Cutaneous malignant melanoma incidence and mortality trends in Canada: A comprehensive population-based study

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Background: The incidence of cutaneous malignant melanoma (CMM) is on the rise in many parts of the world. However, there is limited knowledge on the epidemiology of CMM in Canada.

Objective: To conduct a comprehensive population-based study of CMM in Canada.

Methods: We examined patient clinical and pathologic characteristics as well as the incidence and mortality trends of CMM in Canada using 3 independent population-based registries.

Results: In total, 72,565 Canadian patients were given CMM diagnoses during 1992-2010; 47.5% were women. Average age at the time of diagnosis was 56.5 years for women and 60.4 years for men. We report a steady increase in CMM incidence and mortality rates in both sexes. The overall incidence rate of CMM in Canada was 12.29 cases/100,000 person-years. We also report important differences in the incidence and mortality rates between Canadian provinces and territories; the highest incidence of this cancer was documented in Nova Scotia and Prince Edward Island.

Limitations: Data on race, clinical disease stage, and Breslow depth of CMM was not available.

Conclusion: This study, for the first time, defines the disease burden of CMM in Canada and highlights important longitudinal, geographic, and spatial differences in the distribution of CMM in this country. (J Am Acad Dermatol 2019;80:448-59.)

Key words: Canada; CMM; cutaneous malignant melanoma; epidemiology; incidence; lentigo maligna melanoma; mortality; nodular melanoma; risk factors; superficial spreading melanoma.

Cutaneous malignant melanoma (CMM) is one of the most common cancers diagnosed in young adults, accounting for ~1.5% of all cancer deaths in Canada.[1] Globally, melanoma affected >350,000 individuals in 2015 alone.[2] The incidence of melanoma has been on the rise in fair-skinned individuals in Europe, Australia, New Zealand, and North America.[3] In fact, the highest age-standardized incidence rates (ASIR) per 100,000 general population were reported in Australia (54.1),

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United States (21.0), Western Europe (15.6), Central Europe (8.3), and Eastern Europe (7.8).[2] The 5 world regions with the lowest ASIR per 100,000 general population are Asia Pacific (0.7), South Asia (1.1), Southeast Asia (1.3), East Asia (1.4), and North Africa and Middle East (1.6).[2] Unfortunately, the incidence rate of this malignancy is expected to continue to rise in many parts of the world, including the United Kingdom, Australia, United States, and Canada.[4]

There have been a number of CMM studies that have contributed to the understanding of epidemiology and risk factors for this disease in Canada.[5-20] Over the last several decades, the Western Canada Melanoma Study Group has published several papers on the risk factors of melanoma, including socioeconomic status, history of sunburns, and sun tanning; the association between physical activity and occupational risk factors; the anatomic distribution of CMM; and the etiological differences in the histologic subtypes of CMM.[6,12,19,20]

More recently, several other national, provincial, and city-based Canadian studies have echoed their findings, although most have been cohort rather than population-based studies.[8,11,17,21]

CAPSULE SUMMARY

- There is limited knowledge on the epidemiology and geographic distribution of melanoma in Canada.
- This study, for the first time, provides a detailed description of the burden of melanoma in Canada.
- Described trends enable us to develop sex-specific and geographic region–specific recommendations to decrease incidence of melanoma and mortality due to melanoma in Canada.

METHODS

This study was conducted in accordance with the CISS-RDC-668035 protocol approved by the Social Sciences and Humanities Research Council of Canada and 13-SSH-MCG-3749-S001 protocol approved by Québec Inter-University Centre for Social Statistics. In addition, in accordance with the institutional policy, this study received an exemption from the McGill University Research Ethics Board review. We examined the data on incidence and mortality of CMM using the 3 largest distinct population-based cancer databases (Canadian Cancer Registry [CCR], Le Registre Québécois du Cancer [LRQC], and Canadian Vital Statistics) for the period of 1992-2010 using International Classification of Disease Oncology codes for all subtypes of CMM (ICD-O-3, ICD-9, and ICD-10), in a similar manner as previously reported.[22,23] The CCR is a dynamic database of Canadian residents from 12 Canadian provinces and territories (excluding Québec) who received primary tumor diagnoses during 1992-2013, alive or dead. Data for patients from the Québec Province was obtained from the LRQC registry. Patient data from the period 1992-2010 was all that was available from the LRQC

Table I. Clinical characteristics of CMM patients, by sex and age, in Canada during 1992-2010

CMM subtypes	ICD-O-3 code	Patients, N*	% of total	Men, %	Women, %	Mean age ± SD, y
Malignant melanoma, NOS	8720	30,295	41.75	52.40	47.60	58.46 ± 23.46
Superficial spreading melanoma	8743	27,110	37.36	49.61	50.39	54.87 ± 19.73
Nodular melanoma	8721	8160	11.25	59.56	40.44	62.34 ± 17.21
Lentigo maligna melanoma	8742	4470	6.16	58.39	41.61	71.68 ± 22.94
Acral lentiginous melanoma	8744	1235	1.70	42.91	57.09	64.29 ± 15.65
Desmoplastic melanoma	8745	565	0.78	62.83	37.17	67.14 ± 14.39
Amelanotic melanoma	8730	265	0.37	54.72	45.28	62.82 ± 15.85
Malignant melanoma, regressing	8723	190	0.26	65.79	34.21	59.40 ± 15.56
Malignant melanoma in junctional nevus	8740	125	0.17	52.00	48.00	55.94 ± 15.22
Malignant melanoma in a giant pigmented nevus	8761	110	0.15	54.55	45.45	49.49 ± 18.39
Balloon cell melanoma	8722	20	0.03	75.00	25.00	61.60 ± 18.46
Malignant melanoma in precancerous melanosis	8741	15	0.02	33.33	66.67	59.33 ± 16.07
Mucosal lentiginous melanoma	8746	5	0.01	0	100.00	58.80 ± 12.56
Total	-	72,565	100	52.50	47.50	58.54 ± 21.63

CMM, Cutaneous malignant melanoma; *ICD-O-3 code*, International Classification of Diseases Oncology code; *NOS*, not otherwise specified; *SD*, standard deviation.
*Rounded to a multiple of 5.

Abbreviations used:

ASIR: age-standardized incidence rate
CCR: Canadian Cancer Registry
CMM: cutaneous malignant melanoma
IRR: incidence rate ratio
LRQC: Le Registre Québécois du Cancer
MRR: mortality rate ratio

registry. Data on new cases of CMM were obtained from the CCR (2014 version), which spanned the period of 1992-2013. Because the data for Québec from the LRQC registry was only available up to 2010, we chose to analyze for this study the data acquired during 1992-2010 to include all Canadian provinces for the same time period.

RESULTS

Clinical characteristics of Canadian CMM patients

A comprehensive analysis of the epidemiology of CMM in Canada was conducted. The clinical characteristics of the Canadian CMM patients with different types of melanoma during 1992-2010 were examined using 3 population-based health registries that enabled studying the epidemiology of this important malignancy across the entire country, with consistency and accuracy. There were 72,565 patients with CMM diagnoses in Canada during 1992-2010 (Table I).

Sex predilection for this malignancy was confirmed in various CMM subtypes. The overall incidence of this malignancy was slightly higher in men (52.5% men vs 47.5% women), with a consistent trend among most CMM subtypes (Table I). Some differences in this trend were noted for a few types, such as desmoplastic melanoma, balloon cell melanoma, and mucosal lentiginous melanoma. However, because the number of patients with these types of cancers was relatively small, any predilection must be confirmed in a larger cohort of patients (Table I). The male-to-female incidence rate ratio (IRR) was analyzed throughout the period of 1992-2010. We observed a statistically significant upward trend in the male-to-female IRR from 1.09:1 in 1992 to 1.19:1 in 2010 ($P < .0001$; Fig 1, *A*), indicating that the incidence rate of CMM is increasing in men at a faster pace than in women.

The mean ± standard deviation age of diagnosis was 60.4 ± 19.8 years for men and 56.5 ± 23.4 years for women (58.5 ± 21.6 years for both sexes combined) (Table I). Age range distribution analysis confirmed these findings and showed that 48.74% of CMM patients in Canada during 1992-2010 were >60 years of age. This scenario was the case for 54% of men and 42.9% of women (Tables I and II). Analysis of the mean age at diagnosis for the individual subtypes of CMM revealed that most patients with different CMM subtype diagnoses had similar age ranges of in the middle to late 50s and early 60s (Table I). Exceptions were superficial spreading melanoma and malignant melanoma in a giant pigmented nevus with mean ages at diagnosis of 54.87 and 49.49 years, respectively. In addition, the mean age at diagnosis of lentigo maligna melanoma was older, at 71.68 years, which is expected for this subtype.

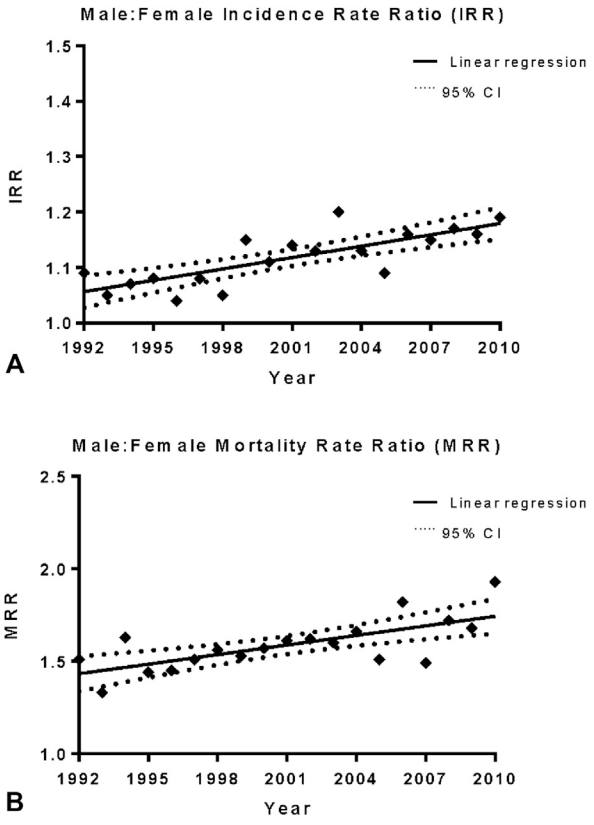

Fig 1. Cutaneous malignant melanoma (CMM) IRR and MRR during 1992-2010. The ratio of male-to-female patients with CMM (13 subtypes) were plotted per year. **A**, Male-to-female IRR. Linear regression analysis of CMM incidence rate over time. The coefficient of determination (R^2) is 0.62 and $P < .0001$. CIs are shown, and the slope of the line is 0.007 ± 0.001. The line of best fit indicates an average IRR of 1.12:1. **B**, Male-to-female MRR. R^2 is 0.49 and $P = .0008$. The slope of the line is 0.017 ± 0.004. The line of best fit indicates an average MRR of 1.59:1. *CI*, Confidence interval; *IRR*, incidence rate ratio; *MRR*, mortality rate ratio.

Anatomic presentation of CMM in Canada during 1992-2010

We subsequently examined the anatomic location of CMM in Canadian patients (Table II and Fig 2).

Table II. Clinical characteristics of patients in Canada with CMM diagnoses given during 1992-2010, age and anatomic distribution analysis by sex

	Male		Female		Both sexes	
Characteristic	**n***	**%**	**n***	**%**	**n***	**%**
Age, y						
0-19	220	0.58	275	0.80	495	0.68
20-39	3965	10.41	6325	18.36	10,290	14.18
40-59	13,320	34.97	13,080	37.96	26,405	36.40
60-79	16,345	42.91	10,970	31.84	27,315	37.65
≥80	4240	11.13	3805	11.04	8045	11.09
Location						
Skin of lip	80	0.21	60	0.17	140	0.19
Eyelid	175	0.46	150	0.44	325	0.45
External ear	1425	3.74	330	0.96	1755	2.42
Skin of other parts of face	3965	10.41	3270	9.49	7235	9.97
Skin of scalp and neck	2785	7.31	1140	3.31	3925	5.41
Skin of trunk	15,775	41.40	7695	22.33	23,470	32.34
Skin of upper limb and shoulder	7625	20.01	8515	24.71	16,140	22.24
Skin of lower limb and hip	4150	10.89	11,910	34.56	16,060	22.13
Overlapping lesion of skin	170	0.45	90	0.26	260	0.36
Skin, NOS	1950	5.12	1305	3.79	3255	4.49
Total	38,100	100	34,465	100	72,565	100.00

CMM, Cutaneous malignant melanoma; *NOS*, not otherwise specified.
*Rounded to a multiple of 5.

Remarkably, the majority (63.5%) of CMM in men developed on the head and trunk, and in women, the lower extremities were the most common site of CMM, accounting for 34.6% of cases. Detailed analysis by anatomic site for this malignancy over time, revealed a statistically significant increase in incidence at all sites in both sexes during 1992-2010 (Fig 2, *B* and *C*) with the most significant rate changes involving the trunk in men and the extremities in women (Fig 2, *B* and *C*). The slope of the best-fit line for CMM incidence on the trunk in men was 0.143 cases/100,000 person-years (Fig 2, *B*), and the slope of the line for both the upper and lower extremities in women was 0.086 cases/100,000 person-years (Fig 2, *C*).

Incidence of CMM in Canada during 1992-2010

We subsequently analyzed the overall incidence rate of CMM in Canada during 1992-2010. The average crude incidence rate was 12.29 (95% confidence interval [CI] 12.20-12.38) cases/100,000 person-years. The ASIR against the world population for the entire period was 9.63 (95% CI 9.56-9.70) cases/100,000 person-years. Linear regression analysis of the CMM crude incidence rate revealed an increasing trend with a slope of 0.352 cases/100,000 person-years (R^2 = 0.937, $P < .0001$; Fig 3, *A*). Similarly, the average incidence rate for men was 12.90 cases/100,000 person-years (R^2 = 0.934, $P < .0001$) and for women 11.48 cases/100,000 person-years (R^2 = 0.928, $P < .0001$). Consistent with the IRR finding (Fig 1, *A*), the rates of increase (as represented by the slope of the line of best fit in Fig 3, *A-C*) were 0.410 and 0.296 cases/100,000 person-years in men and women, respectively.

Subsequently, we analyzed different subtypes of CMM. All subtypes of CMM (except amelanotic melanoma) showed a steady and statistically significant increase in incidence (Fig 4).

Geographic distribution of CMM cases in Canada

The incidence rates for the Canadian provinces and territories revealed notable trends (Fig 5; Table III). The CMM incidence rate was the highest in Nova Scotia (18.87 cases/100,000 person-years), followed by the Province of Prince Edward Island (crude incidence rate 18.82 cases/100,000 person-years), New Brunswick (15.02 cases/100,000 person-years), Ontario (14.19 cases/100,000 person-years), and British Columbia (15.41 cases/100,000 person-years), all of which had higher incidence rates than the national average (12.29 cases/100,000 person-years). On the other hand, the remaining provinces and territories had a lower incidence rate than the national average, ranging 4.69-11.88 cases/100,000 person-years. The distribution of CMM at the city level as well as forward sortation area postal codes

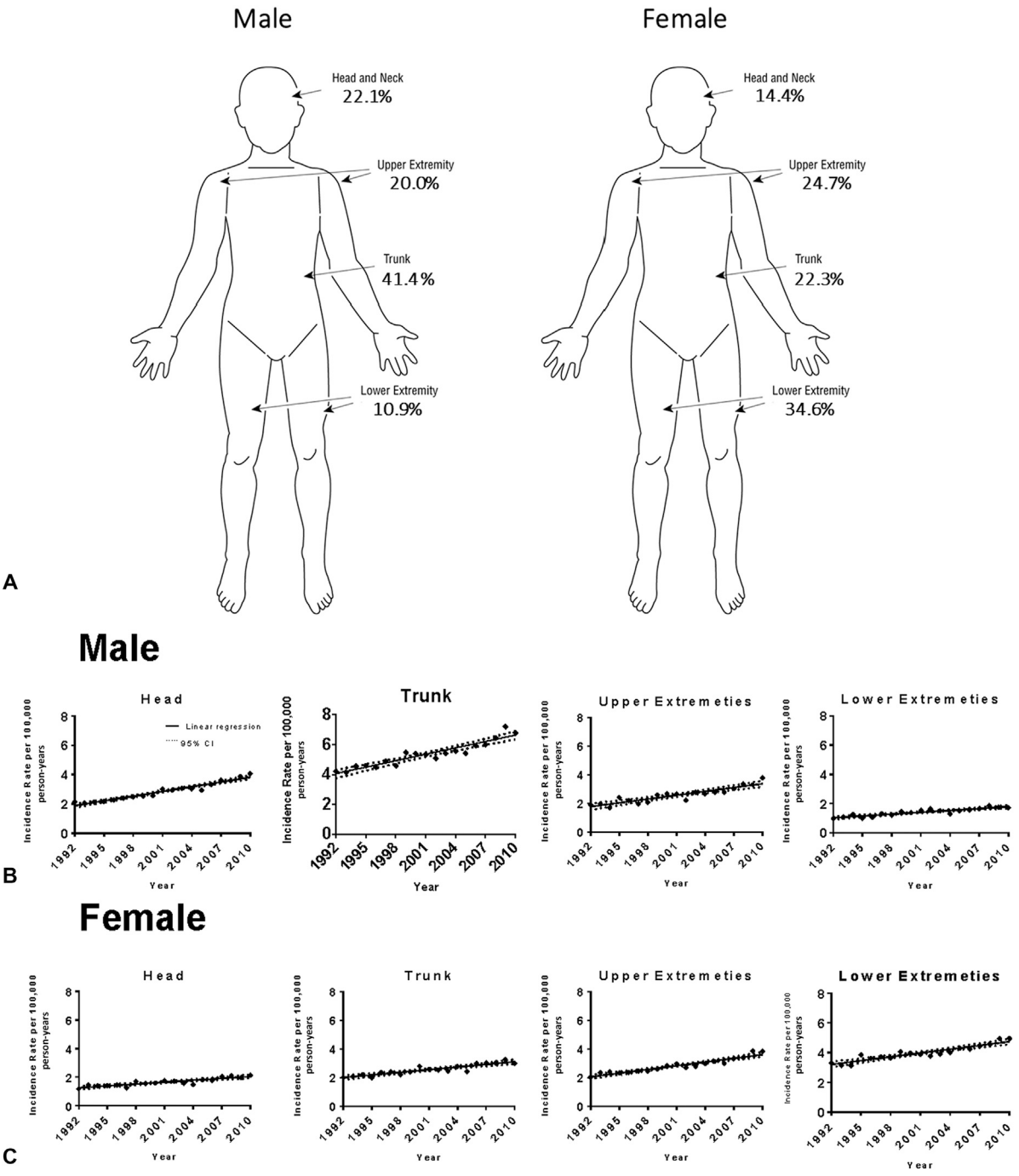

Fig 2. Incidence trends of cutaneous malignant melanoma (CMM) in Canada during 1992-2010 by anatomic site for men and women. **A**, Schematics highlighting that the trunk was the most frequent site of CMM for male patients, and the lower extremities were the most common for female patients. **B**, Trends of CMM incidence per anatomic site (head, upper extremities, trunk, and lower extremities) over time for men. For head, $R^2 = 0.95$, $P < .0001$, and the slope of the line is 0.11 cases/100,000 person-years. For trunk, $R^2 = 0.886$, $P < .0001$, and the slope of the line 0.14 cases/100,000 person-years. For upper extremities, $R^2 = 0.83$, $P < .0001$, and the slope of the line is 0.089 cases/100,000 person-years. For lower extremities, $R^2 = 0.81$, $P < .0001$, and the slope of the line is 0.042 cases/100,000 person-years. **C**, Trends of CMM incidence per anatomic site over time for women. For head, $R^2 = 0.78$, $P < .0001$, and the slope of the line is 0.044 cases/100,000 person-years. For trunk, $R^2 = 0.82$, $P < .0001$, and the slope of the line is 0.062 cases/100,000 person-years. For upper extremities, $R^2 = 0.90$, $P < .0001$, and the slope of the line is 0.086 cases/100,000 person-years. For lower extremities, $R^2 = 0.86$, $P < .0001$, and the slope of the line is 0.086 cases/100,000 person-years.

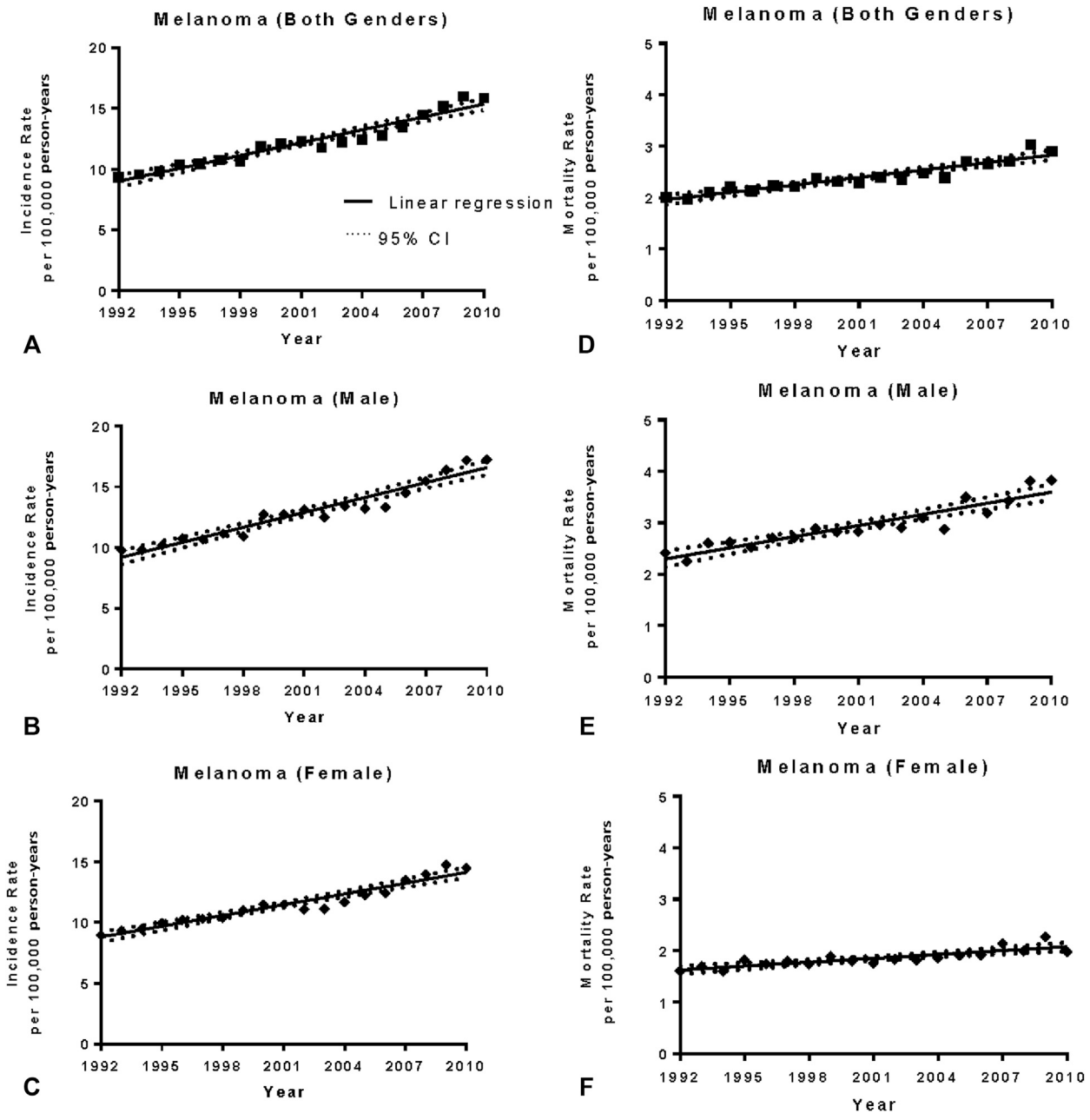

Fig 3. Incidence and mortality rates for all cases during 1992-2010 with the line of best fit and linear regression analysis. **A**, The average incidence rate of this malignancy in Canada for both sexes during 1992-2010 was 12.29 cases/100,000 person-years. $R^2 = 0.94$ and $P < .0001$. The slope of the line is 0.35 ± 0.022 cases/100,000 person-years. **B**, Incidence of cutaneous malignant melanoma (CMM) for the male sex; average rate was 12.90 ($R^2 = 0.93$; $P < .0001$). The slope of the line is 0.41 ± 0.026 cases/100,000 person-years. **C**, Incidence of CMM for the female sex; the average rate was 11.48 ($R^2 = 0.93$; $P < .0001$). The slope of the line is 0.30 ± 0.020 cases/100,000 person-years. **D**, Mortality of CMM for both sexes. $R^2 = 0.88$ and $P < .0001$. The slope of the line is 0.0484 ± 0.004 cases/100,000 person-years. The average mortality rate in Canada was 2.41 (95% CI 2.37-2.45) cases/100,000 person-years. **E**, Mortality of CMM for the male sex. $R^2 = 0.86$ and $P < .0001$. The slope of the line is 0.072 ± 0.0070 cases/100,000 person-years. **F**, Mortality of CMM for the female sex. $R^2 = 0.72$ and $P < .0001$. The slope of the line is 0.025 ± 0.0038 cases/100,000 person-years. *CI*, Confidence interval.

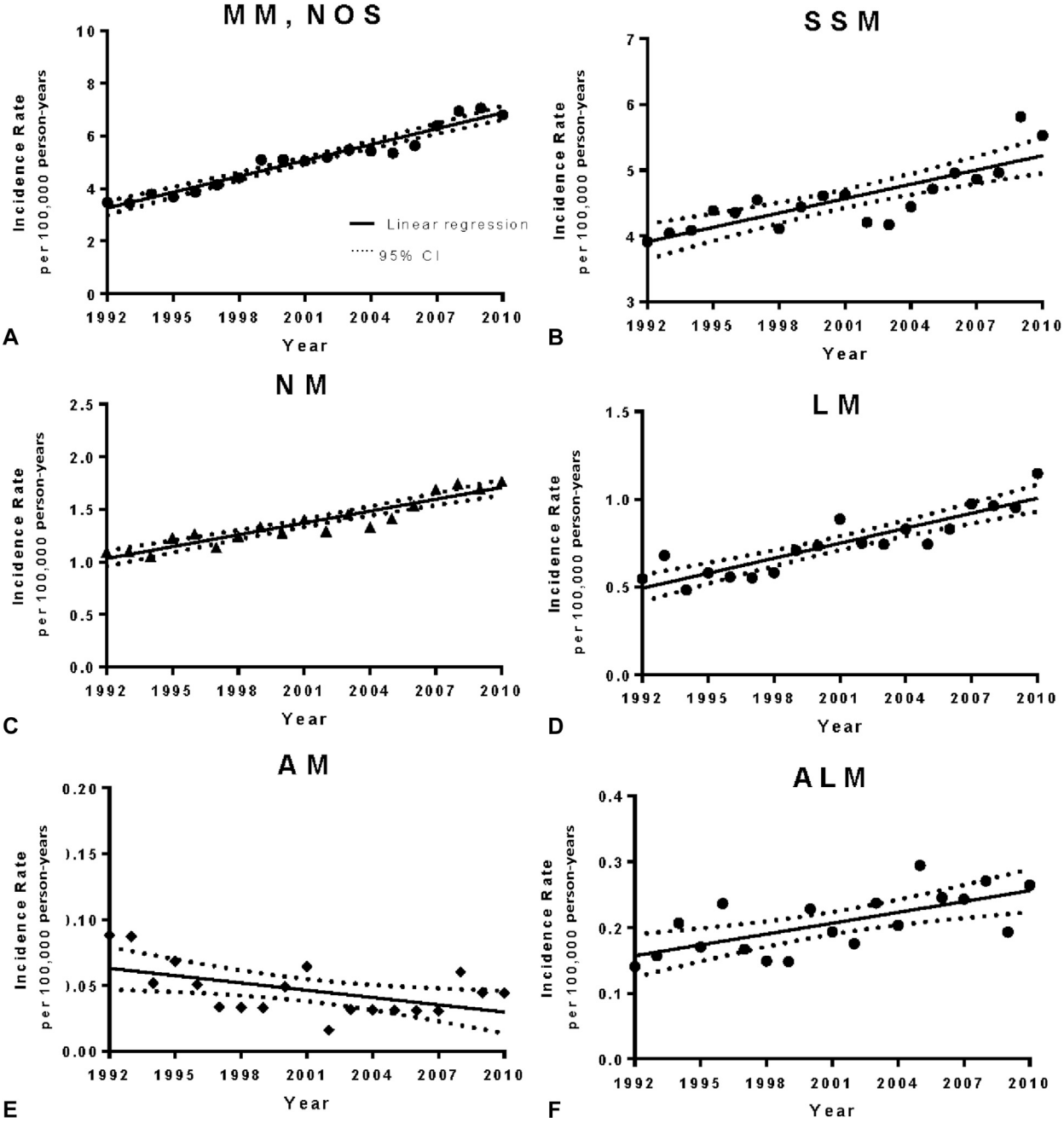

Fig 4. Incidence for cutaneous malignant melanoma subtypes during 1992-2010. Linear regression analysis of cutaneous malignant melanoma subtype incidence rates over time is shown along with CI. **A**, MM, NOS. The slope is 0.20 ± 0.012 cases/100,000 person-years, R^2 = 0.95, and $P < .0001$. **B**, SSM. The slope is 0.073 ± 0.012 cases/100,000 person-years, R^2 = 0.68, and $P < .0001$. **C**, NM. The slope is 0.038 ± 0.003 cases/100,000 person-years, R^2 = 0.88, and $P < .0001$. **D**, LM. The slope is 0.029 ± 0.003 cases/100,000 person-years, R^2 = 0.80, and $P < .0001$. **E**, AM. The slope is −0.002 ± 0.001 cases/100,000 person-years, R^2 = 0.28, and $P = .021$. **F**, ALM. The slope is 0.005 ± 0.001 cases/100,000 person-years, R^2 = 0.45, and $P = .002$. **G**, MMR. The slope is 0.013 ± 0.002 cases/100,000 person-years, R^2 = 0.95, and $P = .005$. **H**, MMJN. The slope is −0.001 ± 0.004 cases/100,000 person-years, R^2 = 0.017, and $P = .84$. **I**, DM. The slope is 0.002 ± 0.001 cases/100,000 person-years, R^2 = 0.20, and $P = .056$. **J**, MMGPN. The slope is 0.007 ± 0.00079 cases/100,000 person-years, R^2 = 0.973, and $P = .013$. *ALM*, Acral lentiginous melanoma; *AM*, amelanotic melanoma; *CI*, confidence interval; *DM*, desmoplastic melanoma; *LM*, lentigo maligna melanoma; *MM*, malignant melanoma; *MMGPN*, malignant melanoma in a giant pigmented nevus; *MMJN*, malignant melanoma in junctional nevus; *MMR*, malignant melanoma, regressing; *NM*, nodular melanoma; *NOS*, not otherwise specified; *SSM*, superficial spreading melanoma.

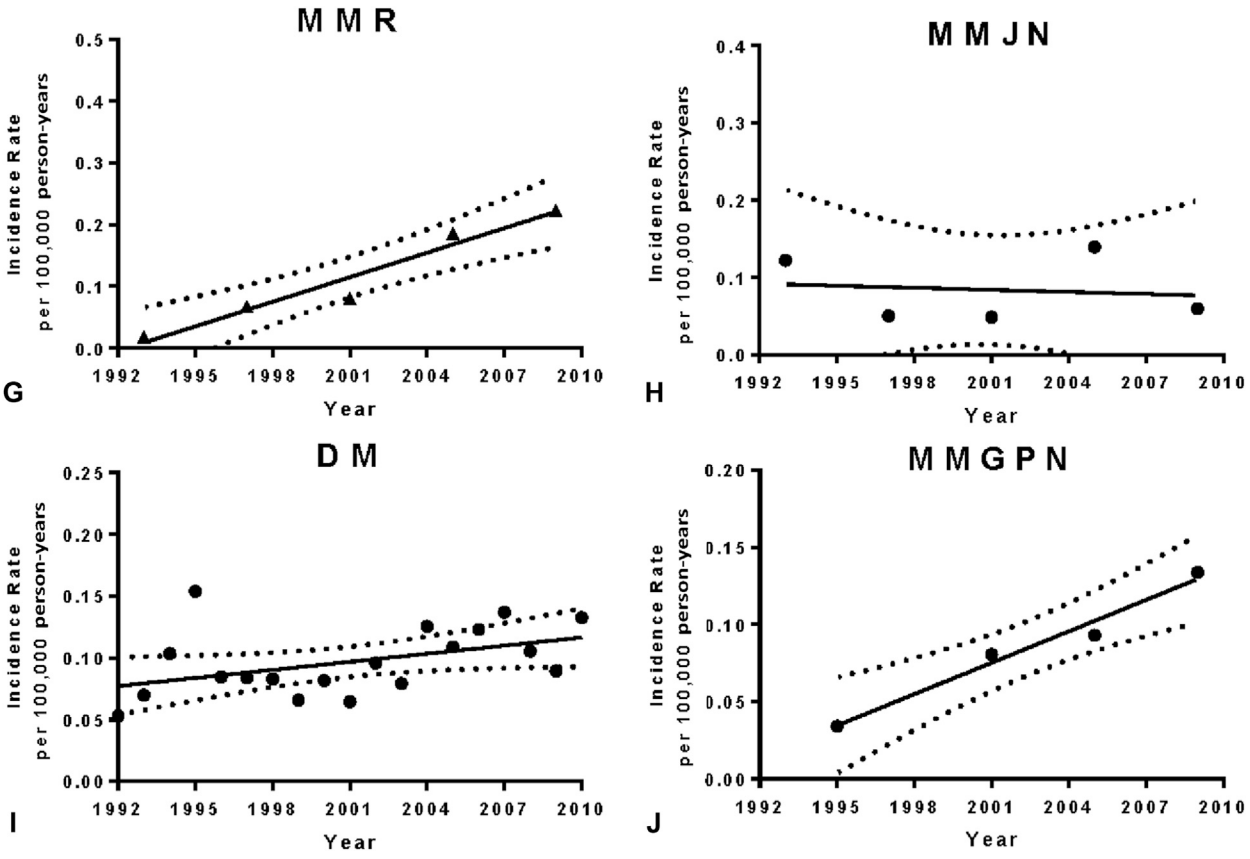

Fig 4. (*continued*).

corroborated these findings. Furthermore, an inverse relationship was observed between geographical latitude and incidence rates of CMM in Canada.

Analysis of CMM incidence per age-group across Canada

We conducted an extensive analysis of CMM incidence per age group and per sex for all Canadian provinces and territories. Generally, the rates of CMM increased with age. Although the overall incidence was higher in men than women, analysis by age group illustrated a higher incidence of CMM in young (20-39 years) and elderly (≥80 years) women than young and elderly men. Analysis of incidence by age at the level of provinces revealed similar trends. Of note, the highest 3 incidence rates of all age groups were reported in elderly women of Nova Scotia, Ontario, and Prince Edward Island, which were provinces with significantly higher incidence rates of CMM.

Analysis of CMM mortality across Canada

We also conducted an analysis of melanoma-specific mortality in Canada using Canadian Vital Statistics population-based database. Our mortality data corroborated our incidence findings (Fig 1, *B*; Fig 3, *D-F*; Fig 5, *B*; Table IV).

DISCUSSION

In this manuscript, we present the first comprehensive analysis of CMM burden across Canada during 1992-2010 using 3 distinct population-based databases and illustrate important trends. Consistently with global trends, both incidence and mortality rates of CMM increased steadily in Canada during these years. The overall incidence rate of CMM in Canada was 12.29 cases/100,000 person-years (12.90 cases/100,000 person-years in men and 11.48 cases/100,000 person-years in women) and the ASIR in Canada was 9.63 (95% CI 9.56-9.70) cases/100,000 person-years. The Surveillance, Epidemiology, and End Results program database in the United States found the ASIR of melanoma to be 15.1 cases/100,000 person-years for men, and 11.1 cases/100,000 person-years for women.[24] The higher incidences in the United States, taking into account differences in latitude, are consistent with our study and confirm the continuity of melanoma trends in the 2 countries.

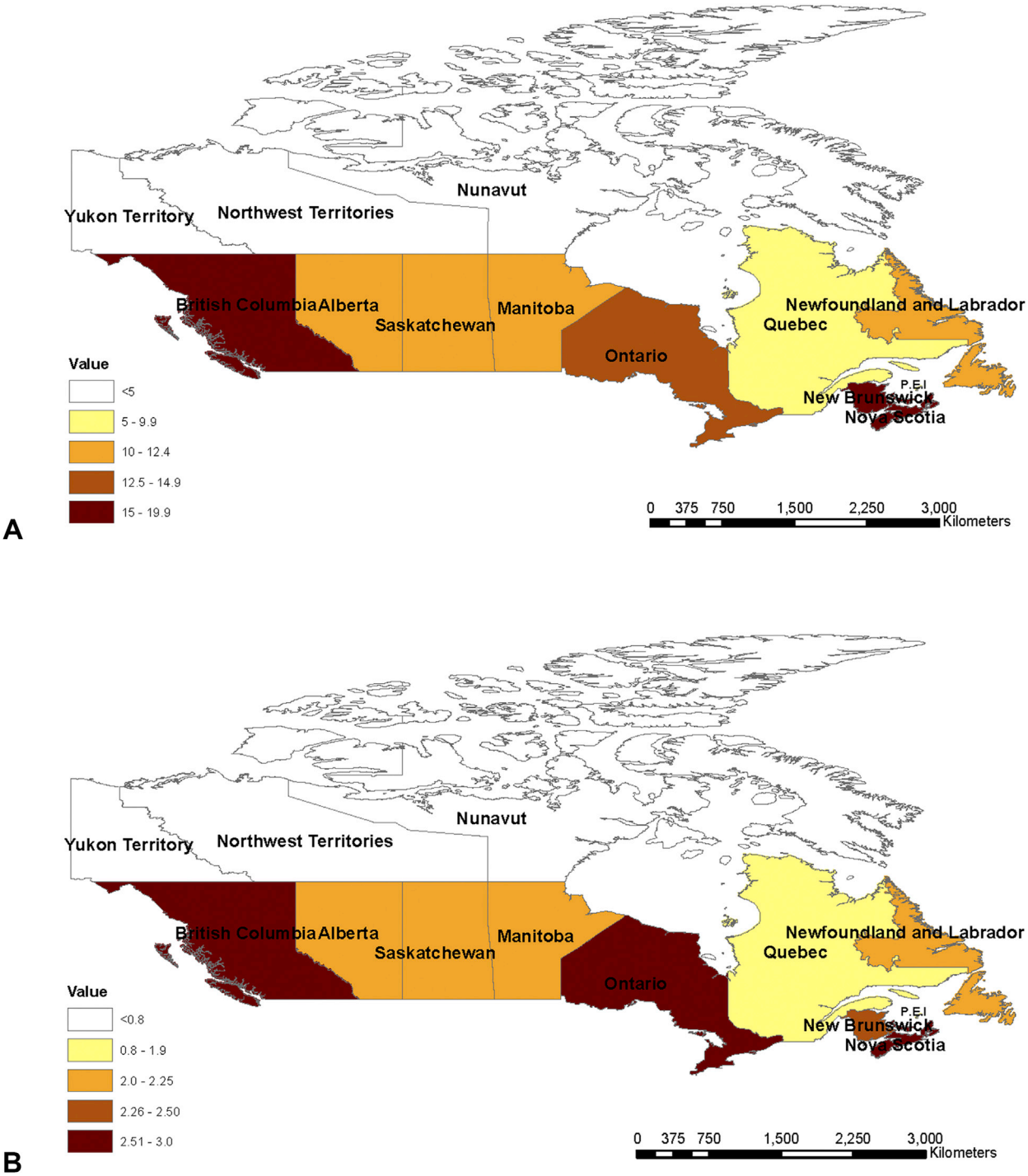

Fig 5. Incidence and mortality rate of cutaneous malignant melanoma in Canadian provinces and territories during 1992-2010. Geographic maps illustrating incidence (**A**) and mortality rate (**B**) of cutaneous malignant melanoma (per 100,000 person-years) across Canadian provinces and territories during 1992-2010. *Statistically significant lower rates ($P < .05$) compared with the Canadian average. †Statistically significant higher rates ($P < .05$) compared with the Canadian average. *PEI*, Prince Edward Island.

The primary risk factor for CMM is prolonged sun exposure, more specifically solar ultraviolet radiation.[25-28] Consistent with the trends on ultraviolet exposure, our study showed an increasing incidence of CMM on the trunk and lower extremities in men and women, respectively.

Table III. Distribution of CMM patient incidence in Canadian provinces and territories

Province	Cases*	Population†	Incidence, per 100,000 person-years	95% CI of incidence, per 100,000 person-years
Nova Scotia‡	3345	933,000	18.87	18.24-19.52
Prince Edward Island‡	490	137,000	18.82	17.19-20.57
British Columbia‡	11,830	4,040,000	15.41	15.14-15.69
New Brunswick‡	2140	750,000	15.02	14.39-15.67
Ontario‡	31,985	11,868,000	14.19	14.03-14.34
Alberta§	7015	3,109,000	11.88	11.60-12.16
Saskatchewan§	2230	1,010,000	11.62	11.14-12.11
Manitoba§	2410	1,158,000	10.95	10.52-11.40
Newfoundland and Labrador§	1050	536,000	10.31	9.70-10.95
Quebec§	9985	7,446,000	7.06	6.92-7.20
Northern Territories§	90	101,000	4.69	3.77-5.77
Canada	72,570	31,087,000	12.29	12.20-12.38

CI, Confidence interval; *CMM*, cutaneous malignant melanoma.
*Rounded to a multiple of 5.
†All population numbers are rounded to the nearest thousand.
‡Statistically significant higher rates than the national average.
§Statistically significant lower rates than the national average.

Table IV. Clinical characteristics of CMM in deceased individuals during 1992-2010

Characteristic	Subcategory	Patients, N*	Reported cases, %
Anatomic site	Lip + eyelid, including canthus	5	0.04
	Ear and external auricular canal	20	0.14
	Other and unspecified parts of face	130	0.90
	Scalp and neck	110	0.77
	Trunk	240	1.69
	Upper limb, including shoulder	135	0.95
	Lower limb, including hip	230	1.62
	Skin, unspecified	13,360	93.89
	Total	14,230	100
Sex	Male	8690	61.07
	Female	5540	38.93
Age of both sexes, y	0-19	20	0.14
	20-39	950	6.68
	40-59	4155	29.20
	60-79	6310	44.34
	≥80	2795	19.64
Age of men, y	0-19	5	0.06
	20-39	550	6.33
	40-59	2555	29.40
	60-79	4105	47.24
	≥80	1475	16.97
Age of women, y	0-19	15	0.27
	20-39	400	7.22
	40-59	1600	28.88
	60-79	2205	39.80
	≥80	1320	23.83

CMM, Cutaneous malignant melanoma.
*Rounded to a multiple of 5.

The steady increased incidence in these preferential sites in both sexes indicates the need for implementing sex-specific recommendations to lower the risks of developing CMM. It is worth noting that our IRR and MRR analyses confirmed a statistically significant upward trend in men compared with women, illustrating that both incidence and mortality rates of CMM in Canada

in men are increasing at a faster pace than they are in women.

The distribution of CMM in Canada showed notable trends for select provinces and territories. The provinces of Prince Edward Island, Nova Scotia, New Brunswick, Ontario, and British Columbia had higher crude incidence rates than the national average. We also noted high incidence and mortality of CMM in these provinces among elderly women (≥80 years of age). It is worth noting that a number of coastal provinces (including New Brunswick) were identified in the study as having higher than expected rates of CMM incidence and mortality. Individuals in these communities might be enjoying the beach or outdoors more often than in other regions of the country, which would place them at a higher risk of developing a CMM. Although the oceans that surround Canada are often cold, New Brunswick is home to several highly-popular warm, saltwater beaches that remain warm due to low current and shallow waters. Also, water and sand have increased surface reflection compared with grass, which could further increase the risk for CMM.[29,30]

We found that the incidence rates in the northern territories were lower than the incidence in the rest of Canada. This might reflect false-negative rates secondary to low reporting and inadequate surveillance and screening for this potentially fatal malignancy in the northern territories. However, our results also indicate that lower CMM rates in the northern territories are expected, due to the North-South gradient of increasing incidence of melanoma, which we confirmed exists in Canada (data not shown).

Finally, to elucidate if a relationship exists between numbers and density of dermatologists in a given province versus CMM incidence rates, an analysis was conducted and showed no significant correlation between the number of dermatologists per province and the rates of CMM incidence. Further follow-up studies are needed to elucidate the specific risk factors for several provinces to establish specific disease prevention programs and lifestyle behavior modifications that can lower CMM incidence rates in these jurisdictions.

This retrospective study had several limitations. Unfortunately, many large population-based studies have similar limitations, including missing data and a risk for misclassification of patients that were discussed elsewhere.[31] In addition, this study was not able to take into account additional confounding factors that might be playing a role in melanoma incidence and mortality. For instance, as melanoma has a substantial variation in incidence by ethnicity, ethnic differences might confound the variations of incidence and mortality findings at different geographic levels. Unfortunately, we were not able to analyze the data on the basis of ethnic background of Canadian patients because this information was not collected in the CCR and LRQC databases. In addition, unfortunately, no data on the clinical staging of CMM or Breslow thickness were available in the databases examined.

In conclusion, we conducted the first population-based study using 3 national cancer registries spanning a period of 19 years and covering a large population size to analyse melanomas in Canada, providing a statistical power to calculate incidences and mortality rates. This study for the first time details the burden of this important skin cancer in Canada and highlights continuity of trends between the Unites States and Canada.

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