


 A B S T R A C T

**Associations between sun exposure in occupational settings and cancer risk,
as indicated by South Australian cancer-registry data**

There is compelling evidence that outdoor workers chronically exposed to the sun have an increased risk of non-melanocytic skin cancer and cancer of the lip. By comparison, the risk of melanoma is thought to be raised among workers who spend more of their time indoors but are exposed intermittently to the sun. These associations were tested, using occupational data from the South Australian cancer registry to infer levels of sun exposure.

Occupational data are obtained by the registry mostly from hospital and death records. The occupation recorded is generally the last one, not necessarily the one applying at the time of cancer initiation. Because of this deficiency, other limitations with the occupational data, and a lack of information on non-occupational exposures, the results of these analyses should be interpreted with caution.

The analyses included data on 45,567 cancer cases notified to the cancer registry for the 1977-98 diagnostic period. After adjusting for age and sex, the relative risks (95% confidence limits) of lip as opposed to other cancer cases being classified as mixed indoor/outdoor and outdoor workers, rather than indoor workers, were 1.99 (1.56, 2.53) and 2.56 (1.90, 3.40) respectively. The results therefore supported the established link between chronic sun exposure and lip cancer.

The results also pointed to a non-significant increase in risk of invasive melanoma for mixed indoor/outdoor when compared with indoor or outdoor occupations. This is consistent with the hypothesis that risk is elevated among workers who are exposed intermittently to the sun.

There is also limited epidemiological and experimental evidence in the scientific literature to suggest that non-Hodgkins lymphomas and skin cancers may share common causal factors. This has raised the spectre of a possible role of solar radiation in the aetiology of these lymphomas. The present analyses indicated, however, that outdoor workers had a low risk of lymphomas when compared with the risks experienced by indoor and mixed indoor/outdoor workers. A positive association of risk of these cancers with sun exposure therefore was not supported.

PHOTO 1: The Anti-Cancer Foundation promotes sun protection in SA, both in workplaces and elsewhere, to reduce the risk of skin cancer.



C H A P T E R 11

Associations between sun exposure in occupational settings and cancer risk, as indicated by South Australian cancer-registry data

I N T R O D U C T I O N

There is compelling evidence that outdoor workers who experience chronic sun exposure are at an increased risk of non-melanocytic skin cancer.^{1,2} By comparison, the risk of melanoma is thought to be raised among workers who spend more of their time indoors, but nonetheless are exposed intermittently to the sun. These associations were tested using occupational histories recorded by the cancer registry.

It was hypothesized that increasing levels of sun exposure, as inferred from occupational histories, would relate directly and progressively to the risk of cancer of lip. These cancers mostly occur on the vermilion border of the lower lip and share many of the epidemiological characteristics of non-melanocytic skin cancers, including an association with chronic sun exposure.³

By comparison, it was anticipated that melanoma risk would be higher among occupational groups who worked both indoors and outdoors, and were more likely to experience intermittent exposure to the sun.

There is also limited epidemiological and experimental evidence to suggest that non-Hodgkin's lymphomas and skin cancers may share common causal factors.⁴ This has raised the spectre of a possible role of solar radiation in the aetiology of lymphomas. In this chapter, the association of non-Hodgkin's lymphoma risk with occupationally related sun exposure is explored, using exposure levels inferred from the occupational histories recorded by the cancer registry.

M E T H O D S

Approximately 40% of cancer cases notified to the registry have a recorded occupation. The source of this information generally was hospital records or state death notifications. Mostly the recorded occupation was the last one, that is, not necessarily the one applying at the time of cancer initiation. Another limitation of the occupational information was the frequent designation of "retired" or "pensioner" on source documents. Nonetheless, there were 45,567 case records on the registry for the diagnostic period since 1977 where the occupation was specified.

Initially a job-exposure matrix was developed by assigning each occupation a score from one to three according to the likely level of associated sun exposure. A score of one denoted an indoor occupation, such as a clerical or sales worker in a department store, whereas a score of three referred to occupations that were predominantly outdoor, such as farming, fishing, fruit growing, and timber getting. A score of two referred to occupations that shared more equally an inside and outside environment, such as bus drivers and other transport workers for example.

The relative risk of lip cancer, invasive melanoma, and a non-Hodgkin's lymphoma, respectively, as opposed to another cancer type, was calculated in a multivariate context. The reference category was indoor worker, with mixed indoor/outdoor and outdoor workers being expressed as two dummy variables. A Cox proportional hazards regression model was used in which survival was treated as a constant and the censoring variable was used to indicate whether the cancer was an index cancer (ie, lip cancer, melanoma, or non-Hodgkin's lymphoma, respectively) or another cancer type.⁵ In the multivariate analyses, adjustment was made for age at diagnosis and sex using classifications that are presented with the results. Assumptions underlying these models, such as a lack of colinearity, were tested and found to be met.⁵

RESULTS

Of the 45,567 cases with recorded occupations, 16% were classified as indoor workers, 78% as mixed indoor/outdoor workers, and 6% as outdoor workers. The relative risk (95% confidence limits) of lip as opposed to other cancer cases being classified as mixed indoor/outdoor and outdoor workers, rather than indoor workers, was 1.44 (1.14, 1.82) and 3.51 (2.63, 4.68) respectively, as indicated by the univariate analysis. After adjusting for age and sex, the respective relative risks were 1.99 (1.56, 2.53) and 2.56 (1.90, 3.40) (Table 1).

While univariate analyses also revealed an association of occupational environment with melanoma ($p < 0.001$) and non-Hodgkin's lymphoma ($p = 0.013$), dose-response relationships with outdoor occupation were not apparent. The multivariate analysis indicated that while indoor workers tended to have a comparatively low risk of melanoma, outdoor workers did not have a higher risk than mixed indoor/outdoor workers (Table 1). Indeed, there was the suggestion that their risk was lower. Furthermore, for non-Hodgkin's lymphomas, outdoor workers presented the lowest risk of the occupational categories.

DISCUSSION

Despite deficiencies in the quality of occupational information available for these analyses, a predicted dose-response relationship of outdoor occupation with risk of lip cancer was evident. This is consistent with the results of separate analyses of South Australian registry data that point to an age-sex standardized incidence for farmers, fruit growers, fishermen and fisherwomen, and related occupations 51% higher than the South Australian mean, and a corresponding incidence for clerks, secretaries and white-collar managers 45% lower than this mean.

Although variations in melanoma risk by occupational category were small, the results pointed to a non-significantly higher risk for mixed indoor/outdoor than indoor or outdoor classifications. This is consistent with the hypothesis that risk is elevated among workers who are exposed intermittently to the sun.

The results for non-Hodgkin's lymphoma did not support the hypothesis that solar radiation was a risk factor. Indeed, the lowest risk for these cancers was evident among outdoor workers.

It can be concluded, therefore, that the results: support the established link between chronic sun exposure and risk of lip cancer; offer weak support for an association between intermittent sun exposure and melanoma risk; and do not support the hypothesis that solar radiation is a risk factor for non-Hodgkin's lymphoma. There is a need for caution in the interpretation of these results, however, due to the poor quality of the data on occupational histories and the potential for confounding effects from non-occupational exposures.

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TABLE 1: Associations of lip cancer, invasive melanoma, and non-Hodgkin's lymphoma with occupational setting, classified as indoors, mixed indoors/outdoors, and outdoors*

<i>Predictors</i>	<i>Relative risk (95% confidence limits)</i>		
	<i>Lip cancer (n = 730)</i>	<i>Melanoma (n = 2,919)</i>	<i>NH lymphoma (n = 1,921)</i>
Age at diag. (yrs.):			
Under 40 (reference)	1.00	1.00	1.00
40-49	0.95 (0.72, 1.25)	0.60 (0.53, 0.67)	0.97 (0.82, 1.14)
50-59	0.64 (0.49, 0.83)	0.37 (0.33, 0.42)	0.71 (0.60, 0.83)
60-69	0.62 (0.47, 0.81)	0.35 (0.31, 0.39)	0.70 (0.60, 0.82)
70-79	0.83 (0.62, 1.09)	0.32 (0.28, 0.36)	0.78 (0.66, 0.92)
80+	1.49 (1.12, 1.99)	0.25 (0.21, 0.30)	0.69 (0.56, 0.85)
Sex:			
Female (reference)	1.00	1.00	1.00
Male	3.11 (2.64, 3.66)	0.99 (0.91, 1.07)	1.34 (1.21, 1.48)
Occupational setting:			
Indoors (reference)	1.00	1.00	1.00
Indoors/outdoors	1.99 (1.56, 2.53)	1.07 (0.97, 1.18)	0.98 (0.87, 1.11)
Outdoors	2.56 (1.90, 3.44)	1.03 (0.87, 1.23)	0.81 (0.65, 1.00)

* As indicated by adapted Cox proportional hazards regression (see text).
Analysis of 45,567 cases diagnosed in 1977-98 and notified with an occupational history to the South Australian cancer registry.

