a high of 8.51 percent (rectal cancer). For white male farmers aged 16 to 64, colon cancer represented the bulk of the selected malignancies (83) followed by non-Hodgkin's lymphoma (41), rectal cancer (24), and melanoma (15).

Table 2 displays the results of the SMR analyses. From 1981 to 1990, Wisconsin white male farmers were at significantly lower mortality risk for colon cancer (SMR: 0.763, 95% CI: 0.928-0.599) when compared to their nonfarming peers. This SMR of 0.763 represents a risk decrement of 23.7 percent for farmers. Wisconsin farmers also had a significantly lower mortality risk for malignant melanoma (SMR:

Table 1. Selected Malignancy Frequencies (Percent) for Wisconsin White Male Farmers and Nonfarmers Aged 16-64 Years, 1981-1990.

Cancer Type	Farmers	Nonfarmers	Total
Colon	83 (6.58%)	1,178 (93.42%)	1,261 (100%)
Rectum	24 (8.51%)	258 (91.49%)	282 (100%)
Melanoma	15 (4.75%)	301 (95.25%)	316 (100%)
Non-Hodgkin's Lymphoma	41 (7.45%)	509 (92.55%)	550 (100%)
Total Selected Malignancies	163 (6.77%)	2,246 (93.23%)	2,409 (100%)

Table 2. Selected Malignancy Frequencies for White Male Wisconsin Farmers Aged 16 to 64 Years with Age-adjusted Standardized Mortality Ratios (SMRs) and 95 Percent Confidence Interval (CI), 1981-1990.

Cancer Type	Observed Deaths Total (O)	Expected Deaths Total (E)	SMR* (O)/(E)	95% CI** Upper	95% CI** Lower
Colon	83	108.714	0.763	0.928	0.599
Rectum	24	23.698	1.013	1.418	0.608
Melanoma	15	22.749	0.659	0.993	0.326
Non-Hodgkin's Lymphoma	41	44.098	0.930	1.214	0.645

* $SMR=(O)/(E)$

** 95 % $CI=SMR \pm 1.96(\text{sqrt}\{SMR/E\})$

$(O)=D_{16-44}+\ldots+D_{59-64}$;
where D_i=farmer deaths in age group.

$(E)=R_{16-44}{}^{*}P_{16-44}+\ldots+R_{59-64}{}^{*}P_{59-64}$;
where R_i=WI age, cause specific death rate and P_i=farmer age specific population estimate.

0.659, 95% CI: 0.993-0.326). Thus, for farmers the age-adjusted mortality rate for melanoma was 34.1 percent lower when compared to nonfarmers. A lower cancer mortality risk was also seen for non-Hodgkin's lymphoma, however it was not significant. The non-Hodgkin's lymphoma SMR of 0.930 (95% CI: 1.214-0.645) indicated a nonsignificant, 7 percent lower mortality risk for farmers. The rectal cancer SMR of 1.013 (95% CI: 1.418-0.608) for farmers represented a 1.3 percent nonsignificant risk increment.

Discussion

This study found Wisconsin farmers to be at decreased risk for colon cancer when compared to Wisconsin nonfarmers. Wisconsin farmers experienced a colon cancer mortality rate that overall was 23.7 percent lower than the nonfarming population. This observation is consistent with findings demonstrating lower socioeconomic groups to be at lower risk (Schottenfeld & Winawer, 1982) for colon cancer and a number of occupational studies of colon cancer. For example, a California occupational mortality study (Kizer, 1987) found white male farmers to have a lower (nonsignificant) colon cancer risk (SMR: 0.85; 95% CI: 1.27-0.43) while farm laborers were at a significantly lower risk (SMR: 0.47; 95% CI: 0.73-0.22) for colon cancer. A summary of five colon cancer SMR studies of farmers (Blair, et al., 1985) noted that three of the five investigations found significant risk deficits for colon cancer, a fourth study showed a nonsignificant increase, and a fifth study exhibited nonsignificant decrement.

Physical activity, sun exposure, and exposure to pesticides have been hypothesized to be related to lower and higher cancer risks for farm populations. For example, increased physical activity has been hypothesized to protect against colon cancer. This could explain the farmer colon cancer risk decrement if farmers are more physically active than their counterparts. In a study of occupational activity level and the risk of male colon cancer (Kato, Tominaga, & Ikari, 1990), farmers were classified into a high activity level group. In this study, farmers represented the most frequent occupation in the group, or 40 percent of the subjects in the category. Farmers did not substantially contribute to low or moderate activity levels. This investigation of 1,716 colon cancer cases found that occupations with low or moderate physical activity levels had a significantly

increased risk of colon cancer when compared to the farmer-dominated, high-activity reference group (Kato, et al., 1990).

The finding of a nonsignificant risk increment (SMR: 1.013) for rectal cancer is similar to many other studies of farmers (Blair, et al., 1985)—risks are either no different or lower. For example, one of the seven studies found a significant risk deficit for rectal cancer; three studies found nonsignificant decrements; one study found a rate identical to the referent population; and one study reported a 15 percent nonsignificant increase (Blair, et al., 1985). Two case-referent studies reported risk decrements, but only one was statistically significant (Blair, et al., 1985). In California, white male farmers experienced a statistically nonsignificant risk decrement for rectal cancers and other digestive organ cancers (SMR: 0.92; 95% CI: 1.25-0.58) (Kizer, 1987). Finally, a study of occupational activity level for 1,611 rectal cancer cases found that occupations with low or moderate physical activity levels had a significantly increased risk of rectal cancer when compared to the high activity referent group that was mostly composed of farmers. Farmers did not materially contribute to the two other low activity levels (Kato, et al., 1990).

White male farmers in Wisconsin experienced a significant 34.1 percent lower risk for melanoma mortality. This finding of a risk decrement was seen in other farmer mortality studies, such as an incidence study of melanoma in 383 Swedish farmers that noted a significant 15 percent mortality risk deficit (Blair, et al., 1985). Previous studies (Vagero, et al., 1990) have shown that professionals have greater melanoma risk compared to other occupations and that individuals in jobs having some outdoor and sunlight exposure appear to be at a decreased risk. Professional occupations were primarily listed as having significant, elevated malignant melanoma risk based on cancer registration data in England, Wales, and Sweden, farmers were not listed in the elevated group (Vagero, et al., 1990). An incidence study of melanoma stratifying occupations by sunlight exposure (ie., indoor, outdoor, and combined indoor/outdoor) found that workers with indoor occupations had the highest age-adjusted incidence rate of melanoma, while those working in combined indoor/outdoor occupations had the lowest rate (Garland, White, Garland, Shaw, & Gorham, 1990). Finally, a recent review of melanoma and sun exposure stated that while the evidence linking cutaneous malignant melanoma to previous solar exposure was now very strong, the relationship is complex—melanoma risk appears to be related to short periods of intense exposure in early adult life, while a regular outdoor occupation, through long-term chronic exposure, confers a decreased risk for the cancer (Elwood, 1992).

The finding of a nonsignificant risk decrement for non-Hodgkin's lymphoma in farmers overall is consistent with several other studies—risks are not elevated or nonsignificant for farmers as a whole. However, this outlook changes in some studies when pesticide exposure is considered. In this study, Wisconsin farmers could not be classified according to pesticide exposure levels. In seven other SMR, SIR, or case-referent studies of non-Hodgkin's lymphoma risk and farmers, two had statistically significant risk decrements, a third had a nonsignificant decrement, and four had nonsignificant risk elevations, three of which were very small (ie., between 1.0 and 1.12) (Blair, et al., 1985). In contrast, when pesticide exposure estimates were available, one case-control study found a significant non-Hodgkin's lymphoma risk elevation related to farm phenoxy-herbicide exposure (Pierce & Reif, 1990). However, another exposure study found no excess risk for Danish farmers, and only a slight excess risk for Italian farmers who were more likely to handle phenoxy-herbicides (Ronco, Costa, & Lynge, 1992). An earlier study (Cantor, 1982) of Wisconsin farmers (1968-1976) found a nonsignificant non-Hodgkin's lymphoma risk elevation overall, but risks became significant on an ecologic basis for farmers younger than age 65 in counties with small grain acreages and high pesticide use. Finally, a non-Hodgkin's lymphoma study of white males in Minnesota and Iowa found a nonsignificant but slight elevation for farmers overall, and risks increased and became significant when cases were factored by exposure to pesticides (Cantor, et al., 1992).

The findings of this investigation are largely compatible with the literature on risk factors for colon and rectal cancer, melanoma, and non-Hodgkin's lymphoma. Colon and rectal cancer, non-Hodgkin's lymphoma and melanoma all afflict the higher socioeconomic groups in greater proportions. As a lower socioeconomic group, farmers would have a lower risk and indeed this is the observation of this study, especially for colon cancer and melanoma. Farmers are also more likely to have a higher activity level than the average worker, and this too may provide added protection from colon cancer. Farmers' chronic exposure to sunlight may result in a significant risk decrement for melanoma when the group is compared to others, such as professionals working indoors and those who may suffer acute, episodic exposures to

excessive sunlight. Finally, previous studies indicate that, overall, non-Hodgkin's lymphoma risk is on balance no different than the general population risk, or it is lower for farmers. Only when farming practices are factored by pesticide exposures have some studies found significant non-Hodgkin's lymphoma risks. Although Wisconsin farmers experienced a nonsignificant risk decrement for non-Hodgkin's lymphoma, this study was unable to factor mortality experience by pesticide exposure.

Although this investigation corroborates many of the findings in previous SMR, SIR, and case-referent farmer cancer studies, a number of limitations should be noted. First, the results are dependent on the accuracy and completeness of the occupation listed on the death certificate, as well as the completeness of coding the cause of death. Misclassification in the form of incomplete and inaccurate occupation and/or cause of death coding could result in bias. Second, only the "usual" occupation is listed on the death certificate; classification is not derived from an occupational history. This, too, could affect the accuracy of coding farmers and nonfarmers.

The census occupation population counts represent working individuals, whereas the death certificates ask for the decedent's usual occupation, even if retired. However, by restricting the analysis to individuals aged 64 and younger, this study maximized the likelihood that observed deaths are on the currently working farmer population. Any divergence of the death certificates from the census would, if anything, tend to overenumerate farmer deaths (i.e., usual occupation versus current occupation; usual occupation even though now retired before age 64 because of a disability, etc.), resulting in a bias toward a higher death rate and consequent elevated SMR (i.e., more deaths observed than expected). However significant, elevated SMRs were not found in this study. Finally, farmers as an occupation were broadly categorized. As a result, specific farming types and attendant exposures (e.g., volume use of pesticides and duration of work with sunlight exposure) could not be obtained and studied from the death certificate data set.

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