Prevalence of Exposure to Solar Ultraviolet Radiation (UVR) on the Job in Canada

Cheryl E. Peters, MSc,[1,2] Anne-Marie Nicol, PhD,[1,2] Paul A. Demers, PhD[2,3]

ABSTRACT

Objective: Over one third of all newly diagnosed cancers in Canada in 2010 were skin cancer, despite the fact that skin cancer is largely preventable by limiting ultraviolet radiation (UVR) exposure. Outdoor workers are at risk of exposure to UVR, yet the prevalence of exposure in Canada is unknown. The objective of this study was to estimate the number of outdoor workers in Canada.

Methods: Building on CAREX Canada methods, we used a combination of data in the original Finnish CAREX, an Australian skin cancer prevention workbook, career-selection websites, and published studies to flag jobs at high risk of exposure. We also created a category for moderate exposure, where workers were unlikely to spend their whole day outside. Adjustments were made for industry-driven exposure, and prevalence of exposure was assigned for all jobs. Prevalence data were linked to census data to derive the number of workers exposed to solar UVR.

Results: Over 1.5 million Canadian workers are exposed to solar UV at work, and approximately 897,000 of these were flagged as "high exposed" (outdoors ≥75% of the workday). The largest occupational groups were farmers, construction labourers, and landscapers. Proportions of the workforce exposed ranged by province, with 6.9% of workers exposed in Ontario, and up to 17.3% in Prince Edward Island.

Conclusions: Information on solar UVR exposure prevalence is needed for primary skin cancer prevention with regard to targeting of high-risk groups, priority setting, and better risk assessment. This study showed that solar UVR exposure is occurring on a large scale in Canada.

Key words: Occupational exposure; skin neoplasms; primary prevention; sunlight

La traduction du résumé se trouve à la fin de l'article.

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In 2010, over 80,000 of the 250,000 newly diagnosed cancers in Canada were skin cancer (5,300 of which were melanoma, and a further 75,500 of which were basal and squamous cell carcinomas, collectively known as non-melanoma skin cancer [NMSC]).[1] Despite the fact that these cancers are largely preventable (by limiting ultraviolet radiation [UVR] exposure), the incidence of skin cancer is increasing in Canada.[2] All skin cancer types are related to increased exposure to UVR, though the pattern of exposure differs between the cancer types. Canadian estimates are not available, but in Australia 65-90% of skin cancer is attributed to UVR, and in the US the attributable percentage is over 90%,[2] including occupational sun exposure.[3] Melanoma is strongly linked with high doses of intermittent sunlight (causing sunburn), especially early in life.[4] Squamous cell carcinoma is more strongly linked to higher cumulative exposure, such as is seen in occupationally-exposed groups. More recently, basal cell carcinoma has also been linked more conclusively to occupational solar UVR exposure.[5]

Outdoor workers (e.g., construction workers, farmers, postal workers) are a group at particular risk of high UVR exposure.[6] Elevated rates of NMSC are seen in outdoor workers, as compared to indoor workers, and the risk is highest among those with the highest exposure.[7] The Canadian Second National Sun Survey (NSS2) found that 26% of Canadians reported working outdoors in the summer (67% of those for 2+ hours per day),[8] and many of these workers use inadequate sun protection. In a workshop held post-survey, participants identified outdoor workers as key targets for skin cancer prevention efforts.[9] The first Canadian sun survey (1996) showed that outdoor workers report low levels of sun protection behaviours, a finding similar to those of studies in the US and Australia.[10]

Occupational cancer prevention requires information on the occurrence of exposure – in particular, how many people are exposed – but this information is rarely available.[11] Exposure surveillance data of this type has many potential uses in the primary prevention of workplace cancers, including priority setting for prevention activities, targeting of high-risk groups, education for the public and policy makers, the monitoring of trends, and the assessment of the impact of regulatory change.[12]

Prevalence data on occupational sun exposure in particular can be used in estimating the contribution of workplace sun exposure to the burden of skin cancer in Canada. While estimates of the

Author Affiliations

1. CAREX Canada, Vancouver, BC
2. School of Population and Public Health, University of British Columbia, Vancouver, BC
3. Occupational Cancer Research Centre, Cancer Care Ontario, Toronto, ON

Correspondence: Cheryl E. Peters, School of Population and Public Health, University of British Columbia, 3rd Floor, 2206 East Mall, Vancouver, BC V6T 1Z3, Tel: 604-822-0511, Fax: 604-822-4994, E-mail: cepeters@mail.ubc.ca

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Table 1. Prevalence of Exposure to Solar Ultraviolet Radiation in Canada by Occupation

Occupation	Total Population Exposed (n)	% Exposed	Exposure Category
Farmers and farm managers	150,000	75	High
Construction trade helpers and labourers	125,000	75	High
Landscaping and grounds maintenance labourers	115,000	100	High
General farm workers	84,000	80	High
Heavy equipment operators (except crane)	83,000	100	Moderate
Truck drivers	61,000	20	Low
Carpenters	53,000	40	Moderate
Delivery and courier service drivers	51,000	50	Low
Public works and maintenance labourers	33,000	100	Moderate
Couriers, messengers and door-to-door distributors	30,000	100	Moderate
Letter carriers	29,000	100	High
Fishing vessel skippers and fishermen/women	28,000	100	High
Heavy-duty equipment mechanics	27,000	70	Moderate
Roofers and shinglers	22,000	100	High
Nursery and greenhouse workers	22,000	100	High
Bricklayers	19,000	100	High

prevalence of occupational sun exposure are available elsewhere (e.g., US, Great Britain, European Union),[6,11,13] solar UVR exposure varies spatially and with labour and market patterns. Even in Australia, which has the highest rates of skin cancer in the world and where an estimated 34,000 NMSCs per year may be caused by occupational exposure, comprehensive estimates of the number of workers exposed are unavailable.[14]

CAREX Canada is a national carcinogen exposure surveillance project that uses methods adapted from the European project of the same name developed by the Finnish Institute of Occupational Health.[11] The goals of CAREX Canada are: 1) to develop estimates of the numbers of workers exposed to high-priority carcinogens; and 2) where data allow, develop estimates of the levels of exposure to these carcinogens in Canada. For this study, our objective was to estimate the number of Canadians occupationally exposed to solar UVR.

METHODS

Exposure to solar UVR was defined as exposure to the sun at work that is likely to exceed typical non-occupational exposure (not including heavy recreational sunbathing). It did not include exposure to artificial sources of UVR (e.g., tanning beds, welding arcs). In the original CAREX project, jobs were counted as "exposed" if workers were expected to be outside ≥75% of the workday. We used this definition and flagged those workers in a "high-exposure" category, but also developed flags for other jobs where exposure may also occur.

To identify jobs in the high-exposure category, we used the occupational skin cancer prevention workbook developed by Cancer Council Australia's SunSmart program, which identifies "typical" outdoor jobs.[15] This category includes such jobs as gardening and roofing, where we expect that all workers are likely to have relatively high exposure to UVR. In addition, an indicator variable noting level of confidence in the estimate (low, medium, high confidence) was included for all job and industry combinations. We consulted previously published studies that flagged jobs classified as exposed to solar UVR to confirm our selection of job titles.[7,16,17]

In order to create other general exposure categories that were relevant in the Canadian context, we focused on occupations first, and industry second. To classify occupations with respect to UVR exposure, we used two career-selection websites that describe tasks by job title and include information on outdoor work (and expected amount of time spent outdoors).[18,19] This allowed the creation of a low-exposure category (i.e., almost never exposed, such as office managers), as well as two moderate-exposure categories. Moderate-exposure categories are divided into two types falling on the continuum between "always" and "never" exposed: 1) all workers in that job are similar and perform similar but mixed indoor and outdoor tasks; and 2) different workers in the job may have very different amounts of time spent indoors and outdoors. For moderate-exposure Group 1, we assigned the proportion of workers exposed to solar UVR to reflect an approximate weighting for the time spent outdoors. An example of this job type would be a construction inspector; while much of their work is indoors, site inspections may take up a significant proportion of the day and could involve measureable solar UVR exposure. For moderate-exposure Group 2, we reviewed industry information to assign the proportion of workers exposed. For example, the occupation "Tour and Travel Guides" includes people who work outdoors all day (i.e., providing walking tours in a city) and also those who work indoors all day (people offering tours of historic buildings). Low and moderately exposed groups are then flagged as such in the CAREX database.

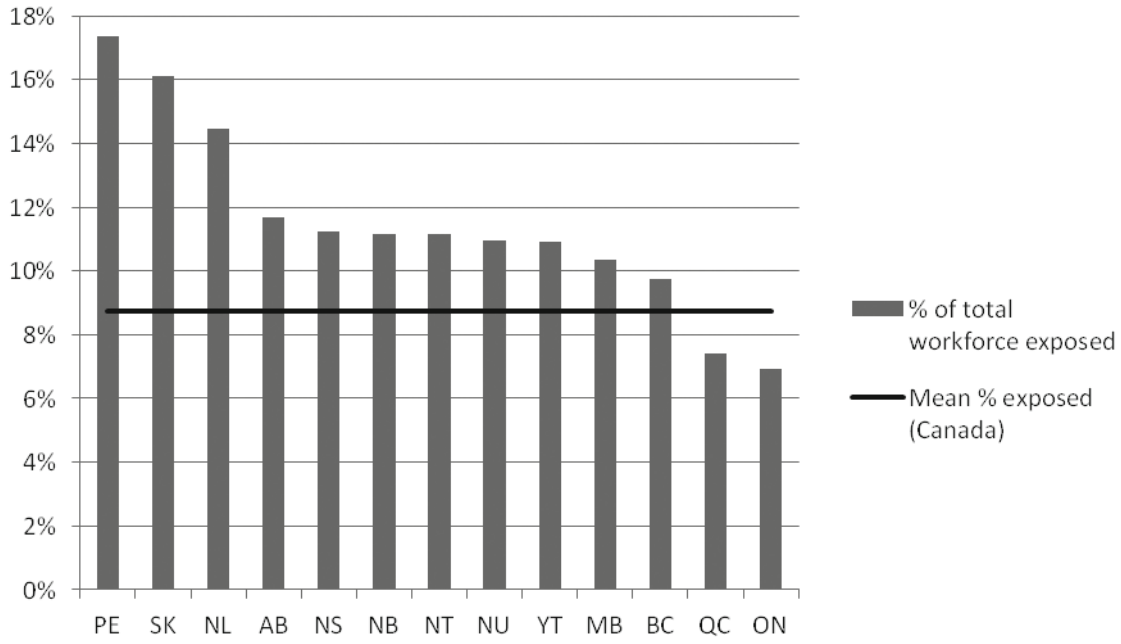
Table 2. Prevalence of Exposure to Solar Ultraviolet Radiation in Canada by Industry

Industry	Total Population Exposed (n)	% of Industry Exposed
Farms	264,000	68.6
Residential building construction	108,000	36.0
Services to buildings and dwellings	83,000	31.7
Foundation, structure, and building exterior contractors	68,000	55.5
Local, municipal and regional public administration	60,000	20.8
Other amusement and recreation industries	45,000	29.6
Other specialty trade contractors	40,000	50.8
Support activities for mining and oil and gas extraction	37,000	37.4
Fishing	37,000	89.0
Logging	36,000	62.9

Next, in situations where exposure is largely driven by industry rather than occupation, we selectively added in several jobs as "exposed" to UVR in those industries. This usually occurred in the farming and construction industries (where jobs that may normally take place inside are located outside). For example, the job code H144 (Painters and Decorators) mostly includes indoor workers, with a negligible number of outdoor workers in the whole workforce; but within the construction industry, a substantial proportion of this job would be exterior building painters, and so a proportion was flagged as exposed in this industry only.

Once all job and industry intersections were evaluated for the proportion of outdoor workers exposed to UVR and entered into

Figure 1. Percentage of working population exposed to solar ultraviolet radiation at work, by province/territory*



* PE: Prince Edward Island; SK: Saskatchewan; NL: Newfoundland & Labrador; AB: Alberta; NS: Nova Scotia; NB: New Brunswick; NT: Northwest Territory; NU: Nunavut; YT: Yukon Territory; MB: Manitoba; BC: British Columbia; QC: Québec; ON: Ontario

the CAREX Canada database, we applied these proportions to the 2006 Canadian Census of Population to obtain estimates of the number of people exposed to UVR on the job by industry, occupation, and sex.[20] Industry was classified by North American Industry Classification System (NAICS, 2002), and occupation by the National Occupational Classification for Statistics (NOC-S, 2006). This study was conducted within the CAREX Canada project, with approval of the Research Ethics Board of the University of British Columbia.

RESULTS

Overall, approximately 1.5 million Canadians (82% males) are likely to be exposed to solar UVR on the job; this amounts to 8.8% of the Canadian working population. Notably, 61% (897,000) of those exposed fell in the high-exposure category, which denotes workers outside ≥75% of the time. Exposed proportions by job or job/industry combination ranged from 2 to 100% of workers per category.

The occupations with the highest prevalence of exposure to solar UVR (largest number of workers exposed), the percentage of workers exposed in that job, and the exposure category (high, moderate, low) are shown in Table 1. The largest groups are farmers and landscapers, and construction trade helpers. It should be noted that these numbers are driven not only by prevalence of exposure, but also by the number of workers in a given occupation.

CAREX methods also permit the examination of exposure by industry. The most important broad categories (with respect to total number of workers exposed) were construction, agriculture, forestry, fishing and hunting, and services to buildings. Exposure by industry at a more detailed level is shown in Table 2.

Because our estimates are derived at a national level, the provinces with the largest populations will have more people exposed; however the industry balance by province differs, leading to different proportions exposed. This is illustrated in Figure 1. While the province of Ontario has the largest number of solar UVR-exposed workers (450,000, data not shown), relatively few of Ontario's entire workforce are exposed (6.9%). In contrast, 17.3% of the Prince Edward Island workforce is exposed (n=13,000).

DISCUSSION

Our results show that occupational exposure to UVR in Canada is common, with 1.5 million workers likely to be exposed, and 897,000 of these in the highest category of exposure (5.3% of Canadian workers). In the NSS2, workers were classified as "outdoor" if they "reported having a job that required them to work outdoors during the summer months of June, July and/or August of 2006", and this classified 5.9 million Canadians as potentially exposed.[21] Our estimates are lower, but we feel that there are two plausible reasons for this, stemming from over-reporting of outdoor work in the NSS2. First, there is no clear definition of what qualifies as "working outdoors", and indeed respondents could answer "yes" based on minimal time spent outside. Second, participants were asked about a specific time period. This could lead to over-reporting where a specific project required outdoor work for a short time. Our detailed review of several data sources was focused on increased specificity of classification. In addition, our estimates are similar to those in Great Britain, a country with exposure patterns likely to mimic the Canadian setting with respect to latitude. There, it was estimated that 6.8% of workers were exposed to solar UVR at work.[13] Our estimate ranges from 5.3-8.8%, with the low end representing those at high risk, and the high end representing all workers at risk of exposure.

There are several imitations to this study that should be noted. First, solar UVR exposure in Canada is not directly comparable to exposure in Australia. However, relatively speaking, jobs in Australia are not different from jobs in Canada with respect to the potential for outdoor work (i.e., gardeners are outdoor workers

whether they are in Canada or Australia). Therefore, exposure levels should be qualitatively similar, even if absolute values are higher in Australia.

Our study also does not take into account the effect of latitude or seasonality. The effect of latitude is particularly important for northern Canada, where we can see (Figure 1) a relatively high proportion of the workforce is exposed due to outdoor work in the primary industries (a large part of the northern labour market). The level of exposure to solar UVR decreases away from the equator, so we expect the risk of skin cancer to be lower in the north. However, with respect to the number of people exposed, most Canadians (80%) live below the 50th parallel,[22] making latitude a less important modifier. There is also the potential that our exposure metric (working outdoors) differs by province, and this is likely to occur where weather patterns are markedly different. However, mean UV Index values for North America have been mapped and match very well with latitude (particularly in summer),[23] which diminishes the impact of east-west variability (differences by province). In addition, the *relative* levels of exposure will hold true regardless of province. The seasonality of outdoor work in Canada was incorporated into the assigning of exposure proportions, but it is true that over-estimation of outdoor work may have occurred where exposure occurs mostly in summer. By flagging jobs in a "high-exposure" category where we are more certain of year-round exposure and providing a range of the number of workers exposed, we feel we have conveyed this degree of uncertainty. However, an advisable next step would be a refinement of the estimates by province, taking into account regional environmental data (e.g., days of clear skies, UV Index). This is also warranted given our observations on the differing proportions of the workforce exposed to solar UVR by province. CAREX Canada is not a static database, and estimates are continually improved and updated as new information becomes available.

In summary, occupational solar UVR exposure is occurring on a large scale in Canada. Estimates of the prevalence of exposure to solar UVR are important to facilitate targeted prevention strategies in the workplace, in addition to population-level studies on the occupational burden of skin cancer.

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RÉSUMÉ

Objectif : Plus du tiers des cancers nouvellement diagnostiqués au Canada en 2010 étaient des cancers de la peau, malgré le fait que ce cancer est en grande partie évitable en limitant l'exposition aux rayons ultraviolets (RUV). Les travailleurs en plein air sont particulièrement exposés aux RUV, et pourtant la prévalence de l'exposition au Canada est inconnue. L'objectif de notre étude était d'estimer le nombre de travailleurs en plein air au Canada.

Méthode : En faisant fond sur les méthodes de CAREX Canada, pour identifier les emplois à risque élevé d'exposition nous avons utilisé, en combinaison, les données originales de CAREX Finlande, un cahier australien sur la prévention du cancer de la peau, des sites Web de sélection de carrière et des études publiées. Nous avons aussi créé une catégorie d'exposition modérée pour les travailleurs peu susceptibles de passer toute la journée dehors. Nous avons apporté des ajustements pour tenir compte des expositions venant de l'industrie et affecté une prévalence d'exposition à chaque emploi. Les données de prévalence ont été maillées aux données du Recensement pour calculer le nombre de travailleurs exposés aux RUV solaires.

Résultats : Plus d'un million et demi de Canadiens et de Canadiennes sont exposés aux RUV solaires au travail, et environ 897 000 sont « très exposés » (passent ≥75 % de la journée de travail à l'extérieur). Les plus grands groupes de professions étaient les agriculteurs et les agricultrices, les ouvriers et les ouvrières du bâtiment, et les paysagistes. Par province, la proportion de la main-d'œuvre exposée était de 6,9 % en Ontario et atteignait 17,3 % à l'Île-du-Prince-Édouard.

Conclusion : Il faudrait plus d'information sur la prévalence de l'exposition aux RUV solaires pour prévenir le cancer primaire de la peau en ciblant les groupes fortement exposés, en établissant des priorités et en améliorant l'évaluation du risque. Notre étude montre que l'exposition aux RUV solaires est présente à grande échelle au Canada.

Mots clés : exposition professionnelle; tumeurs de la peau; prévention primaire; lumière solaire