CANADIAN PARTNERSHIP AGAINST CANCER | PARTENARIAT CANADIEN CONTRE LE CANCER

# The Economic Burden of Skin Cancer in Canada:

# Current and Projected

## Final Report

## February 26th, 2010

**The views expressed herein represent the views of the research and writing team and as such, do not necessarily represent the views of the Partnership.**

## Table of Contents

**The views expressed herein represent the views of the research and writing team and as such, do not necessarily represent the views of the Partnership.**

## Acknowledgments


***Research & Writing:***

1. Dr. **Hans Krueger**, H. Krueger & Associates Inc.
2. **Dan Williams**, H. Krueger & Associates Inc.
3. **Marianne Chomiak**, H. Krueger & Associates Inc.
4. **Logan Trenaman**, H. Krueger & Associates Inc.

***Advisory Group:***

1. Dr. **Alain Demers**, Epidemiologist/Team Leader, Epidemiology and Cancer Registry, CancerCare Manitoba
2. Dr. **Lynn From**, Head of Dermatology, Sunnybrook and Women's College Health Sciences Centre; Cancer Care Ontario
3. Dr. **Jon Kerner**, Chair, Primary Prevention Action Group and Senior Scientific Advisor for Cancer Control and Knowledge Translation, Canadian Partnership Against Cancer—synthesized feedback from **Janey Shin** and **Gina Lockwood**, part of the Partnership program team leading the Cancer Risk Management (CRM) initiative, and from members of the Technical Advisory Committee working with the same initiative.
4. Dr. **Lorraine Marrett**, Senior Epidemiologist, Division of Preventive Oncology, Cancer Care Ontario
5. Dr. **Anthony Miller**, Professor of Epidemiology, Dalla Lana School of Public Health, University of Toronto
6. Ms. **Corinne Parker**, Chair, National Skin Cancer Prevention Committee, Canadian Partnership Against Cancer; Environment Lead, Alberta Health Services - Cancer Bureau
7. Ms. **Jennie Petersen,** Research Associate - Environmental Carcinogens, Cancer Prevention Department, Alberta Health Services
8. Ms. **Judith Purcell**, Prevention Coordinator, Cancer Care Nova Scotia
9. Mr. **Steve Quantz**, Program Coordinator - Environment, Cancer Prevention Department, Alberta Health Services
10. Dr. **Jason Rivers**, Clinical Professor of Dermatology, Department of Medicine, UBC
11. Dr. **Sophy Shih**, Health Economist, School of Health and Social Development, Deakin University, Melbourne, Australia
12. Dr. **Gordon Walsh**, Epidemiologist, Cancer Care Nova Scotia

***Access to Unpublished Resources***

1. This project would not have been possible without access to information in key provincial data sources. In Manitoba, Ms. **Cheryl Clague**, Dr. **Donna Turner**, Dr. **Alain Demers**, Ms. **Humaira Khair** and Ms. **Gail Noonan** generously provided data on age- and gender- specific incidence, prevalence and mortality for basal cell

carcinoma, squamous cell carcinoma, and 'other' non-melanoma skin cancers. In New Brunswick, Ms. **Suzanne Leonfellner** and Dr. **Bin Zhang** were very helpful, not only in providing access to data, but also in suggesting additional sources of information. In British Columbia, Mr. **Rick Gallagher** took time out of a very busy schedule to provide incidence data on short notice. In Saskatchewan, Ms. **Heather Stuart** and Dr. **Riaz Alvi** provided data on NMSC in that province, while Ms. **Angela Eckstrand** and Ms. **Li Huang** did the same for Alberta. Detailed data on melanoma incidence and populations in the state of Victoria, Australia, were graciously provided by Ms. **Vicky Thursfield**.

2. Dr. **Zoann Nugent** provided important analysis using the Joinpoint Regression Program.
3. Access to several unpublished economic analyses of the *SunSmart* prevention program in Australia were sent to us by Professor **Rob Carter**.
4. Dr. **Jason Rivers** provided key information on the process of care provided to patients with the various types of skin cancer.
5. Dr. **Evert Tuyp** allowed us to access data from a previous H. Krueger & Associates Inc. project that, in part, included a cost comparison of dermatology procedures across the country.

**Production of this report has been made possible through a financial contribution from Health Canada, through the Canadian Partnership Against Cancer.**

# The Economic Burden of Skin Cancer in Canada: *Current and Projected*

## Executive Summary

The sponsor of this project, the National Skin Cancer Prevention Committee, is a subcommittee of the Primary Prevention Action Group of the Canadian Partnership Against Cancer. Skin malignancies are the most common type of human cancer. There are three major forms of skin cancer: basal cell carcinoma (BCC), squamous cell carcinoma (SCC), and melanoma. BCC and SCC are the most frequent skin cancers; together, they are usually referred to as non-melanoma skin cancer (NMSC).

Since patients with NMSC (including recurrent cases) are sometimes treated without histological confirmation, some cancer registries do not attempt to register cases of NMSC. This report has attempted to mitigate this gap for Canada. Using data from some Canadian cancer registries and taking into consideration both initial and subsequent NMSC diagnoses experienced by individuals, there were an estimated 76,000 cases in Canada in 2004. As a comparison, the Canadian Cancer Society reported that *all other cases* of cancer in the country in 2004 totalled to 148,000. Even though the mortality rate of NMSC is low, the sheer volume of cases drives a large burden of treatment costs and lost productivity.

Although melanoma accounts for only about 4% of all skin cancers, it is the most serious form of cutaneous malignancy, causing almost 80% of skin cancer deaths. Based on the analysis in the present report, there were over 4,700 cases of melanoma in Canada in 2004, and an average of 745 annual melanoma-related deaths from 2000 to 2004 (as compared to 204 annual deaths due to NMSC). This once again represents a substantial burden in terms of medical costs and years of life lost.

The totals for melanoma and for NMSC in Canada are projected to move dramatically upwards over the next decades, largely driven by a growing and ageing population and not necessarily by elevated incidence rates. This makes planning for prevention efforts all the more urgent.

Excessive exposure to ultraviolet (UV) radiation increases risk of skin cancer in general, and melanoma in particular. Sunlight is a major source of UV radiation, and therefore sun safety is a key priority of primary prevention efforts related to skin cancer and its associated economic burden. Because of the dominant position of skin cancer in Australia, it represents a jurisdiction that has mounted comprehensive sun protection efforts and tracked the results beyond 3 to 4 years. Relevant Australian data span two decades, sufficient time to see a clear public health impact beyond the latency time involved with skin carcinogenesis. Therefore, developments in that country have provided the foundation in this report for projected impacts of “best practice” prevention efforts in the Canadian context.

To better inform the efforts of primary prevention, the purpose of the report was to:

- Estimate the number of melanoma[1] and NMSC cases and deaths in 2004 in Canada by age, gender and geographic region (province/territory).

- Project the number of new cases and deaths in Canada in future years (specifically, 2011, 2016, 2021, 2026 and 2031) by age, gender, and geographic region.

- Estimate the economic burden, including direct and indirect costs, associated with these skin cancer cases and deaths in each of the index years listed above.

- Estimate the potential effectiveness of a comprehensive skin cancer prevention program in Canada up to 2031, and then compare the costs of such a program with potential costs avoided due to a future reduction in skin cancer cases and deaths.

### Projected Skin Cancer Cases and Deaths in 2031

A number of assumptions and adjustments were introduced in the methodology of the report to refine the estimate of actual cases and deaths related to the main types of skin cancer for the year 2004. One important innovation was to account more fully for the cases of recurrent and second primary skin cancers that are not reflected in cancer registries in Canada. This more comprehensive assessment, referred to as a *diagnosis-based approach*, was adopted as the standard for this report.

In projecting both cases and deaths through the various index years up to 2031, there were three different scenarios developed with respect to potential changes in the age-specific incidence rates:

**Medium Annual Percent Change Scenario** – In this scenario, it was assumed that there was zero annual percent change (APC) in younger males or females (< age 50 for melanoma and <age 40 for NMSC). This zero APC for younger age cohorts replicate the most recent Canadian trends in these cohorts, possibly reflecting changes in sun-safety behaviours in Canadian young people over the last several decades. For all other age cohorts, an age-, gender- and skin cancer-specific APC was used based on most recent Canadian trends. Age cohorts maintained their initial APC throughout the projection period.

**Low Annual Percent Change Scenario** – In this scenario, the assumption of a zero APC in younger males or females was maintained. For all other age cohorts, the APC was reduced by one-half. This scenario was intended to reflect the possibility that some of the observed increases in rates may be partly related to improvements in case ascertainment over time, rather than being solely driven by true increases in incidence. In addition, changes in the ethnic mix of Canada's population (increases in the proportion of the population from a visible minority) could result in decreases in the APC.

[1] Both the Canadian Cancer Society and the Public Health Agency of Canada produce detailed reports on the number of melanoma cases and deaths in Canada. A number of deficiencies in this data were identified by Dr. Lorraine Marrett in a December 4, 2008 email to Dr. Hans Krueger; in particular, the need to adjust for known under-reporting in Quebec and the conservative coding in the Canadian Cancer Registry. Dr. Marrett has been chair of the Steering Committee for the Canadian Cancer Statistics reports (jointly produced by the Canadian Cancer Society, Statistics Canada, Provincial/Territorial Cancer Registries and the Public Health Agency of Canada) since 2007 (and a member since 2004).

**No Annual Percent Change Scenario** – Estimates of future increases in annual cases based solely on population growth and ageing (i.e., zero APC assumed for all age groups). The No APC Scenario was chosen as a base estimate to assess the future impact of population growth and ageing only. It is not a realistic estimate of future cases as current observed increases in APC in older population cohorts are unlikely to approach 0% for at least several decades.

The Low APC scenario was adopted as the base case for projections in the report. The Medium and No APC scenarios provided the foundation for specific sensitivity analyses.

The following table provides the estimated actual cases and deaths for the main types of skin cancer in 2004 across Canada, as well as the projections to 2031 based on the Low APC Scenario.

**Skin Cancer Cases and Deaths in Canada**
**Estimated Actual (2004) and Projected (2031)**
Base Scenario Involving Low Annual Percent Change in Incidence Rates

| | 2004 | | 2031 | |
|---|---|---|---|---|
| | Cases | Deaths | Cases | Deaths |
| **Melanoma** | 4,755 | 745 | 9,070 | 1,644 |
| **Non-melanoma skin cancer** | 75,953 | 204 | 201,302 | 608 |
| Basal cell carcinoma | 60,587 | 80 | 157,711 | 237 |
| Squamous cell carcinoma | 15,366 | 124 | 43,591 | 371 |

## Projected Economic Burden of Skin Cancer in 2031

Several assumptions were applied in the analysis to determine the economic burden of skin cancer in Canada, including both direct medical costs and indirect costs related to lost productivity. The results derived from the estimated cases and deaths in 2004 are summarized in the following table.

**Annual Direct and Indirect Costs of Skin Cancers in Canada**
**2004** (in $millions, 2004 constant dollars, undiscounted)

| Type of Cost | MM | % | BCC | % | SCC | % | Total | % |
|---|---|---|---|---|---|---|---|---|
| Primary care | 1.76 | 0.4% | 24.90 | 51.5% | 6.34 | 15.9% | 33.00 | 6.2% |
| Hospital-based day surgery | 17.01 | 3.8% | 0.91 | 1.9% | 2.22 | 5.5% | 20.14 | 3.8% |
| Hospital inpatient care | 10.78 | 2.4% | 0.58 | 1.2% | 1.56 | 3.9% | 12.92 | 2.4% |
| **Total direct costs** | **29.55** | **6.7%** | **26.39** | **54.6%** | **10.12** | **25.3%** | **66.05** | **12.4%** |
| Mortality | 410.07 | 92.5% | 18.20 | 37.7% | 28.73 | 71.9% | 457.00 | 85.9% |
| Morbidity | 3.86 | 0.9% | 3.74 | 7.7% | 1.10 | 2.8% | 8.70 | 1.6% |
| **Total indirect costs** | **413.93** | **93.3%** | **21.94** | **45.4%** | **29.83** | **74.7%** | **465.70** | **87.6%** |
| **Total costs** | **443.48** | **100%** | **48.32** | **100%** | **39.95** | **100.0%** | **531.75** | **100%** |

*Note:* MM, malignant melanoma; BCC, basal cell carcinoma; SCC, squamous cell carcinoma.

The majority of the total estimated economic burden of skin cancer in Canada for 2004, $532 million, is attributable to melanoma (83.4%), with the balance distributed between BCC (9.1%) and SCC (7.5%).

The economic burden related to the cases/deaths projected to 2031 (using the base Low APC scenario in terms of anticipated changes to the age-specific skin cancer incidence rates) is summarized as follows:

**Annual Direct and Indirect Costs of Skin Cancers in Canada**
Low APC Scenario
**2031** (in $millions, 2004 constant dollars, undiscounted)

| Type of Cost | MM | % | BCC | % | SCC | % | Total | % |
|---|---|---|---|---|---|---|---|---|
| Primary care | 3.35 | 0.5% | 64.76 | 52.7% | 17.95 | 17.4% | 86.06 | 9.3% |
| Hospital-based day surgery | 36.75 | 5.3% | 2.35 | 1.9% | 6.12 | 5.9% | 45.22 | 4.9% |
| Hospital inpatient care | 24.62 | 3.5% | 1.53 | 1.2% | 4.43 | 4.3% | 30.58 | 3.3% |
| **Total direct costs** | **64.72** | **9.3%** | **68.64** | **55.9%** | **28.50** | **27.7%** | **161.86** | **17.6%** |
| Mortality | 624.78 | 89.8% | 45.44 | 37.0% | 71.74 | 69.6% | 741.96 | 80.5% |
| Morbidity | 6.46 | 0.9% | 8.73 | 7.1% | 2.79 | 2.7% | 17.98 | 2.0% |
| **Total indirect costs** | **631.24** | **90.7%** | **54.17** | **44.1%** | **74.53** | **72.3%** | **759.94** | **82.4%** |
| **Total costs** | **695.96** | **100%** | **122.81** | **100.0%** | **103.03** | **100.0%** | **921.80** | **100%** |

*Note:* MM, malignant melanoma; BCC, basal cell carcinoma; SCC, squamous cell carcinoma.

Thus, the total economic burden of skin cancer in Canada would rise to $922 million annually by 2031, with melanoma accounting for 75.5%, BCC 13.3%, and SCC 11.2%.

### Sensitivity Analyses

A number of potential costs have not been included in the economic assessment. For example, including costs for prescription drugs based on the ratio of costs in a relevant U.S. study would increase direct costs by $8.75 million. Likewise, including patient costs based on the ratio of costs in an applicable UK study would increase indirect costs by $25.12 million.

Variations in the methodology used to estimate indirect costs create an even larger impact on the results. In this report, the standard human capital approach was modified by valuing "non-productive" time lost (using each province's minimum wage). This strategy was intended to address the failure of the human capital approach to value unpaid work and leisure time, especially the time spent by people who have reached the age beyond normal workforce participation. Excluding non-workforce participation costs would reduce the estimated indirect costs in 2004 from $466 to $216 million.

Projecting the economic burden to 2031 is also affected by variation in the assumptions concerning secular changes to the underlying incidence rates over time. The economic burden estimated for 2031 decreased from the base case of $922 million to $784 million for the No APC scenario, and increased to $1,060 million for the Medium APC Scenario.

Finally, discount rates are most commonly applied to both costs and effects in economic evaluations in order to take into account time preference.

The results of adjustments for different discount rates and APC scenarios are summarized in the following table for both a modified human capital approach (i.e., including the costs of productivity losses among those not participating in the formal workforce) and the standard human capital approach (excluding such costs).

**Economic Burden of Skin Cancer in Canada**
In 2031, Sensitivity Analysis

| | Discount Rate | | |
|---|---|---|---|
| | 0% | 3% | 5% |
| **No APC Scenario** | | | |
| ***Including*** Non-Workforce Participation Costs | | | |
| Direct | $ 123.35 | $ 123.35 | $ 123.35 |
| Indirect | $ 660.49 | $ 515.08 | $ 443.65 |
| **Total** | **$ 783.83** | **$ 638.42** | **$ 567.00** |
| ***Excluding*** Non-Workforce Participation Costs | | | |
| Direct | $ 123.35 | $ 123.35 | $ 123.35 |
| Indirect | $ 253.98 | $ 198.51 | $ 171.44 |
| **Total** | **$ 377.33** | **$ 321.86** | **$ 294.79** |
| **Low APC Scenario** | | | |
| ***Including*** Non-Workforce Participation Costs | | | |
| Direct | $ 161.86 | $ 161.86 | $ 161.86 |
| Indirect | $ 759.94 | $ 602.55 | $ 523.73 |
| **Total** | **$ 921.80** | **$ 764.40** | **$ 685.59** |
| ***Excluding*** Non-Workforce Participation Costs | | | |
| Direct | $ 161.86 | $ 161.86 | $ 161.86 |
| Indirect | $ 271.47 | $ 216.29 | $ 188.82 |
| **Total** | **$ 433.33** | **$ 378.15** | **$ 350.68** |
| **Medium APC Scenario** | | | |
| ***Including*** Non-Workforce Participation Costs | | | |
| Direct | $ 200.35 | $ 200.35 | $ 200.35 |
| Indirect | $ 859.40 | $ 689.09 | $ 602.66 |
| **Total** | **$ 1,059.75** | **$ 889.44** | **$ 803.01** |
| ***Excluding*** Non-Workforce Participation Costs | | | |
| Direct | $ 200.35 | $ 200.35 | $ 200.35 |
| Indirect | $ 288.97 | $ 233.37 | $ 205.31 |
| **Total** | **$ 489.32** | **$ 433.72** | **$ 405.66** |

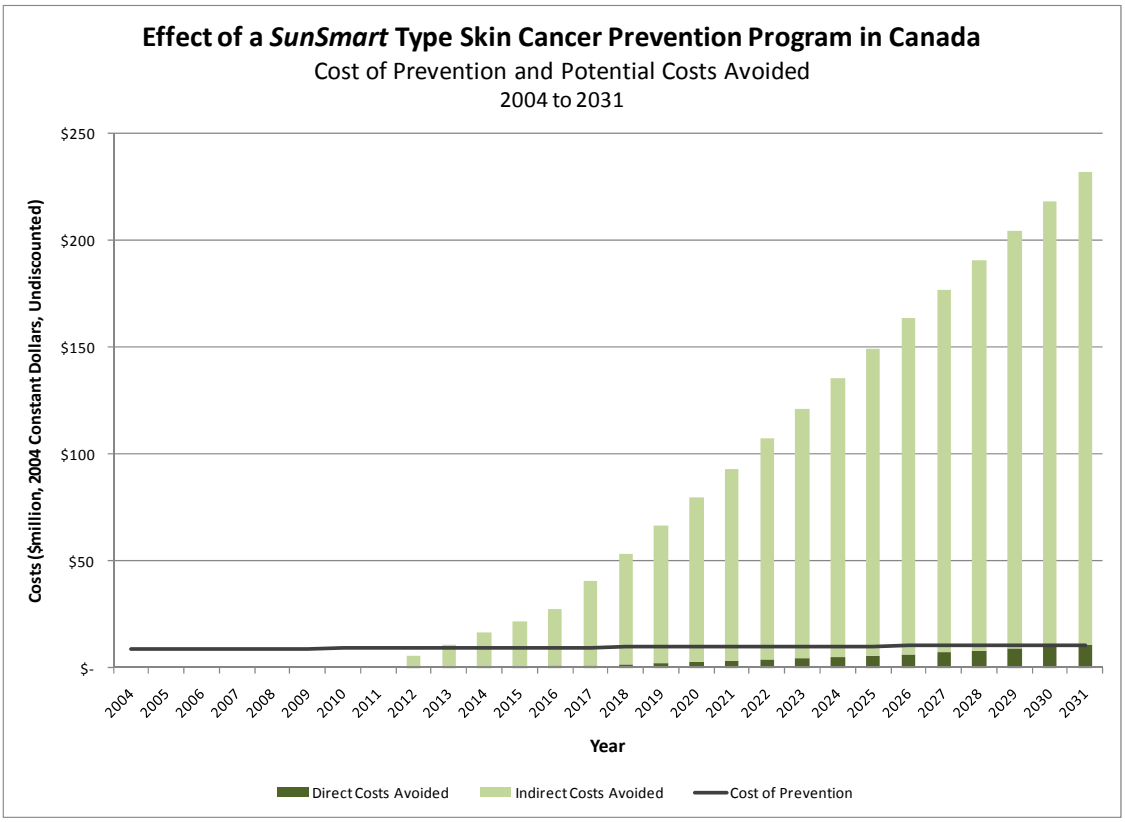
The results are highly sensitive to the three variables represented, with the estimated economic burden ranging from a discounted $295 million to a non-discounted $1,060 million in 2031.

### Impact of a Comprehensive, Sustained Skin Cancer Prevention Program

It is estimated that a cumulative total of 2,500 deaths related to skin cancer could be avoided in Canada by a comprehensive skin cancer prevention program sustained until 2031.

Extending the work of Carter and colleagues in Australia and incorporating recent statistical information from the state of Victoria, it was possible to estimate the impact of a similar prevention program in Canada; the cost of such a prevention effort in Canada was estimated based on per capita program spending in Australia. Using present rates of currency conversion, annual program spending would increase from $8.7 to $10.6 million over the 28-year modelling period. Cumulative costs over 28 years would be approximately $270 million.

Combining these two streams of information, the economic impact over time of a skin cancer prevention program in Canada can be pictured as follows:




On an annualized basis, the prevention program would not be cost-saving in terms of the direct costs avoided (medical spending) until late in the modelling period; however, total annual direct *and indirect* costs avoided exceed program spending at a much earlier point. Cumulatively, combined costs avoided over the 28 years modelling period are estimated to total $2.1 ***billion***, or 7.8 times the cost of prevention.

However, these prevention modelling results are sensitive to the application of discount rates and whether or not lost "non-productive time" is given a value. If lost "non-productive" time is not given a monetary value (i.e., not incorporating the recommendation of the modified human capital approach), and a 5% discount rate is assumed, then the total cumulative costs avoided over the 28 year time period would decrease to $622 million. While this is less than a third of the base case total, it is still 2.3 times the estimated cumulative cost of a comprehensive skin cancer prevention program.

# Fardeau Économique du Cancer de la Peau au Canada:
## *Situation Actuelle et Projections*

### Sommaire

Le parrain de ce projet, le Comité national de prévention du cancer de la peau, est un sous-comité du Groupe consultatif de la prévention primaire du Partenariat canadien contre le cancer. Les tumeurs malignes de la peau représentent le type le plus courant de cancer chez l'humain, et prennent trois formes principales, soit le carcinome basocellulaire (CB), le carcinome squameux (CS) et le mélanome. Le CB et le CS sont les cancers de la peau les plus fréquents, qui portent habituellement l'appellation commune de cancer de la peau avec mélanome bénin (CPMB).

Les patients atteints de CPMB (y compris les cas récurrents) étant parfois traités sans confirmation histologique, certains registres du cancer ne tentent pas de consigner les cas de CPMB. Le présent rapport vise à corriger cette lacune pour le Canada. À partir des données de certains registres canadiens du cancer et en tenant compte des diagnostics initiaux et subséquents de CPMB, on estimait à 76 000 le nombre de cas en 2004 au Canada. À titre comparatif, la Société canadienne du cancer rapportait pour 2004 un total de 148 000 cas pour *tous les autres cas* de cancer au pays. Bien que le taux de mortalité soit faible pour le CPMB, la quantité de ces cas crée en soi un lourd fardeau de coûts de traitement et de pertes de productivité.

Le mélanome ne compte que pour environ 4 % de l'ensemble des cancers de la peau, mais il s'agit de la forme la plus grave de malignité cutanée, à l'origine de près de 80 % des décès par cancer de la peau. Selon l'analyse dans le présent rapport, il y avait plus de 4 700 cas de mélanome au Canada en 2004, avec une moyenne de 745 décès annuels liés au mélanome de 2000 à 2004 (comparativement à 204 décès annuels attribuables au CPMB). Il s'agit là encore d'un fardeau considérable en termes de coûts médicaux et d'années de vie perdues.

Les projections des totaux de mélanome et de CPMB laissent prévoir une augmentation fulgurante au cours des prochaines décennies, attribuable en grande partie à une population vieillissante et en accroissement, et non nécessairement à des taux d'incidence élevés, facteur qui ajoute à l'urgence de planifier des efforts de prévention.

L'exposition excessive au rayonnement ultraviolet (UV) relève le risque général du cancer de la peau, et du mélanome en particulier. La lumière du soleil est une source majeure de rayonnement UV, et la prudence au soleil représente donc une grande priorité des efforts de prévention primaire du cancer de la peau et de son fardeau économique. À cause de l'incidence prédominante du cancer de la peau en Australie, ce pays a mis en œuvre des initiatives globales de protection solaire et suit les résultats sur une période plus longue que trois ou quatre ans. Les

données australiennes pertinentes couvrent deux décennies, une période suffisante pour percevoir clairement l'impact sur la santé publique au-delà de la période de latence associée à la carcinogenèse de la peau. L'évolution de la situation dans ce pays a donc servi de référence au présent rapport pour la projection de l'incidence d'efforts de prévention fondés sur des pratiques exemplaires dans le contexte canadien.

Pour mieux étayer les efforts de prévention primaire, le rapport visait les objectifs suivants :

- Estimer le nombre de cas de mélanome[2] et de CPMB et de décès connexes en 2004 au Canada, par âge, sexe et région géographique (province ou territoire).

- Effectuer une projection du nombre de nouveaux cas et de décès connexes au Canada pour les années à venir (plus précisément, 2011, 2016, 2021, 2026 et 2031), par âge, sexe et région géographique.

- Estimer le fardeau économique, notamment les coûts directs et indirects, rattaché à ces cas de cancer de la peau et décès connexes pour chacune des années de référence indiquées précédemment.

- Estimer l'efficacité éventuelle d'un programme global de prévention du cancer de la peau au Canada jusqu'en 2031, et comparer les coûts d'un tel programme aux coûts potentiels évités grâce à une réduction future des cas de cancer de la peau et des décès connexes.

### Projection des Cas de Cancer de la Peau et des Décès Connexes jusqu'en 2031

La méthodologie du rapport a intégré plusieurs hypothèses et rajustements pour cerner plus précisément l'estimation des cas et décès réels liés aux principaux types de cancer de la peau pour l'année 2004. Une innovation importante a consisté à consigner de façon plus complète les cas récurrents et les deuxièmes cas primaires de cancer de la peau qui ne figurent pas dans les registres du cancer au Canada. Cette évaluation plus complète, appelée *approche fondée sur le diagnostic*, a été adoptée à titre de norme pour le présent rapport.

Pour la projection du nombre de cas et de décès dans chacune des années de référence jusqu'en 2031, trois scénarios ont été élaborés en fonction de changements éventuels dans les taux d'incidence par âge.

> **Scénario de Changement Moyen dans le Pourcentage Annuel** – Ce scénario part de l'hypothèse d'un pourcentage de changement annuel (PCA) nul chez les hommes et les femmes plus jeunes (< de 50 ans pour le mélanome et < de 40 ans pour le CPMB). Ce PCA nul pour les cohortes plus jeunes correspond aux tendances canadiennes les plus récentes dans ces cohortes, peut-être attribuables au changement des comportements de prudence au soleil chez les jeunes Canadiens au fil des dernières décennies. Pour toutes

[2] Tant la Société canadienne du cancer que l'Agence de la santé publique du Canada produisent des rapports détaillés sur le nombre de cas de mélanome et de décès connexes au Canada. D^re^ Lorraine Marrett a relevé plusieurs lacunes de ces données dans un courriel du 4 décembre 2008 à D^r^ Hans Krueger, en particulier le besoin de compenser les pratiques connues de sous-notification au Québec et le codage conservateur du Registre canadien du cancer. D^re^ Marrett préside le Comité directeur des statistiques canadiennes sur le cancer et la production de ses rapports (un effort conjoint de la Société canadienne du cancer, de Statistique Canada, des registres provinciaux et territoriaux du cancer et de l'Agence de la santé publique du Canada) depuis 2007, et en est membre depuis 2004.

les autres cohortes d'âges, on a utilisé un PCA selon l'âge, le sexe et le type de cancer de la peau conforme aux tendances les plus récentes. Les cohortes d'âges conservent leur PCA initial tout au long de la période de projection.

**Scénario de Faible Changement dans le Pourcentage Annuel** – Ce scénario part aussi de l'hypothèse d'un PCA nul chez les hommes et les femmes plus jeunes. Le PCA a été réduit de moitié pour toutes les autres cohortes d'âges. Ce scénario vise à tenir compte de la possibilité que les augmentations de taux constatées puissent découler en partie d'une meilleure détermination des cas au fil des années, plutôt qu'uniquement d'un accroissement véritable d'incidence. De plus, l'évolution de la composition ethnique de la population canadienne (proportion accrue de membres de minorités visibles) pourrait entraîner une baisse du PCA.

**Scénario sans Changement dans le Pourcentage Annuel** – Estimation des augmentations futures de cas annuels reposant uniquement sur la croissance démographique et le vieillissement de la population (soit PCA nul pour tous les groupes d'âge). Le scénario de PCA nul a été retenu pour produire une estimation de base afin d'évaluer l'incidence future des seuls facteurs de la croissance démographique et du vieillissement de la population. Il ne s'agit pas d'une estimation réaliste du nombre de cas futurs, car l'augmentation courante observée du PCA chez les populations plus vieilles est peu susceptible de s'approcher de 0 % avant au moins plusieurs décennies.

Le scénario de faible PCA a été retenu comme référence pour les projections dans le présent rapport. Les scénarios de PCA moyen et nul ont servi de point de départ pour des analyses de sensibilité spécifiques.

Le tableau suivant présente le nombre estimatif de cas réels et de décès connexes pour les principaux types de cancer de la peau en 2004 dans l'ensemble du Canada, ainsi que les projections pour 2031 à partir du scénario de faible PCA.

**Cas de Cancer de la Peau et Décès Connexes au Canada**
**Estimation du Nombre Réel (2004) et Projeté (2031)**
Scénario de Référence avec Faible Changement du Pourcentage Annuel des Taux d'Incidence

| | 2004 | | 2031 | |
|---|---|---|---|---|
| | Cas | Décès | Cas | Décès |
| **Mélanome** | 4,755 | 745 | 9,070 | 1,644 |
| **Cancer de la peau non mélanique** | 75,953 | 204 | 201,302 | 608 |
| Carcinome basocellulaire | 60,587 | 80 | 157,711 | 237 |
| Carcinome squameux | 15,366 | 124 | 43,591 | 371 |

### Projection du Fardeau Économique du Cancer de la Peau en 2031

Plusieurs hypothèses ont été appliquées à l'analyse pour établir le fardeau économique du cancer de la peau au Canada, notamment les coûts médicaux directs et les coûts indirects de la perte de productivité. Le tableau suivant résume les résultats dérivés du nombre estimatif de cas et de décès en 2004.

| Coûts Annuels Directs et Indirects des Cancers de la Peau au Canada<br>**2004** (millions $, dollars constants, non actualisés) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Type de Coût** | **M** | **%** | **CB** | **%** | **CS** | **%** | **Total** | **%** |
| Soins primaires | 1,76 | 0,4% | 24,90 | 51,5% | 6,34 | 15,9% | 33,00 | 6,2% |
| Chirurgie ambulatoire en mileu hospitalier | 17,01 | 3,8% | 0,91 | 1,9% | 2,22 | 5,5% | 20,14 | 3,8% |
| Soins aux clients hospitalisés | 10,78 | 2,4% | 0,58 | 1,2% | 1,56 | 3,9% | 12,92 | 2,4% |
| **Total des coûts directs** | **29,55** | **6,7%** | **26,39** | **54,6%** | **10,12** | **25,3%** | **66,05** | **12,4%** |
| Mortalité | 410,07 | 92,5% | 18,20 | 37,7% | 28,73 | 71,9% | 457,00 | 85,9% |
| Morbidité | 3,86 | 0,9% | 3,74 | 7,7% | 1,10 | 2,8% | 8,70 | 1,6% |
| **Total des coûts indirects** | **413,93** | **93,3%** | **21,94** | **45,4%** | **29,83** | **74,7%** | 465,70 | **87,6%** |
| **Total des coûts** | **443,48** | **100%** | **48,32** | **100%** | **39,95** | **100.0%** | **531,75** | **100%** |
| *Nota:* M, mélanome; CB, carcinome basocellulaire; CS, carcinome squameux. | | | | | | | | |

La majeure partie du fardeau économique total estimé du cancer de la peau au Canada pour 2004, soit 532 millions $, est attribuable au mélanome (83,4 %), le reste se répartissant entre le CB (9,1 %) et le CS (7,5 %).

Le fardeau économique rattaché aux projections de cas et de décès pour 2031 (fondées sur le scénario de référence de faible PCA pour les taux d'incidence de cancer de la peau en fonction de l'âge) se résume comme suit.

| Coûts Annuels Directs et Indirects des Cancers de la Peau au Canada<br>Scénario de Faible PCA<br>**2031** (millions $, dollars constants, non actualisés) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Type of Cost** | **M** | **%** | **CB** | **%** | **CS** | **%** | **Total** | **%** |
| Soins primaires | 3,35 | 0,5% | 64,76 | 52,7% | 17,95 | 17,4% | 86,06 | 9,3% |
| Chirurgie ambulatoire en mileu hospitalier | 36,75 | 5,3% | 2,35 | 1,9% | 6,12 | 5,9% | 45,22 | 4,9% |
| Soins aux clients hospitalisés | 24,62 | 3,5% | 1,53 | 1,2% | 4,43 | 4,3% | 30,58 | 3,3% |
| **Total des coûts directs** | **64,72** | **9,3%** | **68,64** | **55,9%** | **28,5** | **27,7%** | **161,86** | **17,6%** |
| Mortalité | 624,78 | 89,8% | 45,44 | 37,0% | 71,74 | 69,6% | 741,96 | 80,5% |
| Morbidité | 6,46 | 0,9% | 8,73 | 7,1% | 2,79 | 2,7% | 17,98 | 2,0% |
| **Total des coûts indirects** | **631,24** | **90,7%** | **54,17** | **44,1%** | **74,53** | **72,3%** | **759,94** | **82,4%** |
| **Total des coûts** | **695,96** | **100%** | **122,81** | **100.0%** | **103,03** | **100.0%** | **921,8** | **100%** |
| *Nota:* M, mélanome; CB, carcinome basocellulaire; CS, carcinome squameux. | | | | | | | | |

Le fardeau économique total du cancer de la peau au Canada augmenterait donc jusqu'à 922 millions $ par année d'ici 2031, le mélanome comptant pour 75,5 % des coûts, le CB, pour 13,3 %, et le CS pour 11,2 %.

### Analyses de Sensibilité

L'évaluation économique ne tient pas compte de plusieurs coûts possibles. Ainsi, l'inclusion des médicaments sur ordonnance à partir d'un ratio de coûts établi dans une étude pertinente des É.-U. relèverait les coûts directs de 8,75 millions. De même, l'inclusion des coûts des patients se

fondant sur le ratio de coûts dans une étude pertinente du Royaume-Uni augmenterait les coûts indirects de 25,12 millions $.

Des variations dans la méthodologie d'estimation des coûts indirects ont une incidence encore plus marquée sur les résultats. Dans le présent rapport, l'approche habituelle du capital humain a été modifiée en attribuant une valeur au temps « non productif » perdu (à partir du salaire minimum de chaque province). Cette stratégie visait à rectifier le défaut de l'approche du capital humain d'attribuer une valeur au travail non rémunéré et au temps de loisir, en particulier le temps des personnes ayant dépassé l'âge d'une participation normale à la population active. L'exclusion des coûts de non-participation à la population active réduirait les coûts indirects estimés pour 2004 de 466 à 216 millions $.

La projection du fardeau économique jusqu'en 2031 est également affectée par des variations dans les hypothèses sur les changements à long terme des taux d'incidence présumés au fil des années. Le fardeau économique estimé pour 2031 recule depuis le scénario de référence de 922 millions $ à 784 millions $ pour le scénario de PCA nul, et augmente à 1 060 millions $ pour le scénario de PCA moyen.

Finalement, des taux d'actualisation sont la plupart du temps appliqués tant aux coûts qu'aux effets dans les évaluations économiques, afin de tenir compte du taux de préférence pour le présent.

Le tableau suivant résume les rajustements pour différents taux d'actualisation et scénarios de PCA, pour une approche modifiée du capital humain (comprenant les coûts des pertes de productivité chez les non-participants à la population active officielle) et pour l'approche standard du capital humain (excluant de tels coûts).

| Fardeau Économique du Cancer de la Peau au Canada<br>En 2031, Analyse de Sensibilité | | | |
|---|---|---|---|
| | Taux d'Actualisation | | |
| | 0% | 3% | 5% |
| **Scénario de PCA Nul** | | | |
| **Incluant les Coûtes des Non-Participants à la Population Active** | | | |
| Coûtes Directs | 123,35 $ | 123,35 $ | 123,53 $ |
| Coûtes Indirects | 660,49 $ | 515,08 $ | 443,65 $ |
| **Total** | **783,83** $ | **638,42** $ | **567,00** $ |
| **Excluant les Coûtes des Non-Participants à la Population Active** | | | |
| Coûtes Directs | 123,35 $ | 123,35 $ | 123,35 $ |
| Coûtes Indirects | 253,98 $ | 198,51 $ | 171,44 $ |
| **Total** | **377,33** $ | **321,86** $ | **294,79** $ |
| **Scénario de PCA Faible** | | | |
| **Incluant les Coûtes des Non-Participants à la Population Active** | | | |
| Coûtes Directs | 161,86 $ | 161,86 $ | 161,86 $ |
| Coûtes Indirects | 759,94 $ | 602,55 $ | 523,73 $ |
| **Total** | **921,80** $ | **764,40** $ | **685,59** $ |
| **Excluant les Coûtes des Non-Participants à la Population Active** | | | |
| Coûtes Directs | 161,86 $ | 161,86 $ | 161,86 $ |
| Coûtes Indirects | 271,47 $ | 216,29 $ | 188,82 $ |
| **Total** | **433,33** $ | **378,15** $ | **350,86** $ |
| **Scénario de PCA Moyen** | | | |
| **Incluant les Coûtes des Non-Participants à la Population Active** | | | |
| Coûtes Directs | 200,35 $ | 200,35 $ | 200,35 $ |
| Coûtes Indirects | 859,40 $ | 689,09 $ | 602,66 $ |
| **Total** | **1059,75** $ | **889,44** $ | **803,01** $ |
| **Excluant les Coûtes des Non-Participants à la Population Active** | | | |
| Coûtes Directs | 200,35 $ | 200,35 $ | 200,35 $ |
| Coûtes Indirects | 288,97 $ | 233,37 $ | 205,31 $ |
| **Total** | **489,32** $ | **433,72** $ | **405,66** $ |

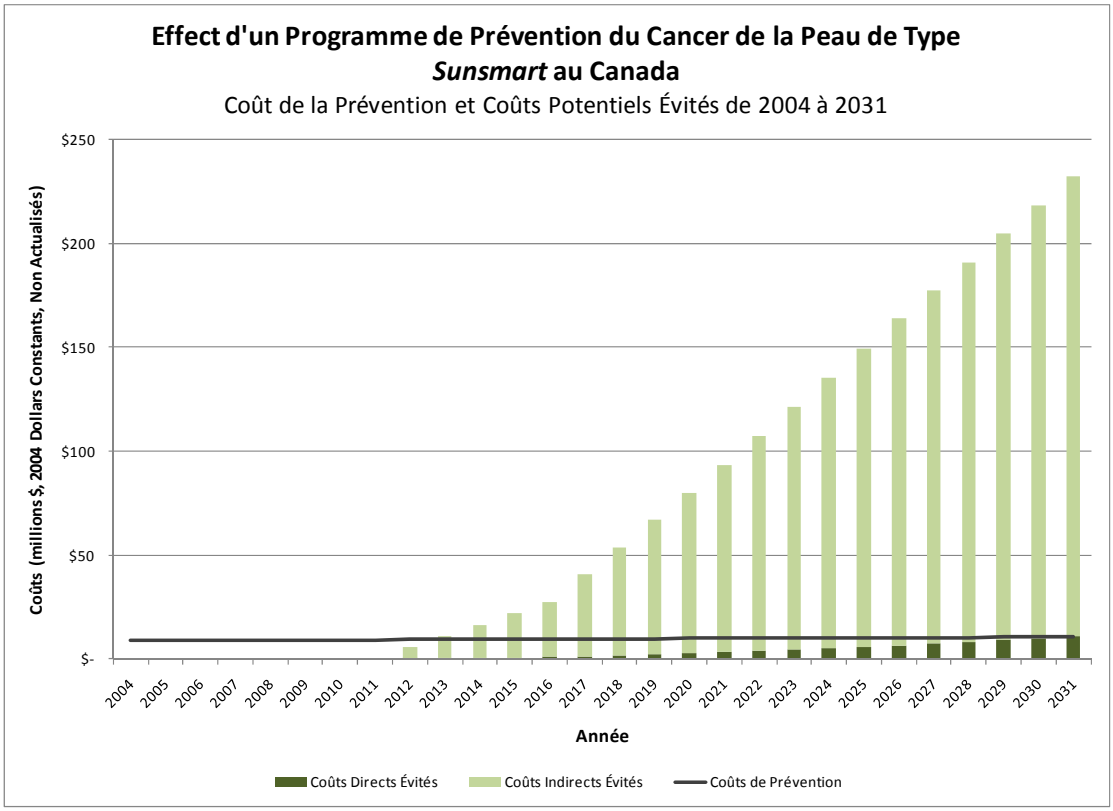
Les résultats sont très sensibles aux trois variables représentées, le fardeau économique estimé allant d'un montant actualisé de 295 millions $ à un montant non actualisé de 1 060 millions $ en 2031.

### Impact d'un Programme Global Soutenu de Prévention du Cancer de la Peau

L'on estime qu'un programme global soutenu de prévention du cancer de la peau pourrait permettre d'éviter au Canada un total cumulatif de 2 500 décès rattachés au cancer de la peau d'ici 2031.

En extrapolant les résultats des travaux de Carter et ses collègues en Australie et en intégrant des données statistiques récentes de l'état de Victoria, il est possible d'estimer l'impact d'un programme similaire au Canada; le coût d'un tel effort de prévention au Canada a été estimé à partir des dépenses de programme par personne en Australie. En appliquant les taux de change courants, les dépenses annuelles de programme augmenteraient de 8,7 à 10,6 millions $ au cours de la période de modélisation de 28 ans. Les coûts cumulatifs sur 28 ans s'établiraient à environ 270 millions $.

En combinant ces deux ensembles de données, l'impact économique au fil du temps d'un programme de prévention du cancer de la peau au Canada peut être illustré comme suit.




Année par année, le programme de prévention ne produirait que tard dans la période de modélisation des économies au titre des coûts directs évités (dépenses médicales); toutefois, le total des coûts annuels directs *et indirects* évités dépasse les dépenses de programme beaucoup plus tôt dans la période. Cumulativement, les coûts évités combinés pour la période de modélisation de 28 ans sont estimés à un total de 2,1 ***milliards*** $, soit 7,8 fois le coût de la prévention.

Toutefois, ces résultats de modélisation de la prévention sont sensibles à l'application de taux d'actualisation et à l'attribution ou non d'une valeur au temps « non productif » perdu. Si aucune valeur n'est accordée au temps « non productif » perdu (en ne tenant pas compte de la recommandation de l'approche modifiée du capital humain), et que l'on présume un taux d'actualisation de 5 %, le total des coûts cumulatifs évités sur la période de 28 ans diminuerait à 622 millions $. Bien que ce montant représente moins du tiers du total pour le scénario de référence, il demeure 2,3 fois plus élevé que le coût cumulatif estimé d'un programme global de prévention du cancer de la peau.

## Introduction

### Skin Cancer

Skin malignancies are the most common type of human cancer. There are three major forms of skin cancer: basal cell carcinoma (BCC), squamous cell carcinoma (SCC), and cutaneous melanoma. BCC and SCC are the most frequent skin cancers; together, they are often referred to as non-melanoma skin cancer (NMSC). There are other, much rarer types of skin cancer that sometimes are included under the NMSC heading, including Kaposi's sarcoma and Merkel cell carcinoma. These are often classified as "other" skin cancers in statistical reports.

Capturing and combining statistical and other data under the heading of "non-melanoma skin cancers" is very common; this has the collateral effect of highlighting the only skin cancers omitted from the NMSC category, namely, melanoma. Melanoma warrants a particular focus in the taxonomy and reporting of skin cancer because of its distinctive pathology; for example, it can invade other tissues and organs, which is rarely the case with NMSC. Melanoma will be described further here before introducing the broader topic of NMSC. Additional background on the various skin cancers can be found in Appendix A.

Although melanoma accounts for only about 4% of total skin cancers, it is the most serious form of cutaneous malignancy, causing about 73% of skin cancer deaths. An estimated 4,600 cases of melanoma were diagnosed in Canada in 2008.[3]

Melanoma has a wide age distribution. While it is most prevalent in those over 80 years of age, it is also one of the more common cancers among the spectrum of malignancies that occur in adolescents and young adults.[4] In Canada, melanoma is the third most common cancer in females aged 15-29 (exceeded only by thyroid cancer and Hodgkin's Lymphoma) and the fourth most common cancer in males aged 15-29 (exceeded only by cancer of the testis, Hodgkin's Lymphoma and leukemia).[5]

The risk of developing melanoma is associated with several factors, including sun exposure, presence of moles, family history, and complexion (as a proxy for skin sensitivity).[6] Excessive exposure to ultraviolet (UV) radiation increases risk of skin cancer in general, and melanoma in particular. Sunlight is a major source of UV radiation; blistering sunburns in childhood and cumulative exposure to solar radiation are considered to be specific risk factors for melanoma.

NMSC accounts for the majority of skin cancer in humans. The two major forms of NMSC are basal cell carcinoma (BCC) and squamous cell carcinoma (SCC). BCCs represent approximately 70-80% of all skin cancers, and about one-quarter of all cancers.[7,8]

---

[3] Canadian Cancer Society/ National Cancer Institute of Canada. *Canadian Cancer Statistics 2008*. 2008.
[4] American Cancer Society. *Melanoma Skin Cancer*. 2008. Available at http://documents.cancer.org/170.00/170.00.pdf. Accessed January 2009.
[5] Cancer in adolescents and young adults (15-29 years). *Canadian Cancer Statistics*. Canadian Cancer Society, 2009. Available at http://www.cancer.ca/canada-wide/about%20cancer/cancer%20statistics/~/media/CCS/Canada%20wide/Files%20List/English%20files%20heading/pdf%20not%20in%20publications%20section/Stats%202009E%20Special%20Topics.ashx. Accessed October 2009.
[6] Skin Cancer Foundation. *Melanoma*. 2008. Available at http://www.skincancer.org/Melanoma.html. Accessed January 2009.
[7] American Cancer Society. *Skin Cancer: Basal and Squamous Cell*. 2008. Available at http://documents.cancer.org/118.00/118.00.pdf. Accessed January 2009.
[8] Langley RGB. *Excellence in Cancer Care: Skin Cancer*. Cancer Care Nova Scotia. Available at http://www.cancercare.ns.ca/media/documents/skincancer.pdf. Accessed January 2009.

SCCs are the second most common form of skin cancer. SCC is more aggressive than BCC, although the likelihood of it spreading to distant parts of the body is still low. With early identification and prompt treatment, most SCCs are not considered serious. Similar to BCC, tumours appear most frequently on sun-exposed areas such as the face, neck, shoulders, arms, and back.

Besides BCC and SCC, there are a number of other types of NMSC that are much rarer. In total, they comprise only 1-5% of NMSC.[9,10]

As noted above, exposure to UV radiation is considered the major risk factor for skin cancer. The relative risk for BCC, SCC, and melanoma varies with the type of sun exposure. It typically is measured under three headings: total (or lifetime) exposure, occupational (or exposure experienced in a continuous, intensive pattern), and intermittent exposure (as seen in recreational or leisure contexts). The following table lists the relative risk for skin cancers according to type of sun exposure:

**Types of Sun Exposure and Risks of BCC, SCC, and Melanoma**

| Type of sun exposure | Relative Risk (95% CI) | | |
|---|---|---|---|
| | BCC | SCC | Melanoma |
| **Total** | 0.98 (0.68-1.41) | 1.53 (1.02-2.27) | 1.20 (1.00-1.44) |
| **Occupational** | 1.19 (1.07-1.32) | 1.64 (1.26-2.13) | 0.86 (0.77-0.96) |
| **Intermittent** | 1.38 (1.24-1.54) | 0.91 (0.68-1.22) | 1.71 (1.54-1.90) |

Source: Armstrong and Kricker, *Journal of Photochemistry and Photobiology B*, 2001.

SCC is substantially (and significantly) associated with total and occupational sun exposure, whereas BCC and melanoma appear to be more influenced by intermittent sun exposure.

Other patterns and markers of sun exposure are also important. For instance, a history of sunburn increases the risk of BCC and melanoma, and to a lesser extent SCC.[11,12] Timing of sun exposure contributes to the risk profile as well; thus, excessive childhood exposure is known to increase the risk of BCC and melanoma.[13,14]

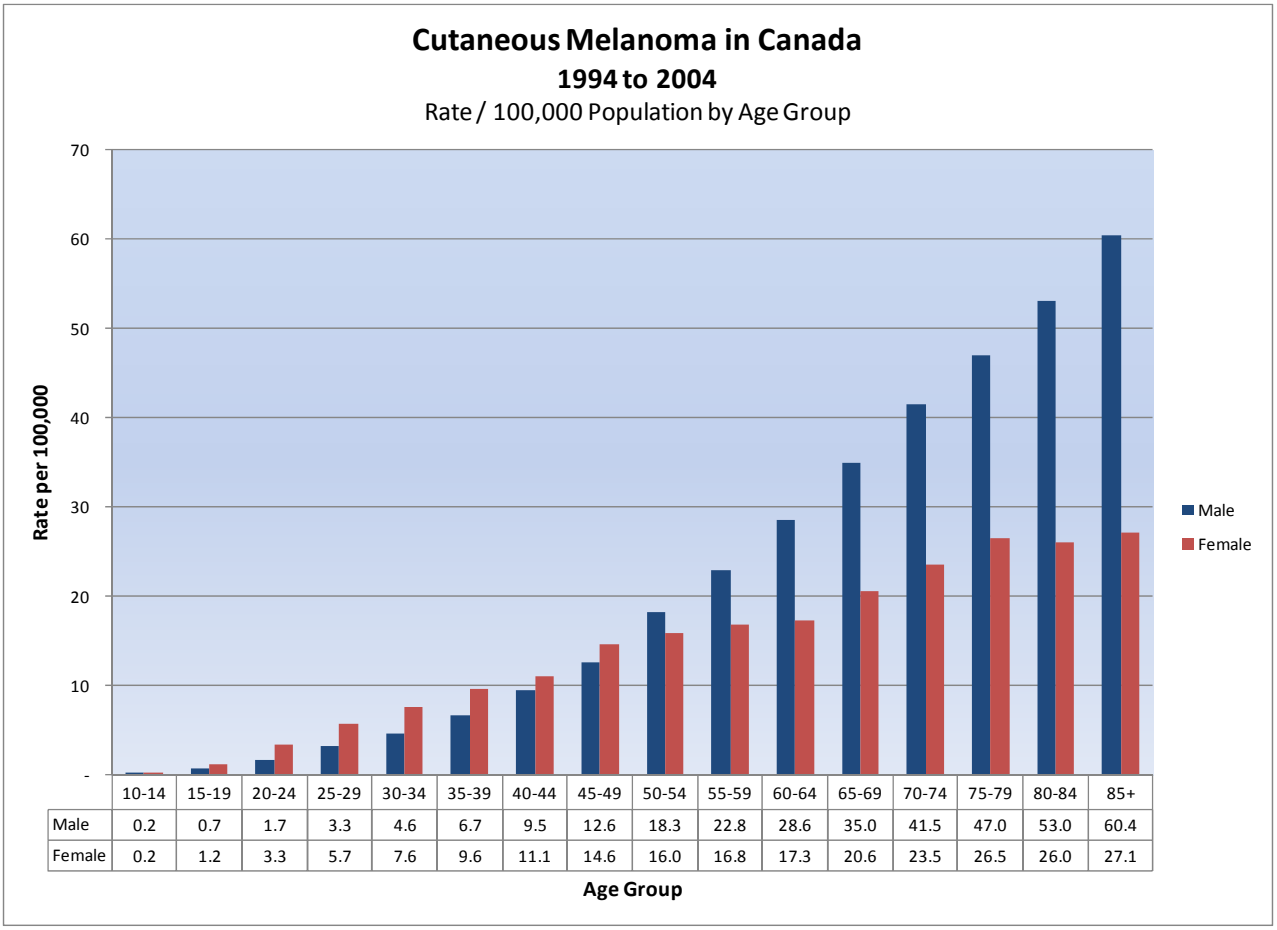
[9] *Other Types of Skin Cancer*. Skin Cancer Guide . ca. Available at http://www.skincancerguide.ca/other/types_skin_cancer.html. Accessed January 2009.
[10] American Cancer Society. *Skin Cancer: Basal and Squamous Cell*. 2008. Available at http://documents.cancer.org/118.00/118.00.pdf. Accessed January 2009.
[11] Armstrong BK, Kricker A. The epidemiology of UV induced skin cancer. *Journal of Photochemistry and Photobiology B: Biology.* 2001; 63(1-3): 8-18.
[12] NSW Skin Cancer Prevention Working Group. *Skin Cancer Prevention Evidence Summary*. 2007. Available at http://www.nswcc.org.au/html/prevention/sunsmart/downloads/skincancer_prevention_evidence_summary.pdf. Accessed January 2009.
[13] Gallagher RP, Lee TK. Adverse effects of ultraviolet radiation: a brief review. *Progress Biophysics and Molecular Biology.* 2006; 92(1): 119-31.
[14] Whiteman DC, Whiteman CA, Green AC. Childhood sun exposure as a risk factor for melanoma: a systematic review of epidemiologic studies. *Cancer Causes and Control.* 2001; 12(1): 69-82.

## Skin Cancer Rates and Trends

### Cutaneous Melanoma

#### Incidence

As noted earlier, the incidence of cutaneous melanoma tends to increase with age; furthermore, males, on average, have a higher rate than females. The following chart provides information on the age-specific incidence rates for melanoma in both the male and female population in Canada.[15] Note that rates are actually higher for females than males between the ages of 15 and 49. As noted earlier, melanomas are the third most common cancer in females and fourth most common in males aged 15-29. The overall incidence rate in Canada in 2005 was 13.2 per 100,000 (14.0 for males and 12.4 for females).[16]




| | 10-14 | 15-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Male | 0.2 | 0.7 | 1.7 | 3.3 | 4.6 | 6.7 | 9.5 | 12.6 | 18.3 | 22.8 | 28.6 | 35.0 | 41.5 | 47.0 | 53.0 | 60.4 |
| Female | 0.2 | 1.2 | 3.3 | 5.7 | 7.6 | 9.6 | 11.1 | 14.6 | 16.0 | 16.8 | 17.3 | 20.6 | 23.5 | 26.5 | 26.0 | 27.1 |

[15] This chart is based on data extracted from Public Health Agency's Cancer Surveillance Online data system available at http://dsol-smed.phac-aspc.gc.ca/dsol-smed/cancer/index_e.html

[16] Cancer Surveillance Online, Public Health Agency of Canada. Available at http://dsol-smed.phac-aspc.gc.ca/dsol-smed/cancer/c_dis-eng.php.

**Body Site**

According to research in Germany, approximately one-third of cutaneous melanomas occur on the trunk of the body and one-third on the leg and/or hip area (see table below).[17] There is a marked gender differential in each instance, perhaps reflecting which body parts men and women characteristically expose to the sun. The trunk of the body is the location for almost half of cutaneous melanomas in males. A further 20% of melanomas in men and women occur in the arm and shoulder area. The general pattern for melanoma differs from non-melanoma skin cancer, in which almost half of the cancers occur on the face.

**Localization of Cutaneous Melanoma and Non-Melanoma Skin Cancer**

Percent of Total Cases by Gender in Germany

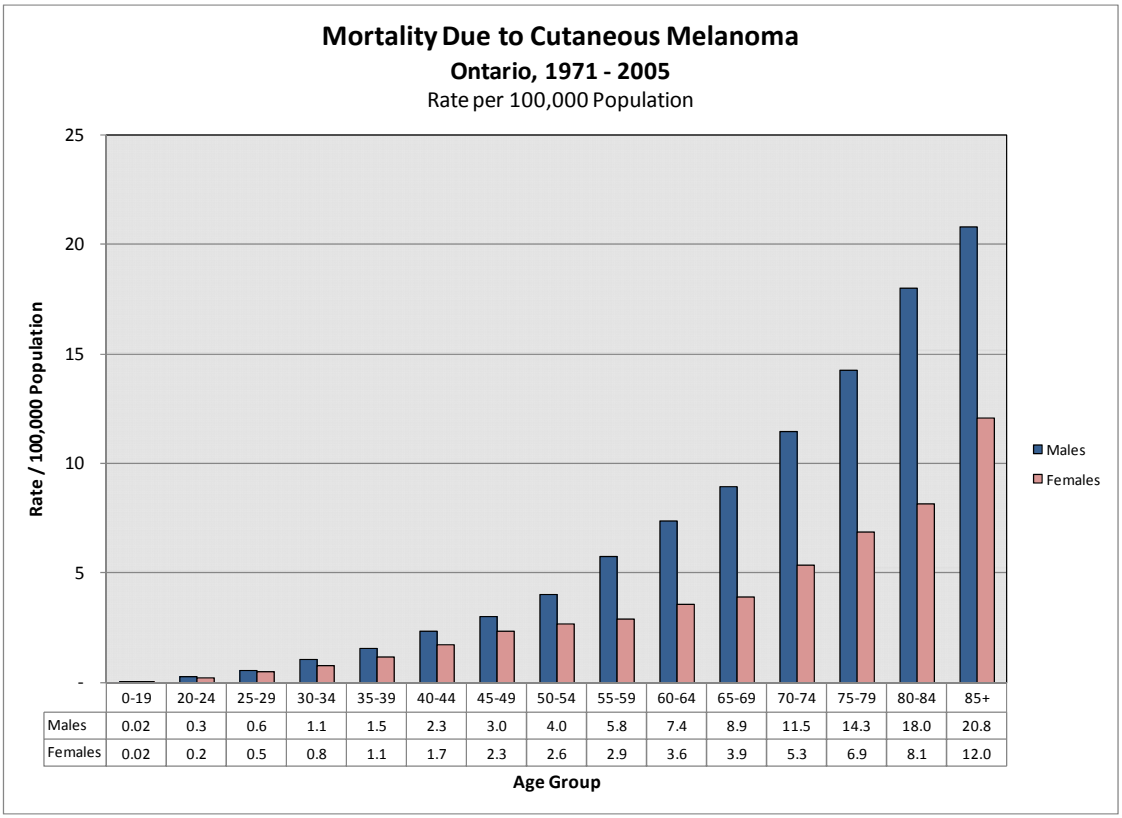
| | Melanoma | | | Non-Melanoma | | |
|---|---|---|---|---|---|---|
| **Localization** | **Male** | **Female** | **Total** | **Male** | **Female** | **Total** |
| Lips | 0.1% | 0.5% | 0.3% | 2.1% | 2.3% | 2.2% |
| Eyelid | | | | 3.7% | 5.4% | 4.5% |
| External Ear | 0.6% | 1.0% | 0.8% | 6.0% | 1.3% | 3.7% |
| Face | 7.9% | 8.5% | 8.2% | 43.6% | 49.3% | 46.4% |
| Scalp | 5.3% | 2.4% | 3.6% | 8.1% | 7.3% | 7.7% |
| Trunk | 46.8% | 22.4% | 33.3% | 17.2% | 15.5% | 16.4% |
| Arm and Shoulder | 17.0% | 22.4% | 20.1% | 9.0% | 7.3% | 8.2% |
| Leg and Hip | 16.7% | 40.3% | 30.1% | 3.7% | 6.3% | 5.0% |
| Other | 5.6% | 2.5% | 3.6% | 6.6% | 5.3% | 5.9% |

Source: Katalinic et al. *British Journal of Dermatology,* 2003

[17] Katalinic A, Kunze U, Schafer T. Epidemiology of cutaneous melanoma and non-melanoma skin cancer in Schleswig-Holstein, Germany: incidence, clinical subtypes, tumour stages and localization (epidemiology of skin cancer). *British Journal of Dermatology.* 2003; 149(6): 1200-6.

**Mortality**

As with incidence rates, age-specific mortality rates also tend to increase with age, and are consistently higher in males than in females (in contrast with the higher incidence rates for younger female groups in Canada, as reported earlier). As an example, the following chart indicates mortality data for Ontario between 1971 and 2005.[18] The overall mortality rate due to melanoma during this time period was 5.52 per 100,000 (4.22 for females and 6.96 for males). The chart displays the variation in mortality rates across different age groups for both the male and female population.

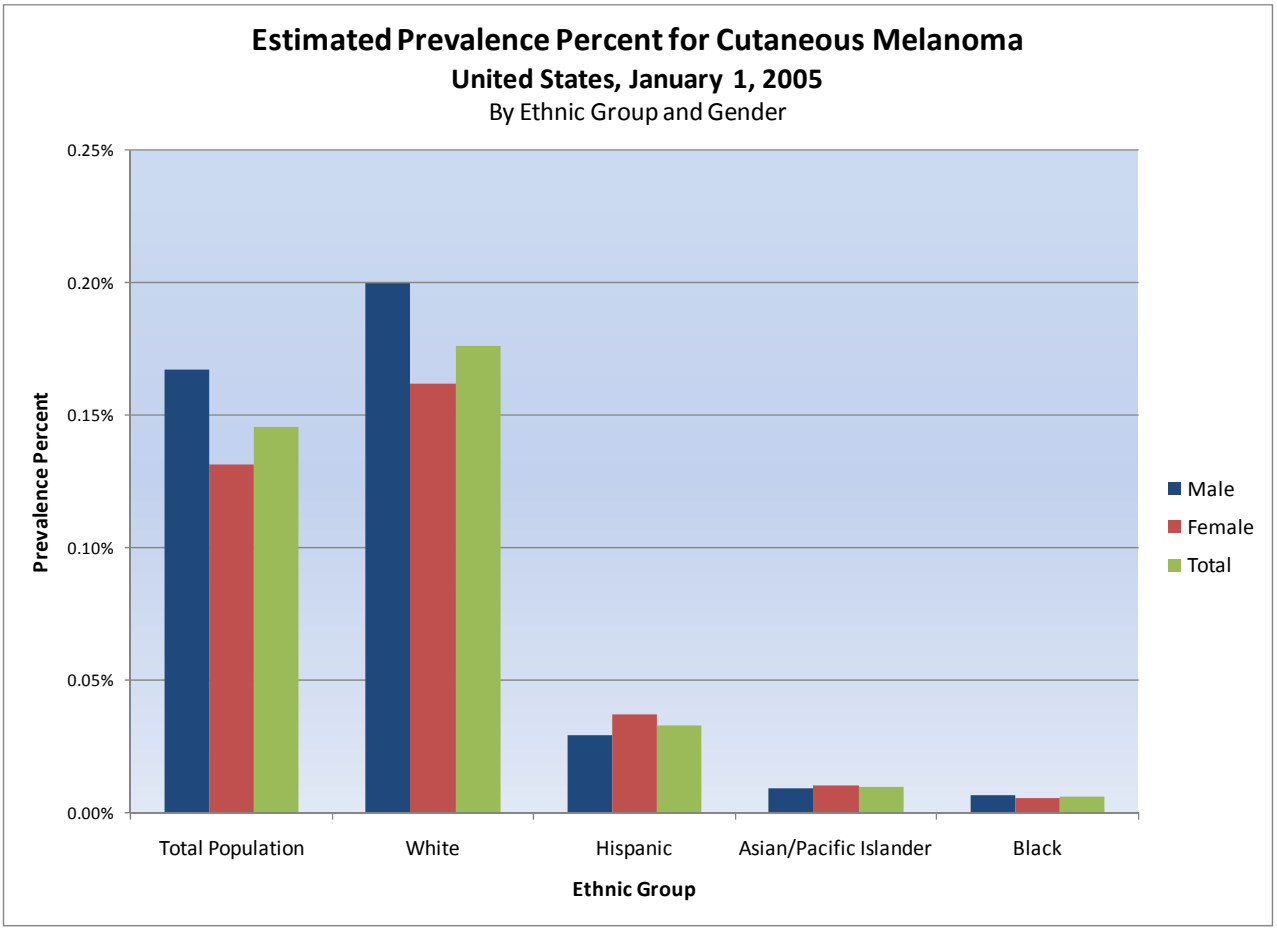



| | 0-19 | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Males | 0.02 | 0.3 | 0.6 | 1.1 | 1.5 | 2.3 | 3.0 | 4.0 | 5.8 | 7.4 | 8.9 | 11.5 | 14.3 | 18.0 | 20.8 |
| Females | 0.02 | 0.2 | 0.5 | 0.8 | 1.1 | 1.7 | 2.3 | 2.6 | 2.9 | 3.6 | 3.9 | 5.3 | 6.9 | 8.1 | 12.0 |

[18] Cancer Care Ontario - SEER**Stat Release 7* - OCRIS (February 2009) released March 2009; Population Data Source: *Demographic Estimates Compendium 2007*. Statistics Canada, April 2008 (1971–2005).

**Prevalence**

The following chart provides information on the estimated proportion of the population living with diagnosed melanoma on January 1, 2005 in the United States, stratified by ethnic group and gender.[19] Melanoma is most prevalent in the white population. In the United States, 0.18% of the white population (0.20% of males and 0.16% of females) had been diagnosed with melanoma.




U.S. data on the prevalence of cutaneous melanoma was located as there is minimal data on prevalence available in Canada, and no information on the differences between ethnic groups equivalent to that found in the United States.

In considering the U.S. prevalence data, it should be noted that incidence rates for melanoma in the U.S. are generally higher than in Canada, suggesting that Canadian prevalence is likely lower. In 2005, the U.S. incidence rate was 25.2 per 100,000 in males and 15.9 per 100,000 in females[20]; in Canada, male and female rates were 14.0 and 12.4 per 100,000, as mentioned earlier. One possible explanation for the difference is the dissimilar latitude range of the two countries. A major risk factor for skin cancer is UV radiation exposure, and greater proximity to the equator results in greater UV exposure; this is sometimes referred to as the "latitude

[19] Ries LAG, Melbert D, Krapcho M et al. *SEER Cancer Statistics Review, 1975-2005*. 2008. National Cancer Institute. Available at http://seer.cancer.gov/csr/1975_2005/. Accessed January 2009.
[20] Available at http://seer.cancer.gov/faststats/selections.php#Output. Accessed September 2009.

gradient." Various studies have demonstrated that melanoma incidence among Caucasians in North America significantly increases in lower latitudes, which naturally would propel U.S. incidence ahead of that in Canada.[21] A recent review of the literature may allow explanations for this pattern to be nuanced; Oliveria et al. examined results of studies on migration and found that there was an increased risk specific to individuals who spent their childhood in sunny geographical regions.[22] Another major risk factor for skin cancer is having fair skin. However, the Caucasian proportions of the U.S. and Canada population are very similar (at 75% and 78%, respectively), largely ruling this out as a contributing factor to the difference in melanoma incidence rates between the two countries.[23,24]

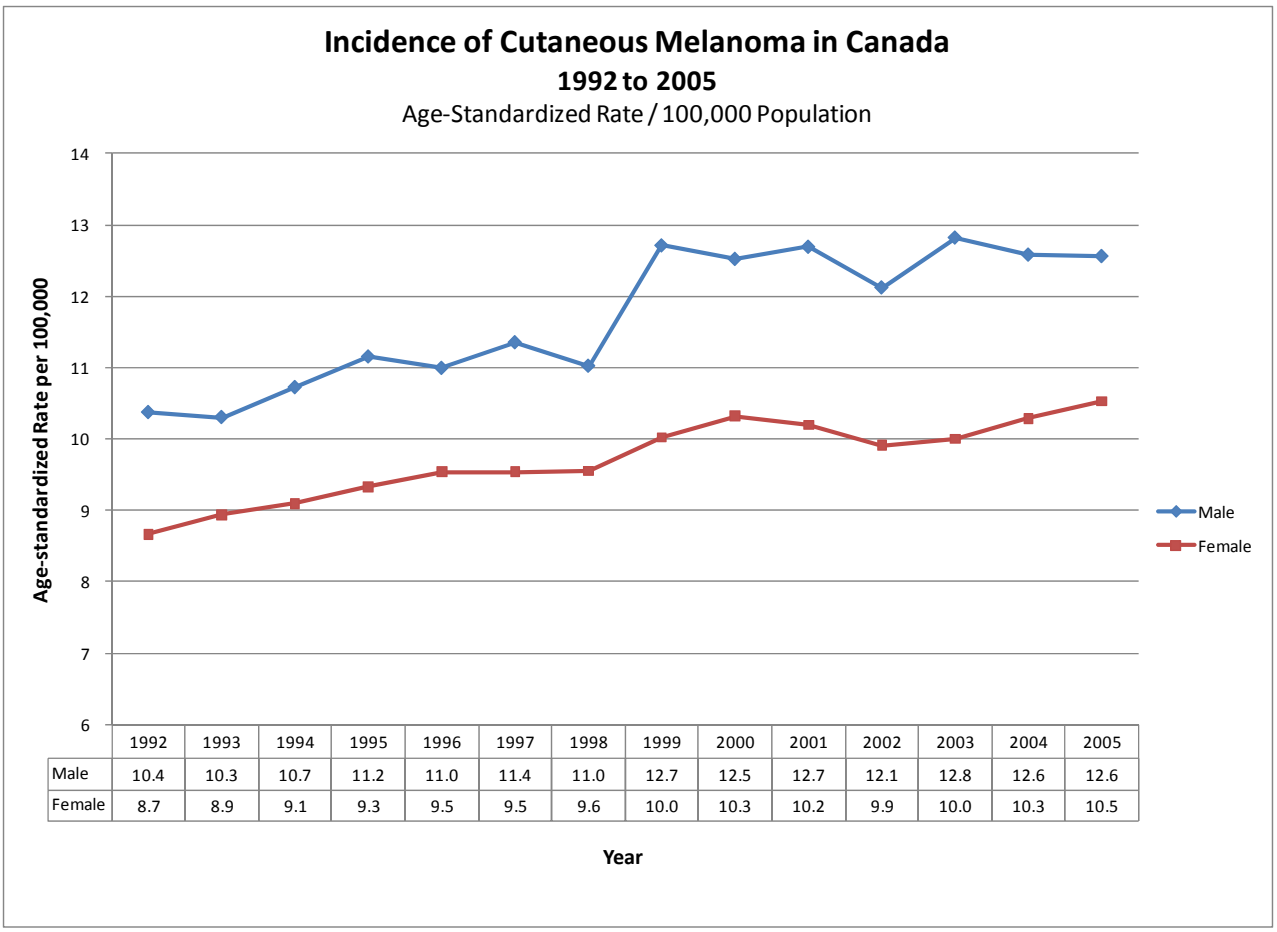
### Trends

*Age-Standardized Incidence Rate*

Rising incidence rates for melanoma have been observed throughout the world during the last four decades. However, in a number of jurisdictions (including Canada), data since the 1990s suggest that the rising incidence rates are slowing or stabilizing.[25,26,27] This may be due to changes in sun safety behaviour in younger population cohorts in response to enhanced prevention efforts.

The latest Canadian trend data from the Public Health Agency's Cancer Surveillance On-Line system indicates that the age-standardized rate for melanoma in Canada increased from 9.39 to 11.36/100,000 between 1992 and 2005, an overall increase of 21.0%. As indicated in the following chart, the rate per 100,000 males increased from 10.37 to 12.56 (21.1%) in this time period. The increase for females was 8.67 to 10.53/100,000, or 21.5%.

[21] Eide MJ, Weinstock MA. Association of UV index, latitude, and melanoma incidence in nonwhite populations--US Surveillance, Epidemiology, and End Results (SEER) Program, 1992 to 2001. *Archives of Dermatology.* 2005; 141(4): 477-81.
[22] Oliveria SA, Saraiya M, Geller AC et al. Sun exposure and risk of melanoma. *Archives of Disease in Childhood.* 2006; 91(2): 131-8.
[23] The White Population: 2000. Census 2000 Brief. Available at http://www.census.gov/prod/2001pubs/c2kbr01-4.pdf.
[24] Statistics Canada 2006 Census. Available at http://www12.statcan.gc.ca/english/census06/data/topics/RetrieveProductTable.cfm?ALEVEL=3&APATH=3&CATNO=97-555-XCB2006052&DETAIL=0&DIM=&DS=99&FL=0&FREE=0&GAL=&GC=99&GK=NA&GRP=0&IPS=97-555-XCB2006052&METH=0&ORDER=&PID=97298&PTYPE=88971&RL=0&S=1&ShowAll=&StartRow=&SUB=&Temporal=2006&Theme=70&VID=&VNAMEE=&VNAMEF=
[25] Garbe C, Leiter U. Melanoma epidemiology and trends. *Clinics in Dermatology*. 2009; (27): 3-9.
[26] Marrett LD, Nguyen HL, Armstrong BK. Trends in the incidence of cutaneous malignant melanoma in New South Wales, 1983-1996. *International Journal of Cancer*. 2001; 92(3): 457-62.
[27] Bulliard JL, Cox B, Semenciw R. Trends by anatomic site in the incidence of cutaneous malignant melanoma in Canada, 1969-93. *Cancer Causes and Control.* 1999; 10(5): 407-16.




| | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Male | 10.4 | 10.3 | 10.7 | 11.2 | 11.0 | 11.4 | 11.0 | 12.7 | 12.5 | 12.7 | 12.1 | 12.8 | 12.6 | 12.6 |
| Female | 8.7 | 8.9 | 9.1 | 9.3 | 9.5 | 9.5 | 9.6 | 10.0 | 10.3 | 10.2 | 9.9 | 10.0 | 10.3 | 10.5 |

This information was analyzed using the Joinpoint Regression Program (v2.7) to assess trends and annual percent change (APC) by gender and age.[28] The age groups (15-34, 35-49, 50-64, 65-74, and 75+) were chosen to coincide with similar research in Australia.[29] The p-values, presented along with the APC in the following table, indicate whether or not the slope is significantly different from zero. In addition to an analysis of Canadian data, the same method was applied to both Ontario and British Columbia data.

Based on results for the entire Canadian population, there is a non-significant *decrease* in the incidence rate of melanoma for younger males (ages 15-49) and a non-significant *increase* for younger females (ages 15-49) between 1992 and 2005. In both the male and female older cohorts, there was a significant increase in the melanoma incidence rate over the time period. In addition, the APC was higher with increasing age in both males and females, suggesting that the incidence was accelerating at a greater rate in the oldest cohorts. In other words, there is the suggestion of an improving pattern for younger age groups. This may be reflected in the non-significant APC for all females in Canada in 2000-2005, which at 0.59% suggests a recent stabilization in the melanoma incidence trend.

[28] Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression analysis with application to cancers rates. *Statistics in Medicine.* 2000; 19: 335-51.
[29] Marrett LD, Nguyen HL, Armstrong BK. Trends in the incidence of cutaneous malignant melanoma in New South Wales, 1983-1996. *International Journal of Cancer.* 2001; 92(3): 457-62.

**Trends in Cutaneous Melanoma**
**Annual Percent Change (1992 to 2005)**
**By Jurisdiction, Gender, Age Group and Time Frame**

| Type | Gender | Age | Annual Percent Change (Time Frame) {P-value} | |
|---|---|---|---|---|
| **Canada** | | | | |
| | **Male** | 15-34 | -0.32% (1992 - 2005) {0.62} | |
| | | 35-49 | -0.35% (1992 - 2005) {0.30} | |
| | | 50-64 | 1.31% (1992 - 2005) {0.006}* | |
| | | 65-74 | 2.79% (1992 - 2005) {<0.001}* | |
| | | 75+ | 3.69% (1992 - 2005) {<0.001}* | |
| | | **All Ages** | **1.78% (1992 - 2005) {<0.001}*** | |
| | **Female** | 15-34 | 0.17% (1992 - 2005) {0.76} | |
| | | 35-49 | 0.43% (1992 - 2005) {0.28} | |
| | | 50-64 | 1.67% (1992 - 2005) {<0.001}* | |
| | | 65-74 | 1.84% (1992 - 2005) {<0.001}* | |
| | | 75+ | 3.27% (1992 - 2005) {<0.001}* | |
| | | **All Ages** | **1.88% (1992 - 2000) {<0.001}*** | **0.59% (2000 - 2005) {0.32}** |
| **Ontario** | | | | |
| | **Male** | 15-34 | 1.32% (1992 - 2005) {0.23} | |
| | | 35-49 | -0.99% (1992 - 2005) {0.11} | |
| | | 50-64 | 1.77% (1992 - 2005) {<0.001}* | |
| | | 65-74 | 2.86% (1992 - 2005) {<0.001}* | |
| | | 75+ | 4.04% (1992 - 2005) {<0.001}* | |
| | | **All Ages** | **2.09% (1992 - 2005) {<0.001}*** | |
| | **Female** | 15-34 | 1.72% (1992 - 2005) {0.037} | |
| | | 35-49 | 0.73% (1992 - 2005) {0.21} | |
| | | 50-64 | 1.61% (1992 - 2005) {0.0012} | |
| | | 65-74 | 2.42% (1992 - 2005) {<0.001}* | |
| | | 75+ | 4.15% (1992 - 2005) {<0.001}* | |
| | | **All Ages** | **1.96% (1992 - 2005) {<0.001}** | |
| **British Columbia** | | | | |
| | **Male** | 15-34 | -1.13% (1992 - 2005) {0.76} | |
| | | 35-49 | -0.60% (1992 - 2005) {0.52} | |
| | | 50-64 | 0.20% (1992 - 2005) {0.76} | |
| | | 65-74 | 1.72% (1992 - 2005) {0.16} | |
| | | 75+ | 4.10% (1992 - 2005) {0.019}* | |
| | | **All Ages** | **1.22% (1992 - 2005) {0.021}*** | |
| | **Female** | 15-34 | -0.79% (1992 - 2005) {0.74} | |
| | | 35-49 | -1.48% (1992 - 2005) {0.016}* | |
| | | 50-64 | 0.53% (1992 - 2005) {0.60} | |
| | | 65-74 | 1.33% (1992 - 2005) {0.08} | |
| | | 75+ | 3.04% (1992 - 2005) {0.031}* | |
| | | **All Ages** | **0.29% (1992 - 2005) {0.63}** | |

While the Ontario and B.C. data show some variation in their contribution to the national picture, the overall Canadian pattern may be helpfully nuanced by a more detailed analysis from Manitoba. Data summarized in the following table are based on melanoma incidence trends in that province from 1956 to 2005.[30] Incidence rates show signs of slowing in 1981 for females and in 1992 for males. The observed stabilization of the once increasing incidence rates

[30] Pruthi DK, Guilfoyle R, Nugent Z et al. Incidence and anatomic presentation of cutaneous malignant melanoma in central Canada during a 50-year period: 1956 to 2005. *Journal of the American Academy of Dermatology*. 2009; 61(1): 44-50.

appears to be largely related to declining rates in younger populations for both genders. Trends similar to those seen in Manitoba, namely, increasing rates in older populations but decreasing rates in younger populations, have also been observed in Australia, New Zealand, and Germany.[31,32,33,34]

**Trends in Cutaneous Malignant Melanoma in Manitoba**
**Annual Percentage Change (1956 to 2005)**
**By Gender, Age Group and Time Frame**

| Gender | Age | Annual Percent Change (Time Frame) {P-value} | | | |
|---|---|---|---|---|---|
| Male | < 40 | 5.1% (1956 - 1992) | {<0.001} | -5.3% (1992 - 2005) | {0.03} |
| | 40-59 | 5.4% (1956 - 1992) | {<0.001} | 0.6% (1992 - 2005) | {0.65} |
| | 60-79 | 4.5% (1956 - 2005) | {<0.001} | | |
| | 80+ | 2.7% (1956 - 2005) | {<0.001} | | |
| | **All Ages** | **5.3% (1956 - 1992)** | **{<0.001}** | **0.7% (1992 - 2005)** | **{0.51}** |
| Female | < 40 | 5.5% (1956 - 1987) | {<0.001} | -1.8% (1987 - 2005) | {0.15} |
| | 40-59 | 5.8% (1956 - 1983) | {<0.001} | -0.3% (1983 - 2005) | {0.68} |
| | 60-79 | 2.8% (1956 - 2005) | {<0.001} | | |
| | 80+ | 1.9% (1956 - 2005) | {0.002} | | |
| | **All Ages** | **6.2% (1956 - 1981)** | **{<0.001}** | **0.3% (1981 - 2005)** | **{0.52}** |

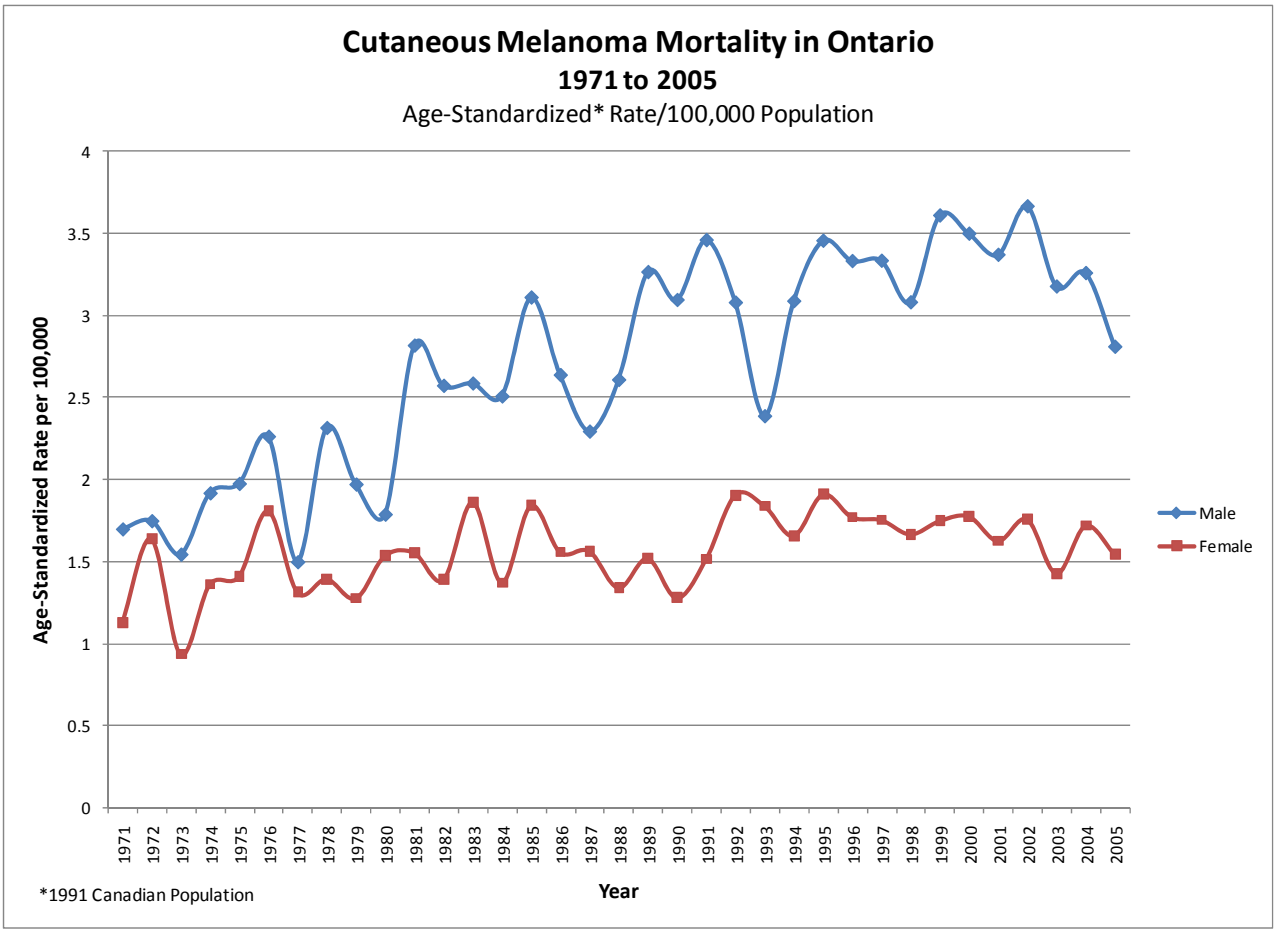
Source: Pruthi et al, *Journal of the American Academy of Dermatology* , 2009

*Age-Standardized Mortality Rate*

Similar to incidence, age-standardized mortality rates due to melanoma have also tended to increase, at least until the 1980s; evidence of this pattern exists across most regions, including Europe, North America, and Australia/New Zealand.[35] In recent years, many jurisdictions have seen a levelling-off or even a decline in this trend.[36,37,38,39,40] For example, the following chart displays the age-standardized mortality rates for both the male and female population in

[31] Coory M, Baade P, Aitken J et al. Trends for in situ and invasive melanoma in Queensland, Australia, 1982-2002. *Cancer Causes and Control.* 2006; 17(1): 21-7.
[32] Marrett LD, Nguyen HL, Armstrong BK. Trends in the incidence of cutaneous malignant melanoma in New South Wales, 1983-1996. *International Journal of Cancer.* 2001; 92(3): 457-62.
[33] Bulliard JL, Cox B. Cutaneous malignant melanoma in New Zealand: trends by anatomical site, 1969-1993. *International Journal of Epidemiology.* 2000; 29(3): 416-23.
[34] Buettner PG, Leiter U, Eigentler TK et al. Development of prognostic factors and survival in cutaneous melanoma over 25 years: An analysis of the Central Malignant Melanoma Registry of the German Dermatological Society. *Cancer.* 2005; 103(3): 616-24.
[35] Garbe C, Leiter U. Melanoma epidemiology and trends. *Clinics in Dermatology.* 2009; (27): 3-9.
[36] La Vecchia C, Lucchini F, Negri E et al. Recent declines in worldwide mortality from cutaneous melanoma in youth and middle age. *International Journal of Cancer.* 1999; 81(1): 62-6.
[37] Jemal A, Devesa SS, Fears TR et al. Cancer surveillance series: changing patterns of cutaneous malignant melanoma mortality rates among whites in the United States. *Journal of the National Cancer Institute.* 2000; 92(10): 811-8.
[38] de Vries E, Bray FI, Coebergh JW et al. Changing epidemiology of malignant cutaneous melanoma in Europe 1953-1997: rising trends in incidence and mortality but recent stabilizations in western Europe and decreases in Scandinavia. *International Journal of Cancer.* 2003; 107(1): 119-26.
[39] Bosetti C, La Vecchia C, Naldi L et al. Mortality from cutaneous malignant melanoma in Europe. Has the epidemic levelled off? *Melanoma Research.* 2004; 14(4): 301-9.
[40] Cayuela A, Rodriguez-Dominguez S, Lapetra-Peralta J et al. Has mortality from malignant melanoma stopped rising in Spain? Analysis of trends between 1975 and 2001. *British Journal of Dermatology.* 2005; 152(5): 997-1000.

Ontario.[41] A number of possible reasons exist for the more recent favourable mortality trends, including changing patterns of sun exposure and sunburn and earlier diagnosis, with both factors leading to a higher proportion of thinner, less invasive melanomas.[42,43] Recent analyses indicate that these very forces are at work in younger cohorts, suggesting some success in both primary and secondary prevention programs.[44,45]




[41] Cancer Care Ontario - SEER*Stat Release 7 - OCRIS (February 2009) released March 2009. Population Data Source: Demographic Estimates Compendium 2007. Statistics Canada, April 2008 (1971–2005).
[42] Garbe C, Leiter U. Melanoma epidemiology and trends. *Clinics in Dermatology*. 2009; (27): 3-9.
[43] Coory M, Baade P, Aitken J et al. Trends for in situ and invasive melanoma in Queensland, Australia, 1982-2002. *Cancer Causes and Control*. 2006; 17(1): 21-7.
[44] Cayuela A, Rodriguez-Dominguez S, Vigil E et al. Effect of age, birth cohort and period of death on skin melanoma mortality in Spain, 1975 through 2004. *International Journal of Cancer*. 2008; 122(4): 905-8.
[45] Downing A, Yu XQ, Newton-Bishop J et al. Trends in prognostic factors and survival from cutaneous melanoma in Yorkshire, UK and New South Wales, Australia between 1993 and 2003. *International Journal of Cancer*. 2008; 123(4): 861-6.

## Non-Melanoma Skin Cancer

### Incidence

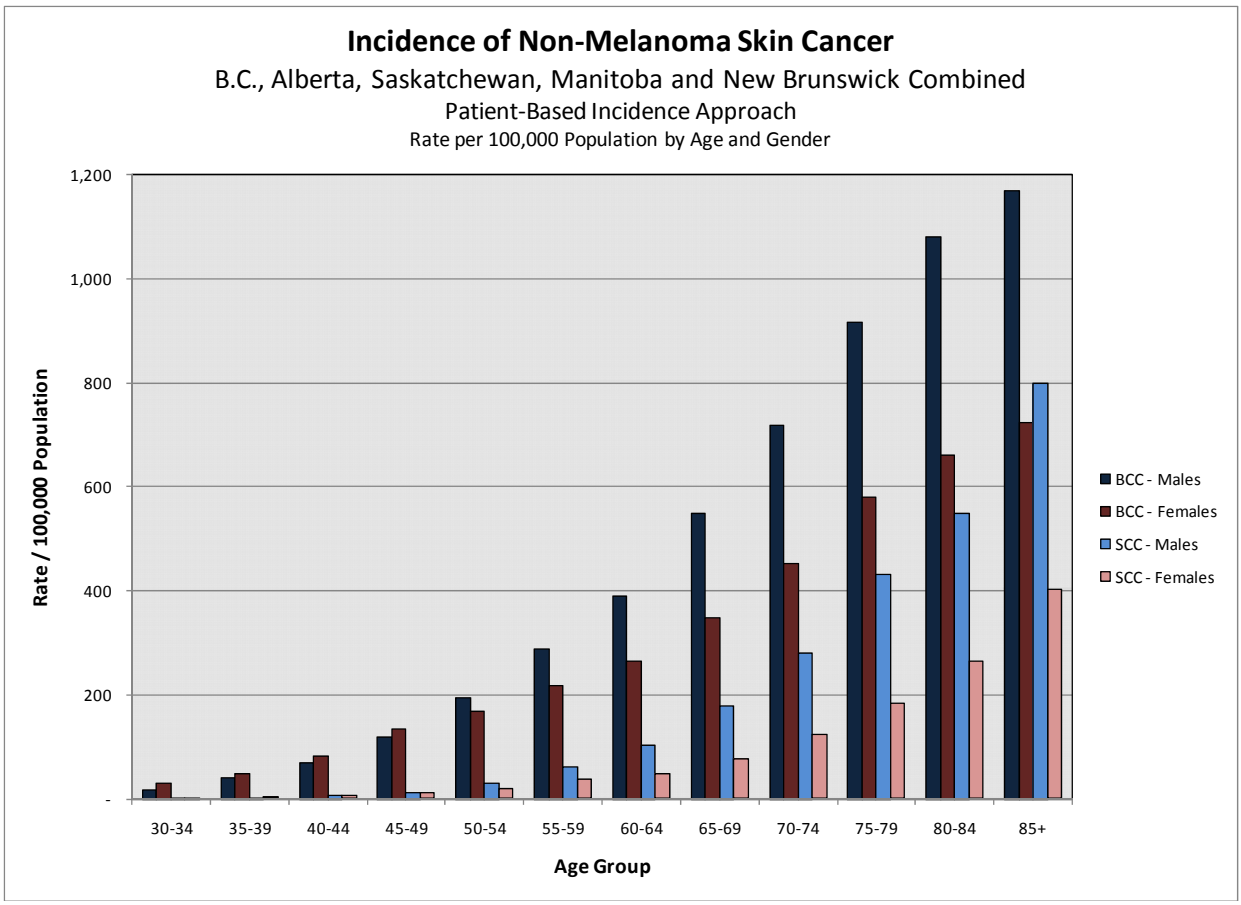
In Canadian jurisdictions, approximately 74% of non-melanoma skin cancers (NMSC) are basal cell carcinomas (BCC).[46] For example, in Manitoba, BCC accounts for 73.6% of NMSC, squamous cell carcinoma (SCC) for 21.9%, and other NMSC for 4.6%.[47]

The following chart has been generated based on data gathered for this project using a 'patient-based incidence approach', that is, skin cancers are only counted once for any given patient. An important goal of this project is to estimate the economic burden of skin cancers in Canada. From this perspective, it would be important to include subsequent primary melanoma and non-melanoma skin cancers and recurrences as they both require treatment and thus utilize resources. Stang and colleagues refer to this as a 'diagnosis-based incidence approach' as compared to a 'patient-based incidence approach,' terminology which has been adopted for this report. Because recurrences and second primary skin cancers are not usually captured by registries, Stang and colleagues argue that a patient-based incidence approach tends to significantly underestimate the true burden of skin cancers in the population.[48]

The age- and gender-specific rates used to generate the data for the following chart are based on information for the five years from 2000 to 2004 in Alberta, Saskatchewan, Manitoba, and New Brunswick, and from 2003 in British Columbia. The incidence of both BCC and SCC increases with age, and is higher in males than females.

The estimated overall incidence rate of NMSC was 179.2 per 100,000 (138.4 for BCC and 40.8 for SCC) while the rate by gender (male/female) of NMSC was 197.2/161.2 per 100,000 (147.9/129.0 for BCC and 49.3/32.2 for SCC).

[46] Hayes RC, Leonfellner S, Pilgrim W et al. Incidence of nonmelanoma skin cancer in New Brunswick, Canada, 1992 to 2001. *Journal of Cutaneous Medicine and Surgery.* 2007; 11(2): 45-52.
[47] Demers AA, Nugent Z, Mihalcioiu C et al. Trends of nonmelanoma skin cancer from 1960 through 2000 in a Canadian population. *Journal of the American Academy of Dermatology.* 2005; 53(2): 320-8.
[48] Stang A, Ziegler S, Buchner U, et al. Malignant melanoma and nonmelanoma skin cancers in Northrhine-Westphalia, Germany: a patient- vs. diagnosis-based incidence approach. *International Journal of Dermatology*. 2007; 46: 564-70.


Incidence of Non-Melanoma Skin Cancer
B.C., Alberta, Saskatchewan, Manitoba and New Brunswick Combined
Patient-Based Incidence Approach
Rate per 100,000 Population by Age and Gender
Rate / 100,000 Population
1,200
1,000
800
600
400
200
-
30-34
35-39
40-44
45-49
50-54
55-59
60-64
65-69
70-74
75-79
80-84
85+
Age Group
BCC - Males
BCC - Females
SCC - Males
SCC - Females

**Body Site**

The face is the most common location of NMSC. Research from New Brunswick, for example, indicates that just over 50% of BCC occur on the face, compared to 39% of SCC (see following table).[49] According to this provincial data, the second most common location for BCC is the trunk (14.4%); for SCC, it is the upper limbs and shoulders (18.8%). The third most common location for SCC is the external ear (13.6%), a site that is far more common in males (20.6%) than females (2.6%).

**Localization of Non-Melanoma Skin Cancers**
**Percent of Total Cases by Gender and Type**
New Brunswick, 1992 to 2001

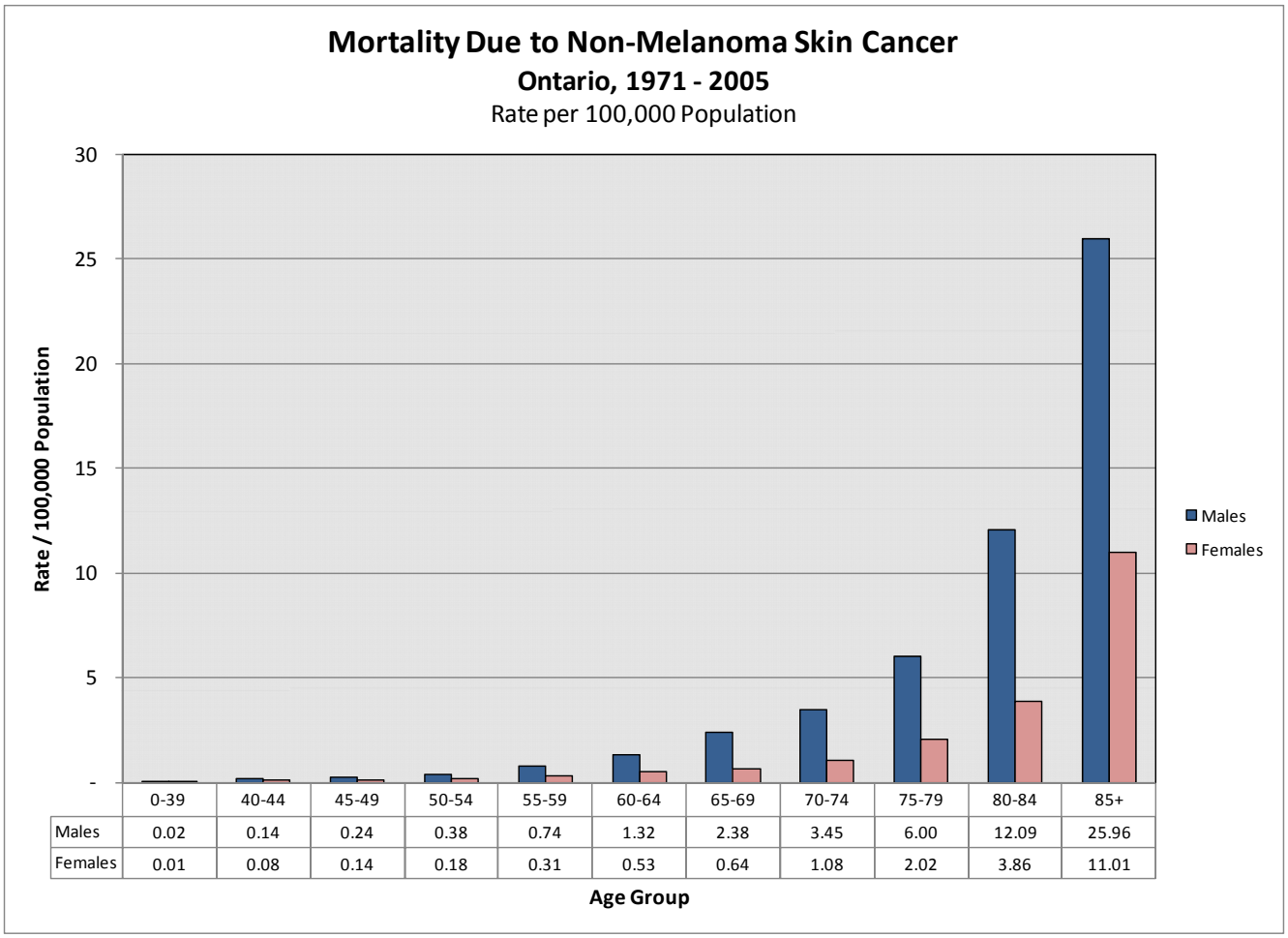
| | Basal Cell Carcinoma | | | Squamous Cell Carcinoma | | |
|---|---|---|---|---|---|---|
| **Localization** | Male | Female | Total | Male | Female | Total |
| Lips | 2.0% | 4.0% | 2.9% | 9.8% | 2.7% | 7.0% |
| Eyelid | 6.6% | 7.8% | 7.2% | 2.7% | 3.0% | 2.8% |
| External Ear | 11.6% | 2.2% | 7.1% | 20.6% | 2.6% | 13.6% |
| Face | 48.2% | 53.4% | 50.7% | 33.3% | 47.8% | 38.9% |
| Scalp/Neck | 6.2% | 6.6% | 6.4% | 7.7% | 4.4% | 6.4% |
| Trunk | 16.2% | 12.4% | 14.4% | 6.3% | 7.3% | 6.7% |
| Upper Limb and Shoulder | 7.1% | 6.6% | 6.9% | 16.9% | 20.6% | 18.3% |
| Leg and Hip | 1.4% | 6.5% | 3.8% | 1.9% | 11.1% | 5.5% |
| Other | 0.6% | 0.6% | 0.6% | 0.8% | 0.6% | 0.7% |

Source: Hayes et al. *Journal of Cutaneous Medicine and Surgery* , 2007

[49] Hayes RC, Leonfellner S, Pilgrim W et al. Incidence of nonmelanoma skin cancer in New Brunswick, Canada, 1992 to 2001. *Journal of Cutaneous Medicine and Surgery*. 2007; 11(2): 45-52.

**Mortality**

As with incidence rates, mortality rates also tend to increase with age, and are consistently higher in males than females. As an example, the following chart indicates mortality data for Ontario between 1971 and 2005.[50] The overall mortality rate due to non-melanoma skin cancer during this time period was 0.55 per 100,000 (0.71 for females and 0.40 for males). The chart displays the variation in mortality rates across different age groups for both the male and female population.



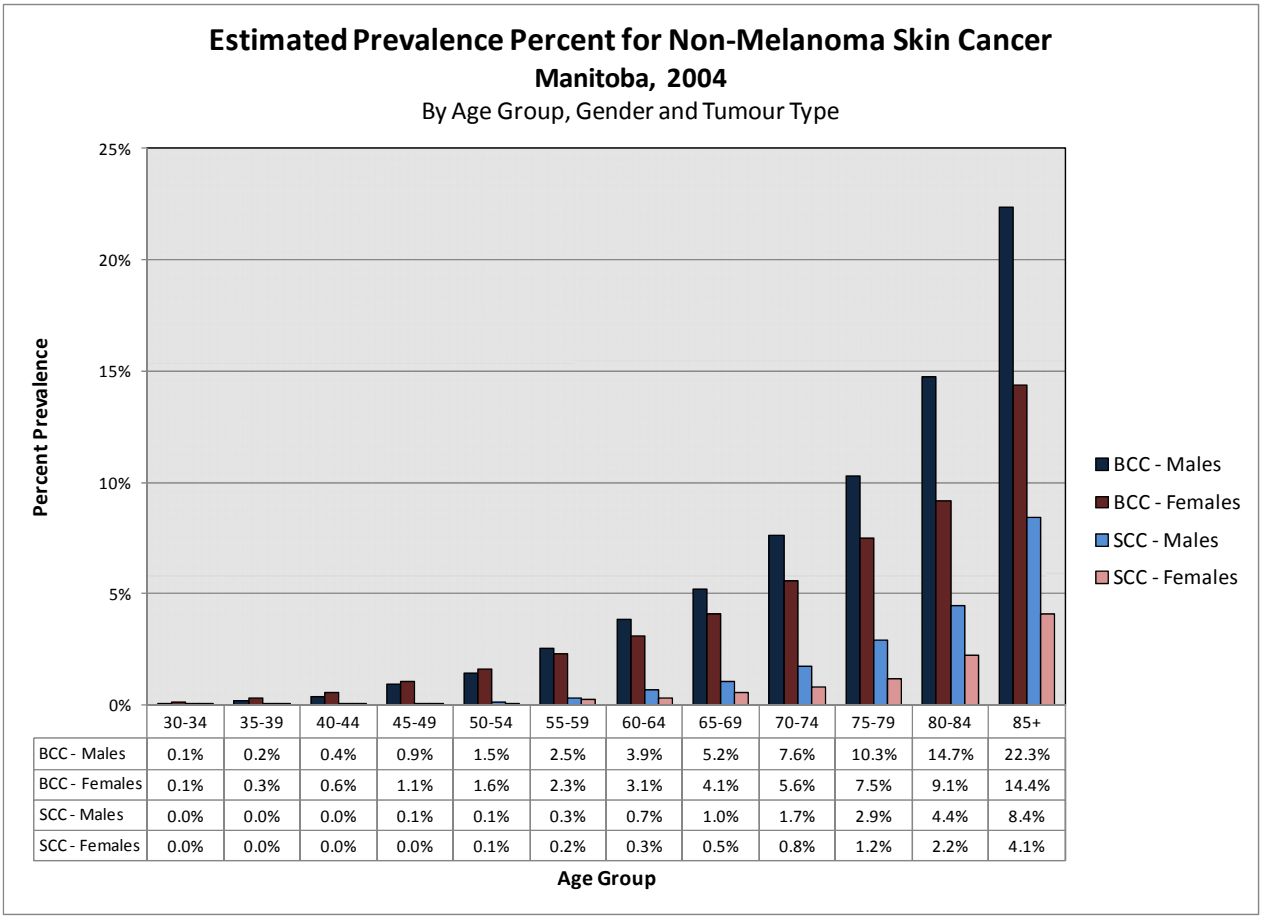

| | 0-39 | 40-44 | 45-49 | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85+ |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Males | 0.02 | 0.14 | 0.24 | 0.38 | 0.74 | 1.32 | 2.38 | 3.45 | 6.00 | 12.09 | 25.96 |
| Females | 0.01 | 0.08 | 0.14 | 0.18 | 0.31 | 0.53 | 0.64 | 1.08 | 2.02 | 3.86 | 11.01 |

[50] Cancer Care Ontario - SEER**Stat Release 7* - OCRIS (February 2009) released March 2009; Population Data Source: *Demographic Estimates Compendium 2007*. Statistics Canada, April 2008 (1971–2005).

**Prevalence**

In the New Brunswick population, the lifetime risk of developing BCC and SCC has been calculated at 13% and 5%, respectively.[51]

Data on the prevalence of NMSC in Manitoba in 2004 were gathered for this project and used to generate the following chart.[52] The overall prevalence for BCC and SCC is 1.70% and 0.34%, respectively. The prevalence increases with age for both BCC and SCC in males and females. By age 75, 10.3% of males and 7.5% of females have been diagnosed with BCC. The equivalent data for SCC are 2.9% and 1.2%.




| | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| BCC - Males | 0.1% | 0.2% | 0.4% | 0.9% | 1.5% | 2.5% | 3.9% | 5.2% | 7.6% | 10.3% | 14.7% | 22.3% |
| BCC - Females | 0.1% | 0.3% | 0.6% | 1.1% | 1.6% | 2.3% | 3.1% | 4.1% | 5.6% | 7.5% | 9.1% | 14.4% |
| SCC - Males | 0.0% | 0.0% | 0.0% | 0.1% | 0.1% | 0.3% | 0.7% | 1.0% | 1.7% | 2.9% | 4.4% | 8.4% |
| SCC - Females | 0.0% | 0.0% | 0.0% | 0.0% | 0.1% | 0.2% | 0.3% | 0.5% | 0.8% | 1.2% | 2.2% | 4.1% |

[51] Hayes RC, Leonfellner S, Pilgrim W et al. Incidence of nonmelanoma skin cancer in New Brunswick, Canada, 1992 to 2001. *Journal of Cutaneous Medicine and Surgery*. 2007; 11(2): 45-52.

[52] Personal communication, Cheryl Clague, Project Manager, Population Health & Research Epidemiology and Cancer Registry, CancerCare Manitoba, November 13, 2009.

**Trends**

*Age-Standardized Incidence Rate*

Available research on trends in NMSC provides mixed information, depending on the jurisdiction. Research from Eastern Canada, Finland, Scotland, and New Mexico suggests persistent increases in age-adjusted rates.[53,54,55,56] A study from Arizona demonstrated stabilizing rates of SCC over time.[57]

In Australia, the age-standardized incidence rate for BCC between 1985 and 2002 increased by 42% in males and 26% in females, while the rate for SCC increased by 139% in both males and females.[58] Although overall incidence rates continue to increase in Australia, there is some evidence of a reduction, at least for BCC, in younger cohorts; the suggestion is that "public health campaigns to reduce sun exposure may be having a beneficial effect on skin cancer rates."[59,60] The beginning of these positive trends may be associated with long-term prevention programs initiated in that country in the 1980s and 90s (see the relevant section of the report below). Prevention programs tend to take a long period of time (usually decades) to yield benefits.[61] Given this lag time, even with the advent of prevention programs in many countries, "ongoing increases in age-adjusted incidence, combined with ageing of the population, will have major implications for the clinical workload associated with NMSC for the foreseeable future."[62]

Between 1960 and 2000, the age-standardized incidence rate for NMSC in Manitoba increased from 36/100,000 (41 for men and 30 for women) to 99/100,000 (112 for men and 90 for women).[63] However, as summarized in the following table, the annual percent change (APC) in the most recent time period has actually decreased. For instance, while rates for BCC in males

[53] Hayes RC, Leonfellner S, Pilgrim W et al. Incidence of nonmelanoma skin cancer in New Brunswick, Canada, 1992 to 2001. *Journal of Cutaneous Medicine and Surgery.* 2007; 11(2): 45-52.
[54] Hannuksela-Svahn A, Pukkala E, Karvonen J. Basal cell skin carcinoma and other nonmelanoma skin cancers in Finland from 1956 through 1995. *Archives of Dermatology.* 1999; 135(7): 781-6.
[55] Brewster DH, Bhatti LA, Inglis JH et al. Recent trends in incidence of nonmelanoma skin cancers in the East of Scotland, 1992-2003. *British Journal of Dermatology.* 2007; 156(6): 1295-300.
[56] Athas WF, Hunt WC, Key CR. Changes in nonmelanoma skin cancer incidence between 1977-1978 and 1998-1999 in Northcentral New Mexico. *Cancer Epidemiology, Biomarkers and Prevention.* 2003; 12(10): 1105-8.
[57] Harris RB, Griffith K, Moon TE. Trends in the incidence of nonmelanoma skin cancers in southeastern Arizona, 1985-1996. *Journal of the American Academy of Dermatology.* 2001; 45(4): 528-36.
[58] Staples MP, Elwood M, Burton RC et al. Non-melanoma skin cancer in Australia: the 2002 national survey and trends since 1985. *Medical Journal of Australia.* 2006; 184(1): 6-10, NSW Skin Cancer Prevention Working Group. *Skin Cancer Prevention Evidence Summary*. 2007. Available at http://www.nswcc.org.au/html/prevention/sunsmart/downloads/skincancer_prevention_evidence_summary.pdf. Accessed January 2009.
[59] Staples M, Marks R, Giles G. Trends in the incidence of non-melanocytic skin cancer (NMSC) treated in Australia 1985-1995: are primary prevention programs starting to have an effect? *International Journal of Cancer.* 1998; 78(2): 144-8.
[60] Staples MP, Elwood M, Burton RC et al. Non-melanoma skin cancer in Australia: the 2002 national survey and trends since 1985. *Medical Journal of Australia.* 2006; 184(1): 6-10.
[61] Krueger H, Williams D, Kaminsky B, McLean D. *The Health Impact of Smoking & Obesity and What to Do About It.* Toronto: University of Toronto Press, 2007.
[62] Brewster DH, Bhatti LA, Inglis JH et al. Recent trends in incidence of nonmelanoma skin cancers in the East of Scotland, 1992-2003. *British Journal of Dermatology.* 2007; 156(6): 1295-300.
[63] Demers AA, Nugent Z, Mihalcioiu C et al. Trends of nonmelanoma skin cancer from 1960 through 2000 in a Canadian population. *Journal of the American Academy of Dermatology.* 2005; 53(2): 320-8.

ages 60-79 increased at an APC of 7.7% between 1964 and 1972, since that time the APC has dropped to 2.9%. This means incidence is still increasing, but at a slower rate.

**Trends in NMSC in Manitoba**
**Annual Percent Change (1960 to 2000)**
**By Type, Gender and Age Group and Time Frame**

| Type | Gender | Age | Annual Percent Change (Time Frame) | | |
|---|---|---|---|---|---|
| BCC | | | | | |
| | Male | 40-59 | 4.8% (1960 - 2000) | | |
| | | 60-79 | -6.6% (1960 - 1964) | 7.7% (1964 - 1972) | 2.9% (1972 - 2000) |
| | | 80+ | 4.1% (1960 - 1982) | 1.3% (1982 - 2000) | |
| | Female | 40-59 | 1.6% (1960 - 2000) | | |
| | | 60-79 | 3.0% (1960 - 2000) | | |
| | | 80+ | 5.5% (1960 - 1974) | 1.3% (1974 - 2000) | |
| SCC | | | | | |
| | Male | 40-59 | 5.5% (1960 - 1977) | 0.5% (1977 - 2000) | |
| | | 60-79 | 7.4% (1960 - 1972) | 2.9% (1972 - 2000) | |
| | | 80+ | 3.4% (1960 - 2000) | | |
| | Female | 40-59 | 14.5% (1960 - 1971) | 1.8% (1971 - 2000) | |
| | | 60-79 | 8.6% (1960 - 1972) | 3.3% (1972 - 2000) | |
| | | 80+ | 2.3% (1960 - 2000) | | |

Source: Demers et al, *Journal of the American Academy of Dermatology*, 2005

Ongoing research from this study group, which has examined trends from 1956 to 2005, confirm that the rates of both BCC and SCC are not only stabilizing but showing signs of decline (see the following table).[64] For example, the APC for incidence of male SCC decreased from +2.6% between 1971 and 1997 to -7.5% between 1997 and 2005.

**Trends in NMSC in Manitoba**
**Annual Percent Change (1956 to 2005)**
**By Type, Gender, Age Group and Time Frame**

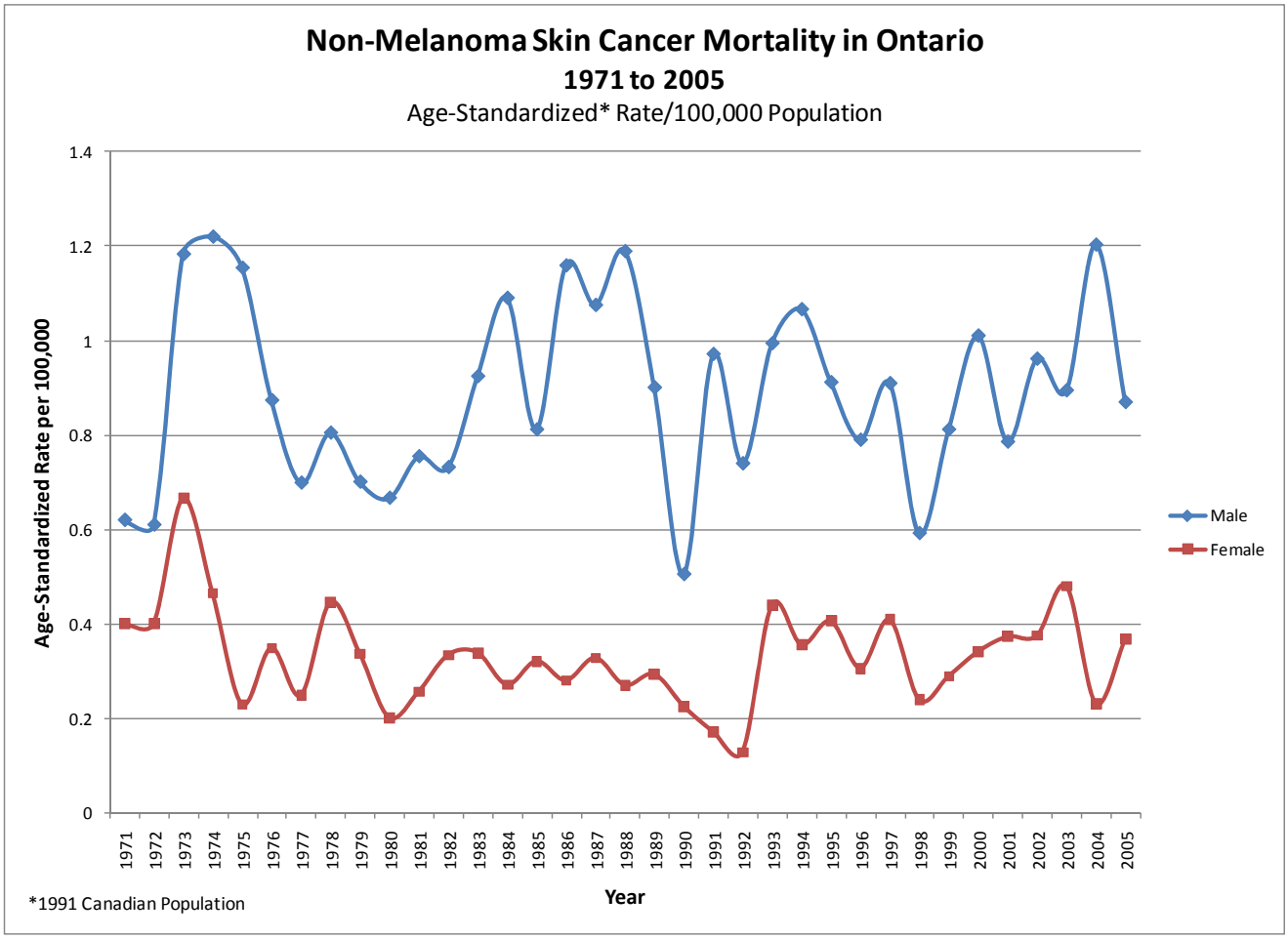
| Type | Gender | Age | Annual Percent Change (Time Frame) {P-value} | | | |
|---|---|---|---|---|---|---|
| **BCC** | | | | | | |
| | **Male** | < 40 | 2.5% (1956 - 2005) {<0.001} | | | |
| | | 40-59 | 4.4% (1956 - 1976) {<0.001} | 1.2% (1976 - 2005) {<0.001} | | |
| | | 60-79 | 0.4% (1956 - 1967) {0.77} | 10.9% (1967 - 1971) {0.18} | 3.0% (1971 - 1999) {<0.001} | -2.9% (1999 - 2005) {0.047} |
| | | 80+ | 3.8% (1956 - 1983) {<0.001} | 1.2% (1983 - 2005) {0.002} | | |
| | | **All Ages** | **0.9% (1956 - 1967) {0.37}** | **11.0% (1967 - 1971) {0.09}** | **2.2% (1971 - 2000) {<0.001}** | **-2.9% (2000 - 2005) {0.06}** |
| | **Female** | < 40 | 4.3% (1956 - 1994) {<0.001} | -0.4% (1994 - 2005) {0.85} | | |
| | | 40-59 | -0.8% (1956 - 1965) {0.76} | 9.6% (1965 - 1973) {0.003} | 2.2% (1973 - 2005) {<0.001} | |
| | | 60-79 | 2.9% (1956 - 2002) {<0.001} | -7.6% (2002 - 2005) {0.17} | | |
| | | 80+ | 3.1% (1956 - 1987) {<0.001} | 0.2% (1987 - 2005) {0.62} | | |
| | | **All Ages** | **-0.8% (1956 - 1967) {0.52}** | **17.3% (1967 - 1970) {0.32}** | **2.5% (1970 - 2001) {<0.001}** | **-3.5% (2001 - 2005) {0.16}** |
| **SCC** | | | | | | |
| | **Male** | 40-59 | 6.5% (1956 - 1971) {0.001} | 1.5% (1971 - 1998) {0.006} | -20.9% (1998 - 2003) {0.01} | 32.6% (2003 - 2005) {0.04} |
| | | 60-79 | 3.8% (1956 - 1997) {<0.001} | -7.6% (1997 - 2005) {<0.001} | | |
| | | 80+ | 3.5% (1956 - 1997) {<0.001} | -4.5% (1997 - 2005) {0.04} | | |
| | | **All Ages** | **-0.1% (1956 - 1965) {0.96}** | **12.0% (1965 - 1971) {0.03}** | **2.6% (1971 - 1997) {<0.001}** | **-7.5% (1997 - 2005) {<0.001}** |
| | **Female** | 40-59 | -9.6% (1956 - 1966) {0.06} | 31.2% (1966 - 1971) {0.14} | 1.9% (1971 - 1998) {0.007} | -8.0% (1998 - 2005) {0.05} |
| | | 60-79 | 7.1% (1956 - 1973) {<0.001} | 3.5% (1973 - 1998) {<0.001} | -10.8% (1998 - 2005) {<0.001} | |
| | | 80+ | 3.1% (1956 - 1994) {<0.001} | -3.2% (1994 - 2005) {0.06} | | |
| | | **All Ages** | **6.1% (1956 - 1974) {<0.001}** | **3.0% (1974 - 1998) {<0.001}** | **-9.8% (1998 - 2005) {<0.001}** | |

Source: Demers, *Personal Communication*, 2009

[64] Demers, AA. Personal Communication, January, 2009. Based on a paper submitted for publication to the *British Journal of Cancer*.

*Age-Standardized Mortality Rate*

Trends in the mortality of NMSC are notoriously difficult to ascertain, since many of the deaths attributed to NMSC may be misclassified. The trends in age-adjusted mortality rates for males and females due to NMSC in Ontario between 1971 and 2005 are shown in the following chart.[65]




[65] Cancer Care Ontario - SEER*Stat Release 7 - OCRIS (February 2009) released March 2009. Population Data Source: Demographic Estimates Compendium 2007. Statistics Canada, April 2008 (1971–2005).

### Recurrence and Second Primary Cancers

The risk of recurrence of a skin cancer, or the risk of second primary cancers following a first primary skin cancer, represents a component of the total burden of skin cancer incidence. For example, an estimated 6.6% of reported melanomas are in fact recurrences, and a further 2.6% of individuals with a primary melanoma will develop a subsequent primary melanoma.[66] Individuals who have had an initial diagnosis of BCC or SCC are at a substantially increased risk of a second BCC or SCC. In their meta-analysis, Marcil and Stern found that an average of 44% of individuals with an incident BCC had a subsequent BCC within three years. For SCC, this proportion was 18%.[67] Efird et al. found that individuals with SCC had a relative risk of 13.8 (95% CI = 8.8-21.9) for developing a subsequent BCC.[68] (See Appendix B for additional details).

### The Economic Burden of Skin Cancers

The average cost per episode of NMSC care in the United States has been estimated at $330 to $470 (US$). [69,70] This figure varies significantly depending on the clinical setting in which the care occurs. An episode of care in an outpatient setting is double that offered in a physician's office, while care in an inpatient setting is 10-20 times greater.[71,72,73] These differences likely reflect the typical complexity and stage of the cancer treated in different settings.

The type of treatment provided, and whether the cancer is primary or recurrent, also impacts the cost. A recent study in Ontario found that the direct treatment costs for a complex *primary* facial BCC using Mohs surgery was $881, versus $3,726 for radiation therapy. For a complex *recurrent* facial BCC the costs were $1,011 for Mohs surgery, versus $3,788 for radiation therapy.[74]

The average annual direct cost per melanoma patient in the United States was estimated to be $12,500 (1997 US$).[75] These costs vary substantially by cancer stage, ranging from $1,310 (for Stage I) to $42,410 (for Stage 4). Aggregated over the patient population, an estimated 90% of such costs are attributable to the 20% of patients with Stage III or IV cancer. Patients with the

[66] Francken AB, Bastiaannet E, Hoekstra HJ. Follow-up in patients with localised primary cutaneous melanoma. *Lancet Oncology.* 2005; 6(8): 608-21.
[67] Marcil I, Stern RS. Risk of developing a subsequent nonmelanoma skin cancer in patients with a history of nonmelanoma skin cancer: a critical review of the literature and meta-analysis. *Archives of Dermatology.* 2000; 136(12): 1524-30.
[68] Efird JT, Friedman GD, Habel L et al. Risk of subsequent cancer following invasive or in situ squamous cell skin cancer. *Annals of Epidemiology.* 2002; 12(7): 469-75.
[69] Joseph AK, Mark TL, Mueller C. The period prevalence and costs of treating nonmelanoma skin cancers in patients over 65 years of age covered by Medicare. *Dermatologic Surgery.* 2001; 27(11): 955-9.
[70] Housman TS, Williford PM, Feldman SR et al. Nonmelanoma skin cancer: an episode of care management approach. *Dermatologic Surgery.* 2003; 29(7): 700-11.
[71] Chen JG, Fleischer AB, Jr., Smith ED et al. Cost of nonmelanoma skin cancer treatment in the United States. *Dermatologic Surgery.* 2001; 27(12): 1035-8.
[72] Housman TS, Williford PM, Feldman SR et al. Nonmelanoma skin cancer: an episode of care management approach. *Dermatologic Surgery.* 2003; 29(7): 700-11.
[73] Chen JG, Yelverton CB, Polisetty SS et al. Treatment patterns and cost of nonmelanoma skin cancer management. *Dermatologic Surgery.* 2006; 32(10): 1266-71.
[74] Lear W, Mittmann N, Barnes E et al. Cost comparisons of managing complex facial basal cell carcinoma: Canadian study. *Journal of Cutaneous Medicine and Surgery.* 2008; 12(2): 82-7.
[75] Tsao H, Rogers GS, Sober AJ. An estimate of the annual direct cost of treating cutaneous melanoma. *Journal of the American Academy of Dermatology.* 1998; 38(5 Pt 1): 669-80.

most advanced cancer, metastatic melanoma, cost an average of $59,400; despite treatment efforts, 82% of these patients die within 9 months.[76]

Australian lifetime treatment costs for melanoma, estimated to be AUS$3,341, tend to be lower than in the United States. This likely reflects differences in health system practices and the stage at which the majority of cancer cases are treated.[77]

Studies in both England and the United States have estimated the aggregate costs associated with treating both melanoma and NMSC. A study by The Lewin Group, Inc. found the annual costs associated with melanoma in the U.S. in 2004 to be $3.12 billion ($280 million in direct costs and $2.84 billion in indirect costs).[78] The direct costs included the following categories: office visits ($101 million), hospital outpatient ($76 million), hospital inpatient ($35 million), prescription drugs ($78 million), and emergency department ($1 million). Indirect costs are those associated with disease-specific morbidity and premature mortality.

For NMSC, the same study found the annual costs to be $2.41 billion ($1.46 billion in direct costs and $950 million in indirect costs).[79] The direct costs comprised office visits ($1,205 million), hospital outpatient ($162 million), hospital inpatient ($65 million), prescription drugs ($19 million), and emergency department ($1 million).

A recent study in England estimated the costs of all skin cancers to be £240 million,[80] with 42% of these costs being classified as direct and 58% as indirect (see following table).[81] The indirect costs associated with melanoma are substantially higher than for NMSC, largely due to the higher mortality rate linked to melanoma. By comparison, total direct costs for NMSC are four times higher than the direct costs for treating melanoma, reflecting the higher volume of NMSC across the population.

[76] Hillner BE, Kirkwood JM, Agarwala SS. Burden of illness associated with metastatic melanoma: an audit of 100 consecutive referral center cases. *Cancer.* 2001; 91(9): 1814-21.
[77] Australian Institute of Health and Welfare. *Health system expenditures on cancer and other neoplasms in Australia, 2000-01*. 2005. Available at http://www.aihw.gov.au/publications/hwe/hsecna00-01/hsecna00-01.pdf. Accessed January 2009.
[78] Lewin Group Inc. *The Burden of Skin Diseases 2004.* 2006. Society for Investigative Dermatology and American Academy of Dermatology Association. Available at http://www.lewin.com/content/publications/april2005skindisease.pdf. Accessed January 2009.
[79] Lewin Group Inc. *The Burden of Skin Diseases 2004.* 2006. Society for Investigative Dermatology and American Academy of Dermatology Association. Available at http://www.lewin.com/content/publications/april2005skindisease.pdf. Accessed January 2009.
[80] One British pound was valued at $1.82 Can$ on January 19, 2009.
[81] Morris S, Cox B, Bosanquet N. Cost of skin cancer in England. *European Journal of Health Economics.* 2008: Epublished ahead of print.

**Cost of Skin Cancer**
**England, 2002 (£000s)**

| | Malignant Melanoma | | Other Malignant Neoplasms of the Skin | | All Skin Cancers | |
|---|---|---|---|---|---|---|
| GP consultations | 475 | 0.3% | 2,163 | 2.1% | 2,638 | 1.1% |
| Inpatient care | 6,806 | 4.9% | 18,071 | 17.8% | 24,877 | 10.4% |
| Day cases | 1,509 | 1.1% | 12,036 | 11.9% | 13,545 | 5.6% |
| Outpatient attendances | 11,611 | 8.4% | 48,924 | 48.2% | 60,535 | 25.2% |
| **Sub-Total NHS Cost** | **20,401** | **14.7%** | **81,194** | **80.0%** | **101,595** | **42.3%** |
| Patient costs | 3,616 | 2.6% | 15,659 | 15.4% | 19,275 | 8.0% |
| Indirect morbidity costs | 20,859 | 15.1% | - | | 20,859 | 8.7% |
| Indirect mortality costs | 93,551 | 67.6% | 4,616 | 4.5% | 98,167 | 40.9% |
| **Total cost** | **138,427** | **100.0%** | **101,469** | **100.0%** | **239,896** | **100.0%** |

Source: Morris et al., *European Journal of Health Economics* , 2008.

A number of studies have placed the costs of treating NMSC within the context of treating other cancers. In the U.S. Medicare population, Houseman and colleagues found that NMSC is among the most costly of all cancers to treat.[82] Based on Medicare payment information (i.e., direct care costs only), they estimated the annual costs for treating NMSC to be $562 million between 1992 and 1995. These annual costs are exceeded only by the treatment expenses associated with lung, prostate, colorectal, and female breast cancers (see following table).

**Annual Mean Cancer Medicare Payments**
**Millions of U.S. Dollars**
**1992-1995**

| Malignancy | Payment |
|---|---|
| All cancers | $12,547 |
| Lung and bronchus | $1,793 |
| Prostate | $1,706 |
| Colon and rectum | $1,479 |
| Breast (female) | $840 |
| Nonmelanoma skin cancer | $562 |
| Leukemia | $482 |
| Non-Hodgkin's lymphoma | $477 |
| Ovarian | $262 |
| Pancreatic | $256 |
| Stomach | $236 |
| Melanoma | $28 |

Source: Housman et al., *Journal of the American Academy of Dermatology* , 2003.

[82] Housman TS, Feldman SR, Williford PM et al. Skin cancer is among the most costly of all cancers to treat for the Medicare population. *Journal of the American Academy of Dermatology.* 2003; 48(3): 425-9.

In Australia, NMSC is the most costly cancer in terms of direct health care costs.[83] In 2001, AUS$264[84] million was spent on treating NMSC, exceeding both breast (AUS$241 million) and colorectal (AUS$235 million) cancers. This is largely due to the sheer volume of NMSC cases in that country. Of the total new cancer cases in 2001, 80.5% were NMSC (364,140 of 452,538). In this light, it is not surprising that Australia has invested significantly in skin cancer prevention efforts, establishing itself as a leader in this area (see below).

### Effective Prevention Programs

The most comprehensive and arguably most successful population-level skin cancer prevention programs have been conducted in Australia (see Appendix C for details). This is consistent with Australia's status as the country with the highest incidence and mortality rates for skin cancer in the world.[85] Various awareness campaigns and multi-component interventions at community, state, and national levels have not only resulted in changes in knowledge and attitudes but have also increased sun protection behaviours. There are even early indications that the positive behavioural changes, which are a reasonable proxy for reduced sun exposure, have led to a reduction in melanoma incidence. The fact that occurrence of melanoma is the leading-edge indicator makes sense, since that form of skin cancer develops more frequently at younger ages as compared with NMSC.

The *SunSmart Program* was launched in the state of Victoria, Australia, in 1987 and continues to be used up to the present time. Building on an earlier, modestly funded Australian campaign known as *Slip! Slop! Slap!*, the more comprehensive Victorian program has been progressively adopted by other states in the country.

*SunSmart* and similar Australian efforts differ from the more basic programs common in other parts of the world; in short, they represent a comprehensive health promotion strategy involving mass media, local and state government efforts, school programs, and community organizations, with a focus on supporting the implementation of sun protection policies and practices that lead to long-term structural and organizational change.

A fundamental objective of *SunSmart* is to effect changes in sun protection behaviour, with an aim to reducing sun exposure and its attendant health risks. Results suggest some progress in this regard, indicating that there was a consistent increase in the proportion of people practicing sun protection measures between 1988 and 2001, as well as reductions in reported sore or tender sunburns.[86,87] Although the occurrence of both melanoma and NMSC is still increasing in most of the Australian population, some age-specific incidence data for the state of Victoria show a more encouraging trend. For the period 1995-2004, melanoma incidence rates

[83] Australian Institute of Health and Welfare. *Health system expenditures on cancer and other neoplasms in Australia, 2000-01*. 2005. Available at http://www.aihw.gov.au/publications/hwe/hsecna00-01/hsecna00-01.pdf. Accessed January 2009.
[84] One Australian dollar was valued at $0.84 Can$ on January 19, 2009.
[85] Carter R, Marks R, Hill D. Could a national skin cancer primary prevention campaign in Australia be worthwhile?: an economic perspective. *Health Promotion International.* 1999; 14(1): 73-82.
[86] *SunSmart Program 2003-2006*. 2002. Available at http://www.sunsmart.com.au/downloads/about_sunsmart/reports/sunsmart_program_2003_2006.pdf. Accessed January 2009.
[87] NSW Skin Cancer Prevention Working Group. *Skin Cancer Prevention Evidence Summary*. 2007. Available at http://www.nswcc.org.au/html/prevention/sunsmart/downloads/skincancer_prevention_evidence_summary.pdf. Accessed January 2009.

*decreased* in Victorian men and women aged under 60 years.[88] The trend for BCC incidence in Australia may be similar to melanoma, especially in the Victorian context. There were reductions in BCC rates for men and women under forty years of age between 1985 and 1995 in that state; this may be compared with the relatively stable rates for those between 40 and 49 years, and increasing rates in older cohorts.[89]

## The Canadian Context

### Canadian Initiatives

There are a number of national initiatives related to sun awareness in Canada. Since the late 1980s, the Canadian Cancer Society has been producing sun safety materials; in 1993, "SunSense" became one of the Society's four health promotion priorities. In 1992, Environment Canada launched the UV Index Forecast Program, through which information regarding the intensity of solar UV radiation is provided to Canadians to motivate personal protection measures. In a related effort, Health Canada collaborated with Environment Canada to launch the UV Index Sun Awareness Program. This is an annual campaign designed to teach Canadian children in schools and daycare centers about UV radiation, the harmful effects of overexposure, and how to protect themselves. The Canadian Dermatology Association has organized a nationwide Sun Awareness Week since 1988, with the goal of educating the Canadian public about the dangers of too much sun.[90] The Canada Safety Council, along with various partners, developed the Canada Sun Guide in 1996, aimed to help Canadians incorporate sun safety into outdoor activities.

### National Sun Survey Results

Two surveys regarding sun-related behaviours, knowledge, and attitudes have been conducted in Canada: the *National Survey on Sun Exposure & Protective Behaviours* (1996) and the *National Sun Survey* (2006). The two surveys showed a significant change in the experience of sunburns. In 1996, about half of the Canadian population aged 15 years or older had one or more sunburns during the summer, compared with only 19% of adults in 2006.[91,92, 93] Further highlights of the 2006 National Sun Survey are outlined in the following table.

---

[88] Cancer Council Victoria Epidemiology Centre. *Canstat: Skin Cancer*. 2007. Available at http://www.cancervic.org.au/downloads/about_our_research/canstats/more_canstats/Canstat_45_cancer_stats_2005.pdf. Accessed January 2009.

[89] Cancer Council Victoria Epidemiology Centre. *Canstat: Skin Cancer*. 2007. Available at http://www.cancervic.org.au/downloads/about_our_research/canstats/more_canstats/Canstat_45_cancer_stats_2005.pdf. Accessed January 2009.

[90] Rivers JK, Gallagher RP. Public education projects in skin cancer. Experience of the Canadian Dermatology Association. *Cancer*. 1995; 75(2 Suppl): 661-6.

[91] Shoveller JA, Lovato CY, Peters L, Rivers JK. Canadian National Survey on Sun Exposure & Protective Behaviours: adults at leisure. *Cancer Prevention & Control.* 1998; 2(3): 111-6.

[92] Purdue MP, Marrett LD, Peters L et al. Predictors of sunburn among Canadian adults. *Preventive Medicine.* 2001; 33(4): 305-12.

[93] Marrett L. *Sun exposure, tanning and protective behaviours: How are we doing? Results from the Second National Sun Survey (Part 1).* 2008. Cancer Care Ontario. Available at http://www.partnershipagainstcancer.ca/assets/SkinCancer/sun_consult_ppag_2008_LMarrett_SecondSunSafety_pt1.pdf. Accessed August 2008. and Marrett L. *Sun exposure, tanning and protective behaviours: How are we doing? Results from the Second National Sun Survey (Part 2).* 2008. Cancer Care Ontario. Available at http://www.partnershipagainstcancer.ca/assets/SkinCancer/sun_consult_ppag_2008_LMarrett_SecondSunSafety_pt2.pdf. Accessed August 2008.

| Selected Results from the National Sun Survey, 2006 | |
|---|---|
| **Sun-related Behaviour** | **Canadian adults (%)** |
| Seeking a tan from the sun | 22 |
| Practicing sun protection behaviours | 69 |
| Seeking shade for 30 minutes or more | 44 |
| Always or often wearing protective clothing when in the sun for 30 minutes or more | 37 |
| Always or often wearing sunscreen SPF15 or greater on face and body when in the sun for 30 minutes or more | 29 |
| Source: Marrett L., *Cancer Care Ontario* , 2008. | |

### Estimates of Skin Cancer Cases and Deaths in Canada

Fundamental to the present project will be the quantification of annual skin cancer burden in Canada. Estimates of the number of new melanoma and non-melanoma skin cancers in the country for 2008 are included in *Canadian Cancer Statistics 2008*.[94] An estimated 73,000 non-melanoma cases and 4,600 new melanomas will occur in Canada in 2008, with an estimated 260 and 910 deaths, respectively. The equivalent estimates for melanoma in 2004 were 4,200 new cases and 850 deaths; indicating, in other words, an appreciable increase over the time period. As will be explained below, achieving a similar comparison for NMSC incidence is more challenging, given a variation in methodology between the two evaluation points.

As is true for many jurisdictions in the world, non-melanoma skin cancers are not routinely tracked in most Canadian provinces. The authors of *Canadian Cancer Statistics 2008* used the following approach to generate their projections:

> *For 2008 non-melanoma skin cancer estimates were the average of estimates obtained by applying British Columbia, Manitoba and New Brunswick rates to the Canadian population. The pathology laboratories in British Columbia send all diagnostic reports of non-melanoma (basal cell and squamous cell) skin cancer to the provincial registry. It is assumed that non-melanoma skin cancer is under-reported to some extent. The age- and sex-specific incidence rates in British Columbia for 2003 has been projected to the current year and applied to the Canadian population estimates to generate a minimal estimate of the number of cases for Canada as a whole. For Manitoba summary counts of new basal and squamous cell cases 1986 to 2005 by age group were provided by the Cancer Registry and rates were projected using linear regression to 2008. For New Brunswick, summary counts of new basal and squamous cell cases 1989 to 2006 by age group were provided by the Cancer Registry and rates were projected using linear regression to 2008.* (pg. 91)

In short, projections based on one province were moderated in two parts of the country, specifically by actual incidence data made available by other provinces. By contrast, in 2004, the estimated number of NMSC in Canada was solely based on the age- and gender-specific incidence rates in British Columbia for 1985-1994 (in 20-year age groups), which were then

[94] Canadian Cancer Society/ National Cancer Institute of Canada. *Canadian Cancer Statistics 2008*. 2008.

applied to total Canadian population estimates. This approach suggested that 76,000 new non-melanoma skin cancer cases would occur in Canada in 2004.[95]
NMSC rates in B.C. tend to be higher than those in Manitoba or New Brunswick (see Appendix E of this report), thus explaining the higher Canadian estimate in 2004 (compared to 2008). Once again, the 2008 estimates used data from all three provinces in estimating total NMSC cases in Canada for 2008; the result of this refinement of the methodology was a lower estimate for incidence (73,000, as cited earlier, compared to 76,000 for 2004).

The authors of this report are not aware of any studies that have used any such methodology to project the number of melanoma or non-melanoma skin cancers in Canada into the future, or that have estimated the economic burden of these cancers in Canada.

### Purpose of the Current Project

This project has been commissioned by the National Skin Cancer Prevention Committee (NSCPC). The NSCPC is a sub-committee of the Canadian Partnership Against Cancer's Primary Prevention Action Group.

The goals of the project are as follows:

- Estimate the number of melanoma[96] and non-melanoma skin cancers cases in 2004 in Canada by age, gender and geographic region (province/territory).
- Estimate the number of deaths due to melanoma and non-melanoma skin cancers in 2004 in Canada by age, gender and geographic region (province/territory).
- Project the number of new cases and deaths in Canada in future years (specifically, 2011, 2016, 2021, 2026 and 2031) by age, gender, and geographic region.
- Estimate the economic burden associated with these skin cancer cases and deaths in each of the years (i.e., in 2004, as well as the years used for the incidence and mortality projections). The economic burden is intended to include estimates of both direct and indirect costs.
- Estimate the potential effectiveness and costs of a comprehensive skin cancer prevention program in Canada. Compare the costs of such a program with potential costs avoided due to a future reduction in skin cancer cases and deaths.

[95] National Cancer Institute of Canada. *Canadian Cancer Statistics 2004*. 2004.
[96] Both the Canadian Cancer Society and the Public Health Agency of Canada produce detailed reports on the number of melanoma cases and deaths in Canada. A number of deficiencies in this data were identified by Dr. Lorraine Marrett in a December 4, 2008 email to Dr. Hans Krueger; in particular, the need to adjust for known under-reporting in Quebec and the conservative coding in the Canadian Cancer Registry.

## Methods

This section of the report briefly introduces the methods used to estimate the following data:

1. Current and projected incidence and mortality for the main types of skin cancer in Canada
2. Economic burden associated with skin cancer incidence and mortality
3. Potential benefit of a Canadian skin cancer prevention program in terms of reduced incidence and avoided costs

Additional details are offered in a series of appendices to the report.

### Current and Projected Skin Cancer Incidence and Mortality in Canada

*Note: At the time of writing of this report, "current" refers to the most recent year when actual incidence data were available, usually 2004. Projections were built on this base information, calculated to 2031, the most distant year that population projections were available from Statistics Canada. The entire time period of 28 years between 2004 and 2031 was utilized in modelling the potential change in incidence of skin cancers and associated economic burden. This approach was taken given the known time lag between prevention efforts and a potential change in incidence and economic burden.*

#### Cutaneous Melanoma

##### Estimating the Number of Melanoma Cases in 2004

The *Cancer Surveillance Online* system, maintained by the Public Health Agency of Canada, represents a key resource for directly determining melanoma incidence in most provinces and across most age- and gender-based categories. It also allows for the calculation of age- and gender-specific rates for 1994-2004; the latter information was useful both for filling in missing incidence data and for the subsequent step of projecting future melanoma incidence.

Accounting for the known deficiencies in the online data was accomplished as follows:

- *"Gaps" Related to Low Incidence Situations:* The age- and gender-specific rate for all of Canada was applied to the relevant age- and gender-specific population to deal with any situation where the number of melanoma cases dropped below 5 (such cells are routinely left blank in the online system). The incidence figures were uniformly increased or decreased so that the final total number of cases equalled the total by gender for that province/territory (as provided online).
- *Quebec Adjustment:* The number of melanoma cases in the Quebec cancer registry is under-ascertained due to that province's dependence on hospital separation data.[97] The adjustment method adopted in the report involved calculating the ratio of incidence to mortality in Canada for 2000-2004 (exclusive of Quebec data) and then applying that information to Quebec mortality data.
- *Adjustment Due To Conservative Coding in Cancer Registries:* The International Agency for Research on Cancer "second primary melanoma" coding rules, which currently inform official Canadian cancer statistics, have been shown to lead to under-

[97] Brisson J, Major D, Pelletier E. *Evaluation of the completeness of the fichier des tumeurs du Québec*. Institut national de la santé publique du Québec, 2003.

reporting of melanoma incidence (compared to, for example, the U.S. approach found in the Surveillance, Epidemiology and End Results, or SEER, system). The average "under-reporting rate," as determined by a number of studies, was applied in this report to adjust the incidence rate upward. [98,99,100] A further proportion of melanomas are in fact recurrences, which are also not captured in cancer registries according to standard coding rules; this yielded a second adjustment amount for the purposes of the present project.[101] These sorts of adjustments have been described as a "diagnosis-based incidence approach," which can be contrasted with the "patient-based incidence approach" that typically yields smaller case numbers.[102]

The several strategies employed to generate melanoma incidence in Canada in 2004 are explained in greater detail in Appendix D.

#### Estimating Melanoma Mortality in 2000-2004

Actual deaths for men and women due to melanoma are available in the annual Canadian Cancer Statistics reports. However, age-specific mortality rates are not provided. Such information is useful in apportioning known deaths into age categories, which in turn is critical for making population-based projections of mortality to 2031. As the foundation of this process, it was possible to apply average age- and gender-specific mortality rates from Ontario between 1971 and 2005 to apportion the actual number of deaths in the Canadian provinces into 5-year age groups. These rates also allowed the missing information to be filled in for provinces/territories with smaller populations, so that a more complete accounting of total melanoma deaths over a 5-year period (from 2000-2004) for each jurisdiction could be developed. See Appendix D for details.

#### Projecting Melanoma Cases to 2031

Age-standardized incidence rates of melanoma skin cancers in the Canadian population were analyzed using the Joinpoint Regression Program (v2.7) to assess trends and annual percent change (APC) by gender and age.[103] The aim is to determine whether the incidence rate is increasing (positive APC) or decreasing (negative APC) over the time period. The analysis of trends for melanoma was then adapted to develop three scenarios for incidence changes in the future:

**Medium Annual Percent Change Scenario** – In this scenario, it was assumed that there was zero annual percent change (APC) in males or females under the age of 50. This 0% APC for younger age cohorts reflects the most recent Canadian trends in these cohorts, possibly reflecting changes in sun-safety behaviours in Canadian young people over the last

[98] Ferrone CR, Porat LB, Panageas KS, et al. Clinicopathological features of and risk factors for multiple primary melanomas. *Journal of the American Medical Association.* 2005; 294(13): 1647-54.
[99] Freedman DM, Miller BA, Tucker MA. Chapter 13. New Malignancies Following Melanoma of the Skin, Eye Melanoma, and Non-melanoma Eye Cancer. In: Curtis RE, Freedman DM, Ron E et al., eds. *New Malignancies Among Cancer Survivors: SEER Cancer Registries, 1973-2000.* Bethesda, MD: National Cancer Institute 2006.
[100] Parkin DM and Plummer M. Chapter 5. Comparability and quality of data in Parkin DM, Whelan SL, Ferlay J, et al (eds). Cancer incidence in five continents. Volume VIII. *IARC Scientific Publications.* 2002; (155): 1-781.
[101] Francken AB, Bastiaannet E, Hoekstra HJ. Follow-up in patients with localised primary cutaneous melanoma. *Lancet Oncology.* 2005; 6(8): 608-21.
[102] Stang A, Ziegler S, Buchner U, et al. Malignant melanoma and nonmelanoma skin cancers in Northrhine-Westphalia, Germany: a patient- vs. diagnosis-based incidence approach. *International Journal of Dermatology*. 2007; 46: 564-70.
[103] Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression analysis with application to cancers rates. *Statistics in Medicine.* 2000; 19: 335-51.

several decades. The other age groups had an APC for males/females as indicated: 50-64 years: 1.31%/1.67%; 65-74 years: 2.79%/1.84%; 75+ years: 3.69%/3.27%.

**Low Annual Percent Change Scenario** – In this scenario, it was assumed that there was zero annual percent change (APC) in males or females under the age of 50 (as in the Medium APC Scenario). For age groups 50+ years, the APC was reduced by one-half for males/females as indicated: 50-64 years: 0.66%/0.84%; 65-74 years: 1.40%/0.92%; 75+ years: 1.85%/1.64%. This scenario was intended to reflect the possibility that some of the observed increases in rates may be partly related to improvements in case ascertainment over time, rather than being solely driven by true increases in incidence. In addition, changes in the ethnic mix of Canada's population (increases in the proportion of the population from a visible minority) could result in decreases in the APC.

**No Annual Percent Change Scenario** – Estimates of future increases in annual cases based solely on population growth and ageing (i.e., zero APC assumed for all age groups). The No APC Scenario was chosen as a base estimate to assess the future impact of population growth and ageing only. It is not a realistic estimate of future melanoma cases as current observed increases in APC in older population cohorts are unlikely to approach 0% for at least several decades.

The age- and gender-specific incidence rates, modified according to the APC assumptions laid out in each scenario above, were applied to the projected age- and gender-specific populations for each of the provinces/territories. An age-cohort strategy was followed; that is, as younger groups aged, they maintained the lower APC appropriate for their age cohort at the start of the modelling period. Population projections were based on Statistics Canada projections for medium (Scenario 3) population growth.[104] The overall approach can be applied from the perspective of either patient-based or diagnosis-based incidence. See Appendix D for details.

#### Projecting Melanoma Deaths to 2031

The process for projecting the number of deaths is substantially equivalent to the one used in projecting the number of cases, that is, incorporating the same three APC scenarios in order to generate appropriate adjustments to the mortality rate in each age cohort for each gender throughout the modelling period. Again, Appendix D provides more details.

### Non-Melanoma Skin Cancer

#### Estimating the Number of Non-Melanoma Skin Cancer Cases in 2004

The analysis of non-melanoma skin cancer is more challenging because information on numbers of cases is not routinely collected across Canada. The exceptions have been the provinces of Manitoba and New Brunswick; recently, statistical reporting on basal cell carcinoma and squamous cell carcinoma has also been established in Saskatchewan, Alberta, and British Columbia. All of the available data were gathered from the relevant registries to inform the analysis in this report (see Appendix E for additional details).

The estimation of total NMSC in the country proceeded in three phases. First, what is known about NMSC cases in the five provinces noted above allowed age- and gender-specific incidence rates for BCC and SCC to be calculated and applied to the population data in other provinces/territories.

[104] Statistics Canada, *Population Projections for Canada, Provinces and Territories 2005-2031*. 2005. Catalogue no. 91-520-XIE. Pages 149-162 (for Scenario 3 – medium growth projections).

Second, variation in the age-standardized *melanoma* incidence rates (by gender) in the various provinces/territories when compared with the combined information for the five reference provinces (i.e., Manitoba, New Brunswick, etc.) were calculated and then applied as an adjustment to the NMSC rates derived in phase one; the assumption is that common risk factors (especially sun exposure) for melanoma and NMSC would drive a similar province-specific epidemiologic pattern for these two categories of skin cancer.

Third, it is clear that individuals who have had an initial diagnosis of BCC or SCC are at a substantially increased risk of experiencing a second BCC or SCC.[105,106] As with multiple melanomas, neither second primary cancers of the same histology nor recurrences of NMSC are routinely recorded in cancer registries in Canada. Thus, it is appropriate to make adjustments to the data derived in phase two in order to generate diagnosis-based incidence results for NMSC; not accounting for such multiple occurrences in patients would underestimate the total treatment and other costs related to these diseases. Research on NMSC by Stang and colleagues in Germany provided an estimate for the difference between patient-based incidence rates and diagnosis-based incidence rates by gender- and age-group.[107] The details on this process and other calculations related to NMSC burden may be found in Appendix E.

#### Estimating Non-Melanoma Skin Cancer Mortality in 2004

Data from Ontario on deaths due to NMSC between 1971 and 2005 allowed age- and gender-specific rates to be developed that were then applied to the 2004 population cohorts in each of the other provinces /territories.[108] The mortality rates were then adjusted based on the variation in age-standardized melanoma mortality rates between Ontario and the other provinces/territories; in other words, variation in melanoma mortality is interpreted and applied as a proxy for regional differences in NMSC mortality rates.

#### Projecting Non-Melanoma Skin Cancer Cases to 2031

The analysis of trends for NMSC incidence over multiple decades in Manitoba by Demers et al.[109] was used to develop the following three scenarios (similar to the three melanoma scenarios):

- **Medium Annual Percent Change Scenario** – Applying annual percent change (APC) in BCC and SCC incidence for males and females according to the most recent trends in Manitoba (see following table). Note that the APC for the population under age 40 is 0%.

[105] Marcil I, Stern RS. Risk of developing a subsequent nonmelanoma skin cancer in patients with a history of nonmelanoma skin cancer: a critical review of the literature and meta-analysis. *Archives of Dermatology.* 2000; 136(12): 1524-30.
[106] Efird JT, Friedman GD, Habel L et al. Risk of subsequent cancer following invasive or in situ squamous cell skin cancer. *Annals of Epidemiology*. 2002; 12(7): 469-75.
[107] Stang A, Ziegler S, Buchner U, et al. Malignant melanoma and nonmelanoma skin cancers in Northrhine-Westphalia, Germany: a patient- vs. diagnosis-based incidence approach. *International Journal of Dermatology*. 2007; 46: 564-70.
[108] Cancer Care Ontario - SEER*Stat Release 7 - OCRIS (February 2009) released March 2009. Population Data Source: Demographic Estimates Compendium 2007. Statistics Canada, April 2008 (1971–2005).
[109] Demers AA, Nugent Z, Mihalcioiu C et al. Trends of nonmelanoma skin cancer from 1960 through 2000 in a Canadian population. *Journal of the American Academy of Dermatology.* 2005; 53(2): 320-8.

| Recent Trend in NMSC in Manitoba<br>Annual Percentage Change<br>By Type, Gender and Age Group | | | | |
|---|---|---|---|---|
| | | Age Group | | |
| | | 40-59 | 60-79 | 80+ |
| BCC | | | | |
| | Male | 4.8% | 2.9% | 1.3% |
| | Female | 1.6% | 3.0% | 1.3% |
| SCC | | | | |
| | Male | 0.5% | 2.9% | 3.4% |
| | Female | 1.8% | 3.3% | 2.3% |

- **Low Annual Percent Change Scenario** – Reducing by one-half the APC applied in the Medium APC scenario.
- **No Annual Percent Change Scenario** – Zero APC for every age group, reflecting the situation where the incidence rates were stable, so that an increase in NMSC cases would be based solely on population growth and ageing.

Base incidence rates were calculated by province/territory, age, and gender using the five years (2000-2004) of data available in the several reference provinces. These were then adjusted based on the variation in the age-standardized (by gender) *melanoma* incidence rates in each province compared to the five reference provinces (i.e., Manitoba, New Brunswick, etc.). Finally, age- and gender-specific rates in the future were modified according to the APC assumptions laid out in each scenario above and applied to the projected age- and gender-specific populations for each of the provinces/territories. As was the case with the melanoma projections, an age-cohort strategy was followed. Population projections were based on Statistics Canada projections for medium (Scenario 3) population growth. See Appendix E for additional details.

#### Projecting Non-Melanoma Skin Cancer Deaths to 2031

Projecting non-melanoma skin cancer deaths used the same approach as projecting cases with the following exceptions:

- Base age- and gender-specific mortality rates were calculated using Ontario data from 1971 to 2005.
- These base rates were adjusted according to the variation in the age-standardized (by gender) *melanoma* mortality rates in each province compared to Ontario.

## Economic Burden of Skin Cancer in Canada

In estimating the economic burden of skin cancer in Canada, a cost-of-illness approach was employed that included three main components: direct costs, and two classic generators of indirect costs, namely, morbidity and mortality.[110]

### Direct Costs

The first economic component, direct costs, was elucidated under three headings: expenditures related to primary care-based treatment, day surgery in outpatient clinics, and inpatient/hospital stays.

[110] Brown ML, Lipscomb J, Snyder C. The burden of illness of cancer: economic cost and quality of life. *Annual Review of Public Health.* 2001; 22: 91-113.

**Primary Care-Based Treatment**

While referred to as primary care-based treatment, it is convenient to include under this rubric the physician services that technically are provided in secondary and tertiary care platforms (i.e., care offered by specialists such as dermatologists). In estimating all such costs associated with skin cancers in Canada, the following approach and assumptions were used:

- All patients diagnosed with BCC or SCC, and 90% of patients diagnosed with MSC (Stage I or II), receive the following care:[111]
    - An initial visit to a general practitioner
    - An initial consult with a dermatologist
    - A biopsy
    - Treatment of the cancer by excision in 50% of cases, by curettage electro-surgery in 40% of cases, and by Mohs micrographic surgery in 10% of cases
    - 10% of patients will require reconstruction and/or a skin graft
    - Two follow-up visits to a dermatologist in the year following the treatment
- The unit cost for the services was determined for each province based on the physician fee schedule for the province.

**Day Surgery/Outpatient Clinic**

Actual data on the utilization of outpatient services by skin cancer patients in Canada is limited. The province of B.C. does provide information on the number of patients with a "melanoma or other malignant neoplasm" who receive day care surgery in a given fiscal year, as well as the number of acute care admissions, stratified by age group.[112] This information was used to calculate the ratio of day surgery cases to acute care admissions. This ratio, stratified by age group, was used to estimate the volume of day surgery procedures in other provinces using known data on hospital separations from other provinces, stratified across the three main types of skin malignancy (see Appendix F for additional details).

Unit costs for day surgery were developed based on cost information from the Ontario Case Costing Initiative adjusted for differences in wage rates in the health sector between provinces.

A further adjustment involved estimating the number of day surgery cases associated with MSC vs. NMSC. The available data is based on all "melanoma and other malignant neoplasm" which includes both MSC and NMSC. Research in New Zealand suggests a ratio of 0.694 hospital admissions per new melanoma case and 0.130 hospital admissions per new NMSC case.[113] That is, an estimated 84.2% of hospitalizations were for melanoma and 15.8% for NMSC. This ratio was used to apportion day surgery cases into MSC and NMSC.

NMSC cases were then allocated into BCC and SCC categories based on research by Lucas and colleagues that suggests that, in 1% of new BCC and 0.1% of new SCC cases, the cancer is

[111] The care process was developed with input from Dr. Jason Rivers, a clinical professor in Dermatology at the University of British Columbia, combined with an analysis of the dermatology billing patterns in the British Columbia Medical Services Plan. As one point of "triangulation," the study Chen GJ, Yelverton CB, Polisetty SS, et al. Treatment patterns and costs of nonmelanoma skin cancer management. *Dermatologic Surgery*. 2006; 32: 1266-71 indicated that 10% of patients with NMSC received surgery with the Mohs procedure.

[112] Derived from the Health Ideas database of the B.C. Ministry of Health.

[113] New Zealand Cancer Society. The Cost of Skin Cancer in New Zealand, *Cancer Update in Practice*, Issue 2, 2000.

disseminated and that these patients would require hospital-based care.[114] Based on the estimated volume of new BCC and SCC cases in Canada in 2004, it was calculated that 28.3% of the NMSC hospital-based care would be for BCC and 71.7% for SCC.

#### Inpatient Hospital Stays

The final element of direct costing comprises hospital stays. Data from the Canadian Institute for Health Information (CIHI) was used to estimate the number of hospital separations, days and average length of hospital stay based on the Canadian Diagnosis List code,'27-Malignant Neoplasms of Skin.'[115] Data on the ratio of the number of hospital admissions to new cases (MSC, BCC and SCC) and average length of hospital stay by age group (0-44; 45-64; 65-74; 75+), gender and province were generated and used in estimating the cost of inpatient hospital stays. As noted above, research in New Zealand was used to estimate the proportion of hospitalizations for MSC, BCC, and SCC (84.2%, 4.5% and 11.3%, respectively).[116]

Unit costs for inpatient hospitals stays were developed based on cost information CIHI adjusted for differences in wage rates in the health sector between provinces (see Appendix F for additional details).[117]

### Indirect Costs

#### Mortality

The most commonly used method in valuing indirect costs is the human-capital approach. In this approach, gender- and age-specific average earnings are combined with productivity trends and years of life lost due to a specific disease/condition to estimate unrealized lifetime earnings. An important criticism of this method is that it places a higher value on the years of life lost for someone with higher earning potential (e.g., males aged 35-55) than someone with lower earning potential (e.g. females aged 75+).[118] In particular, unpaid work and leisure time are not explicitly accounted for in the human-capital approach.[119,120] A modified human-capital approach was employed that attempts to address some of the issues involved with valuing so-called "non-productive" time. In essence, lost non-productive time was valued using the minimum wage rate from each province (see Appendix F for additional details). This assumption was subjected to sensitivity analysis after the base case results were estimated.

#### Morbidity

To determine the level of disability following a diagnosis of melanoma, an estimate of the annual number of lost days from work following a diagnosis of melanoma was established. The mean of 28 days derived from three national study results offered a reasonable basis for a Canadian analysis. It was estimated that a patient hospitalized for melanoma will spend 6.23

---

[114] Lucas R, McMichael T, Smith W et al. *Solar ultraviolet radiation: global burden or disease from solar ultraviolet radiation*. 2006. World Health Organization. Available at http://www.who.int/uv/health/solaruvradfull_180706.pdf. Accessed January 2009.

[115] Canadian Institute for Health Information. *Hospital Morbidity Database 1997/98 – 2000/01 Tabular Reports*. Available at http://secure.cihi.ca/cihiweb/products/HospitalMorbidityTabularReports[*fiscal year*].pdf

[116] New Zealand Cancer Society. The Cost of Skin Cancer in New Zealand, *Cancer Update in Practice*, Issue 2, 2000.

[117] Canadian Institute for Health Information, *The Cost of Acute Care Hospital Stays by Medical Condition in Canada, 2004-2005*. Ottawa: CIHI, 2008.

[118] Yabroff KR, Bradley CJ, Mariotto AB et al. Estimates and projections of value of life lost from cancer deaths in the United States. *Journal of the National Cancer Institute.* 2008; 100(24): 1755-62.

[119] Tranmer JE, Guerriere DN, Ungar WJ et al. Valuing patient and caregiver time: a review of the literature. *Pharmacoeconomics.* 2005; 23(5): 449-59.

[120] Morris S, Cox B, Bosanquet N. Cost of skin cancer in England. *European Journal of Health Economics.* 2008: Epublished ahead of print.

days in hospital per separation. The remaining 21.8 work-loss days are associated with at-home recovery, out-patient care, and other follow-up appointments.

Patients age 75+ years stay in hospital, on average, for 7.19 days, or 13% more than the average 6.23 days. The non-hospital work-loss days for this older cohort were thus increased by 13%, from 21.8 days to 24.7 days. Arguing in similar fashion, the non-hospital work-loss days for the 0-44 year old cohort was 15.2 days, for the 45-64 year old cohort – 18.5 days, and for the 65-74 year old cohort – 23.6 days. These work-loss days were assigned a disability weight of 0.5, following the approach used for calculating short-term disability in the *Economic Burden of Illness in Canada, 1998* report.[121]

The approach to indirect costs associated with morbidity due to NMSC included elements parallel to those employed for melanoma. To determine the level of disability and associated value of work-loss days following a diagnosis of BCC or SCC, the algorithm developed by Lucas et al. was used.[122] For BCC, they suggested that 99.98% of incident cases would be treated for local disease with curative results; these patients would experience an average of 14 days of disability (with a disability weight of 0.05). The remainder of BCC patients (0.02%) develop disseminated disease; these patients would experience 2.4 years (876 days) of disability (with a disability weight of 0.2). For SCC, the algorithm suggested that 99.0% of incident cases that are treated have no lymph node involvement; these patients experience 14 days of disability (with a disability weight of 0.07). The remainder of SCC patients (1.0%) have lymph node involvement; these patients experience 21 days of disability (with a disability weight of 0.3).

### Modelling Skin Cancer Prevention Impacts in Canada

As outlined in Appendix C, the most comprehensive, long-term skin cancer prevention programs have occurred in Australia. Based on a review of research in that country supplemented with additional analysis (as found in Appendix C), the following major assumptions associated with a skin cancer prevention program in Canada were made (see Appendix G for additional details):

*Cutaneous Melanoma*

- Assume a **9-year lag time** before any observed reduction in melanoma incidence/mortality. The analysis of the Victoria data suggests a major change in trend at approximately 1997, i.e., 9 years after the *SunSmart* program began in 1988.
- Adjust the **Low Annual Percent Change Scenario** from:
    - No annual percent change (APC) in males or females under the age of 50 (note that the other age groups had an APC for males/females at 50-64 years of 0.66%/0.84%; at 65-74 years, 1.40%/0.92%; and 75+ years, 1.85%/1.64%).

    To:

    - APC for males/females age less than 20: -4.98%/-13.85%; 20-29: -0.47%/-4.69%; 30-39: -1.04%/-5.31%; 40-49: -3.39%/-3.52% (the APC for the older age groups remains the same as above).

[121] Health Canada, *The Economic Burden of Illness in Canada, 1998* Available at http://www.hc-sc.gc.ca. Accessed March 2009.
[122] Lucas RM, McMichael AJ, Armstrong BK et al. Estimating the global disease burden due to ultraviolet radiation exposure. *International Journal of Epidemiology.* 2008; 37(3): 654-67.

- Assume that the change in the model from 0% APC for the age groups up to 50 years to the observed decrease in APC identified in Victoria (by gender and age group) is entirely attributable to a prevention program.

*Non-melanoma Skin Cancer*

- Assume a 5% reduction in SCC for individuals under the age of 50
- Assume a reduction in BCC by age-group over a 10-year period
    - 20-24 – 30%
    - 25-29 – 25%
    - 30-34 – 20%
    - 35-39 – 15%
    - 40-44 – 10%
    - 45-49 – 5%
- Assume a **15-year lag time** before any observed reduction in NMSC incidence/mortality

## Results

### Current and Projected Skin Cancer Incidence and Mortality in Canada

Cutaneous Melanoma

**Estimating the Number of Melanoma Cases in 2004**

Adjustment for some under-reporting in Canadian cancer registries (see Appendix D) generated the following estimate of melanoma burden, following a diagnosis-based incidence approach.

**Estimated New & Recurrent Cutaneous Melanoma Cases in Canada**
**By Age Group and Gender**
**2004 (Diagnosis-based Incidence Approach)**

| | 0-44 | | | 45-64 | | | 65-74 | | | 75+ | | | 2004 Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 73 | 85 | 159 | 164 | 135 | 298 | 63 | 46 | 109 | 97 | 70 | 167 | 397 | 336 | 733 |
| AB | 53 | 95 | 148 | 106 | 90 | 196 | 52 | 21 | 73 | 43 | 40 | 83 | 254 | 245 | 499 |
| SK | 7 | 16 | 23 | 26 | 26 | 51 | 10 | 8 | 18 | 15 | 17 | 32 | 58 | 66 | 124 |
| MB | 9 | 12 | 22 | 38 | 21 | 58 | 21 | 10 | 31 | 13 | 16 | 29 | 81 | 60 | 141 |
| ON | 164 | 259 | 423 | 414 | 349 | 764 | 229 | 164 | 392 | 274 | 206 | 480 | 1,081 | 978 | 2,058 |
| QC | 61 | 92 | 153 | 183 | 147 | 330 | 105 | 52 | 157 | 73 | 53 | 127 | 423 | 344 | 767 |
| NB | 7 | 13 | 21 | 20 | 25 | 45 | 17 | 3 | 20 | 18 | 15 | 33 | 62 | 56 | 118 |
| NF&L | 4 | 8 | 12 | 16 | 13 | 29 | 5 | 5 | 10 | 5 | 6 | 10 | 30 | 32 | 62 |
| PEI | 2 | 4 | 6 | 5 | 7 | 11 | 2 | 3 | 5 | 2 | 4 | 6 | 11 | 17 | 28 |
| NS | 14 | 21 | 35 | 43 | 34 | 78 | 27 | 20 | 46 | 21 | 33 | 54 | 104 | 109 | 213 |
| YK | 0 | 1 | 1 | 1 | 1 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 2 | 4 |
| NWT | 1 | 1 | 2 | 1 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 2 | 4 |
| NV | 0 | 1 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 2 |
| **Canada** | **395** | **609** | **1,004** | **1,017** | **848** | **1,866** | **532** | **332** | **864** | **562** | **459** | **1,021** | **2,506** | **2,249** | **4,755** |

The total number of new cases of melanoma in Canada in 2004 was estimated to be 4,755, with over 40% of these occurring in Ontario. As a comparison, applying the patient-based incidence approach would generate only 4,303 cases in 2004, or 9.5% less than the diagnosis-based total (see details in Appendix D). The estimated 4,303 cases in 2004 is, however, 207 cases (or 5.1%) higher than the 4,096 cases suggested in the Canadian Cancer Statistics 2008 annual report.[123]

In most provinces, melanoma incidence in males exceeds that found in females; the breakdown for melanoma nationally is 53% male and 47% female, yielding a ratio of 1.11. This situation is reversed, however, in the youngest age group (0-44), where 61% of melanomas are found in females.

[123] Both the Canadian Cancer Society and the Public Health Agency of Canada produce detailed reports on the number of melanoma cases and deaths in Canada. A number of deficiencies in this data were identified by Dr. Lorraine Marrett in a December 4, 2008 email to Dr. Hans Krueger; in particular, the need to adjust for known under-reporting in Quebec and the conservative coding in the Canadian Cancer Registry.

**Estimating Melanoma Mortality in 2000-2004**

Because of low numbers of deaths in jurisdictions with smaller populations, it is convenient to track mortality results over a 5-year timeframe. The modest number of melanoma deaths in less populous provinces/territories was estimated and then added to the total mortality reported by the Canadian Cancer Society for the rest of the country in 2000-2004. The combined and average results over that time period are summarized in the following tables.

**Estimated Deaths Due to Cutaneous Melanoma In Canada By Province/Territory and Gender**
2000 to 2004

| | Five Year Total | | |
|---|---|---|---|
| | Male | Female | Total |
| BC | 315 | 220 | 535 |
| AB | 180 | 110 | 290 |
| SK | 70 | 50 | 120 |
| MB | 90 | 55 | 145 |
| ON | 1,050 | 630 | 1,680 |
| QC | 405 | 260 | 665 |
| NB | 45 | 40 | 85 |
| NF&L | 30 | 25 | 55 |
| PEI | 10 | 7 | 17 |
| NS | 70 | 55 | 125 |
| YK | 2 | 1 | 3 |
| NWT | 2 | 1 | 3 |
| NV | 1 | 0 | 1 |
| **Canada** | **2,270** | **1,454** | **3,724** |

**Estimated Annual Deaths Due to Cutaneous Melanoma In Canada By Province/Territory and Gender**
2000 to 2004

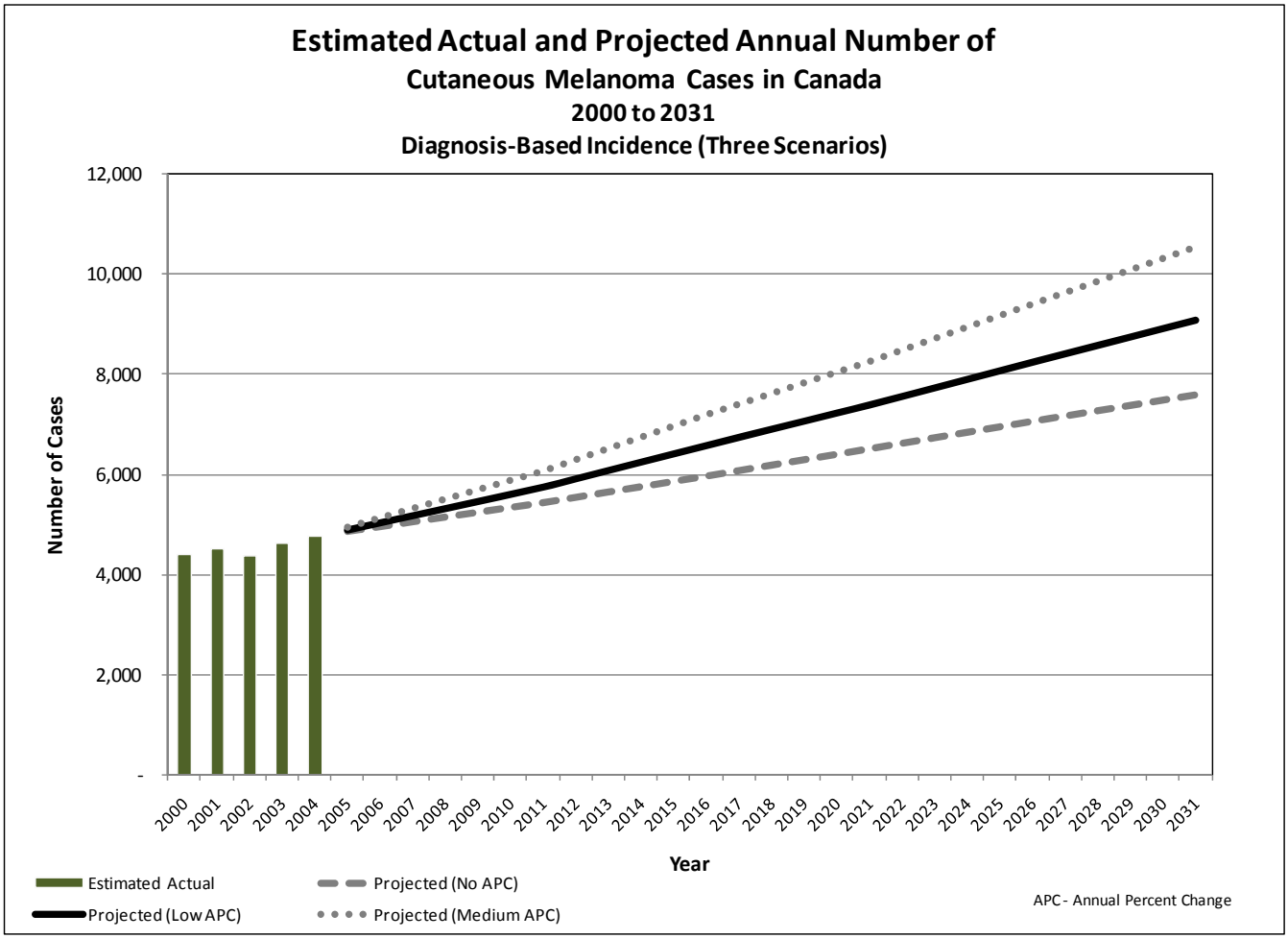
| | Annual Estimate | | |
|---|---|---|---|
| | Male | Female | Total |
| BC | 63 | 44 | 107 |
| AB | 36 | 22 | 58 |
| SK | 14 | 10 | 24 |
| MB | 18 | 11 | 29 |
| ON | 210 | 126 | 336 |
| QC | 81 | 52 | 133 |
| NB | 9 | 8 | 17 |
| NF&L | 6 | 5 | 11 |
| PEI | 2 | 1 | 3 |
| NS | 14 | 11 | 25 |
| YK | 0 | 0 | 1 |
| NWT | 0 | 0 | 1 |
| NV | 0 | 0 | 0 |
| **Canada** | **454** | **291** | **745** |

The average total annual number of deaths due to melanoma was 745 during the 2000-2004 time period. The total estimated number of deaths between 2000 and 2004 of 3,724 is just marginally (0.4%) higher than the actual number provided in Canadian Cancer Statistics for the same time period (3,709). This difference reflects the process of estimating the actual number of deaths for the smaller provinces and territories.

The ratio of male-to-female deaths was 1.56, which suggests excess mortality in males given that the male-to-female incidence ratio in 2004, for instance, was only 1.11 (see previous subsection).

**Projecting Melanoma Cases to 2031**

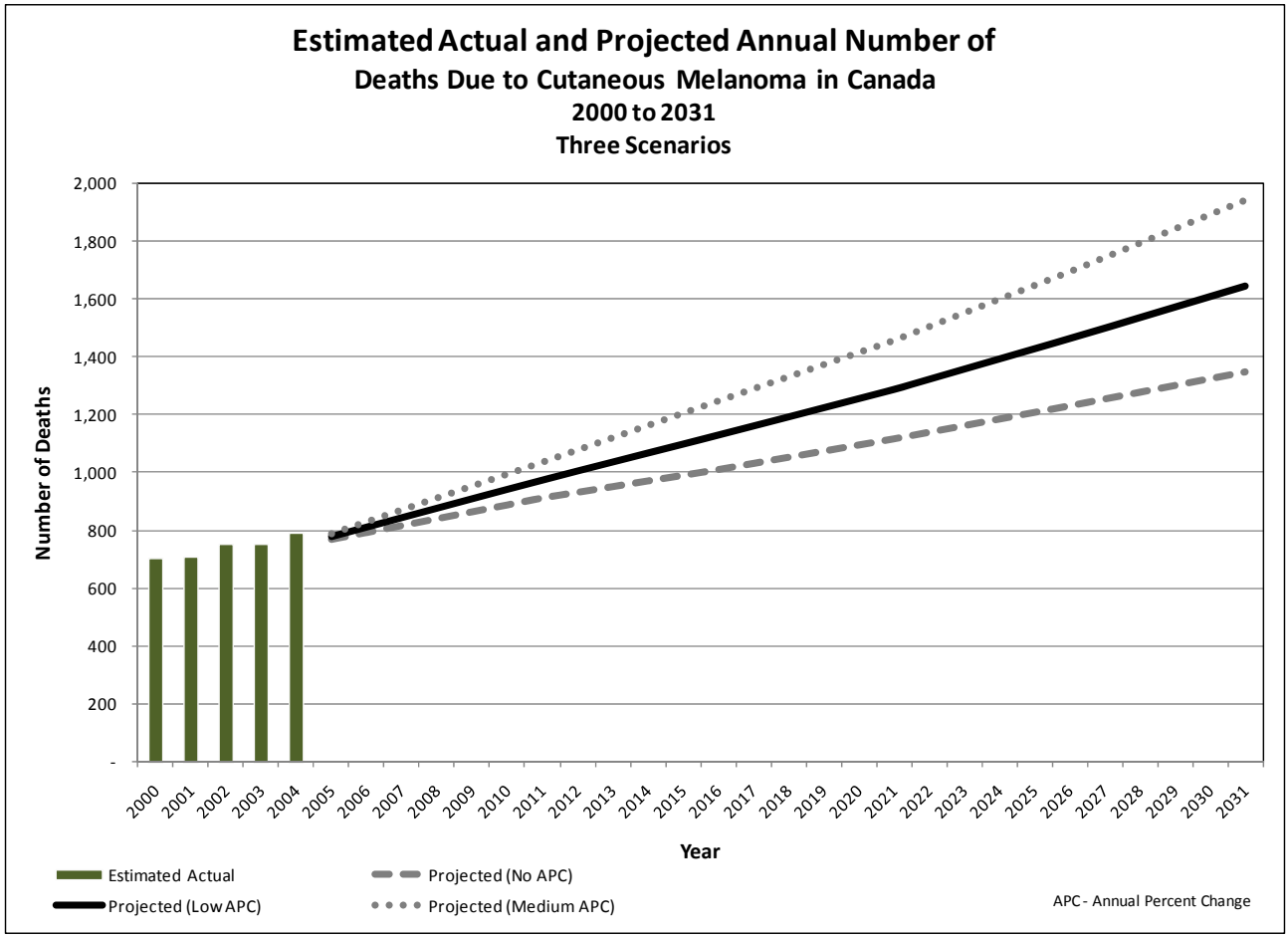
Using the diagnosis-based incidence approach, the **No Annual Percent Change Scenario** (No APC) would increase the number of melanoma cases from an estimated 4,755 in 2004 to 7,600 in 2031 (+60%). The estimated cases in 2031 based on the **Low Annual Percent Change Scenario** (Low APC) would be 9,070 (+91%) and, for the **Medium Annual Percent Change Scenario** (Medium APC), 10,540 (+122%), as indicated in the following chart. Additional details are available in Appendix D.



**Projecting Melanoma Deaths to 2031**

The three APC scenarios used to project incidence cases, combined with age- and gender-specific mortality rates based on Ontario data, were used to project melanoma-related mortality to 2031.

Based on the **No Annual Percent Change Scenario** (No APC), the number of deaths in Canada due to melanoma would increase from an estimated 790 in 2004 to 1,346 in 2031 (+70%). The estimated deaths in 2031 based on the **Low Annual Percent Change Scenario** (Low APC) would be 1,644 (+108%) and, for the **Medium Annual Percent Change Scenario** (Medium APC), 1,942 (+146%), as indicated in the following chart.




While the age-specific mortality-to-incidence ratios are assumed to be fixed for each age group, the modestly higher base ratios (i.e., excess mortality or lower survival) among older populations would have the effect of gradually *increasing* the mortality-to-incidence ratio across the whole population. This in fact was observed, with the mortality-to-incidence ratio increasing from 0.181 in 2000-2004 to between 0.196 (No APC Scenario) and 0.204 (Medium APC Scenario) in 2031. See Appendix D for additional details.

## Non-Melanoma Skin Cancer

**Estimating the Number of Non-Melanoma Skin Cancer Cases in Canada in 2004**

The estimated number of NMSC in Canada in 2004, using the patient-based incidence approach, was 60,591. The diagnosis-based incidence approach increases the number of cases further, to 75,953 (+ 25.4%), as indicated in the following tables.

**Estimated New & Recurrent Non-Melanoma Skin Cancer Cases in Canada**
**By Age Group**
**2004 (Diagnosis-based Incidence Approach)**

| | 0-44 | | | 45-64 | | | 65-74 | | | 75+ | | | 2004 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 269 | 394 | 664 | 2,127 | 1,763 | 3,889 | 1,962 | 1,268 | 3,230 | 3,073 | 2,208 | 5,281 | 7,431 | 5,633 | 13,064 |
| AB | 211 | 287 | 498 | 1,150 | 997 | 2,146 | 942 | 624 | 1,566 | 1,295 | 1,048 | 2,344 | 3,598 | 2,957 | 6,555 |
| SK | 49 | 56 | 105 | 334 | 273 | 606 | 397 | 235 | 631 | 843 | 622 | 1,465 | 1,622 | 1,186 | 2,808 |
| MB | 62 | 79 | 141 | 358 | 327 | 685 | 340 | 250 | 590 | 549 | 495 | 1,043 | 1,308 | 1,150 | 2,459 |
| ON | 851 | 1,057 | 1,908 | 5,047 | 4,117 | 9,163 | 4,854 | 3,038 | 7,892 | 7,045 | 5,221 | 12,266 | 17,797 | 13,432 | 31,229 |
| QC | 328 | 407 | 735 | 2,253 | 1,874 | 4,128 | 2,032 | 1,373 | 3,405 | 2,682 | 2,289 | 4,971 | 7,295 | 5,943 | 13,239 |
| NB | 37 | 47 | 85 | 274 | 240 | 514 | 241 | 166 | 407 | 373 | 293 | 666 | 925 | 747 | 1,672 |
| NF&L | 23 | 33 | 56 | 171 | 154 | 325 | 148 | 100 | 249 | 196 | 161 | 357 | 538 | 448 | 987 |
| PEI | 9 | 17 | 26 | 65 | 80 | 144 | 62 | 57 | 119 | 89 | 108 | 196 | 224 | 262 | 485 |
| NS | 73 | 106 | 179 | 515 | 477 | 992 | 474 | 341 | 816 | 715 | 636 | 1,351 | 1,778 | 1,560 | 3,338 |
| YK | 2 | 3 | 4 | 13 | 9 | 22 | 8 | 4 | 11 | 6 | 4 | 10 | 29 | 19 | 48 |
| NWT | 3 | 3 | 6 | 13 | 9 | 22 | 7 | 3 | 10 | 7 | 3 | 10 | 29 | 19 | 48 |
| NV | 2 | 2 | 3 | 6 | 5 | 10 | 3 | 1 | 4 | 3 | 1 | 3 | 13 | 8 | 21 |
| **Canada** | **1,917** | **2,493** | **4,411** | **12,324** | **10,323** | **22,648** | **11,469** | **7,461** | **18,931** | **16,875** | **13,089** | **29,964** | **42,586** | **33,367** | **75,953** |

**Estimated Non-melanoma Skin Cancer Cases in Canada**
**By Province/Territory and Gender In 2004**
**Diagnosis-Based Incidence Approach**

| | BCC | | | SCC | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 5,949 | 4,718 | 10,667 | 1,482 | 916 | 2,398 | 7,431 | 5,633 | 13,064 |
| AB | 2,723 | 2,419 | 5,141 | 876 | 538 | 1,413 | 3,598 | 2,957 | 6,555 |
| SK | 1,194 | 944 | 2,139 | 427 | 241 | 669 | 1,622 | 1,186 | 2,808 |
| MB | 1,064 | 991 | 2,054 | 245 | 160 | 404 | 1,308 | 1,150 | 2,459 |
| ON | 13,713 | 11,110 | 24,824 | 4,084 | 2,322 | 6,406 | 17,797 | 13,432 | 31,229 |
| QC | 5,656 | 4,913 | 10,569 | 1,639 | 1,030 | 2,669 | 7,295 | 5,943 | 13,239 |
| NB | 681 | 596 | 1,277 | 244 | 151 | 396 | 925 | 747 | 1,672 |
| NF&L | 417 | 373 | 790 | 121 | 76 | 197 | 538 | 448 | 987 |
| PEI | 172 | 214 | 386 | 52 | 47 | 100 | 224 | 262 | 485 |
| NS | 1,363 | 1,280 | 2,643 | 415 | 280 | 695 | 1,778 | 1,560 | 3,338 |
| YK | 23 | 17 | 40 | 6 | 3 | 8 | 29 | 19 | 48 |
| NWT | 23 | 17 | 40 | 6 | 2 | 8 | 29 | 19 | 48 |
| NV | 11 | 8 | 18 | 2 | 1 | 3 | 13 | 8 | 21 |
| **Canada** | **32,989** | **27,598** | **60,587** | **9,597** | **5,768** | **15,366** | **42,586** | **33,367** | **75,953** |

*Note: Numbers are not rounded and thus may appear to not add appropriately.*

Approximately 56% of NMSC cases occur in males. Similar to other jurisdictions in the world, BCC dominates the overall NMSC picture, accounting for almost 80% of the total cases in Canada. Finally, almost 40% of NMSCs occur in individuals 75 years of age or older.

**Estimating the Number of Non-Melanoma Skin Cancer Deaths in Canada in 2004**

The number of deaths due to NMSC in Canada are estimated at 204 (128 males and 75 females), as indicated in the following table.

**Adjusted Estimated Annual Number of Non-Melanoma Skin Cancer Deaths in Canada By Province and Gender (2004)**

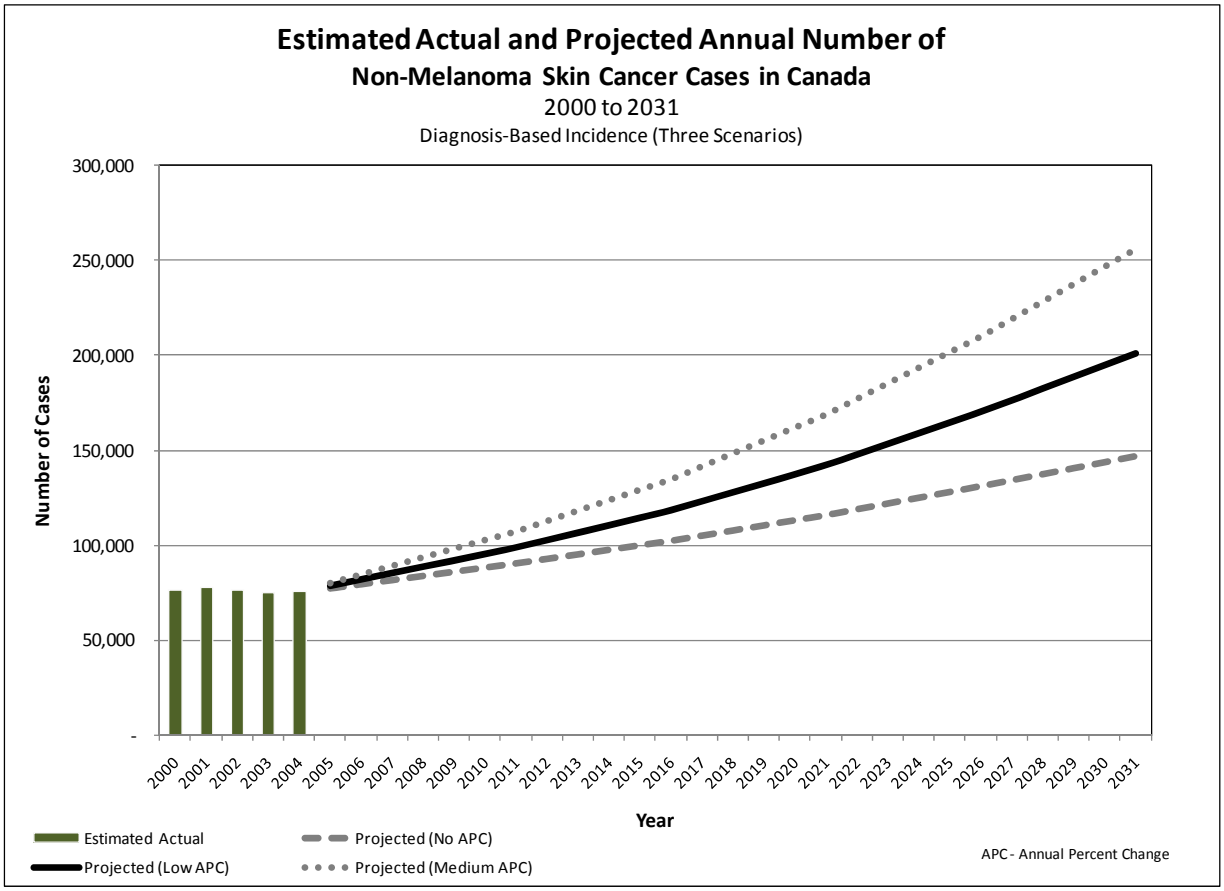
| | Male | Female | Total |
|---|---|---|---|
| BC | 21 | 12 | 33 |
| AB | 11 | 7 | 17 |
| SK | 4 | 3 | 7 |
| MB | 4 | 2 | 7 |
| ON | 55 | 30 | 85 |
| QC | 22 | 14 | 35 |
| NB | 3 | 2 | 6 |
| NF&L | 2 | 1 | 3 |
| PEI | 1 | 1 | 1 |
| NS | 6 | 4 | 9 |
| YK | 0 | 0 | 0 |
| NWT | 0 | 0 | 0 |
| NV | 0 | 0 | 0 |
| **Canada** | **128** | **75** | **204** |

*Note: Based on Ontario age and gender specific rates (1971-2005) adjusted to reflect variances in age-standardized incidence rates for MSC.*
*Numbers are not rounded and thus may appear to not add appropriately.*

NMSC-related deaths are low in both absolute and relative terms; the annual estimated deaths due to NMSC of 204 should be compared with the estimated 745 annual deaths in Canada due to melanoma. More importantly, the mortality-to-incidence ratios for melanoma (0.181) and NMSC (0.0034) are significantly different.

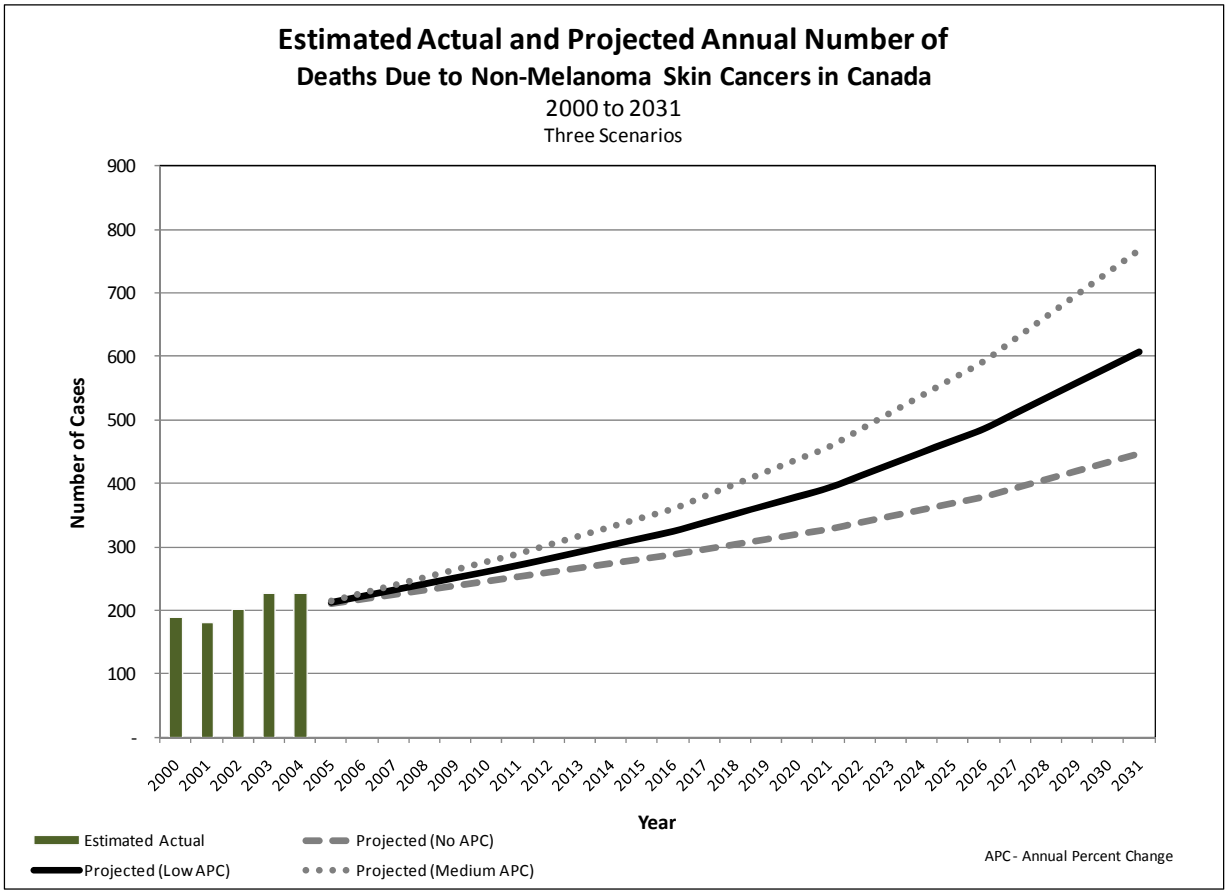
**Projected Non-Melanoma Skin Cancer Cases to 2031**

Using the diagnosis-based incidence approach, the **No Annual Percent Change Scenario** (No APC) would increase the number of NMSC cases from an estimated annual average of 75,953 between 2000 and 2004 to 147,000 in 2031 (+93%). The estimated cases in 2031 based on the **Low Annual Percent Change Scenario** (Low APC) would be 201,000 (+165%) and, for the **Medium Annual Percent Change Scenario**, 256,000 (+237%), as indicated in the following chart. See Appendix E for additional details.



**Projected Non-Melanoma Skin Cancer Deaths to 2031**

Using the **No Annual Percent Change Scenario** (No APC) would increase the number of deaths due to NMSC from an estimated annual average of 204 between 2000 and 2004 to 447 in 2031 (+120%). The estimated deaths in 2031 based on the **Low Annual Percent Change Scenario** (Low APC) would be 608 (+198%) and, for the **Medium Annual Percent Change Scenario**, 768 (+277%), as indicated in the following chart. See Appendix E for additional details.



## Summary of the Economic Burden of Skin Cancer in Canada

### Total Economic Burden in 2004 and 2031

In 2004, the total estimated economic burden of skin cancer in Canada was $532 million, the majority being attributable to melanoma (83.4%), and the balance distributed between BCC (9.1%) and SCC (7.5%). Of the $532 million, $66 million (12.4%) is associated with direct costs and $466 million (87.6%) with indirect costs, as indicated on the following table.

**Annual Direct and Indirect Costs of Skin Cancers in Canada**
**2004** (in $millions, 2004 constant dollars, undiscounted)

| Type of Cost | MM | % | BCC | % | SCC | % | Total | % |
|---|---|---|---|---|---|---|---|---|
| Primary care | 1.76 | 0.4% | 24.90 | 51.5% | 6.34 | 15.9% | 33.00 | 6.2% |
| Hospital-based day surgery | 17.01 | 3.8% | 0.91 | 1.9% | 2.22 | 5.5% | 20.14 | 3.8% |
| Hospital inpatient care | 10.78 | 2.4% | 0.58 | 1.2% | 1.56 | 3.9% | 12.92 | 2.4% |
| **Total direct costs** | **29.55** | **6.7%** | **26.39** | **54.6%** | **10.12** | **25.3%** | **66.05** | **12.4%** |
| Mortality | 410.07 | 92.5% | 18.20 | 37.7% | 28.73 | 71.9% | 457.00 | 85.9% |
| Morbidity | 3.86 | 0.9% | 3.74 | 7.7% | 1.10 | 2.8% | 8.70 | 1.6% |
| **Total indirect costs** | **413.93** | **93.3%** | **21.94** | **45.4%** | **29.83** | **74.7%** | **465.70** | **87.6%** |
| **Total costs** | **443.48** | **100%** | **48.32** | **100%** | **39.95** | **100.0%** | **531.75** | **100%** |

*Note:* MM, malignant melanoma; BCC, basal cell carcinoma; SCC, squamous cell carcinoma.

The total estimated economic burden of skin cancer in Canada would rise to $922 million annually by 2031. The distribution across the three cancer types would also have shifted: melanoma (75.5%); BCC (13.3%); and SCC (11.2%). A higher proportion of total costs are also associated with direct costs (17.6% in 2031 vs. 12.4% in 2004), as indicated on the following table.

**Annual Direct and Indirect Costs of Skin Cancers in Canada**
Low APC Scenario
**2031** (in $millions, 2004 constant dollars, undiscounted)

| Type of Cost | MM | % | BCC | % | SCC | % | Total | % |
|---|---|---|---|---|---|---|---|---|
| Primary care | 3.35 | 0.5% | 64.76 | 52.7% | 17.95 | 17.4% | 86.06 | 9.3% |
| Hospital-based day surgery | 36.75 | 5.3% | 2.45 | 2.0% | 6.38 | 6.2% | 45.58 | 4.9% |
| Hospital inpatient care | 24.62 | 3.5% | 1.48 | 1.2% | 4.25 | 4.1% | 30.35 | 3.3% |
| **Total direct costs** | **64.72** | **9.3%** | **68.69** | **55.9%** | **28.58** | **27.7%** | **161.99** | **17.6%** |
| Mortality | 624.78 | 89.8% | 45.44 | 37.0% | 71.74 | 69.6% | 741.96 | 80.5% |
| Morbidity | 6.46 | 0.9% | 8.73 | 7.1% | 2.79 | 2.7% | 17.98 | 2.0% |
| **Total indirect costs** | **631.24** | **90.7%** | **54.17** | **44.1%** | **74.53** | **72.3%** | **759.94** | **82.4%** |
| **Total costs** | **695.96** | **100%** | **122.86** | **100.0%** | **103.11** | **100.0%** | **921.93** | **100%** |

*Note:* MM, malignant melanoma; BCC, basal cell carcinoma; SCC, squamous cell carcinoma.

## Total Costs per Patient

The direct cost per melanoma case is estimated to be $6,215 in 2004, increasing to $7,136 by 2031 due to increased inpatient and outpatient hospital costs per case. The economic component of the model assumes that the rate of hospitalization, the length of stay in hospital, and the average cost per day in hospital all increase with increasing age at diagnosis. A higher proportion of melanoma patients are older in 2031 compared to 2004. By contrast, direct costs per NMSC case remained fixed over the modelling period because the vast majority of these costs are physician office-based costs which do not tend to change significantly based on the age of the patient treated. The drop in unit mortality and morbidity costs for all three skin cancer types is also explicable in terms of an ageing population; since a higher proportion of patients are older in 2031, the impact related to lost income decreases. First, a higher average age at death generates lower potential years of life lost (e.g., for melanoma, 22.07 years in 2004 versus 16.82 years in 2031); this directly translates into reduced mortality costs (e.g., for melanoma, $550,000 per death in 2004 versus $380,000 per death in 2031). Second, morbidity costs are less in older patients because their work-generated income is generally reduced after age 60-65; in most analyses using the human-capital approach, lost time in retired and non-employed persons is valued at zero. The current model assumes a value equivalent to the province's minimum wage in these cases. Despite this modification to the human-capital approach, the estimated value of time lost in older persons is still considerably lower than in an employed population.

**Economic Burden of Skin Cancers in Canada**

**Cost per Case in 2004** (2004 constant dollars, undiscounted)

| | MM | % | BCC | % | SCC | % | Total | % |
|---|---|---|---|---|---|---|---|---|
| **Cases in 2004** | **4,755** | | **60,587** | | **15,366** | | **80,708** | |
| **Deaths in 2004** | **745** | | **80** | | **124** | | **949** | |
| **Direct Costs / Case** | | | | | | | | |
| Primary care | $370 | 6.0% | $411 | 94.4% | $413 | 62.8% | $409 | 50.0% |
| Hospital-based day surgery | $3,577 | 57.6% | $16 | 3.6% | $148 | 22.6% | $251 | 30.6% |
| Hospital inpatient care | $2,267 | 36.5% | $9 | 2.1% | $96 | 14.7% | $159 | 19.4% |
| **Total direct costs** | **$6,215** | **100.0%** | **$436** | **100.0%** | **$657** | **100.0%** | **$818** | **100.0%** |
| **Indirect Costs** | | | | | | | | |
| Mortality cost per death | $550,430 | | $228,725 | | $230,896 | | $481,560 | |
| PYLL per death | 22.07 | | 11.61 | | 11.61 | | 19.82 | |
| Mortality cost per PYLL | $24,940 | | $19,701 | | $19,888 | | $24,295 | |
| Morbidity cost per case | $1,359 | | $144 | | $182 | | $223 | |

*Note:* MM, malignant melanoma; BCC, basal cell carcinoma; SCC, squamous cell carcinoma.

**Economic Burden of Skin Cancers in Canada**
**Cost per Case in 2031** (2004 constant dollars, undiscounted)

| | MM | % | BCC | % | SCC | % | Total | % |
|---|---|---|---|---|---|---|---|---|
| **Cases in 2031 (Low APC)** | **9,070** | | **157,711** | | **43,591** | | **210,372** | |
| **Deaths in 2031 (Low APC)** | **1,644** | | **237** | | **371** | | **2,252** | |
| **Direct Costs / Case** | | | | | | | | |
| Primary care | $369 | 5.2% | $411 | 94.3% | $412 | 62.8% | $409 | 53.1% |
| Hospital-based day surgery | $4,052 | 56.8% | $16 | 3.6% | $146 | 22.3% | $217 | 28.1% |
| Hospital inpatient care | $2,714 | 38.0% | $9 | 2.2% | $97 | 14.9% | $144 | 18.7% |
| **Total direct costs** | **$7,136** | **100.0%** | **$436** | **100.0%** | **$656** | **100.0%** | **$770** | **100.0%** |
| **Indirect Costs** | | | | | | | | |
| Mortality cost per death | $380,036 | | $191,621 | | $193,440 | | $329,467 | |
| PYLL per death | 16.82 | | 10.28 | | 10.28 | | 15.05 | |
| Mortality cost per PYLL | $22,594 | | $18,640 | | $18,817 | | $21,885 | |
| Morbidity cost per case | $712 | | $55 | | $64 | | $85 | |

*Note:* MM, malignant melanoma; BCC, basal cell carcinoma; SCC, squamous cell carcinoma.

## Comparison of Costs to That in Other Countries

Comparing cost estimates from Canada to those from other countries is complicated for a number of reasons. These include differences in the time periods when costs are generated, health system practices, unit costs of production, and so on. The following summary comparison is thus a high level comparison to assess whether the costs generated by the foregoing economic analysis are within a reasonable range.

In the current analysis, the average direct cost per episode of care for a BCC was $436 in 2004, while that for an SCC was $657. In the United States in the late 1990s, the average cost per episode of NMSC care has been estimated at between $330 and $470 (US$). [124,125] In Ontario, the direct treatment costs for a ***complex*** *primary* facial BCC using Mohs surgery was $881, and that of a complex *recurrent* facial BCC, $1,011.[126]

In the current analysis, the average direct cost per episode of care for an MSC was $6,215 in 2004. In Australia, the direct costs for melanoma are estimated to be AUS$3,341[127] while in the U.S. they average $12,500 (1997 US$).[128] This variance likely reflects differences in health system practices between the two countries, unit costs, and the stage at which the majority of melanoma cases are treated.

[124] Joseph AK, Mark TL, Mueller C. The period prevalence and costs of treating nonmelanoma skin cancers in patients over 65 years of age covered by Medicare. *Dermatologic Surgery.* 2001; 27(11): 955-9.
[125] Housman TS, Williford PM, Feldman SR et al. Nonmelanoma skin cancer: an episode of care management approach. *Dermatologic Surgery.* 2003; 29(7): 700-11.
[126] Lear W, Mittmann N, Barnes E et al. Cost comparisons of managing complex facial basal cell carcinoma: Canadian study. *Journal of Cutaneous Medicine and Surgery.* 2008; 12(2): 82-7.
[127] Australian Institute of Health and Welfare. *Health system expenditures on cancer and other neoplasms in Australia, 2000-01*. 2005. Available at http://www.aihw.gov.au/publications/hwe/hsecna00-01/hsecna00-01.pdf. Accessed January 2009.
[128] Tsao H, Rogers GS, Sober AJ. An estimate of the annual direct cost of treating cutaneous melanoma. *Journal of the American Academy of Dermatology.* 1998; 38(5 Pt 1): 669-80.

In the current analysis, the direct costs associated with MSC, BCC and SCC are 6.7%, 54.6% and 25.3% of the total costs. A U.S. study[129] estimated that the direct costs associated with melanoma were 9.0% of total costs, while a study in England[130] estimated these to be 14.7% of total costs. These same two studies estimated the direct costs associated with NMSC to be 39.4% and 80.0%, respectively, of total costs. As noted earlier, the assumptions used in valuing indirect costs can dramatically alter the results. Since we modified the standard human capital approach by valuing "non-productive" time lost (using each province's minimum wage), the indirect costs in the current study are somewhat higher than in some other studies.

### Sensitivity Analysis

There are a number of potential economic costs that have not been included in the current study. For example, the U.S. study noted earlier found that prescription drugs accounted for 28% of direct costs for MSC and 1.3% for NMSC.[131] The study from England estimated patient costs (e.g. transport and economic inactivity costs while attending appointments) as 2.6% of total costs for melanoma and 15.4% of total costs for NMSC.[132]

In our base case, the economic burden of skin cancers in Canada in 2004 totals $532 million ($66/$466 million direct/indirect). Including costs for prescription drugs based on the ratio of costs in the U.S. study would increase direct costs by $8.75 million. Including patient costs based on the ratio of costs in the study from England would increase indirect costs by $25.12 million.

As noted earlier, the standard human capital approach was modified by valuing "non-productive" time lost (using each province's minimum wage). This approach was taken to address an important criticism of the human capital approach, namely, that it does not value unpaid work and leisure time. This modification, however, significantly alters the total indirect costs. Using the standard human capital approach (in which non-workforce participation costs are excluded, see following table), would reduce the estimated indirect costs in 2004 from $466 to $216 million (see the following table).

[129] Lewin Group Inc. *The Burden of Skin Diseases 2004.* 2006. Society for Investigative Dermatology and American Academy of Dermatology Association. Available at http://www.lewin.com/content/publications/april2005skindisease.pdf. Accessed January 2009.
[130] Morris S, Cox B, Bosanquet N. Cost of skin cancer in England. *European Journal of Health Economics.* 2008: Epublished ahead of print.
[131] Lewin Group Inc. *The Burden of Skin Diseases 2004.* 2006. Society for Investigative Dermatology and American Academy of Dermatology Association. Available at http://www.lewin.com/content/publications/april2005skindisease.pdf. Accessed January 2009.
[132] Morris S, Cox B, Bosanquet N. Cost of skin cancer in England. *European Journal of Health Economics.* 2008: Epublished ahead of print.

**Annual Direct and Indirect Costs of Skin Cancers in Canada**
Excluding Non-Workforce Participation Costs
**2004** (in $millions, 2004 constant dollars, undiscounted)

| Type of Cost | MM | % | BCC | % | SCC | % | Total | % |
|---|---|---|---|---|---|---|---|---|
| Primary care | 1.76 | 0.8% | 24.90 | 71.9% | 6.34 | 34.6% | 33.00 | 11.7% |
| Hospital-based day surgery | 17.01 | 7.4% | 0.91 | 2.6% | 2.22 | 12.1% | 20.14 | 7.1% |
| Hospital inpatient care | 10.78 | 4.7% | 0.58 | 1.7% | 1.56 | 8.5% | 12.92 | 4.6% |
| **Total direct costs** | **29.55** | **12.9%** | **26.39** | **76.2%** | **10.12** | **55.2%** | **66.05** | **23.4%** |
| Mortality | 195.50 | 85.4% | 4.50 | 13.0% | 7.11 | 38.8% | 207.10 | 73.5% |
| Morbidity | 3.86 | 1.7% | 3.74 | 10.8% | 1.10 | 6.0% | 8.70 | 3.1% |
| **Total indirect costs** | **199.36** | **87.1%** | **8.24** | **23.8%** | **8.21** | **44.8%** | **215.80** | **76.6%** |
| **Total costs** | **228.91** | **100%** | **34.63** | **100%** | **18.32** | **100.0%** | **281.86** | **100%** |

*Note:* MM, malignant melanoma; BCC, basal cell carcinoma; SCC, squamous cell carcinoma.

#### Projected Cost Based on APC Scenario

Attempting to predict the future is always a challenge and filled with uncertainties. These uncertainties multiply the further into the future one attempts to forecast. To partially address this uncertainty, three alternate projection scenarios were developed. The future economic burden of skin cancer in Canada is sensitive to these projection scenarios.

To review, in the **Medium APC Scenario**, assumptions were made about the annual percent change (APC) in males and females based on recent trends in age-standardized incidence rates. In the **Low APC Scenario**, a more conservative approach was used by halving the APC noted in the Medium APC Scenario. This scenario was intended to reflect the possibility that some of the observed increase in rates may be partly related to improvements in case ascertainment over time, rather than being solely driven by true increases in incidence. In addition, a further possible reason for a reduction in APC is the increasing proportion of the Canadian population that is from a visible minority. The **No APC Scenario** assumed that age-standardized incidence rates would remain stable and thus future changes are based solely on population growth and ageing.

In the base case scenario (Low APC), the economic burden of skin cancer in Canada in 2031was estimated at $922 million, as noted above. The economic burden was estimated at $784 million for the No APC Scenario and $1,060 million for the Medium APC Scenario (see Appendix F for details).

#### Using Discount Rates

Discount rates are most commonly applied to both costs and effects in economic evaluations in order to take into account time preference. In short, a dollar spent now (or an effect produced now) is of higher value than the equivalent phenomenon in the future. The further into the future, the lower the value of the dollar or the effect. This is particularly problematic for interventions focusing on future disease prevention, as is the current situation. The most important benefits (prevention of skin cancers) occur decades after prevention programs assist in modifying unhealthy behaviours. As noted by Crott, discounting "clearly favours events that occur close to the moment of intervention and penalise ... those events happening much later in life."[133] Thus a number of research groups have suggested that different discount rates be

[133] Crott R. Economic analysis of HPV-vaccines: Not so simple? *Vaccine.* 2007; 25(45): 7717.

applied to costs and effects when assessing prevention programs.[134,135,136] One group recommends that costs and consequences be first presented in their undiscounted form (essentially utilizing a 0% discount rate) with a sensitivity analysis including rates of 3% and 5%. A key reason for undertaking the sensitivity analysis would be to "alert decision makers to the importance of the choice of discount rate (pg. 73)".[137] This approach has been used in this section.

In 2004, applying a discount rate of 3% reduced the total estimated economic burden from $532 million to $411 million. A 5% discount rate further reduced this value to $355 million.

**Economic Burden of Skin Cancer in Canada**
In 2004, Sensitivity Analysis

| | Discount Rate | | |
|---|---|---|---|
| | 0% | 3% | 5% |
| ***Including*** Non-Workforce Participation Costs | | | |
| Direct | $ 66.05 | $ 66.05 | $ 66.05 |
| Indirect | $ 465.70 | $ 344.60 | $ 288.64 |
| **Total** | **$ 531.75** | **$ 410.65** | **$ 354.69** |
| ***Excluding*** Non-Workforce Participation Costs | | | |
| Direct | $ 66.05 | $ 66.05 | $ 66.05 |
| Indirect | $ 215.80 | $ 160.09 | $ 134.28 |
| **Total** | **$ 281.86** | **$ 226.14** | **$ 200.34** |

The following table provides a summary of the economic burden of skin cancer in Canada in 2031 based on various assumptions regarding discount rates, projection scenarios and whether or not non-workforce participation costs are included (modifying the standard human capital approach). The results are sensitive to these variables, with the estimated economic burden ranging from a low of $295 million to a high of $1,060 million in 2031.

[134] Bos JM, Beutels P, Annemans L et al. Valuing prevention through economic evaluation: some considerations regarding the choice of discount model for health effects with focus on infectious diseases. *PharmacoEconomics.* 2004; 22(18): 1171-9.
[135] Brouwer WB, Niessen LW, Postma MJ et al. Need for differential discounting of costs and health effects in cost effectiveness analyses. *Bmj.* 2005; 331(7514): 446-8.
[136] Gravelle H, Brouwer W, Niessen L et al. Discounting in economic evaluations: stepping forward towards optimal decision rules. *Health Economics.* 2007; 16(3): 307-17.
[137] Drummond MF, O'Brien B, Stoddart GL and Torrance GW. Methods for the Economic Evaluation of Health Care Programmes. 2nd Edition. Oxford University Press, New York. 1997.

**Economic Burden of Skin Cancer in Canada**
In 2031, Sensitivity Analysis

| | Discount Rate 0% | 3% | 5% |
|---|---|---|---|
| **No APC Scenario** | | | |
| ***Including*** Non-Workforce Participation Costs | | | |
| Direct | $ 123.35 | $ 123.35 | $ 123.35 |
| Indirect | $ 660.49 | $ 515.08 | $ 443.65 |
| **Total** | **$ 783.83** | **$ 638.42** | **$ 567.00** |
| ***Excluding*** Non-Workforce Participation Costs | | | |
| Direct | $ 123.35 | $ 123.35 | $ 123.35 |
| Indirect | $ 253.98 | $ 198.51 | $ 171.44 |
| **Total** | **$ 377.33** | **$ 321.86** | **$ 294.79** |
| **Low APC Scenario** | | | |
| ***Including*** Non-Workforce Participation Costs | | | |
| Direct | $ 161.86 | $ 161.86 | $ 161.86 |
| Indirect | $ 759.94 | $ 602.55 | $ 523.73 |
| **Total** | **$ 921.80** | **$ 764.40** | **$ 685.59** |
| ***Excluding*** Non-Workforce Participation Costs | | | |
| Direct | $ 161.86 | $ 161.86 | $ 161.86 |
| Indirect | $ 271.47 | $ 216.29 | $ 188.82 |
| **Total** | **$ 433.33** | **$ 378.15** | **$ 350.68** |
| **Medium APC Scenario** | | | |
| ***Including*** Non-Workforce Participation Costs | | | |
| Direct | $ 200.35 | $ 200.35 | $ 200.35 |
| Indirect | $ 859.40 | $ 689.09 | $ 602.66 |
| **Total** | **$ 1,059.75** | **$ 889.44** | **$ 803.01** |
| ***Excluding*** Non-Workforce Participation Costs | | | |
| Direct | $ 200.35 | $ 200.35 | $ 200.35 |
| Indirect | $ 288.97 | $ 233.37 | $ 205.31 |
| **Total** | **$ 489.32** | **$ 433.72** | **$ 405.66** |

## Effect of a *SunSmart* Type Skin Cancer Prevention Program in Canada

There are a number of ways that modelling the effect of a *SunSmart* type skin cancer prevention program could be accomplished. The approach taken for this study was done so for the following reasons:

- To stabilize rates, especially for mortality, five years of base data were used. The most current five years for which actual data were available when this analysis was completed was 2000 to 2004.
- Given the lag time between a posited prevention program and changes in incidence or mortality rates, the most distant population projections from Statistics Canada were used (to 2031).
- The time between 2004 and 2031 allows for modelling over a 28-year period.
- Using base data earlier than 2000 to 2004 (to be able to lengthen the modelling period) was rejected as the APC has changed over time and it was important to use the most current APC in developing the projection scenarios.

### Incidence and Mortality

In line with the assumption of a 9-year lag time for the impact of a prevention program on the incidence of MSC, the first decrease related to a posited 2004 program launch shows up after 2012; for example, in 2016, a total of 206 melanoma cases would be avoided (based on applying the prevention effect assumptions to the Low APC scenario). By 2031, the decrease would be 2,111 cases. Over the 28 years of the prevention program, a total of 18,047 melanomas and 2,428 deaths due to melanoma would be avoided. Because of longer lag times, changes in the incidence rate and absolute number of NMSC cases appear later in the modelling period. The cumulative impact over 28 years equates to 19,843 BCC cases avoided. The absolute impact on SCC incidence would be quite modest, yielding a cumulative impact over 28 years of only 641 avoided cases. An estimated 85 deaths due to NMSC would also be avoided (see following table).

### Cost of a *SunSmart* Type Program in Canada

The estimated costs of a *SunSmart* type skin cancer prevention program in Canada were calculated by converting the $0.28 AUS annual per capita expenditure in Victoria over the duration of *SunSmart* to an equivalent Canadian $ value ($0.271 CAN) and multiplying this per capita expenditure by the projected annual Canadian population. Based on this assumption, the annual cost of a *SunSmart* type skin cancer prevention program in Canada would be $8.65 million in 2004, increasing to $10.65 million in 2031. The cumulative cost over the 28-year modelling period would be $269.8 million. See Appendix C for more details on the Australian *SunSmart* program.

### Estimating Potential Future Cost Avoidance

The following table provides a summary of the cases, deaths, and direct and indirect costs avoided due to the implementation of such a *SunSmart* type skin cancer prevention program in Canada. As noted in the model assumptions, no effect would be observed for melanoma until 9 years (2012) after the prevention program was initiated; this would increase to 15 years (to 2018) for NMSC. The direct and indirect costs avoided would also be delayed by 9 and 15 years respectively.

Direct costs avoided during the 28-year period from 2004 to 2031 are estimated to be $85 million. On an annualized basis, avoided direct costs will surpass the cost of the program only by the end of the modelling period in 2031 (see Appendix G for additional details). The main reasons for the “delay” in an investment return is, quite simply, that prevention takes time (that is, there is a lag time related to the biological effects of carcinogenesis, and in seeing the impact of such effects being reduced).

The effect on indirect costs avoided, however, shows a very different pattern. The indirect mortality costs associated with any deaths among young individuals (each with multiple decades of life lost and the associated earning potential) create a disproportionately higher impact at an earlier point in the modelling. In the prevention model, for example, initial avoided melanoma deaths resulted in 40 potential years of life lost (PYLL) avoided, valued at $27,772 per year, for a total of $1.1 million per death. This total decreases over time as the longer-term prevention program leads to the reduction of deaths in older cohorts. By 2031, the PYLL avoided per death decreases to 29 PYLL avoided (note that this is still substantially higher than the average of about 20 PYLL per death estimated for all melanoma deaths in 2004), valued at $24,378 per year, for a total of $0.7 million per death.

Indeed, the annual costs for a comprehensive skin cancer prevention program launched in 2004 are exceeded by total costs avoided as early as 2013. Importantly, the same effect leads to *cumulative* prevention program costs of $270 million being exceeded by cumulative total costs avoided as early as 2020. The growing absolute number of skin cancers avoided year-over-year ultimately also plays a strong role in the generation of avoided total costs. Thus, in the last year of the modelling period, *the total costs avoided in that year alone almost match the cumulative prevention spending over 28 years* ($232 million versus $270 million). Total direct and indirect costs avoided during the 28-year modelling period are estimated to total $2.12 ***billion***, or 7.8 times the cost of prevention.

**Estimated Effect of a *SunSmart* Type Skin Cancer Prevention Program in Canada**
**2004 to 2031** (2004 Constant $, Undiscounted)

| | Calendar Year | | | | | | |
|---|---|---|---|---|---|---|---|
| | **2004** | **2011** | **2016** | **2021** | **2026** | **2031** | **28 Year Total** |
| **Cases Avoided** | | | | | | | |
| Melanoma | - | - | 206 | 773 | 1,364 | 2,111 | **18,047** |
| BCC | - | - | - | 545 | 1,626 | 2,996 | **19,843** |
| SCC | - | - | - | 15 | 43 | 117 | **641** |
| **Total** | **-** | **-** | **206** | **1,333** | **3,033** | **5,224** | **38,531** |
| **Deaths Avoided** | | | | | | | |
| Melanoma | - | - | 23 | 104 | 185 | 288 | **2,428** |
| PYLL Avoided | - | - | 952 | 3,369 | 5,805 | 8,485 | **76,872** |
| PYLL Avoided per Death | - | - | 40.5 | 32.4 | 31.3 | 29.4 | **31.7** |
| NMSC | - | - | - | - | 8 | 16 | **85** |
| PYLL Avoided | - | - | - | - | 287 | 450 | **2,839** |
| PYLL Avoided per Death | - | - | - | - | 37.4 | 28.8 | **33.3** |
| **Direct Costs Avoided ($millions)** | | | | | | | |
| Melanoma | | | $0.77 | $3.17 | $5.59 | $9.57 | **$75.91** |
| BCC | | | | $0.24 | $0.70 | $1.29 | **$8.55** |
| SCC | | | | $0.01 | $0.03 | $0.08 | **$0.41** |
| **Total** | | | **$0.77** | **$3.41** | **$6.32** | **$10.94** | **$84.88** |
| **Indirect Costs Avoided - Morbidity ($million)** | | | | | | | |
| Melanoma | | | $0.19 | $0.76 | $1.33 | $1.90 | **$17.06** |
| BCC | | | | $0.06 | $0.19 | $0.35 | **$2.29** |
| SCC | | | | | $0.01 | $0.02 | **$0.09** |
| **Sub-Total** | | | **$0.19** | **$0.82** | **$1.52** | **$2.26** | **$19.44** |
| **Indirect Costs Avoided - Mortality ($million)** | | | | | | | |
| Melanoma ($million) | | | $26.43 | $88.87 | $147.87 | $206.85 | **$1,936.41** |
| NMSC ($million) | | | | | $7.90 | $11.87 | **$75.08** |
| **Sub-Total** | | | **$26.43** | **$88.87** | **$155.77** | **$218.72** | **$2,011.49** |
| **Total Indirect Costs Avoided** | | | **$26.61** | **$89.69** | **$157.29** | **$220.98** | **$2,030.93** |
| **Direct Costs per Case Avoided** | | | | | | | |
| Melanoma | | | $3,715 | $4,100 | $4,100 | $4,534 | **$4,206** |
| BCC | | | | $431 | $431 | $431 | **$431** |
| SCC | | | | $662 | $646 | $644 | **$645** |
| **Indirect Costs Avoided - Mortality** | | | | | | | |
| $ per Melanoma Death | | | $1,124,667 | $855,341 | $798,439 | $717,853 | **$797,386** |
| $ per Melanoma PYLL | | | $27,772 | $26,376 | $25,473 | $24,378 | **$25,190** |
| $ per NMSC Death | | | | | $1,031,107 | $758,672 | **$881,089** |
| $ per NMSC PYLL | | | | | $27,534 | $26,370 | **$26,443** |

*PYLL = Potential Years of Life Lost*

## Sensitivity Analysis

The sensitivity analysis detailed in Appendix F found that indirect costs are quite sensitive to the application of discount rates and whether or not lost "non-productive" time is given a value. As would be expected, the prevention modelling results are also highly sensitive to these two variables (see following table).

**Skin Cancer Prevention Program in Canada**
**Potential Costs Avoided** ($millions)
2004 to 2031, Sensitivity Analysis

| | Discount Rate 0% | 3% | 5% |
|---|---|---|---|
| ***Including*** Non-Workforce Participation Costs | | | |
| Direct | $ 84.9 | $ 84.9 | $ 84.9 |
| Indirect | $ 2,030.9 | $ 1,305.6 | $ 1,017.8 |
| **Total** | **$ 2,115.8** | **$ 1,390.5** | **$ 1,102.7** |
| ***Excluding*** Non-Workforce Participation Costs | | | |
| Direct | $ 84.9 | $ 84.9 | $ 84.9 |
| Indirect | $ 1,061.8 | $ 686.0 | $ 536.9 |
| **Total** | **$ 1,146.6** | **$ 770.9** | **$ 621.8** |

Over the 28-year period of the model (2004 to 2031), total costs avoided were estimated at $2.12 billion compared to the estimated cost of a prevention program of $270 million. If lost non-productive time is not given a monetary value (i.e., contrary to the recommendations for the modified human capital approach detailed in Appendix F), and a 5% discount rate is applied, then the total cumulative costs avoided over the 28-year time period would decrease to $622 million. While this is less than a third of the base case estimate, it is still 2.3 times the estimated cumulative cost of the prevention program.

## Discussion

In a series of modeled estimations over a 2004 to 2031 timeframe, with each analysis building on the preceding work, this report has generated data related to current and projected incidence and mortality for the main types of skin cancer in Canada, and then ascertained how these figures and the associated economic costs would vary under the impact of a comprehensive national skin cancer prevention program. Important sensitivity analyses were also conducted. With annual expenditures rising from about $8.7 million to about $10.6 million per year (amounting to total spending of $270 million in constant, undiscounted 2004 dollars over 28 years), a comprehensive, sustained Canadian program similar to that of the Australian *SunSmart* effort would generate the following impacts:

- Just over **18,000 fewer melanoma** cases and approximately **2,400 fewer melanoma-related deaths**
- About **20,500 fewer basal cell carcinomas** (BCCs) and **squamous cell carcinomas** (SCCs) and approximately **85 fewer NMSC-related deaths**
- **$85 million in direct costs** and just over **$2 billion in indirect productivity costs** avoided
- In sum, **societal economic cost avoidance would be 7.8 times greater than prevention program costs**

Even with conservative cost assumptions applied through sensitivity analyses, the total costs avoided still exceed program costs over the 28-year period by a factor of 2.3 to 1.

Both the results and costs avoided associated with a successful prevention program take a long time to be fully realized. By Year 10 of the program, however, annual total costs avoided ($10.6 million) would begin to exceed annual program costs ($9.3 million). The costs avoided in Year 28 ($232 million) are almost equivalent to the entire cumulative 28 year prevention program costs of $270 million.

These estimates for the Canadian context may be compared with the two comparable country-wide analyses located in the literature that were outlined in the Introduction to this report.

First, an analysis of a school-based program in the U.S. known as *SunWise* estimated that it would avert 10,960 cases of skin cancer (including 51 deaths) between 1999 and 2015 among the approximately 12 million students that would be exposed to the sun safety curriculum. The medical expenditures and productivity losses averted by the program were projected to outweigh program costs by a factor between 2 and 4. This program is narrower in application than the social marketing campaign and other interventions across all age groups envisioned in the Canadian analysis; nonetheless, reflecting the strategic value in targeting children for such education, and the fact that a substantial proportion of skin cancer may in fact be traced to pediatric exposures, the U.S. effort actually suggested health and economic results of a similar order of magnitude to the estimation generated in the present report.

Second, researchers estimated that application of historic levels of spending on a program like *SunSmart* across Australia for 20 years would reduce melanomas by an additional 20,000 cases and NSMC by 49,000 cases; further, over 1,900 premature deaths would be deferred. In this analysis, the program was found to be (modestly) cost saving for the medical system; the impact on productivity losses was not calculated. Perhaps more comparable to the Canadian situation considered in this report, the Australian researchers also modeled the outcome if national program spending was increased from historic lows (0.07 AUD$ per capita) to a

sustained investment of $0.28 per capita (or about $120 million in total program costs over 20 years). On these terms, the additional number of skin cancer cases avoided was estimated to be 190,000, with a savings to the health care system of about $2.30 for each $1.00 invested in the prevention program, a return on investment similar to the more conservative results for Canada generated through the sensitivity analysis conducted for this report.

### Cost Savings in Different National Contexts

As described in Appendices C and G, key principles and information employed in the Australian analysis have been adapted for the economic evaluation of skin cancer prevention in Canada. Given some overlap in methodology, how may one account for the fact that the Australian effort is estimated to be cost saving for the medical system while a similar Canadian program (with similar per capita spending) would not create such savings (on an annual basis) until late in the program? Moreover, on a cumulative basis, direct cost recovery is projected to occur at a point beyond the modelling period in Canada. There are two main explanations for more dramatic impacts in Australia. To begin with, the analysis in the present report posited a longer lag time (9 years versus 5 in the Australian study) before the start of reductions in melanoma incidence and mortality. This more modest assumption concerning the speed of a biological effect in the population seemed to fit the actual pattern of results attributed to *SunSmart* since it began in the state of Victoria in 1988; the differential in terms of a population health effect of a 5- versus 9-year lag time is substantial. Even more significant, however, is the variation in skin cancer burden between the two countries. For instance, the incidence rates for melanoma are much higher than those seen in Canada (or in the United States). This may be illustrated for one of the model cohorts (males aged 45-49 years), where the incidence rates in Canada, the U.S., and Australia are, respectively, about 13, 28, and 53 per 100,000.[138]

### Priorities in Public Health

The sort of evaluation pursued in this report is important for health care planning; however, such investigations have not been pursued very often in the context of skin cancer, which tends to be the "poor cousin" in the world of oncology research. To be sure, melanoma, being a more deadly cancer than NMSC, has received more attention by researchers and government agencies. In contrast, because BCC and SCC are usually easily curable, they have been far less studied in terms of health services utilization and broader societal impacts. The absolute numbers involved, however, arguably should dictate a different attitude among planners, as suggested as long ago as 1994 in another national context: "Non-melanoma skin cancer imposes an enormous public health burden on the U.S. population. Quantification of its morbidity and its prevention are important priorities."[139]

Even modest unit costs mount up as case volumes become more substantial. Compared to the estimated 4,755 diagnosis-based incidence for melanoma in 2004, there were almost 76,000 NMSC cases in Canada. The cumulative number of avoidable NMSC cases exceeds that related to melanoma over the 28-year course of the prevention program and ultimately accounts for almost $9 million in avoided direct costs and over $77 million in avoided indirect costs.

[138] See the Introduction to the report; information from 1982-2006 for Australia derived from data available through the Australian Institute of Health and Welfare, 2007.

[139] Miller DL, Weinstock MA. Nonmelanoma skin cancer in the United States: incidence. *Journal of the American Academy of Dermatology.* 1994; 30(5 Pt 1): 774-8.

Though the economics of NMSC are significant, the main cost drivers (and thus the potential prevention impact) in Canada are strongly related to melanoma. In 2004, the estimated direct costs generated by melanoma cases in Canada were almost $30 million, with indirect costs 14 times higher, for total costs of $443 million. Without a national prevention initiative, this number was projected to grow to $696 million by 2031.

The total direct and indirect costs in 2004, $66 million and $466 million, respectively, may be compared with those for all cancers and for other chronic diseases. The best estimate of the latter in Canada is the report *Economic Burden of Illness in Canada, 1998*.[140] In that study, the estimate was $2.5 billion for direct costs and $11.8 billion for indirect costs of all cancers. Without correcting for inflation, skin cancer appears to contribute about 2.6% of the direct cancer costs and 4.0% of indirect costs.

### International Comparisons

Comparisons with other countries can be useful, especially given the number of assumptions that are part of any modelling project. For example, in the Introduction to this report, a 2004 study was cited that estimated 2004 direct costs for melanoma in the U.S. at $280 million, with indirect costs 10 times higher. The current project estimated direct costs for melanoma at $29.6 million, with indirect costs 14 times higher. While there are differences between the two countries in their health care systems, and the two studies used different costing methodologies, the two results are comparable, after scaling for the population differential between the two countries.

In terms of direct spending in the health care system, the cost per melanoma case in Canada would rise from $6,215 in 2004 to $7,136 in 2031. As noted in the Introduction to this report, the comparable estimates in the U.S. tend to be higher (e.g., $12,500 per melanoma case in 1997) and lower in Australia (e.g., $3,341 in 2001).

In contrast, the direct cost per NMSC case, estimated to fall between $436 and $657 in Canada in 2004, is substantially less than the one found for melanoma patients. Interestingly, the average cost range in the U.S. as noted in the Introduction to this report ($330 to $740) is of a similar order of magnitude for NMSC, suggesting a smaller variation in care practices for these less serious types of skin cancer.

*Aggregate* direct costs related to NMSC in Canada were estimated to be over $36 million in 2004. According to some researchers, the equivalent costs appear to be disproportionately higher in countries such as the U.S., England, and Australia. This may be readily explained by higher skin cancer rates compared with Canada; this phenomenon was already noted above for melanoma in the context of the U.S., where rates for one key cohort were almost double that seen in Canada. Even more dramatic is the remarkably high incidence of NMSC in Australia; in fact, over 80% of all new cancer cases in that country are NMSC, compared to about 30% in Canada, with total medical spending matching this pattern.

Of more value and validity perhaps is a comparison of the *indirect-to-direct cost ratio* for all skin cancers. In Canada, this ratio was 7.0 for 2004, whereas, according to Morris and colleagues, it was 2.4 in England in 2002 (this is despite the fact that they include patient out-

[140] Health Canada. *Economic Burden of Illness in Canada, 1998.* 2002. Available at http://www.phac-aspc.gc.ca/publicat/ebic-femc98/pdf/ebic1998.pdf. Accessed January 2009.

of-pocket costs, which are not included in the Canadian indirect cost assessment).[141] The equivalent ratio estimated in the U.S. for 2004 was 2.2.[142] An explanation for the discrepancy is the impact of adopting a *modified* human-capital approach to estimating mortality and morbidity costs, such that the impact of time loss related to those not in the formal workforce is also valued. This approach was adopted in the current project to address a deficiency of the standard human capital approach for estimating indirect costs; namely that it does not value unpaid work and leisure time. In the sensitivity analysis when the *standard* human capital approach was applied, the ratio of indirect-to-direct costs was 3.3, bringing it more in line with other national estimates.

### Robust Prevention Modelling

As outlined in Appendix C, there are a number of approaches that have been used to evaluate skin cancer prevention, including tracking the impact on sun safety behaviours and biomarkers such as sunburns. However, when estimating the impact of a comprehensive prevention program in Canada, it was valuable to be able to apply available information about the presumed effects of the Australian *SunSmart* program on skin cancer (specifically, melanoma) incidence. Using the pattern related to skin cancer per se, including offering a fresh statistical analysis of the population registry data (rather than population survey information) from the perspective of the trends (or average percent change) in incidence, was a strength of the present project. Further, comparing the Victoria information against what was happening in the rest of Australia before and after the launch of a *SunSmart* program in those other regions, allowed for an approximate identification and exclusion of changes in incidence rates that predated the direct impact of *SunSmart*.

### Strengths and Limitations

The present study offers a number of additional strengths:

- The model is constructed based on 5-year gender-specific population cohorts, allowing gender- and age-specific incidence rates to be modified according to known trends (and assumptions about future trends) in a highly sensitive manner.
- The same is true for the other major data component in the model, namely, costing information. Thus, average unit costs were not implemented across the whole population, but rather the costs specific to an age group; for instance, elderly melanoma patients have higher hospitalization costs, but lower morbidity costs (because they are generating less income even when not under treatment and recovering). In this way, the model is responsive in a more accurate way to the effects of an ageing population.
- Predictions of future burden generally involve applying age- and gender-specific incidence rates to population projections and, importantly, also involve certain assumptions (informed by past data) about the change in such rates in the future (i.e., the so-called average annual percent change, or APC). This approach has been used in the assessment of skin cancer burden in other settings.[143] The present Canadian analysis offers three different approaches to understanding the impact of secular skin cancer trends, labelled No, Low, and Medium APC scenarios. It is also important to note that

[141] Morris S, Cox B, Bosanquet N. Cost of skin cancer in England. *European Journal of Health Economics.* 2008: Epublished ahead of print.
[142] See the details in the Introduction to this report.
[143] Brewster DH, Bhatti LA, Inglis JH et al. Recent trends in incidence of nonmelanoma skin cancers in the East of Scotland, 1992-2003. *British Journal of Dermatology.* 2007; 156(6): 1295-300.

an age-cohort strategy was followed in this report; that is, as younger cohorts aged, they maintained the (relatively low) APC appropriate for their age cohort at the start of the modelling period.

- To our knowledge, this is the first time that NMSC data from five Canadian provinces (British Columbia, Alberta, Saskatchewan, Manitoba and New Brunswick) has been aggregated and used to project NMSC in the other Canadian provinces/territories.
- To come as close as possible to the true disease burden, adjustments have been posited for base and future case numbers. For instance, the model incorporates an adjustment to take into consideration under-ascertainment in Quebec registries (which only track hospital separations to count melanoma cases).
- The estimates for NMSC incidence (and mortality) are further adjusted to reflect differences in melanoma rates between provinces/territories (where melanoma rates are thus serving as a proxy for risk factor exposure differences across the country).
- The registry information concerning melanomas that is typically captured in Canada does not take into account recurrences or second primary skin cancers. The same is true for NMSC. The present model seeks to adjust for this in a manner that is referred to as a "diagnosis-based incidence approach." The impact of this adjustment is substantial. A patient-based incidence approach, corrected for Quebec under-ascertainment, suggested 4,303 cases of melanoma occurred in 2004. These figures may be compared to 4,755 diagnosis-based cases. As for NMSC, the patient-based incidence figure for 2004 was 60,591, compared to 75,953 once recurrences and second primaries were taken into account.
- Establishing cost information that is accurate across the country is quite challenging, but there has been a concerted effort to generate data specific to each province/territory, adjusting for the main cost driver in each instance (which include medical staff expenses, length of stay in hospital, average annual earnings, etc.).
- As noted earlier, one of the standard approaches to calculating mortality and morbidity costs, namely, the human-capital approach, was modified by placing a value (according to the minimum wage) on all years of life lost or days of normal activity lost, even when the personal timeline extended into the typical retirement period.

The present project also has some limitations. Any complex disease burden model, which always must strive to bridge the gap of critical missing information, inevitably depends on multiple assumptions. Each assumption is a potential weak point that must be defended with respect to its face validity, or the appropriateness of any deviation from other accepted norms; this would include, for example, the shift from a patient-based incidence approach to one that is diagnosis-based. Sometimes, even after applying adjustments, data remains elusive or uncertain. An example of the latter is the fact that, even after modifying the numbers upward, the incidence and mortality data for skin cancer in Quebec still seems low compared to other provinces. Furthermore, melanomas in the other Canadian provinces also tend to be incompletely reported, generally leading to case under-ascertainment in the country.[144,145]

[144] Semenciw RM, Nhu DL, Marrett LD, et al. Methodological issues in the development of the Canadian Cancer Incidence Atlas. *Statistics in Medicine*. 2000; 19: 2437-49.

[145] Cockburn M, Swetter SM, Peng D et al. Melanoma underreporting: why does it happen, how big is the problem, and how do we fix it? *Journal of the American Academy of Dermatology*. 2008; 59(6): 1081-5.

Other data and analysis gaps that may be identified in the project as a whole are as follows:

- The lack of robust registry data from every province/territory in Canada for NMSC, which means extending information from a limited number of settings in order to assess and apply trends to other regions.
- Not including *in situ* skin cancers, including melanomas *in situ*, Bowen's disease and erythroplasia of Queyrat, and mucosal skin tumours (e.g., of the nasal cavity, oral cavity, lip, and genital organs), even though such lesions definitely generate medical and societal costs.
- The limited number of melanoma-related deaths, which meant applying average percent change information from the incidence data to estimate mortality trends for different age groups (this assumes that mortality-to-incidence ratios will remain fixed over time).
- The lack of information on the long-term impact on skin cancer incidence from a sun-safety prevention program; the data available in Australia are suggestive only, as they fall short of the multiple-decade period over which skin carcinogenesis may finally occur, and it is difficult to untangle the confounding effects of any secular trends related to skin cancer reduction.
- Excluding patient out-of-pocket expenses or caregiver costs as part of the direct costing analysis, items that are difficult to calculate but that may be substantial;[146,147] for instance, Morris et al. estimated that patient out-of-pocket costs were 8% of total costs for skin cancer in England.[148]
- Not balancing the benefits of sun safety (which extend beyond skin cancer prevention) against the potential harms due to vitamin D insufficiency. The global disease burden of UVR exposure is estimated at 1.6 million disability-adjusted life years (DALYs) in 2000, while a burden of 3.3 million DALYs could result from a reduction in global UVR exposure to very low levels; the conclusion by Lucas et al. is pertinent: "Sun protection messages are important to prevent diseases of UVR exposure. However, without high dietary (or supplemental) intake of vitamin D, some sun exposure is essential to avoid disease of vitamin D insufficiency."[149]
- Any study that projects results over a longer time period (as in the 28 years in the current study) is very susceptible to unforeseen changes at the societal, behavioural, political, and health system level that may not be reflected in the modelling.

Notwithstanding the aforementioned limitations, the main policy message of this project is that, with costs and losses of about $2 billion over a 28-year period, skin cancer ought to be taken more seriously. Although Canada will experience a unique skin cancer pattern in the future, the conclusion drawn about the ongoing Australian prevention effort is still an apt one for the Canadian context, namely, that it "constitutes excellent value-for-money."

[146] Arozullah AM, Calhoun EA, Wolf M et al. The financial burden of cancer: estimates from a study of insured women with breast cancer. *Journal of Supportive Oncology.* 2004; 2(3): 271-8.
[147] Hayman JA, Langa KM, Kabeto MU et al. Estimating the cost of informal caregiving for elderly patients with cancer. *Journal of Clinical Oncology.* 2001; 19(13): 3219-25.
[148] Morris S, Cox B, Bosanquet N. Cost of skin cancer in England. *European Journal of Health Economics.* 2008: Epublished ahead of print.
[149] Lucas RM, McMichael AJ, Armstrong BK et al. Estimating the global disease burden due to ultraviolet radiation exposure. *International Journal of Epidemiology.* 2008; 37(3): 654-67.

## Appendix A: An Introduction to Skin Cancers

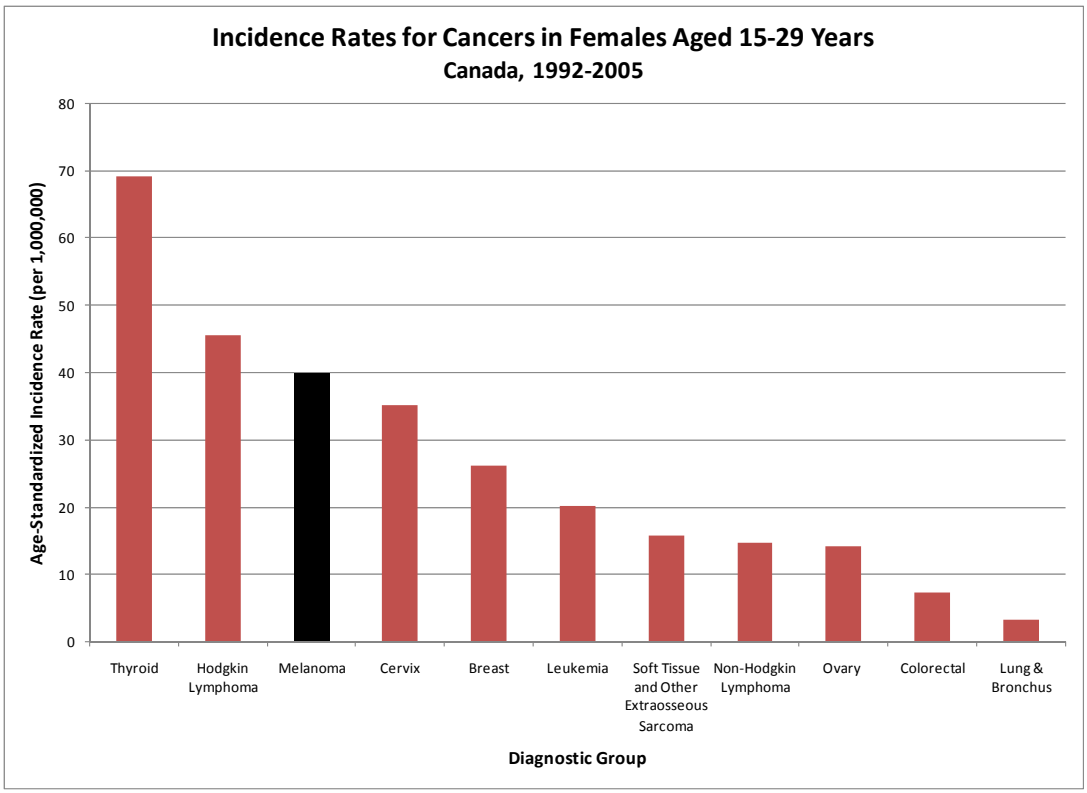
### Cutaneous Melanoma

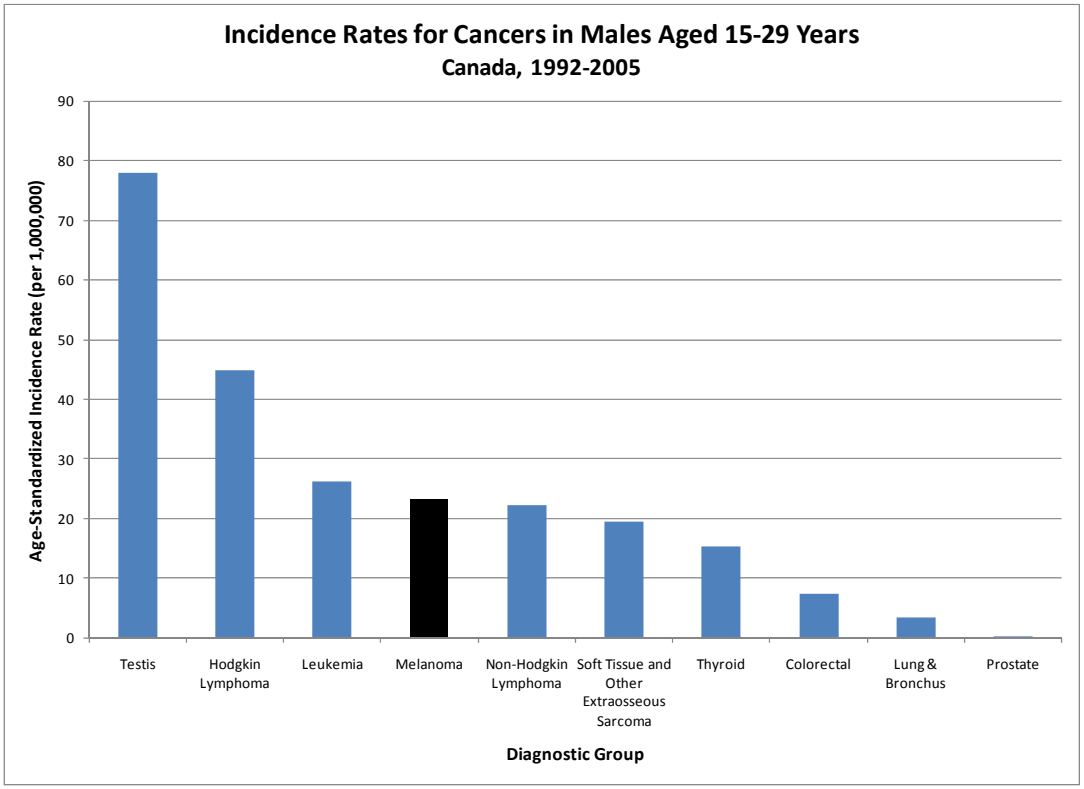
As the great majority of melanoma cases in fact develop on the skin, "melanoma" is routinely used as shorthand for cutaneous melanoma. However, melanomas do occur (rarely) in mucosal epithelial layers and other tissues,[150] so more precise terms such as "cutaneous melanoma" and "cutaneous malignant melanoma" are sometimes used in the literature to label the cases occurring specifically on the skin.

Although melanoma accounts for only about 4% of total skin cancers, it is the most serious form of cutaneous malignancy, causing about 73% of skin cancer deaths. An estimated 4,600 cases of melanoma were diagnosed in Canada in 2008.[151]

Melanoma has a wide age distribution. While it is most prevalent in those over 80 years of age, it is also one of the more common cancers among the spectrum of malignancies that occur in adolescents and young adults. [152] A special analysis in *Canadian Cancer Statistics* in 2009 demonstrated the position occupied by melanoma among cancers that afflict those under age 30 (see the following charts).[153]

[150] McLaughlin CC, Wu XC, Jemal A et al. Incidence of noncutaneous melanomas in the U.S. *Cancer.* 2005; 103(5): 1000-7.
[151] Canadian Cancer Society/ National Cancer Institute of Canada. *Canadian Cancer Statistics 2008*. 2008.
[152] American Cancer Society. *Melanoma Skin Cancer*. 2008. Available at http://documents.cancer.org/170.00/170.00.pdf. Accessed January 2009.
[153] Cancer in adolescents and young adults (15-29 years). *Canadian Cancer Statistics.* Canadian Cancer Society, 2009. Available at http://www.cancer.ca/canada-wide/about%20cancer/cancer%20statistics/~/media/CCS/Canada%20wide/Files%20List/English%20files%20heading/pdf%20not%20in%20publications%20section/Stats%202009E%20Special%20Topics.ashx. Accessed October 2009.


Incidence Rates for Cancers in Females Aged 15-29 Years
Canada, 1992-2005
Age-Standardized Incidence Rate (per 1,000,000)
0
10
20
30
40
50
60
70
80
Thyroid
Hodgkin Lymphoma
Melanoma
Cervix
Breast
Leukemia
Soft Tissue and Other Extraosseous Sarcoma
Non-Hodgkin Lymphoma
Ovary
Colorectal
Lung & Bronchus
Diagnostic Group


Incidence Rates for Cancers in Males Aged 15-29 Years
Canada, 1992-2005
Age-Standardized Incidence Rate (per 1,000,000)
0
10
20
30
40
50
60
70
80
90
Testis
Hodgkin Lymphoma
Leukemia
Melanoma
Non-Hodgkin Lymphoma
Soft Tissue and Other Extraosseous Sarcoma
Thyroid
Colorectal
Lung & Bronchus
Prostate
Diagnostic Group

A report recently developed for Cancer Care Ontario further indicated that melanoma is the second most common cancer among young adults (defined as age 20-44 years).[154] Similarly, U.S. data have shown that melanoma accounts for fully 7% of all cancers among patients aged 15-19 years.[155]

There are clear ethnic and gender patterns as well. Caucasians and men over the age of 50 have a higher risk of developing melanoma than the general population.[156] In the U.S., it has been estimated that men have a 1 in 58 chance of developing melanoma, compared to 1 in 82 for women.[157]

Melanoma originates in melanocytes, cells located in the top layer of skin that produce the pigment melanin. The high mortality rate seen with melanoma is attributable to its ability to metastasize (spread) quickly to other parts of the body via the lymph system or the blood. On the other hand, when detected at an early stage, melanoma is almost always curable. The five-year survival rate in cases where melanoma is detected and treated before it spreads to the lymph nodes is 99%.[158]

The risk of developing melanoma is associated with several factors, including sun exposure, presence of moles, family history, and complexion (as a proxy for skin sensitivity).[159] Excessive exposure to ultraviolet (UV) radiation increases risk of skin cancer in general, and melanoma in particular. Sunlight is a major source of UV radiation; blistering sunburns in childhood and cumulative exposure to solar radiation are considered to be specific risk factors for melanoma. Moles are melanocytic tumours that are considered benign. The more moles a person has, however, the greater the risk of melanoma. People with fair skin, or those with family members who have been diagnosed with melanoma, are also at increased risk. Factors that influence skin cancer risk will be discussed in greater detail below.

[154] *Cancer in Young Adults in Canada.* Cancer Care Ontario. 2006. Available at Accessed http://www.phac-aspc.gc.ca/publicat/cyac-cjac06/pdf/cyac-cjac-2006_e.pdf. October 2009.
[155] Pappo AS. Melanoma in children and adolescents. *European Journal of Cancer.* 2003; 39(18): 2651-61.
[156] National Cancer Institute. *Melanoma of the Skin SEER Stat Fact Sheet.* Available at http://www.seer.cancer.gov/statfacts/html/melan.html. Accessed January 2009.
[157] Houghton AN, Polsky D. Focus on melanoma. *Cancer Cell.* 2002; 2(4): 275-8.
[158] American Cancer Society. *2008 Cancer Facts and Figures*. Available at http://www.cancer.org/downloads/STT/2008CAFFfinalsecured.pdf. Accessed January 2009.
[159] Skin Cancer Foundation. *Melanoma*. 2008. Available at http://www.skincancer.org/Melanoma.html. Accessed January 2009.

### Non-Melanoma Skin Cancer

NMSC accounts for the majority of skin cancer in humans. The two major forms of NMSC, basal cell carcinoma and squamous cell carcinoma, are briefly discussed below.

#### Basal Cell Carcinoma

Basal cell carcinomas (BCC) represent approximately 80% of all skin cancers, and about one-quarter of all cancers.[160,161] They arise in the skin's basal cells, which are found in the deepest layer of the epidermis (the outer layer of the skin). BCC usually develop on sun-exposed areas, especially the head and neck region. They tend to be slow-growing tumours that rarely metastasize, and thus are relatively easy to treat. However, the 5-10% of BCC that are locally aggressive and/or resistant to treatment may grow into adjacent areas of the skin and ultimately invade bone or other tissue.

The most important risk factor for BCC is UV radiation; in fact, chronic exposure to sunlight is the cause of almost all BCC. Understandably, a history of intense sun exposure is associated with people who work outdoors, making involvement in such occupations an indirect risk factor for BCC. Finally, as with melanoma, BCC risk is elevated in fair-skinned individuals.

#### Squamous Cell Carcinoma

Squamous cell carcinomas (SCC) are the second most common form of skin cancer. They arise in squamous cells, which are a major component in the epidermis. SCC is more aggressive than BCC; there is a greater likelihood that SCC will spread to distant parts of the body, though such occurrences are still uncommon. With early identification and prompt treatment, most SCCs are not considered serious. Similar to BCC, tumours appear most frequently on sun-exposed areas such as the face, neck, shoulders, arms and back. They demonstrate a propensity to arise from scars, long-standing sores, areas of skin exposure to certain rare chemicals, and benign skin lesions known as actinic keratoses.[162]

The latter precursor is particularly significant. Actinic keratosis (AK) is a UV-induced lesion that occurs primarily on chronically sun-exposed skin surfaces of fair-skinned individuals. It is difficult to establish an incidence rate for AK, as most such lesions are not brought to the attention of the medical system. Consequently, estimates for the rate of progression to invasive SCC range from 0.1% to 10%, depending upon the assessment of the number of actinic keratoses involved.[163] AK has previously been recognized as a precancerous lesion that may lead to SCC, but is now considered by some authorities to be an *in situ* SCC, or a form of tumour at the beginning of a process of cancer development.[164,165]

Risk factors for SCC are similar to those for BCC, with chronic sun exposure being the dominant influence. Other important factors include fair skin, personal or family history of skin

---

[160] American Cancer Society. *Skin Cancer: Basal and Squamous Cell*. 2008. Available at http://documents.cancer.org/118.00/118.00.pdf. Accessed January 2009.
[161] Langley RGB. *Excellence in Cancer Care: Skin Cancer*. Cancer Care Nova Scotia. Available at http://www.cancercare.ns.ca/media/documents/skincancer.pdf. Accessed January 2009.
[162] Skin Cancer Foundation. *Squamous Cell Carcinoma*. 2008. Available at http:www.skincancer.org/Squamous-Cell-Carcinoma.html. Accessed January 2009.
[163] Smoller BR. Squamous cell carcinoma: from precursor lesions to high-risk variants. *Modern Pathology.* 2006; 19 Suppl 2: S88-92.
[164] Roewert-Huber J, Stockfleth E, Kerl H. Pathology and pathobiology of actinic (solar) keratosis - an update. *British Journal of Dermatology.* 2007; 157 Suppl 2: 18-20.
[165] Ackerman AB, Mones JM. Solar (actinic) keratosis is squamous cell carcinoma. *British Journal of Dermatology.* 2006; 155(1): 9-22.

cancer, and a compromised immune system resulting from: (a) chemotherapy or pre-transplant conditioning; (b) HIV infection, or (c) even excessive unprotected sun exposure itself.[166] Factors that influence skin cancer risk will be discussed in greater detail below.

### Other Skin Cancers

Besides BCC and SCC, there are a number of other types of NMSC that are much rarer. In total, they comprise less than 1% of NMSC. Some of these types are listed below:[167,168]

- *Cutaneous T-Cell lymphoma*
  - Cancer of the lymphocytes in the skin that is difficult to treat
  - One type is related to mycosis fungoides/Sezary syndrome
- *Sarcomas*
  - Develop from connective tissue cells in the skin's dermis
  - Examples include *dermatofibrosarcoma protuberans*, various angiosarcomas, and *Kaposi's sarcoma* (see below)
- *Kaposi's sarcoma*
  - A serious form of skin cancer involving lymph and blood vessels
  - More common since the mid-1980s because of the emergence of an aggressive form associated with acquired immunodeficiency syndrome (AIDS)
- *Merkel cell carcinoma*
  - Potentially aggressive tumour developing in neuroendocrine cells in the skin
  - Tumours are found on or just beneath the skin, and in the hair follicles
- *Sebaceous carcinoma*
  - Arises in glands that produce sebum, which keeps the skin moist
  - Potentially aggressive, invading adjacent and surrounding tissue
- *Atypical fibroxanthoma*
  - A spindle cell tumour of the skin
  - Locally aggressive, but unlikely to spread further
- *Microcystic adnexal carcinoma*
  - Low-grade tumour of the sweat glands that is unlikely to spread

[166] Skin Cancer Foundation. *Squamous Cell Carcinoma.* 2008. Available at http:www.skincancer.org/Squamous-Cell-Carcinoma.html. Accessed January 2009.
[167] *Other Types of Skin Cancer*. Skin Cancer Guide . ca. Available at http://www.skincancerguide.ca/other/types_skin_cancer.html. Accessed January 2009.
[168] American Cancer Society. *Skin Cancer: Basal and Squamous Cell*. 2008. Available at http://documents.cancer.org/118.00/118.00.pdf. Accessed January 2009.

## Factors That Influence Skin Cancer Risk

### Skin Type and Colouring

Skin characteristics play a major role in skin cancer risk. Variations in the type and distribution of pigment-producing organelles in melanocytes determine an individual's vulnerability to ultraviolet (UV) radiation.[169] Darker-skinned individuals, such as those of African or Latin American descent, are afforded more protection from sunlight due to their more intense pigmentation; as a result, they are at lower risk of developing skin cancer than those who have fair skin. In the United States, for example, skin cancer rates in African-Americans are 20 times lower than those seen in Caucasians.[170] Another study conducted in New Mexico determined that skin cancer rates were 5-10 times higher in non-Hispanic whites than those found in the darker-skinned Hispanic population.[171] Other important physical markers of risk exist. Due to direct or indirect associations with skin sensitivity (see below), individuals with many freckles, with blond or red hair, or having blue or green eyes are also at higher risk of melanoma, BCC, and SCC.[172,173]

With increasing sun sensitivity (i.e., decreasing ability to tan "normally"), the relative risk for melanoma, BCC, and SCC rises. The steepest gradient for this risk correlate has been observed for SCC.[174] In the Western Canada Melanoma Study, associations were also confirmed between melanoma and poor tanning ability, or the tendency to burn easily upon unaccustomed sun exposure.[175] It remains possible that the mechanism behind such effects are more directly related to natural skin pigmentation levels rather than tanning ability per se.

### Family History

People with at least one first-degree relative (parent, sibling, or offspring) diagnosed with melanoma have a 50% higher risk of developing the disease compared with those who do not have such a family history.[176] The risk is even higher in cases where the relative was diagnosed at a young age (<30 years).[177] About 10% of melanoma cases across the whole population are associated with a family history of melanoma.[178,179] The mechanism of familial risk may be

---

[169] Gohara MA. Skin cancer in skins of color. *Journal of Drugs in Dermatology*. 2008; 7(5): 441-5.
[170] NSW Skin Cancer Prevention Working Group. *Skin Cancer Prevention Evidence Summary*. 2007. Available at http://www.nswcc.org.au/html/prevention/sunsmart/downloads/skincancer_prevention_evidence_summary.pdf. Accessed January 2009.
[171] Armstrong BK, Kricker A. The epidemiology of UV induced skin cancer. *Journal of Photochemistry and Photobiology B: Biology*. 2001; 63(1-3): 8-18.
[172] American Cancer Society. *Skin Cancer: Basal and Squamous Cell*. 2008. Available at http://documents.cancer.org/118.00/118.00.pdf. Accessed January 2009.
[173] Elwood JM, Gallagher RP, Hill GB et al. Pigmentation and skin reaction to sun as risk factors for cutaneous melanoma: Western Canada Melanoma Study. *British Medical Journal (Clinical Research Edition).* 1984; 288(6411): 99-102.
[174] Armstrong BK, Kricker A. The epidemiology of UV induced skin cancer. *Journal of Photochemistry and Photobiology B: Biology*. 2001; 63(1-3): 8-18.
[175] Elwood JM, Gallagher RP, Hill GB et al. Pigmentation and skin reaction to sun as risk factors for cutaneous melanoma: Western Canada Melanoma Study. *British Medical Journal (Clinical Research Edition).* 1984; 288(6411): 99-102.
[176] Skin Cancer Foundation. *Melanoma*. 2008. Available at http://www.skincancer.org/Melanoma.html. Accessed January 2009.
[177] Begg CB, Hummer A, Mujumdar U et al. Familial aggregation of melanoma risks in a large population-based sample of melanoma cases. *Cancer Causes and Control.* 2004; 15(9): 957-65.
[178] American Cancer Society. *Melanoma Skin Cancer*. 2008. Available at http://documents.cancer.org/170.00/170.00.pdf. Accessed January 2009.
[179] Skin Cancer Foundation. *Melanoma*. 2008. Available at http://www.skincancer.org/Melanoma.html. Accessed January 2009.

traced to behaviour (e.g., a shared pattern of frequent sun exposure) or biology (e.g., a common genetic make-up creating fair skin, or inherited mutations in melanoma susceptibility genes; as noted in Appendix C, all inherited susceptibility to melanoma accounts for less than half of the 10% of cases attributable to family risk).[180,181]

### Age

For both NMSC and melanoma, the risk of developing the disease increases with age. In the case of NMSC, this is likely due to the lifetime accumulation of UV exposure. However, incidence of NMSC in people younger than 40 years appears to be on the rise in many jurisdictions.[182] For melanoma, the highest incidence is observed in Caucasian men over the age of 50. Melanoma also occurs in young people; it is the second most common cancer in young adults 15-29 years old in the United States.[183] Familial melanoma especially has a tendency to occur at a younger age.[184]

### Nevi

Nevi are benign melanocytic tumours, also known as moles. They are strongly associated with risk for melanoma development.[185,186] The greater the number of nevi on a person's skin, especially dysplastic or atypical nevi, the greater the risk of melanoma. An individual who has more than 100 common nevi, or more than two atypical nevi, has a 5- to 20-fold increased risk of melanoma.[187]

### Exposure to UV Radiation

See section on *Skin Cancer* in the Introduction.

### Use of Tanning Beds

Indoor tanning using sunbeds or related devices actually exposes the skin to UV radiation 10-15 times higher than that emitted by the midday sun.[188] Consistent with this fact, there is mounting evidence that artificial tanning increases the risk of developing melanoma and SCC. There is an even higher risk of melanoma when tanning bed exposure begins at a young age.[189,190,191,192]

---

[180] Gerstenblith MR, Goldstein AM, Tucker MA et al. Genetic testing for melanoma predisposition: current challenges. *Cancer Nursing.* 2007; 30(6): 452-9; quiz 62-3.

[181] Olsen CM, Carroll HJ, Whiteman DC. Familial melanoma: A meta-analysis and estimates of attributable fraction. *Cancer Epidemiology, Biomarkers and Prevention.* 2010; 19(1): 65-73.

[182] Christenson LJ, Borrowman TA, Vachon CM et al. Incidence of basal cell and squamous cell carcinomas in a population younger than 40 years. *JAMA: the Journal of the American Medical Association.* 2005; 294(6): 681-90.

[183] Skin Cancer Foundation. *2008 Skin Cancer Facts* 2008. Available at http://www.skincancer.org/2008-Skin-Cancer-Facts.html. Accessed January 2009.

[184] American Cancer Society. *Melanoma Skin Cancer*. 2008. Available at http://documents.cancer.org/170.00/170.00.pdf. Accessed January 2009.

[185] Armstrong BK, Kricker A. The epidemiology of UV induced skin cancer. *Journal of Photochemistry and Photobiology B: Biology.* 2001; 63(1-3): 8-18.

[186] Elwood JM, Jopson J. Melanoma and sun exposure: an overview of published studies. *International Journal of Cancer.* 1997; 73(2): 198-203.

[187] Bataille V, de Vries E. Melanoma--Part 1: epidemiology, risk factors, and prevention. *British Medical Journal.* 2008; 337: a2249.

[188] International Agency for Research on Cancer Working Group on artifical UV light and skin cancer. The association of use of sunbeds with cutaneous malignant melanoma and other skin cancers: A systematic review. *International Journal of Cancer.* 2007; 120(5): 1116-22.

[189] Gallagher RP, Spinelli JJ, Lee TK. Tanning beds, sunlamps, and risk of cutaneous malignant melanoma. *Cancer Epidemiology, Biomarkers and Prevention.* 2005; 14(3): 562-6.

[190] International Agency for Research on Cancer Working Group on artifical UV light and skin cancer. The association of use of sunbeds with cutaneous malignant melanoma and other skin cancers: A systematic review. *International Journal of Cancer.* 2007; 120(5): 1116-22.

Conflicting evidence exists regarding artificial tanning as a risk factor for BCC; while a study by Karagas et al. determined there was a modestly elevated risk, other researchers have not confirmed this association.[193, 194]

### Immune Suppression

People with suppressed immune systems, such as organ transplant patients or those with HIV/AIDS, are at increased risk of developing either NMSC or melanoma. Organ transplant recipients have a 65-250 times higher risk of developing NMSC than the general population, while the risk is 3-5 times higher in HIV-positive cohorts.[195] However, NMSC and melanoma also tend to be more aggressive in HIV-infected individuals, resulting in higher mortality than that seen with cases in the general population.[196]

### Other Risk Factors for NMSC

Other risk factors for NMSC have been identified. These include receiving therapeutic doses of ionizing radiation[197] and exposure to chemicals such as insecticides (including those containing arsenic, a known carcinogen), petroleum products, and dry cleaning agents.[198] People who smoke are at increased risk of developing SCC, especially on the lips.[199]

There are rare inherited genetic conditions, such as basal cell nevus syndrome, that demonstrate an elevated risk of skin cancer. Some of these conditions, including epidermodysplasia verruciformis, Fanconi anemia, and xeroderma pigmentosum, appear to have a propensity for skin cancer development where human papillomavirus (HPV) infection is also implicated.[200,201,202] While NMSC dominates the total picture of virally-induced skin cancer, evidence has begun to emerge of an HPV link to melanoma.[203] Similarly, certain genetic

---

[191] Gallagher RP, Lee TK. Adverse effects of ultraviolet radiation: a brief review. *Progress Biophysics and Molecular Biology.* 2006; 92(1): 119-31.

[192] Westerdahl J, Ingvar C, Masback A et al. Risk of cutaneous malignant melanoma in relation to use of sunbeds: further evidence for UV-A carcinogenicity. *British Journal of Cancer.* 2000; 82(9): 1593-9.

[193] Karagas MR, Stannard VA, Mott LA et al. Use of tanning devices and risk of basal cell and squamous cell skin cancers. *Journal of the National Cancer Institute.* 2002; 94(3): 224-6.

[194] International Agency for Research on Cancer Working Group on artifical UV light and skin cancer. The association of use of sunbeds with cutaneous malignant melanoma and other skin cancers: A systematic review. *International Journal of Cancer.* 2007; 120(5): 1116-22.

[195] Oberyszyn TM. Non-melanoma skin cancer: importance of gender, immunosuppressive status and vitamin D. *Cancer Letters.* 2008; 261(2): 127-36.

[196] Wilkins K, Turner R, Dolev JC et al. Cutaneous malignancy and human immunodeficiency virus disease. *Journal of the American Academy of Dermatology.* 2006; 54(2): 189-206.

[197] Lichter MD, Karagas MR, Mott LA et al. Therapeutic ionizing radiation and the incidence of basal cell carcinoma and squamous cell carcinoma. The New Hampshire Skin Cancer Study Group. *Archives of Dermatology.* 2000; 136(8): 1007-11.

[198] Gallagher RP, Bajdik CD, Fincham S et al. Chemical exposures, medical history, and risk of squamous and basal cell carcinoma of the skin. *Cancer Epidemiology Biomarkers and Prevention.* 1996; 5(6): 419-24.

[199] American Cancer Society. *Skin Cancer: Basal and Squamous Cell*. 2008. Available at http://documents.cancer.org/118.00/118.00.pdf. Accessed January 2009.

[200] Nindl I, Gottschling M, Stockfleth E. Human papillomaviruses and non-melanoma skin cancer: basic virology and clinical manifestations. *Disease Markers.* 2007; 23(4): 247-59.

[201] Human papillomavirus DNA and p53 polymorphisms in squamous cell carcinomas from Fanconi anemia patients. *Journal of the National Cancer Institute.* 2003; 95(22): 1718-21.

[202] Luron L, Avril MF, Sarasin A et al. Prevalence of human papillomavirus in skin tumors from repair deficient xeroderma pigmentosum patients. *Cancer Letters*. 2007; 250(2): 213-9.

[203] Ambretti S, Venturoli S, Mirasoli M et al. Assessment of the presence of mucosal human papillomaviruses in malignant melanomas using combined fluorescent in situ hybridization and chemiluminescent immunohistochemistry. *British Journal of Dermatology.* 2007; 156(1): 38-44.

conditions interacting with UV exposure can lead to melanoma. For example, xeroderma pigmentosum patients have defective DNA repair mechanisms that result in a 1000-fold increase in melanoma risk.[204]

[204] Wang Y, Digiovanna JJ, Stern JB et al. Evidence of ultraviolet type mutations in xeroderma pigmentosum melanomas. *Proceedings of the National Academy of Sciences of the United States of America.* 2009; 106(15): 6279-84.

## Appendix B: Recurrence and Second Primary Cancers

The risk of recurrence of a skin cancer, or the risk of second primary cancers following a first primary skin cancer, represents a component of the total burden of skin cancer incidence. Thus, a full assessment of the burden of each type of skin cancer should consider the special risk of that type of skin cancer recurring, or of another (or second) type of cancer developing.

### Definitions

A person can experience cancer in multiple locations in the same organ, or possibly in a contralateral organ (such as the opposite breast or kidney). Specifically, a second primary cancer (SPC) is a new primary cancer in a person with a history of cancer. The qualifier "primary" is key to the definition; a second primary cancer originates independently at a different site and/or tissue in the body, rather than having spread (or metastasized) to that location from an original primary site.[205]

Clinicians distinguish the phenomenon of SPC from recurrence (or relapse), which is a subsequent cancer in the same tissue and/or location, representing a re-emergence of the original malignancy. In its simplest manifestation, a recurrence refers to a tumour such as a skin lesion that reappears at a site after it has been removed by surgery or other means. Such tumours may be classified as local recurrences, to distinguish them from regional recurrence (usually related to lymph node metastases) or distant recurrence (metastases in other organs).[206]

Skin cancer presents a special problem for epidemiologists tracking incident cancers because the same individual may have many cutaneous tumours over a lifetime. For example, cancer registries, if they record NMSC at all, will often only include the first diagnosis of NMSC.[207,208] Thus, consecutive or recurring NMSC are rarely tracked in a comprehensive or systematic manner. The problems of classification can be compounded by the existence of metastases at sites in the body apart from the original skin tumour. Because metastases of NMSC do not tend to occur widely in the body, they are less likely to be confused with an SPC occurrence (i.e., after a case of non-melanoma skin cancer) at a new site in the body. In short, a second cancer "at a distance" is likely a true second primary rather than a metastasis of the original skin cancer.

Cutaneous melanoma is another matter altogether. Melanoma is arguably the most widely metastasizing cancer; it manifests a particularly unpredictable pattern of spread that can involve one of a wide range of body sites.[209] The main criterion to distinguish an SPC from a metastasis is timing. Following the lead of organizations such as SEER in the United States, an SPC is typically defined as a neoplasm that arises independently in a *new site or tissue* and *subsequent* to the initial cancer, with the intervening period being at least *2 months*.

---

[205] Krueger H, McLean D, Williams D. *The Prevention of Second Primary Cancers.* Basel: Karger, 2008.
[206] Benvenuto-Andrade C, Oseitutu A, Agero AL et al. Cutaneous melanoma: surveillance of patients for recurrence and new primary melanomas. *Dermatologic Therapy.* 2005; 18(6): 423-35.
[207] Hayes RC, Leonfellner S, Pilgrim W et al. Incidence of nonmelanoma skin cancer in New Brunswick, Canada, 1992 to 2001. *Journal of Cutaneous Medicine and Surgery.* 2007; 11(2): 45-52.
[208] Demers AA, Nugent Z, Mihalcioiu C et al. Trends of nonmelanoma skin cancer from 1960 through 2000 in a Canadian population. *Journal of the American Academy of Dermatology.* 2005; 53(2): 320-8.
[209] King DM. Imaging of metastatic melanoma. *Cancer Imaging.* 2006; 6: 204-8.

In the next sections, the concepts of recurrence and SPC will be applied to melanoma and non-melanoma skin cancers.

## Cutaneous Melanoma

### Recurrence

Tumours <1.5 mm appear to dominate among melanoma; as well, their incidence seems to be increasing at a faster rate than found with the thick variety of melanoma.[210,211] Following surgical removal of thin types of melanoma, the recurrence rate has been found to be as low as 1% after 8 years.[212] Other studies have demonstrated a higher recurrence rate (up to 27% within 2 years) in the case of a thin, ulcerated melanoma on a body extremity.[213] The wide range in the data is consistent with a 2005 review of several studies, which found that the recurrence rate of thin melanoma (<1.5 mm) varied from 3% to 24%.[214] Recurrences following treatment of thicker (and generally later stage) melanomas occur more frequently, up to 60% of the time.[215]

On average, 6.6% of reported melanomas are recurrences. Furthermore, 2.6% of individuals with a primary melanoma will develop a subsequent primary melanoma.[216] The risk of the latter type of lesion (often referred to as a multiple primary melanoma) is very high compared to melanoma occurrence in the general population. As shown in a later table on second primary cancers (where the data related to NMSC are also included), the risk of getting a second melanoma is over 38 times higher than the risk of a first melanoma.

### Second Primary Cancers

The results of research on second primary cancers following a first primary melanoma are detailed in a later table (in conjunction with information related to NMSC). The range of SPCs with elevated risk following melanoma is limited compared to squamous and basal cell carcinomas. The observation of excess kidney and non-melanoma skin cancers has been confirmed over a number of studies.[217] The suggestion of increased risk of non-Hodgkin's lymphoma (NHL) is a more recent finding. A 2008 analysis across the network of Italian cancer registries confirmed the limited range of associations.[218]

---

[210] Buettner PG, Leiter U, Eigentler TK et al. Development of prognostic factors and survival in cutaneous melanoma over 25 years: An analysis of the Central Malignant Melanoma Registry of the German Dermatological Society. *Cancer.* 2005; 103(3): 616-24.

[211] Downing A, Newton-Bishop JA, Forman D. Recent trends in cutaneous malignant melanoma in the Yorkshire region of England; incidence, mortality and survival in relation to stage of disease, 1993-2003. *British Journal of Cancer.* 2006; 95(1): 91-5.

[212] Haigh PI, DiFronzo LA, McCready DR. Optimal excision margins for primary cutaneous melanoma: a systematic review and meta-analysis. *Canadian Journal of Surgery.* 2003; 46(6): 419-26.

[213] Soong SJ, Shaw HM, Balch CM et al. Predicting survival and recurrence in localized melanoma: a multivariate approach. *World Journal of Surgery.* 1992; 16(2): 191-5.

[214] Francken AB, Bastiaannet E, Hoekstra HJ. Follow-up in patients with localised primary cutaneous melanoma. *Lancet Oncology.* 2005; 6(8): 608-21.

[215] Sabel MS, Sondak VK. Pros and cons of adjuvant interferon in the treatment of melanoma. *The Oncologist.* 2003; 8(5): 451-8.

[216] Francken AB, Bastiaannet E, Hoekstra HJ. Follow-up in patients with localised primary cutaneous melanoma. *Lancet Oncology.* 2005; 6(8): 608-21.

[217] Krueger H, McLean D, Williams D. *The Prevention of Second Primary Cancers.* Basel: Karger, 2008.

[218] Crocetti E, Guzzinati S, Paci E et al. The risk of developing a second, different, cancer among 14 560 survivors of malignant cutaneous melanoma: a study by AIRTUM (the Italian Network of Cancer Registries). *Melanoma Research.* 2008; 18(3): 230-4.

## Non-melanoma Skin Cancer

### Recurrence and Second Skin Cancers of the Same Type

Individuals who have had an initial diagnosis of BCC or SCC are at a substantially increased risk of a second BCC or SCC, respectively. For example, Efird et al. found that individuals with SCC had a relative risk of 13.8 (95% CI = 8.8-21.9) for developing a subsequent BCC.[219] While this sort of information may be of clinical importance (driving, for example, more intensive surveillance), the most critical point for this project is to assess the burden of second skin cancers that are likely missed from even the most comprehensive registries in Canada.

In their meta-analysis, Marcil and Stern found that an average of 44% of individuals with an incident BCC had a subsequent BCC within three years. For SCC, this proportion was 18%.[220] These data suggest that counting diagnoses rather than patients will result in substantially different results.

Stang and colleagues in Germany compared patient-based incidence rates and diagnosis-based incidence rates by gender and age group.[221] The following table, based on their results, indicates the percentage difference between a patient-based incidence approach and a diagnosis-based incidence approach. The difference is particularly relevant in older populations, where as many as half of all NMSC may be a second or subsequent primary.

**Percentage of Cases of BCC and SCC**
**That Subsequently Develop a Cancer of the Same Type**
By Gender and Age Group

| | Male | Female |
|---|---|---|
| Basal Cell Carcinoma | | |
| 0-39 | 0.0% | 0.0% |
| 40-59 | 2.4% | 18.6% |
| 60-79 | 36.5% | 41.8% |
| 80+ | 59.0% | 22.6% |
| All Ages | **32.7%** | **31.3%** |
| Squamous Cell Carcinoma | | |
| 0-39 | 0.0% | 0.0% |
| 40-59 | 0.0% | 0.0% |
| 60-79 | 0.0% | 0.0% |
| 80+ | 55.6% | 21.4% |
| All Ages | **17.2%** | **11.3%** |

### Second Primary Cancers of a Different Type

Other types of skin cancer also occur more frequently after an experience of a first primary in the skin. For convenience, the information on second primary cancers following each of the main types of first primary skin cancer (melanoma, SCC, and BCC) has been assembled into one table; the data for NMSC were based on the largest available studies. Only the SPC data

[219] Efird JT, Friedman GD, Habel L et al. Risk of subsequent cancer following invasive or in situ squamous cell skin cancer. *Annals of Epidemiology*. 2002; 12(7): 469-75.
[220] Marcil I, Stern RS. Risk of developing a subsequent nonmelanoma skin cancer in patients with a history of nonmelanoma skin cancer: a critical review of the literature and meta-analysis. *Archives of Dermatology.* 2000; 136(12): 1524-30.
[221] Stang A, Ziegler S, Buchner U, et al. Malignant melanoma and nonmelanoma skin cancers in Northrhine-Westphalia, Germany: a patient- vs. diagnosis-based incidence approach. *International Journal of Dermatology*. 2007; 46: 564-70.

that showed statistically significant elevated risk (as measured by standardized incidence ratio, or SIR) are reported. SIR is simply the ratio of observed and expected cancer cases across the same cohort size; for example, a SIR of **2.0** means that the rate of occurrence of an SPC following a specified first primary is **double** that which would be expected for the same cancer in a general population. The inventory of SPCs in the following table is ordered in terms of *decreasing* disease burden (as measured by potential years of life lost).[222]

**Second Primary Cancers at Elevated Risk**
**Following First Primary Skin Cancers**
Standardized Incidence Ratio

| *First Primary Cancer:* / *Second Primary Cancer:* | Melanoma | Squamous Cell | Basal Cell | |
|---|---|---|---|---|
| | | | Males | Females |
| Lung | | 1.7 | 1.1 | - |
| Colon | | 1.2 | 1.3 | 1.2 |
| Female Breast | | - | - | 1.2 |
| NHL | 2.0* | 1.9 | 1.4 | 1.5 |
| Prostate | | - | 1.2 | - |
| Leukemia | | 1.8-2.0 | 1.5 | 1.2 |
| Esophagus | | 1.5 | - | - |
| Stomach | | 1.3 | - | 1.2 |
| Kidney | 3.5** | - | 1.2 | - |
| Oral | | 2 | 1.7 | - |
| Nasopharynx/sinus | | 3 | 1.9 | - |
| Hypopharynx/pharynx | | 2.7 | 1.7 | 1.8 |
| Melanoma, skin | 38.5** | 3 | 2.4 | 2.3 |
| Multiple myeloma | | - | 1.5 | - |
| Cervix | | 2.2 | - | - |
| Hodgkin's disease | | 2.1 | - | - |
| Liver | | 1.3 | 1.4 | - |
| Small intestine | | - | 1.8 | 1.9 |
| Vulva and vagina | | 2.3 | - | - |
| Eye | | - | - | 1.9 |
| Nervous system | | - | 1.3 | 1.3 |
| Salivary gland | | 5.5 | 4.3 | 2.5 |
| Bone | | - | 2.1 | - |
| Lip | | 5.2 | 2.1 | 2.6 |
| Non-melanoma skin | 3.5*** | 15.6 | 3.6 | 4.1 |
| **All Cancers** | **1.3**** | **2.2** | **1.3** | **1.3** |
| *Table References:* *Lens & Newton-Bishop (2004) **Schmid-Wendtner et al. (2001) ***Kroumpouzos et al. (2000) ****Crocetti et al. (2008) | | Adapted from Wassberg et al. (1999) | Adapted from Milan et al. (2000) | |

[222] Table references: Lens MB, Newton-Bishop JA. An association between cutaneous melanoma and non-Hodgkin's lymphoma: pooled analysis of published data with a review. *Annals of Oncology.* 2005; 16(3): 460-5; Schmid-Wendtner MH, Baumert J, Wendtner CM et al. Risk of second primary malignancies in patients with cutaneous melanoma. *The British Journal of Dermatology.* 2001; 145(6): 981-5; Kroumpouzos G, Konstadoulakis MM, Cabral H et al. Risk of basal cell and squamous cell carcinoma in persons with prior cutaneous melanoma. *Dermatologic Surgery.* 2000; 26(6): 547-50; Crocetti E, Guzzinati S, Paci E et al. The risk of developing a second, different, cancer among 14 560 survivors of malignant cutaneous melanoma: a study by AIRTUM (the Italian Network of Cancer Registries). *Melanoma Research.* 2008; 18(3): 230-4; Wassberg C, Thorn M, Yuen J et al. Second primary cancers in patients with squamous cell carcinoma of the skin: a population-based study in Sweden. *International Journal of Cancer.* 1999; 80(4): 511-5; Milan T, Pukkala E, Verkasalo PK et al. Subsequent primary cancers after basal-cell carcinoma: A nationwide study in Finland from 1953 to 1995. *International Journal of Cancer.* 2000; 87(2): 283-8.

The SPCs with the most dramatic elevation in risk following squamous and basal cell carcinoma include salivary gland cancer, lip cancer, and melanoma. These key associations have been confirmed in other, older reports,[223,224,225,226,227] as well as in newer studies.[228,229,230]

Overall, the risk of a different SPC seems to be lower for basal cell carcinoma; according to some research, the range of cancers with a substantial excess incidence may also be more limited following this type of skin cancer.[231,232] This reinforces the conclusion that a "reason for what might be perceived as a relatively low interest in basal cell carcinoma as an antecedent condition to other cancers is the relatively low excess incidence of second primaries as a class."[233]

The other important result is the elevated risk of experiencing a different type of primary NMSC, especially subsequent to squamous cell carcinoma (SIR of 15.6). Other research has shown that much of the excess following SCC constitutes a truly new cancer, rather than simply another SCC. As one might expect, the new cancer in question is actually basal cell carcinoma, where the identified SIR has ranged from 10 to 13.[234,235]

Again, it should be noted that the application of all such data for this project relates not to cancers in organs outside the skin but specifically to the instances of recurrent or second primary skin cancers that may be missed in traditional approaches to case counting.

[223] Friedman GD, Tekawa IS. Association of basal cell skin cancers with other cancers (United States). *Cancer Causes & Control.* 2000; 11(10): 891-7.
[224] Frisch M, Hjalgrim H, Olsen JH et al. Risk for subsequent cancer after diagnosis of basal-cell carcinoma. A population-based, epidemiologic study. *Annals of Internal Medicine.* 1996; 125(10): 815-21.
[225] Levi F, La Vecchia C, Te VC et al. Incidence of invasive cancers following basal cell skin cancer. *American Journal of Epidemiology.* 1998; 147(8): 722-6.
[226] Hemminki K, Dong C. Subsequent cancers after in situ and invasive squamous cell carcinoma of the skin. *Archives of Dermatology.* 2000; 136(5): 647-51.
[227] Levi F, Randimbison L, La Vecchia C et al. Incidence of invasive cancers following squamous cell skin cancer. *American Journal of Epidemiology.* 1997; 146(9): 734-9.
[228] Cantwell MM, Murray LJ, Catney D et al. Second primary cancers in patients with skin cancer: a population-based study in Northern Ireland. *British Journal of Cancer.* 2009; 100(1): 174-7.
[229] Chen J, Ruczinski I, Jorgensen TJ et al. Nonmelanoma skin cancer and risk for subsequent malignancy. *Journal of the National Cancer Institute.* 2008; 100(17): 1215-22.
[230] Nugent Z, Demers AA, Wiseman MC et al. Risk of second primary cancer and death following a diagnosis of nonmelanoma skin cancer. *Cancer Epidemiology, Biomarkers & Prevention.* 2005; 14(11 Pt 1): 2584-90.
[231] Karagas MR, Greenberg ER, Mott LA et al. Occurrence of other cancers among patients with prior basal cell and squamous cell skin cancer. *Cancer Epidemiology, Biomarkers and Prevention.* 1998; 7(2): 157-61.
[232] Cantwell MM, Murray LJ, Catney D et al. Second primary cancers in patients with skin cancer: a population-based study in Northern Ireland. *British Journal of Cancer.* 2009; 100(1): 174-7.
[233] Krueger H, McLean D, Williams D. *The Prevention of Second Primary Cancers.* Basel: Karger, 2008.
[234] Marcil I, Stern RS. Risk of developing a subsequent nonmelanoma skin cancer in patients with a history of nonmelanoma skin cancer: a critical review of the literature and meta-analysis. *Archives of Dermatology.* 2000; 136(12): 1524-30.
[235] Efird JT, Friedman GD, Habel L et al. Risk of subsequent cancer following invasive or in situ squamous cell skin cancer. *Annals of Epidemiology.* 2002; 12(7): 469-75.

## Appendix C: Effective Prevention Programs

### Preamble: Modelling Skin Cancer Prevention Impacts

Public health planners are generally occupied with the following fundamental questions when seeking to set prevention priorities:

- How much will a specific prevention program cost?
- How much disease can be avoided in the population through the program?
- What costs (direct and indirect) will ultimately be avoided?

Estimating prevention program costs is problematic enough, but quantifying future impacts in a country such as Canada is even more fraught with uncertainty. Cancer prevention research is especially challenging because of the prolonged latent time after exposure to a potential carcinogen. There are challenges in terms of epidemiology, that is, in demonstrating a causal link to a risk factor and then confirming it by reducing cancer incidence through preventing exposure; these types of studies can take decades. There are also related policy challenges. In short, how can a health care planner commit resources to a prevention program that is not completely proven - and, even if successful, will not demonstrate disease and cost avoidance for many years - when so many more acute problems are demanding immediate action?

***Both sets of challenges have a bearing on the current project.*** Put simply, there is little experience with long-term skin cancer prevention programs in other jurisdictions, and thus few data are available on either the program costs or benefits (i.e., reductions with respect to disease incidence or direct medical and indirect financial burden) of such efforts.

***There have been three strategic approaches to compensate for this gap in the data:***

1. **Using program impacts on sun safety behaviour** as a proxy for exposure prevalence, which in turn stands in for resulting biological effects (as measured by biomarkers) that are risk factors and/or precursors of skin cancer—ultimately interpreting this chain of events as a proxy for skin cancer incidence.

When the etiologic impact of a risk factor is well-established, changes in the prevalence of the risk factor may be translated into anticipated changes in skin cancer rates. The main focus of skin cancer prevention efforts has been avoidance of risky sun exposure; this is understandable, since solar radiation exposure is the major known modifiable risk factor associated with the highest attributable risk of both melanoma and NMSC. Population attributable risk (PAR) is a metric denoting the proportion of disease burden (i.e., incidence, mortality) across a population that is caused by exposure to a risk factor. Estimates of the PAR of skin cancer related to solar exposure vary between 50-90%, as moderated by skin cancer type.[236] These figures dwarf the PARs proposed for other modifiable risks of skin cancer (e.g., <1% for indoor radon[237] and around 2% for artificial tanning in Australia[238]), as well as for classic non-modifiable factors

[236] Lucas RM, McMichael AJ, Armstrong BK et al. Estimating the global disease burden due to ultraviolet radiation exposure. *International Journal of Epidemiology.* 2008; 37(3): 654-67.
[237] Charles MW. Radon exposure of the skin: II. Estimation of the attributable risk for skin cancer incidence. *Journal of Radiological Protection.* 2007; 27(3): 253-74.
[238] Gordon LG, Hirst NG, Gies PH et al. What impact would effective solarium regulation have in Australia? *Medical Journal of Australia.* 2008; 189(7): 375-8.

(e.g., familial risk of SCC equates to a PAR of about 4%;[239] each of the known inherited mutations accounting for as little as 0.2% of melanoma incidence, with such familial risks perhaps totalling to about 3 to 4%[240,241,242,243]). The only risk factor that comes close to sun exposure in terms of PAR for cutaneous cancer is the condition of having fair skin; of course, skin type is not a modifiable risk factor, so such information is only useful indirectly, as a way to target prevention initiatives (for the most part, related to sun safety) for high risk groups. *Given the preceding discussion, it is clear that interventions related to sun safety will continue to be the dominant focus of skin cancer prevention efforts, and that changes in the prevalence of risky sun exposure may be used as a reasonable basis for projecting improvements in skin cancer burden.* From the perspective of evaluating a preventive intervention, the usual proxy for estimating risky sun exposure prevalence is the uptake of sun-safety behaviours (labelled as "Method C" in the model of evaluation approaches diagrammed below).

2. The second approach to evaluating prevention involves **using program impacts on certain biomarkers**, which in turn point to risk factors and/or precursors of skin cancer, and thus serves as a sort of proxy for skin cancer incidence.

Since it lays the measuring stick closer to carcinogenic effects per se, the evaluation approach involving biomarkers is arguably stronger than depending on "softer" measures such as changes in attitude or even behaviour. In fact, skin cancer prevention programs are known to have an impact on intermediate biological end-points (as measured by biomarkers); the hope is that one or more such impacts may be a suitable proxy for preventing skin malignancies. Given the strong population health effect of sun exposure as described above, it seems reasonable to lean on intermediate end-points related to solar radiation as a basis for projecting the effects of a prevention program on skin cancer. To sum up, on a scale of increasingly direct relevance to skin cancer incidence estimates, end-points of interest include:

- Knowledge of and attitudes toward sun safety
- Changes in sun protection behaviours
- Incidence of sunburns
- Incidence of other elements along the proposed pathway of skin carcinogenesis (for example: presence of sunburn cells, certain mutations, or actinic (solar) keratoses; markers of UV-induced immunosuppression; presence of nevi).

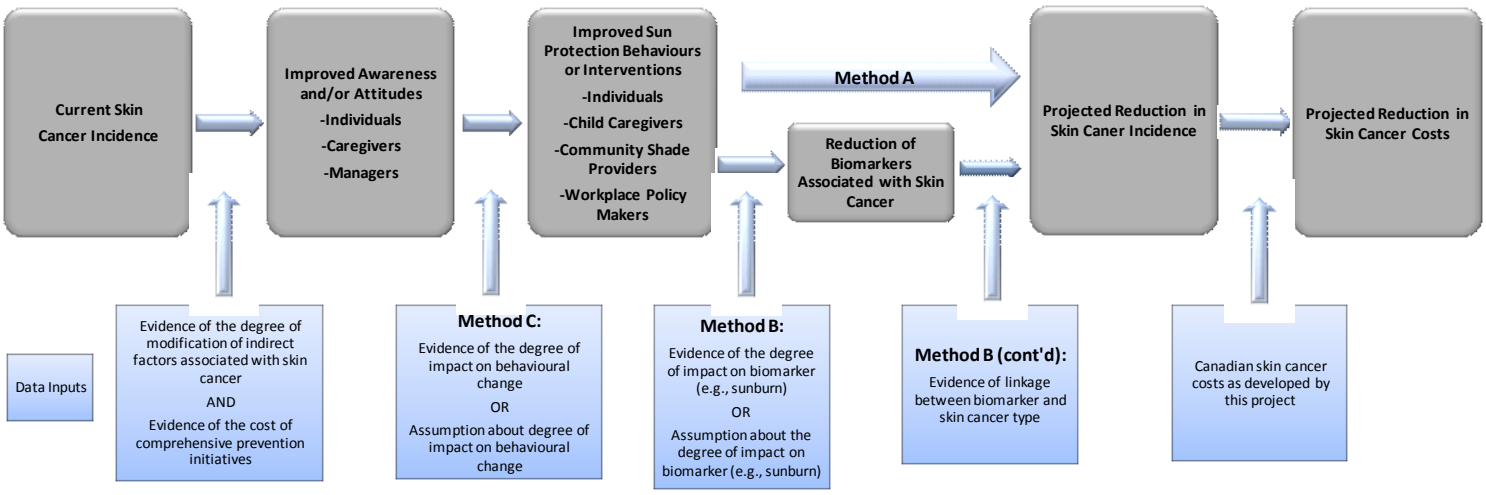
Only the latter two items qualify under the present category, that is, as biomarkers representing potential biological intermediates leading towards skin cancer. As suggested earlier, biomarkers can be a strong predictor of skin cancer risk, especially with respect to melanoma. For example, the Fears et al. model for predicting absolute risk of skin cancer suggests that the cohort of light-complexioned individuals with at least 2 large moles or 17 small ones, combined with an

[239] Hemminki K, Zhang H, Czene K. Familial invasive and in situ squamous cell carcinoma of the skin. *British Journal of Cancer.* 2003; 88(9): 1375-80.
[240] James MR, Roth RB, Shi MM et al. BRAF polymorphisms and risk of melanocytic neoplasia. *Journal of Investigative Dermatology.* 2005; 125(6): 1252-8.
[241] Hemminki K, Zhang H, Czene K. Familial and attributable risks in cutaneous melanoma: effects of proband and age. *Journal of Investigative Dermatology.* 2003; 120(2): 217-23.
[242] Meyer P, Sergi C, Garbe C. Polymorphisms of the BRAF gene predispose males to malignant melanoma. *Journal of Carcinogenesis.* 2003; 2(1): 7.
[243] Olsen CM, Carroll HJ, Whiteman DC. Familial melanoma: A meta-analysis and estimates of attributable fraction. *Cancer Epidemiology, Biomarkers and Prevention.* 2010; 19(1): 65-73.

experience of a blistering burn, could account for 86% of melanoma incidence in men.[244] However, changes in behaviours of individuals and/or caregivers must still be the dominant focus of any prevention initiative. This is because of the fact that, once risky biomarkers are identified (for example, through an early detection program), the opportunities to modify risk are limited. Intensifying prevention efforts among at-risk populations (such as those with a demonstrated tendency to develop moles) once again reverts to modifying individual behaviours (or at least to make healthy individual choices easier on average across a whole population).

Two efforts in the southern hemisphere were launched a decade ago to project the impact of prevention programs on skin cancer incidence. In both cases the researchers extrapolated from the effects of prevention on *sunburn rates* to estimate future reductions in skin cancer burden.[245,246] This approach has been labelled "Method B" in the model of different strategies for quantifying prevention impacts (see the diagram below).

Strategic Model: Quantifying Skin Cancer Prevention Impacts




3. Finally, it is sometimes possible to base an evaluation on the **direct impact of the program on skin cancer incidence.**

Although evaluation data continue to be limited, any skin cancer prevention program that has been operating for a long period of time may offer a basis for projecting impacts on disease and costs in a jurisdiction such as Canada. At the least, there will be data on program costs, which is a key input for any estimations of cost-benefit (or return on investment). There is only one exemplar in the world that may help in this regard. The concerted efforts against skin cancer that have been running for over 20 years in some parts of Australia have been linked to *early direct signs of an impact on skin cancer incidence*.

[244] Fears TR, Guerry Dt, Pfeiffer RM et al. Identifying individuals at high risk of melanoma: a practical predictor of absolute risk. *Journal of Clinical Oncology*. 2006; 24(22): 3590-6.
[245] Carter R, Marks R, Hill D. Could a national skin cancer primary prevention campaign in Australia be worthwhile?: an economic perspective. *Health Promotion International*. 1999; 14(1): 73-82.
[246] Sneyd M, Cox B. The control of melanoma in New Zealand. *New Zealand Medical Journal*. 2006; 119(1242): U2169.

## Skin Cancer Prevention Programs

### An Overview

The table below provides an overview of the available literature on skin cancer prevention programs, with formal references following. Skin cancer prevention interventions are listed in ascending order based on the duration of the intervention. What is immediately clear from this summary is that only the Australian skin cancer prevention programs have been in existence for anything longer than 3 years.

**Skin Cancer Prevention Programs**
By Ascending Duration of the Intervention

| Program | Location | Setting/Participants | Duration | Description | Reference (by Lead Author) |
|---|---|---|---|---|---|
| Go Sun Smart | U.S. and Canada ski resorts | Parents of children enrolled in ski & snowboard schools | <1 year | Sun safety education program at ski resorts that included posters, brochures, and training programs for employees | Walkosz et al. (2007) |
| Beach Survey | New England, USA | Beachgoers aged 18 yrs. and older | <1 year | Survey with framed messages addressing the risk of skin cancer and the importance of sunscreen use | Detweiler et al. (1999) |
| Hawaii SunSmart | Hawaii | Children aged 6-8 yrs. and their parents | <1 year | Multicomponent skin cancer prevention program implemented in outdoor recreation settings | Glanz et al. (2000) |
| Beachgoer education | Midwestern U.S. lakefront | Beachgoers aged 18 yrs. and older | <1 year | Multicomponent intervention that included skin sensitivity assessment and UV photos illuminating skin photodamage | Pagoto et al. (2003) |
| Parent-based communication with children | Idaho and Tennessee | Parents of children aged 9-12 yrs | <1 year | Handbook for parents regarding skin cancer prevention and sun-safe behaviours | Turrisi et al. (2004) |
| Sun safety messages, evaluating "language intensity" | Arizona | Parents of elementary schoolchildren | < 1 year | Sun safety messages of varying language intensity were mailed to participants | Buller et al. (2000) |
| School-based program | Florida | Grade 5 students | < 1 year | Focused on changing children's attitudes and perceptions toward sunscreen use | Hoffman et al. (1999) |
| You and Your Skin | Sweden | Students aged 13-15 yrs | < 1 year | School-based program on skin cancer prevention for adolescents | Kristjansson et al. (2003) |
| Block the Sun, Not the Fun | Colorado | Preschools and daycare centres, parents | < 1 year | Prevention workshops for staff members at intervention centres and parent information packets | Crane et al. (1999) |
| Educational intervention for children & their parents | Bulgaria | Children aged 3-10 yrs. and their parents | <1 year | Sun protection education delivered via leaflets for parents and lectures and consultations for parents and children | Troyanova et al. (2004) |
| SolSano | Spain | Children in grades 1-2 | <1 year | Sun safety program delivered in schools | Gilaberte et al. (2008) |
| SunSmart America | Florida | High school students aged 15-18 yrs. | <1 year | Skin cancer prevention and early detection curriculum | Geller et al. (2005) |
| Health education campaign for primary schools | France | Children aged 8-10 yrs. | <1 year | Educational program about the dangers of sun exposure | Bastuji-Garin et al. (1999) |
| Pool Cool | Hawaii & Massachusetts | Children aged 5-10 yrs., their parents, lifeguards, and aquatic instructors | <1 year | Sun protection program at swimming pools | Glanz et al. (2002) |
| Got Youth Covered | Georgia | Soccer coaches of youth aged 7-13 yrs. | <1 year | Health education program for soccer coaches | Parrott and Duggan (1999) |

| Skin Cancer Prevention Programs (continued)<br>By Ascending Duration of the Intervention | | | | | |
|---|---|---|---|---|---|
| **Program** | **Location** | **Setting/Participants** | **Duration** | **Description** | **Reference (by Lead Author)** |
| Sunny Days, Healthy Ways | Colorado, New Mexico, and Arizona | Students in grades 6-8 | 1 year | Sun safety curriculum taught in schools | Buller et al. (2006) |
| Sunny Days, Healthy Ways | Arizona | Students in kindergarten thru grade 5 | 1 year | Sun safety curriculum taught in schools | Buller et al. (2006) |
| SunSafe | New Hampshire | Children aged 2-11 yrs in 10 towns | 1 year | Promoted sun protection behaviour among children thru schools, daycare centres, primary care practices and recreation areas | Dietrich et al. (1998) |
| SoleSi SoleNo-GISED | Italy | Parents and elementary schoolchildren | 1 year | Educational intervention | Naldi et al. (2007) |
| SunWise | USA | Students in kindergarten thru grade 8 | 1 year | School-based intervention that teaches sun protection | Geller et al. (2003) |
| Sun protection education for beachgoers | Rhode Island | Sunbathers on beaches, aged 16-65 yrs. | 1 year | Program consisting of eductional pamphlets and tailored feedback reports | Weinstock et al. (2002) |
| Raybusters | Massachusetts | Mothers of infants | 1 year | Promotion of sun protective behaviours for infants/toddlers via telephone counselling and educational materials | Benjes et al. (2004) |
| Sun Smart | California | Adolescents aged 11-15 yrs. | 1.5 years | Multicomponent primary care-based intervention to increase sun protection behaviours among adolescents | Norman et al. (2007) |
| Sun Protection is Fun! (S.P.F.) | Texas | Parents of preschool children | 2 years | Educational intervention for parents designed to improve their practices related to protecting their children from sun exposure | Gritz et al. (2005) |
| Falmouth Safe Skin Project | Massachusetts | Children 13 yrs. and younger | 3 years | Multicomponent community-based skin cancer prevention program | Miller et al. (1999) |
| Primary care delivery of sun protection advice | Colorado | Parents of infants | 3 years | Primary care-based intervention to increase sun protection practices of parents | Crane et al. (2006) |
| Curriculum for adolescents | Australia | Students in grades 8-10 | 3 years | School-based intervention to increase adolescent sun protection | Lowe et al. (1999) |
| SunSafe | New Hampshire and Vermont | Children in grades 6-8 | 3 years | Multicomponent community-wide intervention | Olson et al. (2007) |
| Seymour the Snowman advertising campaign | Australia | Children under 12 yrs. and their parents | 3 years | Multi-media advertising campaign aiming to increase the use of sun protection measures | Smith et al. (2002) |
| Kidskin | Australia | Children aged 5-6 yrs. | 4 years | Sun protection curriculum taught in schools | Milne et al. (2006) |
| Workplace sun protection policy | Australia | Outdoor construction workers | 10 years | Mandatory policy for outdoor workers to use sun protection equipment and a yearly education session on skin cancer prevention | Woolley et al. (2008) |
| SunSmart | Australia | Australian residents | 15 years | Multicomponent skin cancer control program, including television advertising campaigns | Dobbinson et al. (2008) |

**References for *Skin Cancer Prevention Programs* Table**

Bastuji-Garin S, Grob JJ, Grognard C et al. Melanoma prevention: evaluation of a health education campaign for primary schools. *Archives of Dermatology*. 1999; 135: 936-40.

Benjes LS, Brooks DR, Zhang Z et al. Changing patterns of sun protection between the first and second summers for very young children. *Archives of Dermatology*. 2004; 140: 925-30.

Buller DB, Burgoon M, Hall JR et al. Using language intensity to increase the success of a family intervention to protect children from ultraviolet radiation: predictions from Language Expectancy Theory *Preventive Medicine*. 2000; 30: 103-14.

Buller DB, Reynolds KD, Yaroch A et al. Effects of the Sunny Days, Healthy Ways curriculum on students in grades 6 to 8. *American Journal of Preventive Medicine*. 2006; 30: 13-22.

Buller DB, Taylor AM, Buller MK et al. Evaluation of the Sunny Days, Healthy Ways sun safety curriculum for children in kindergarten through fifth grade. *Pediatric Dermatology*. 2006; 23: 321-9.

Crane LA, Schneider LS, Yohn JJ et al. "Block the sun, not the fun": evaluation of a skin cancer prevention program for child care centers. *American Journal of Preventive Medicine*. 1999; 17: 31-7.

Crane LA, Deas A, Mokrohisky ST et al. A randomized intervention study of sun protection promotion in well-child care *Preventive Medicine*. 2006; 42: 162-70.

Detweiler JB, Bedell BT, Salovey P et al. Message framing and sunscreen use: gain-framed messages motivate beach-goers. *Health Psychology*. 1999; 18: 189-96.

Dietrich AJ, Olson AL, Sox CH et al. A community-based randomized trial encouraging sun protection for children. *Pediatrics*. 1998; 102: e64-71.

Dobbinson SJ, Wakefield MA, Jamsen KM et al. Weekend sun protection and sunburn in Australia trends (1987-2002) and association with SunSmart television advertising. *American Journal of Preventive Medicine*. 2008; 34: 94-101.

Geller A, Rutsch L, Kenausis K et al. Evaluation of the SunWise school program. *Journal of School Nursing*. 2003; 19: 93-9.

Geller AC, Shamban J, O'Riordan DL et al. Raising sun protection and early detection awareness among Florida high schoolers. *Pediatric Dermatology*. 2005; 22: 112-8.

Gilaberte Y, Alonso JP, Teruel MP et al. Evaluation of a health promotion intervention for skin cancer prevention in Spain: the SolSano Program *Health Promotion International*. 2008; 23: 209-19.

Glanz K, Geller AC, Shigaki D et al. A randomized trial of skin cancer prevention in aquatics settings: the Pool Cool program. *Health Psychology*. 2002; 21: 579-87.

Glanz K, Lew RA, Song V et al. Skin cancer prevention in outdoor recreation settings: effects of the Hawaii SunSmart Program. *Effective Clinical Practice*. 2000; 3: 53-61.

Gritz ER, Tripp MK, James AS et al. An intervention for parents to promote preschool children's sun protection: effects of Sun Protection is Fun! *Preventive Medicine*. 2005; 41: 357-66.

Hoffmann RG 3rd, Rodrigue JR, Johnson JH. Effectiveness of a school-based program to enhance knowledge of sun exposure: Attitudes toward sun exposure and sunscreen use among children. *Children's Health Care*. 1999; 28: 69-86.

Kristjansson S, Helgason AR, Mansson-Brahme E et al. 'You and your skin': a short-duration presentation of skin cancer prevention for teenagers. *Health Education Research*. 2003; 18: 88-97.

Lowe JB, Balanda KP, Stanton WR et al. Evaluation of a three-year school-based intervention to increase adolescent sun protection. *Health Education & Behavior*. 1999; 26: 396-408.

Miller DR, Geller AC, Wood MC et al. The Falmouth Safe Skin project: evaluation of a community program to promote sun protection in youth. *Health Education & Behavior*. 1999; 26: 369-84.

Milne E, Jacoby P, Giles-Corti B et al. The impact of the kidskin sun protection intervention on summer suntan and reported sun exposure: was it sustained? *Preventive Medicine*. 2006; 42: 14-20.

Naldi L, Chatenoud L, Bertuccio P et al. Improving sun-protection behavior among children: results of a cluster-randomized trial in Italian elementary schools. The "SoleSi SoleNo-GISED" Project. *Journal of Investigative Dermatology*. 2007; 127: 1871-7.

Norman GJ, Adams MA, Calfas KJ et al. A randomized trial of a multicomponent intervention for adolescent sun protection behaviors. *Archives of Pediatrics & Adolescent Medicine*. 2007; 161: 146-52.

Olson AL, Gaffney C, Starr P et al. SunSafe in the middle school years: a community-wide intervention to change early-adolescent sun protection. *Pediatrics*. 2007; 119: e247-56.

Pagoto S, McChargue D, Fuqua RW. Effects of a multicomponent intervention on motivation and sun protection behaviors among midwestern beachgoers. *Health Psychology*. 2003; 22: 429-33.

Parrott R, Duggan A. Using coaches as role models of sun protection for youth: Georgia's "Got Youth Covered" project. *Journal of Applied Communication Research*. 1999; 27: 107-19.

Smith BJ, Ferguson C, McKenzie J et al. Impacts from repeated mass media campaigns to promote sun protection in Australia. *Health promotion international*. 2002; 17: 51-60.

Troyanova P, Manolova A, Spangenberg S. Efficacy of educational intervention for skin cancer prevention in childhood. *Acta Medica Bulgarica*. 2004; 31: 57-66.

Turrisi R, Hillhouse J, Heavin S et al. Examination of the short-term efficacy of a parent-based intervention to prevent skin cancer *Journal of Behavioral Medicine*. 2004; 27: 393-411.

Walkosz B, Voeks J, Andersen P et al. Randomized trial on sun safety education at ski and snowboard schools in western North America. *Pediatric Dermatology*. 2007; 24: 222-9.

Weinstock MA, Rossi JS, Redding CA et al. Randomized controlled community trial of the efficacy of a multicomponent stage-matched intervention to increase sun protection among beachgoers. *Preventive Medicine*. 2002; 35: 584-92.

Woolley T, Lowe J, Raasch B et al. Workplace sun protection policies and employees' sun-related skin damage. *American Journal of Health Behavior*. 2008; 32: 201-8.

### Jurisdictions Other Than Australia

As noted in the table above, very few comprehensive skin cancer prevention efforts have been implemented, and even fewer evaluated, outside of Australia. In the U.S. there are two programs that have used comprehensive strategies similar to *SunSmart*, albeit on a smaller scale: the Falmouth *Safe Skin Project* in Massachusetts and the *SafeSun Project* in New Hampshire. [247,248] These represent community-based, multi-component sun protection interventions that were successful in increasing sunscreen use among children and youth.

Understandably, other notable "UV risk zones" in the world (where there is intense sunlight and a substantial number of fair-skinned people) have shown some momentum in terms of prevention programming. Such areas include the southern part of Europe adjacent to the Mediterranean. However, even in these relatively risky settings, most of the interventions have been short-term and limited in terms of the target group; nonetheless, there is evidence of effectiveness for some programs. For example, before/after surveys in Spanish schools using the *SolSano* sun safety program over one school year demonstrated increases in shade-seeking and wearing sun-protective clothing; overall, the incidence of sunburn decreased from 35.8% to 23.5%.[249]

In general, the well-known Task Force on Community Preventive Services in the U.S. identified two interventions that had proven effectiveness in terms of reducing sun exposure: educational and policy interventions in primary schools and programs for adults in outdoor recreational or tourism settings.[250] The Task Force further concluded that, "because sun-protective behaviors are not practiced often enough, and because the incidence of skin cancer is increasing, interventions for which evidence is currently insufficient deserve more research attention, while interventions that have been proven effective merit increased attention to diffusion, dissemination, replication, and implementation."[251]

### The Australian Context

The most comprehensive and arguably most successful population-level skin cancer prevention programs have been conducted in Australia. This is consistent with Australia's status as the country with the highest incidence and mortality rates for skin cancer in the world.[252] Various awareness campaigns and multi-component interventions at community, state, and national levels have not only resulted in changes in knowledge and attitudes but have also increased sun protection behaviours. There are even early indications that the positive behavioural changes, which are a reasonable proxy for reduced sun exposure, have led to an actual reduction in melanoma incidence (see below). The fact that occurrence of melanoma is the leading-edge indicator makes sense, as that form of skin cancer develops more frequently at younger ages when compared with NMSC.

---

[247] Miller DR, Geller AC, Wood MC et al. The Falmouth Safe Skin project: evaluation of a community program to promote sun protection in youth. *Health Education & Behavior.* 1999; 26(3): 369-84.
[248] Dietrich AJ, Olson AL, Sox CH et al. A community-based randomized trial encouraging sun protection for children. *Pediatrics.* 1998; 102(6): e64-71.
[249] Gilaberte Y, Alonso JP, Teruel MP et al. Evaluation of a health promotion intervention for skin cancer prevention in Spain: the SolSano program. *Health Promotion International.* 2008; 23(3): 209-19.
[250] See http://www.thecommunityguide.org/cancer/skin/education-policy/index.html.
[251] Saraiya M, Glanz K, Briss PA et al. Interventions to prevent skin cancer by reducing exposure to ultraviolet radiation: a systematic review. *American Journal of Preventive Medicine.* 2004; 27(5): 422-66.
[252] Carter R, Marks R, Hill D. Could a national skin cancer primary prevention campaign in Australia be worthwhile?: an economic perspective. *Health Promotion International.* 1999; 14(1): 73-82.

The *SunSmart Program* was launched in the state of Victoria, Australia, in 1987, and continues to be used up to the present time. Building on a more basic, modestly funded campaign in the country known as *Slip! Slop! Slap!*, the Victorian approach has been progressively adopted by other Australian states. Program names have varied. For instance, the *Me No Fry* campaign, aimed at adolescents, was conducted in the state of New South Wales between 1991 and 1996.

#### The Australian *SunSmart Program*

The *SunSmart Program* is a comprehensive skin cancer prevention program that was launched in the state of Victoria and has since been implemented nationally in Australia.

The *SunSmart Schools* program was launched nationally by the Cancer Council of Australia in 1998. In order to be accredited as *SunSmart*, schools must:

- Have a written sun protection policy meeting minimum standards relating to curriculum, behaviour and the environment
- Be working to increase shade and reschedule outdoor activities to lower UV times of the day
- Teach children about sun protection

Members of the *SunSmart* schools program receive:

- Advice on incorporating sun protection behaviour and staff role modelling into daily school activities
- Support to implement policies, including newsletter articles and school uniform advice
- Access to curriculum resources, presentations, lesson ideas and resources on topics such as UV, the UV Alert, tanning, and solariums
- A *SunSmart* sign and certificate

The national *SunSmart* program recommends that all workplaces develop a comprehensive sun protection program for workers. *SunSmart* provides the following for employers:

- Guidelines and policy, including a sample UV risk assessment and sun protection policy and a guide with information about control measures and evaluation of compliance
- Education services and training, e.g., an online training course for outdoor workers or a face-to-face education session for employees
- Publications developed specifically for workplaces

*SunSmart* also includes resources specific to sun protection for farmers. Since 2002, outdoor workers in Australia have been able to claim the cost of personal protective equipment such as sunglasses, hats, and sunscreen as a tax deduction.

*SunSmart* recommends that all early childhood services have a sun protection policy. Registered members of the *SunSmart* early childhood program receive:

- Advice on incorporating sun protection behaviour and staff role modelling into daily activities
- Support to implement policies
- Access to resources, activity ideas, and a sample media release to promote *SunSmart* service status to the community

- *SunSmart* services sign and certificate

*SunSmart* resources are also available to local governments to help in providing a combined approach to UV protection for the community. These include:

- Sun protection strategies within council policies and suggested policy statements
- Guides for shade development and best practice shade case studies
- Guide to implementing a sun protection program for council employees
- Guide to sun protection policies and practice at council-controlled facilities such as swimming pools
- *SunSmart* outdoor event kit for council-run summer events

*SunSmart* has maintained a strong media presence, involving an impressive amount of unpaid media exposure and limited paid advertising. The media messages have evolved to meet public demand for harder hitting campaigns. Their more recent campaigns include the 2008 "No tan is worth dying for," featuring a 26-year-old woman who died of melanoma in 2007; the national campaign "Protect yourself in 5 ways" (2007-08), showing the real-life operation on a 22-year-old woman to remove melanoma from her back; and the Tattoo campaign "Skin cancer is killer body art," aimed at 17-24-year-olds. Media message are delivered via television commercials, community service announcements, print advertisements, and radio commercials.

National Skin Cancer Action Week raises awareness of skin cancer and sun protection issues at the beginning of summer. It involves a number of educational and promotional initiatives. In 2008 its high-profile supporters included an Olympic gold-medalist and the Crown Princess of Denmark. Leading up to the National Skin Cancer Action Week is the *SunSmart* Competition, inviting youth aged 12-17 to use images or text to convey *SunSmart* messages about protecting skin from the sun in the summer. Various prizes are awarded for the best entries.

The *SunSmart* UV Alert provides UV radiation information such as the time during the day when *SunSmart* behaviour should be practiced, and when sun protection is not needed. The UV Alert is issued by the Bureau of Meteorology when the UV index is forecast to reach 3 or above, the level at which UV radiation can damage skin and lead to skin cancer. The UV Alert is reported in the weather page of all Australian daily newspapers and on some radio and cell phone weather forecasts.

Resources are also provided regarding the development of quality shade, including:

- Guidelines for developing shade in particular settings
- Shade policy framework for local governments
- Shade funding suggestions
- *SunSmart* eBulletins providing case studies of good shade projects in public places

*SunSmart* Shade Awards acknowledge organizations that have made shade provision a priority, highlighting best practice shade design and shade policy.

#### Effectiveness of the Australian *SunSmart Program*

*SunSmart* and similar Australian efforts differ from the more basic programs common in other parts of the world; in short, they represent a comprehensive health promotion strategy involving mass media, local and state government efforts, school programs, and community

organizations, with a focus on supporting the implementation of sun protection policies and practices that lead to long-term structural and organizational change. In fact, under the umbrella of *SunSmart*, there has been significant adoption of sun protection policies and practices by local government-run facilities such as swimming pools, preschools, and childcare centres, by sport and leisure organizations, and by workplaces.[253] Similarly, the earlier program *Me No Fry* used a combination of mass media advertising, local activities, sponsorship by sporting bodies, endorsements by role models, and policy changes to convey the message to 11- to 16-year-olds.[254]

But what have been the actual or potential health impacts of these efforts? A fundamental objective of *SunSmart* is to effect changes in sun protection behaviour, with an aim to reducing sun exposure and its attendant health risks. Survey results suggest some progress in this regard, indicating that there was a consistent increase in the proportion of people practicing sun protection measures between 1988 and 2001.[255] Likewise, *Me No Fry* resulted in an increase in sun protection behaviour among adolescents, as well as a reduction in reported sore or tender sunburns over two summers.[256] The latter result pertaining to sunburns is important, as it shifts the end-point of evaluation along the disease pathway, from risky behaviours to the incidence of biological intermediates that can serve as a good proxy for sun exposure levels across a population, and possibly for skin cancer itself. Using data on sunburn rates in this way has in fact provided the foundation for projecting the effectiveness or cost-effectiveness of a skin cancer prevention campaign over the long-term in both New Zealand and Australia (see below).[257,258]

Aspects of the *SunSmart* program that have been key to its success include research and evaluation, combined with consistency and continuity of execution. There is an ongoing process of evaluation to ensure that the needs of the community are being met, that the program has reliable and adequate funding, and that it is hosted by a stable and supportive organization.[259] The commitment to monitoring investment levels and health results has led to concerns being expressed about a recent retreat from improved sun protection behaviours; some analysts have linked this phenomenon to reduced state-level spending on programs such as *SunSmart*.[260]

---

[253] *SunSmart Program 2003-2006*. 2002. Available at http://www.sunsmart.com.au/downloads/about_sunsmart/reports/sunsmart_program_2003_2006.pdf. Accessed January 2009.

[254] [254] NSW Skin Cancer Prevention Working Group. *Skin Cancer Prevention Evidence Summary*. 2007. Available at http://www.nswcc.org.au/html/prevention/sunsmart/downloads/skincancer_prevention_evidence_summary.pdf. Accessed January 2009.

[255] *SunSmart Program 2003-2006*. 2002. Available at http://www.sunsmart.com.au/downloads/about_sunsmart/reports/sunsmart_program_2003_2006.pdf. Accessed January 2009.

[256] NSW Skin Cancer Prevention Working Group. *Skin Cancer Prevention Evidence Summary*. 2007. Available at http://www.nswcc.org.au/html/prevention/sunsmart/downloads/skincancer_prevention_evidence_summary.pdf. Accessed January 2009.

[257] Sneyd M, Cox B. The control of melanoma in New Zealand. *New Zealand Medical Journal.* 2006; 119(1242): U2169.

[258] Carter R, Marks R, Hill D. Could a national skin cancer primary prevention campaign in Australia be worthwhile?: an economic perspective. *Health Promotion International.* 1999; 14(1): 73-82.

[259] Montague M, Borland R, Sinclair C. Slip! Slop! Slap! and SunSmart, 1980-2000: Skin cancer control and 20 years of population-based campaigning. *Health Education & Behavior*. 2001; 28(3): 290-305.

[260] Dobbinson SJ, Wakefield MA, Jamsen KM et al. Weekend sun protection and sunburn in Australia trends (1987-2002) and association with SunSmart television advertising. *American journal of preventive medicine.* 2008; 34(2): 94-101.

The ultimate end-point of any primary prevention program is, as suggested earlier, the reduction in disease incidence per se. This is challenging to assess when the disease has a long development lag-time, as is true with skin cancer. However, there are leading-edge indications of improvements in skin cancer statistics in the setting of Australia, where intensive prevention campaigns have been operating the longest. Although the occurrence of both melanoma and NMSC is still increasing in Australia, some age-specific incidence data for the state of Victoria show a more encouraging trend. For the period 1995-2004, melanoma incidence rates *decreased* in Victorian men and women aged under 60 years (see the table below).[261]

**Melanoma Incidence Trends by Age Group and Gender**
**Victoria, Australia 1995-2004**

| Age group | Male | Female |
|---|---|---|
| **<40 years** | -2.2% | -4.8% |
| **40-59 years** | -0.7% | -1.4% |
| **60+ years** | +1.6% | +0.2% |

Source: Cancer Council Victoria Epidemiology Centre, *Canstat: Skin Cancer*, 2007.

Furthermore, though rates continued to rise in the cohort over 60 years of age, the rate of increase is slower than in the previous decade. These figures indicate that sun protection messages and other prevention efforts may be having an effect on skin cancer rates. The younger cohorts would have grown up with *SunSmart*, while the older age group continues to demonstrate incidence rates that are driven in part by pre-*SunSmart* personal behaviours that are not as cognizant of sun safety.

The trend for BCC incidence in Australia may be similar to melanoma, especially in the Victorian context, though the results are less certain because they are not based on cancer registry information. The data in the table below in fact represent estimates from the national skin cancer surveys of the southern latitudinal zone of Australia, within which the state of Victoria lies.

**BCC Incidence Trends by Age Group and Gender**
**Southern Australia, 1985-1995**

| Age group | Male | Female |
|---|---|---|
| **14-39** | -17.0% | -18.0% |
| **40-49** | +0.5% | +0.25% |
| **50-59** | +12.0% | +11.8% |
| **60-69** | +23.8% | +24.0% |
| **70+** | +44.0% | +45.0% |

Source: Cancer Council Victoria Epidemiology Centre, *Canstat: Skin Cancer*, 2007.

There were reductions in rates for men and women under forty years of age between 1985 and 1995; this may be compared with the relatively stable rates for those between 40 and 49 years, and incidence rates increasing at a substantial pace in older cohorts.[262]

[261] Cancer Council Victoria Epidemiology Centre. *Canstat: Skin Cancer*. 2007. Available at http://www.cancervic.org.au/downloads/about_our_research/canstats/more_canstats/Canstat_45_cancer_stats_2005.pdf. Accessed January 2009.
[262] Cancer Council Victoria Epidemiology Centre. *Canstat: Skin Cancer*. 2007. Available at http://www.cancervic.org.au/downloads/about_our_research/canstats/more_canstats/Canstat_45_cancer_stats_2005.pdf. Accessed January 2009.

Recently, the story concerning skin cancer prevention in Australia has expanded to the federal level. The *National Skin Cancer Awareness Campaign* was launched in Australia in 2006, and was fully implemented up until 2008; it was intentionally designed to complement the prototype Victorian *SunSmart* program and the similar efforts eventually adopted at the state level throughout the country. The main target audience consisted of teenagers and young adults, with the primary objective being to increase the adoption of multiple sun protection behaviours using a mass media approach. The campaign was successful in improving adoption of sun protection in the target audiences, specifically with regard to use of clothing, shade, and sunscreens.[263] Recently, advocacy efforts have been directed towards maintaining (or even increasing) the national investment in skin cancer prevention. As noted earlier, part of the motivation entails concern about the *decline* in sun safety gains seen throughout the country when state-level spending shrunk in the years following the initial, fully funded roll-out of *SunSmart* programs.[264]

#### Trends Related to Australian Skin Cancer Prevention Programs

*History of Program Spending*

The level of expenditures on the Victoria *SunSmart* program has averaged $0.26 (2003 AUS$) per capita from 1988 to 2006; it fluctuated between a high of $0.41 in 1988 to a low of $0.12 in 2002. In general, the trend has been toward reduced funding for the program. Starting with an average of $0.39 (2003 AUS$) spent per capita per year in the first four years of the program (1988 to 1991), it decreased to $0.28 between 1992 and 1996, to $0.26 in 1997-2001, and to $0.18 in 2002-2006. Starting in 1998, the Australian states of New South Wales (NSW) and Queensland (QLD) implemented the *SunSmart* program with average annual per capita expenditures of $0.06 (2003 AUS$) between 1998 and 2001, increasing to $0.08 in 2002-2006.[265]

*Melanoma Incidence over a Comparable Timeframe*

To further assess the effectiveness of the *SunSmart* program in Victoria, data on melanoma incidence by gender and pertinent age groups (<20, 20-29, 30-39, 40-49 years) were requested and received from the Cancer Council Victoria, Melbourne, Australia.[266] Similar data for all of Australia were gleaned from the Australian Cancer Incidence & Mortality Books.[267] These datasets, together with population numbers, allowed for an analysis of trends in melanoma incidence rates by gender and age group, ultimately comparing the pattern in Victoria with the rest of Australia. Age groups over 50 were not included, as a 20-year prevention program would not likely influence rates in these older population cohorts.

[263] Ipsos-Eureka Social Research Institute. *Evaluation of National Skin Cancer Campaign*. 2008. Available at http://www.skincancer.gov.au/internet/skincancer/publishing.nsf/Content/7FBE59F095363927CA25721F001C9E0A/$File/Evaluation%20Research%20report.pdf. Accessed January 2009.

[264] Shih ST, Carter R, Sinclair C et al. Economic evaluation of a national SunSmart program. This report has been summarized in the article: Shih ST, Carter R, Sinclair C et al. Economic evaluation of skin cancer prevention in Australia. *Preventive Medicine.* 2009; Epublished ahead of print: 5 pp.

[265] Prof. Rob Carter. Personal communication, May 21, 2009.

[266] Ms. Vicky Thursfield, Cancer Control Information Manager, Cancer Epidemiology Centre, Cancer Council Victoria. Personal communication, June 16, 2009.

[267] Population Health Unit, AIHW, with support from the Cancer Institute NSW. Available online at http://www.aihw.gov.au/cancer/data/acim_books/index.cfm (accessed June, 2009).

These data were analyzed using the Joinpoint Regression Program (v2.7) to assess trends and annual percent change (APC) by gender and age between 1982 and 2003.[268] The year 2003 was chosen as the end-point for the analysis since it is unclear whether the observed increase in incidence rate in 2004 and 2005 in Victoria for the population aged up to 50 is due to random variation and/or a previous decline in funding for skin cancer prevention programs. The melanoma incidence rate decreased again in Victoria in 2006; in addition, no such variation in 2004 and 2005 was observed in the same age cohorts in the rest of Australia (see following charts). Several years of additional trend data will be required to determine whether the observed increases in 2004 and 2005 in Victoria are the beginning of an upward trend or simply random variation. To model key changes in trends over the 1982 to 2003 time period, the Joinpoint Regression Program was programmed to choose one inflection during this time period, as well as the best model fit.

The following table provides the annual percent change (APC) in melanoma incidence in the state of Victoria for males, females, and both genders by pertinent age groups, based on choosing the best inflection point between 1982 and 2003.

**Trends in Cutaneous Melanoma in Victoria, Australia**
**Annual Percentage Change (1982 to 2003)**
**By Gender, Age Group and Time Frame**

| Gender | Age | Time Frame | APC | p-value | Time Frame | APC | p-value |
|---|---|---|---|---|---|---|---|
| **Male** | 0-19 | 1982 - 1988 | 31.62% | 0.130 | 1988 - 2003 | -4.98% | 0.100 |
| | 20-29 | 1982 - 1987 | 9.19% | 0.220 | 1987 - 2003 | -0.47% | 0.660 |
| | 30-39 | 1982 - 1988 | 6.27% | 0.080 | 1988 - 2003 | -1.04% | 0.180 |
| | 40-49 | 1982 - 1997 | 4.09% | 0.001 | 1997 - 2003 | -3.39% | 0.270 |
| | **0-49** | **1982 - 1988** | **10.67%** | **0.008** | **1988 - 2003** | **0.37%** | **0.600** |
| **Female** | 0-19 | 1982 - 1996 | 7.75% | 0.014 | 1996 - 2003 | -13.85% | 0.046 |
| | 20-29 | 1982 - 1997 | 2.07% | 0.090 | 1997 - 2003 | -4.69% | 0.340 |
| | 30-39 | 1982 - 1997 | 2.17% | 0.006 | 1997 - 2003 | -5.31% | 0.055 |
| | 40-49 | 1982 - 1997 | 2.83% | 0.001 | 1997 - 2003 | -3.52% | 0.140 |
| | **0-49** | **1982 - 1997** | **3.61%** | **0.000** | **1997 - 2003** | **-4.57%** | **0.052** |
| **Both Genders** | 0-19 | 1982 - 1988 | 27.10% | 0.007 | 1988 - 2003 | -3.36% | 0.180 |
| | 20-29 | 1982 - 1997 | 2.14% | 0.055 | 1997 - 2003 | -4.63% | 0.300 |
| | 30-39 | 1982 - 1997 | 1.83% | 0.004 | 1997 - 2003 | -4.53% | 0.042 |
| | 40-49 | 1982 - 1997 | 3.44% | 0.000 | 1997 - 2003 | -3.43% | 0.130 |
| | **0-49** | **1982 - 1997** | **3.71%** | **0.000** | **1997 - 2003** | **-4.13%** | **0.080** |

There appears to be an important decline in the APC over the timeframe when a comprehensive skin cancer prevention program has been operating in Victoria. A key change in the trend occurred in 1997. Between 1982 and 1997, melanoma incidence rates in Victoria increased by an average of 3.71% per year. Starting in 1997, an average annual decrease of 4.13% was observed. This would suggest about a 9-year time lag between the launch of a prevention program (1988 in Victoria) and the observation of substantial leading-edge improvements in disease burden. The most dramatic percentage decline in incidence has been seen among female adolescents, which points to the potential impact of a campaign such as *SunSmart* on younger children and their caregivers.

[268] Kim HJ, Fay MP, Feuer EJ, Midthune DN. Permutation tests for joinpoint regression analysis with application to cancers rates. *Statistics in Medicine.* 2000; 19: 335-51.

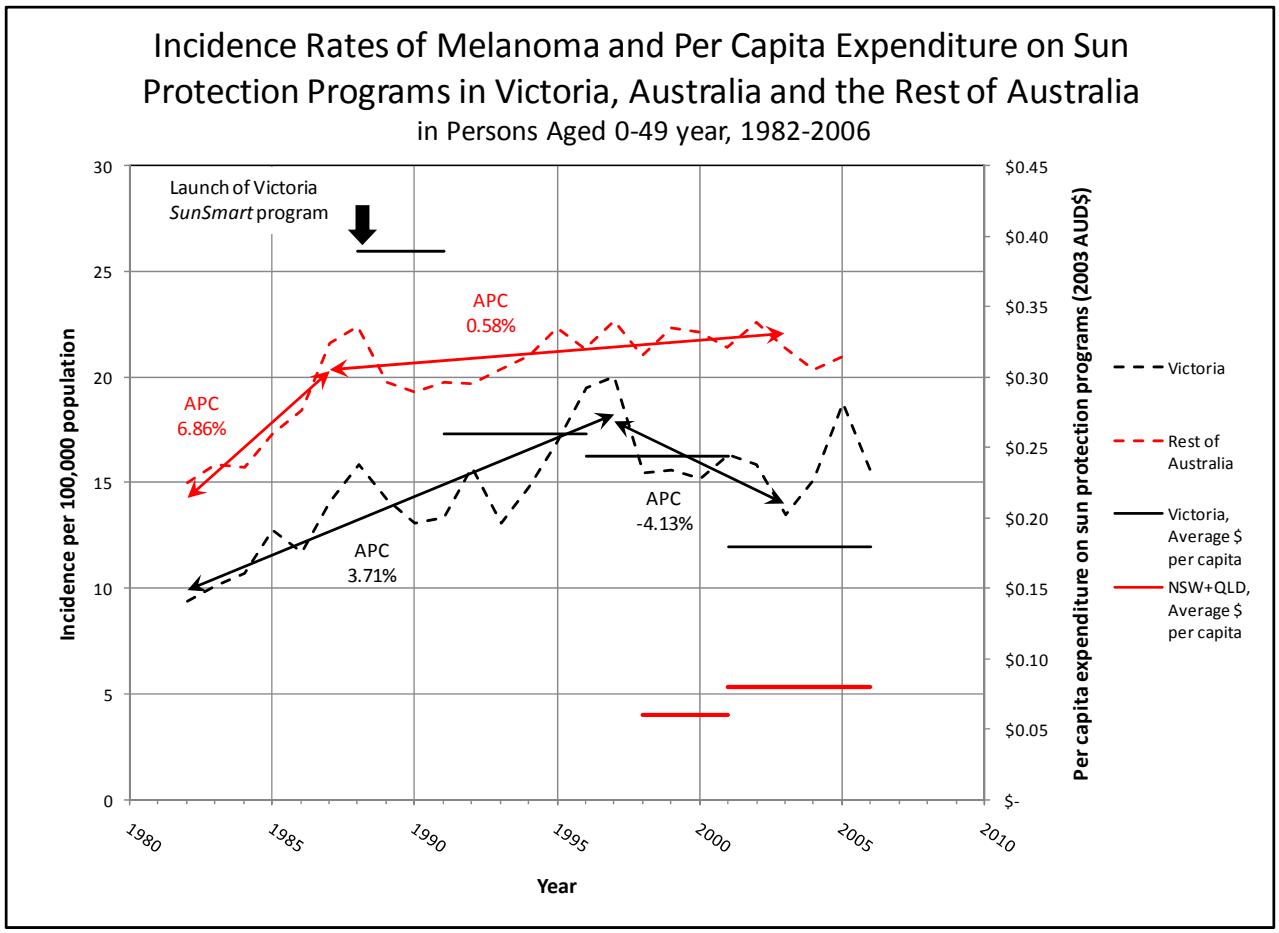
The results for Victoria may be compared with the rest of Australia, that is, available data for states other than Victoria (see the table below). Recalling that additional state-level prevention programs were launched only in 1998, it is clear that secular improvement trends in melanoma burden have been prevailing for some time; again, the greatest declines in incidence have been observed among adolescents. One might also assume that the prevention programming in the state of Victoria may have had some 'spill-over' effect in the rest of Australia.

**Trends in Cutaneous Melanoma in the Rest of Australia**
**Annual Percentage Change (1982 to 2003)**
**By Gender, Age Group and Time Frame**

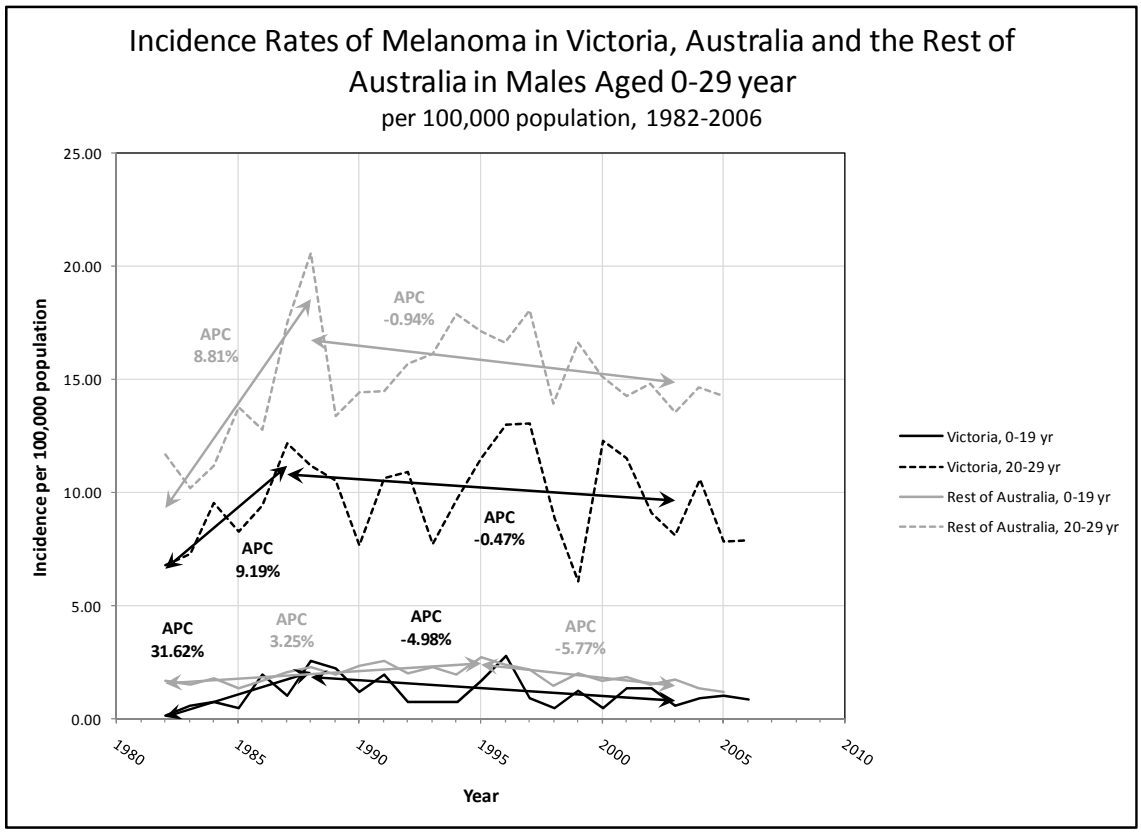
| Gender | Age | Time Frame | APC | p-value | Time Frame | APC | p-value |
|---|---|---|---|---|---|---|---|
| **Male** | 0-19 | 1982 - 1995 | 3.25% | 0.006 | 1995 - 2003 | -5.77% | 0.009 |
| | 20-29 | 1982 - 1988 | 8.81% | 0.007 | 1988 - 2003 | -0.94% | 0.170 |
| | 30-39 | 1982 - 1987 | 9.70% | 0.000 | 1987 - 2003 | -0.54% | 0.100 |
| | 40-49 | 1982 - 1988 | 6.26% | 0.002 | 1988 - 2003 | 0.94% | 0.007 |
| | **0-49** | **1982 - 1987** | **10.67%** | **0.000** | **1987 - 2003** | **0.79%** | **0.008** |
| **Female** | 0-19 | 1982 - 1996 | 1.44% | 0.290 | 1996 - 2003 | -4.57% | 0.210 |
| | 20-29 | 1982 - 1987 | 1.80% | 0.590 | 1987 - 2003 | -0.93% | 0.100 |
| | 30-39 | 1982 - 1985 | 5.15% | 0.410 | 1985 - 2003 | -0.43% | 0.210 |
| | 40-49 | 1982 - 1987 | 2.56% | 0.210 | 1987 - 2003 | 0.28% | 0.300 |
| | **0-49** | **1982 - 1987** | **3.81%** | **0.040** | **1987 - 2003** | **0.37%** | **0.150** |
| **Both Genders** | 0-19 | 1982 - 1996 | 2.02% | 0.051 | 1996 - 2003 | -5.53% | 0.049 |
| | 20-29 | 1982 - 1987 | 5.46% | 0.099 | 1987 - 2003 | -0.79% | 0.120 |
| | 30-39 | 1982 - 1986 | 7.02% | 0.054 | 1986 - 2003 | -0.37% | 0.240 |
| | 40-49 | 1982 - 1987 | 4.93% | 0.016 | 1987 - 2003 | 0.67% | 0.010 |
| | **0-49** | **1982 - 1987** | **6.86%** | **0.001** | **1987 - 2003** | **0.58%** | **0.024** |

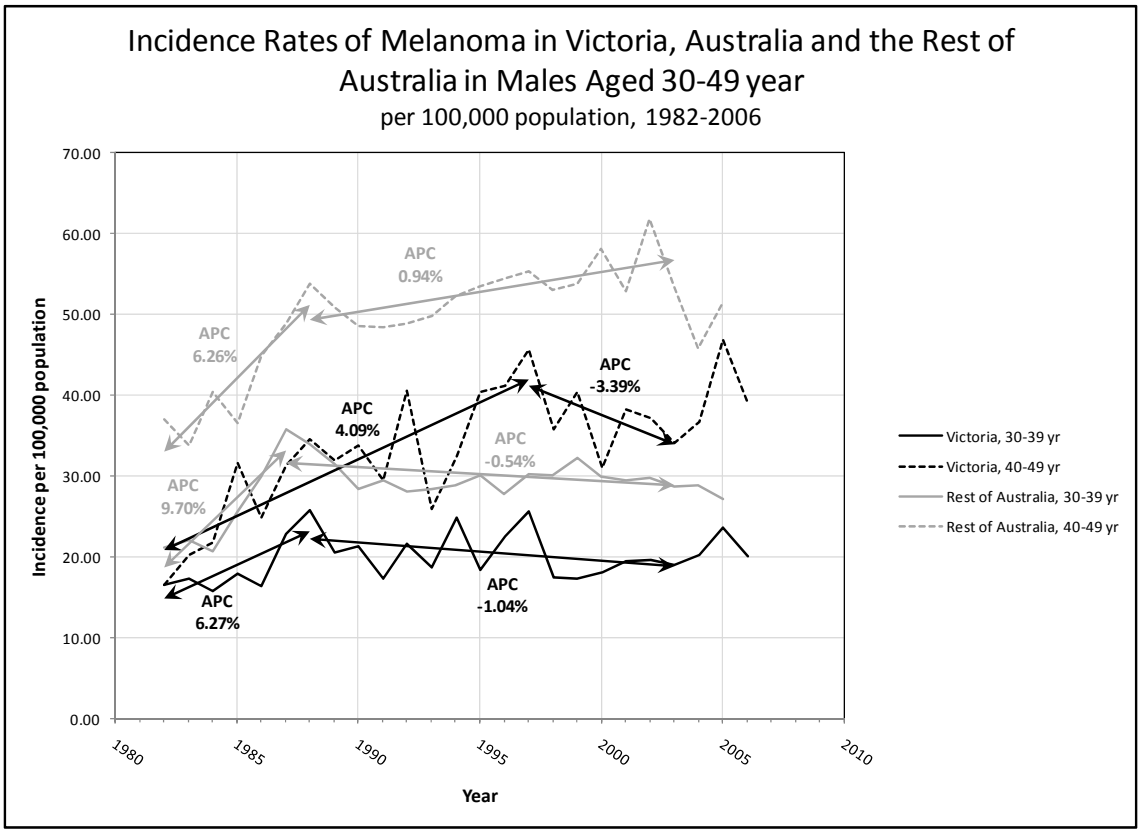
The information on average per capita program spending and APCs at different time periods have been combined on a series of charts to allow results for Victoria and the rest of Australia to be easily compared. A number of features may be seen in the first chart below, which illustrates data for the population under the age of 50 (with both genders combined).

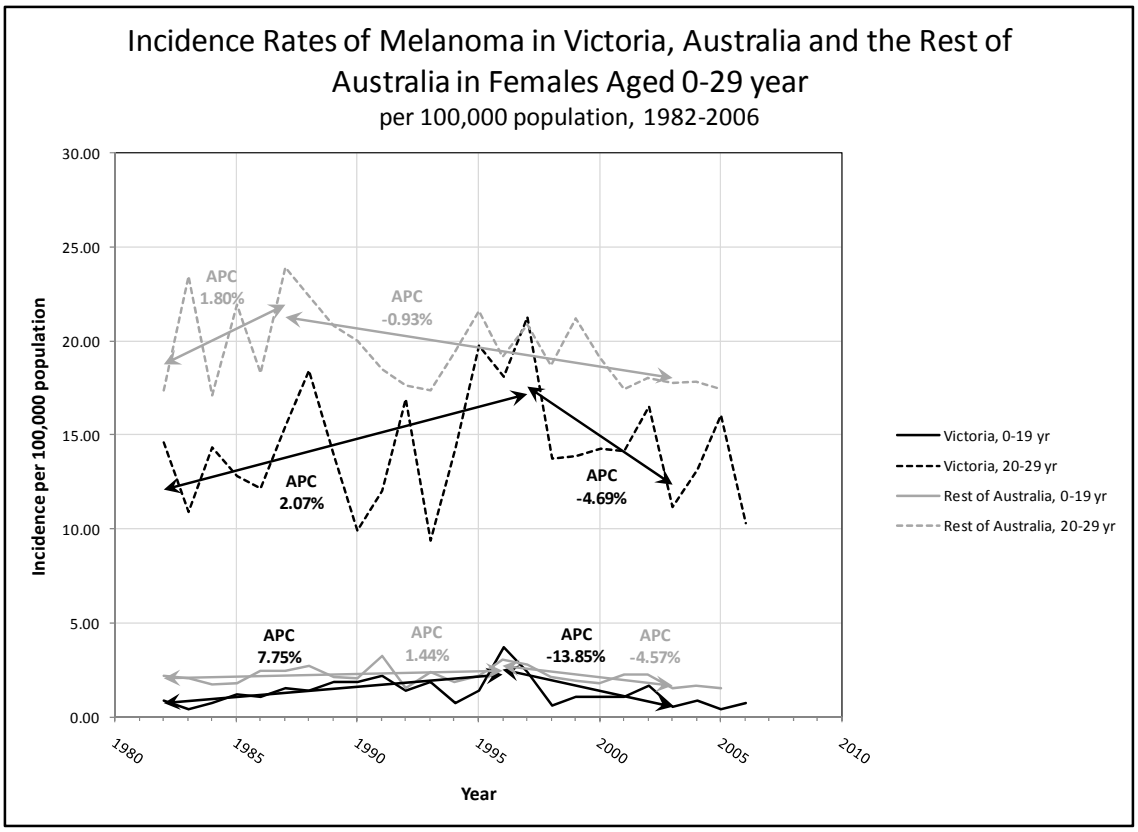
1. Melanoma incidence rates in Victoria increased by an average of 3.71% per year between 1982 and 1997.
2. Melanoma incidence rates increased in the rest of Australia by an average of 6.87% per year between 1982 and 1987.They continued to increase thereafter, but at a much slower rate (APC of 0.58%).
3. Starting in 1997, an average annual decrease in melanoma incidence of 4.13% was observed in Victoria. This would suggest about a 9-year time lag between the launch of the *SunSmart* prevention program and the observation of substantial leading-edge improvements in disease burden.
4. There appears to be an ***increase*** in incidence in Victoria in 2004 and 2005, possibly due to random variation, or attributable to reduced per capita program spending in the 1990s (i.e., reflecting a lag time once again). An actual ***decrease*** was observed in 2006. In addition, a matching increase for 2004 and 2005 was not observed in the rest of Australia.

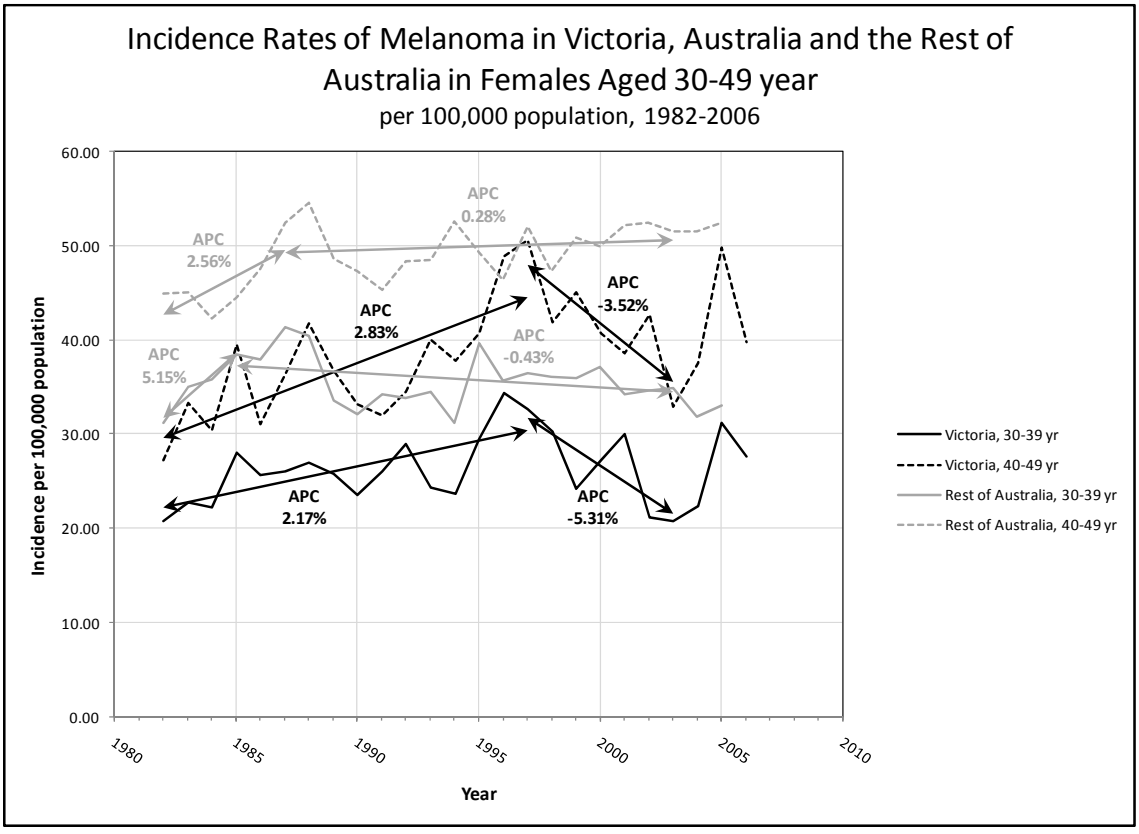



The next four charts illustrate the APC information for males and females by age group. It is clear that in more recent times the melanoma incidence rate has been either declining or relatively stable for all age groups in males. The substantial incidence rate decline in males aged 40-49 years in Victoria is heartening, as this age group represents the highest base incidence rate (and absolute melanoma incidence) among the age groups being compared; the fact that this trend starts in 1997 is suggestive of a *SunSmart* effect involving a certain lag time. However, since the positive (or at least neutral) pattern for males generally extends back to the launch of *SunSmart* in Victoria, one may assume notable secular improvement trends in male age groups that are not attributable to the prevention program per se.


Incidence Rates of Melanoma in Victoria, Australia and the Rest of Australia in Males Aged 0-29 year
per 100,000 population, 1982-2006
Incidence per 100,000 population
25.00
20.00
15.00
10.00
5.00
0.00
1980
1985
1990
1995
2000
2005
2010
Year
APC 8.81%
APC -0.94%
APC 9.19%
APC -0.47%
APC 31.62%
APC 3.25%
APC -4.98%
APC -5.77%
Victoria, 0-19 yr
Victoria, 20-29 yr
Rest of Australia, 0-19 yr
Rest of Australia, 20-29 yr


Incidence Rates of Melanoma in Victoria, Australia and the Rest of Australia in Males Aged 30-49 year
per 100,000 population, 1982-2006
Incidence per 100,000 population
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1980
1985
1990
1995
2000
2005
2010
Year
APC 0.94%
APC 6.26%
APC -3.39%
APC 4.09%
APC -0.54%
APC 9.70%
APC 6.27%
APC -1.04%
Victoria, 30-39 yr
Victoria, 40-49 yr
Rest of Australia, 30-39 yr
Rest of Australia, 40-49 yr


Incidence Rates of Melanoma in Victoria, Australia and the Rest of Australia in Females Aged 0-29 year
per 100,000 population, 1982-2006
Incidence per 100,000 population
Year
APC 1.80%
APC -0.93%
APC 2.07%
APC -4.69%
APC 7.75%
APC 1.44%
APC -13.85%
APC -4.57%
Victoria, 0-19 yr
Victoria, 20-29 yr
Rest of Australia, 0-19 yr
Rest of Australia, 20-29 yr


Incidence Rates of Melanoma in Victoria, Australia and the Rest of Australia in Females Aged 30-49 year
per 100,000 population, 1982-2006
Incidence per 100,000 population
Year
APC 0.28%
APC 2.56%
APC 2.83%
APC -3.52%
APC 5.15%
APC -0.43%
APC 2.17%
APC -5.31%
Victoria, 30-39 yr
Victoria, 40-49 yr
Rest of Australia, 30-39 yr
Rest of Australia, 40-49 yr

The difference in APC patterns for females in Victoria and the rest of Australia is clear in the two preceding charts; whereas the incidence trendline for females in the balance of the country has been relatively flat in recent years (which is by itself positive), the melanoma rates in Victoria have been declining in all female age groups since about 1997. This is highly suggestive of a positive effect from the *SunSmart* program launched in the state in 1988.

#### Cost-Effectiveness of the Australian *SunSmart Program*

As noted above, Australian programs such as *SunSmart* have been associated with a reduction in sunburn incidence, as well as a plateau (and in fact decline in younger age groups) in skin cancer incidence after decades of increasing rates. In an economic evaluation led by Prof. Rob Carter after about a decade of experience with the Victorian comprehensive program, it was found that "...a cost-benefit analysis of the return on investment in skin cancer control programs was favourable, with an estimated investment of $AUD 0.28 per capita for a national program in Australia estimated to avoid 4,300 premature deaths over 20 years and a net saving of $AUD 103 million."[269]

About ten years later, Carter and colleagues conducted a follow-up analysis of the potential for skin cancer prevention in Australia if a nation-wide, comprehensive campaign were sustained over 20 years at adequate funding levels. The calculations were pursued in two ways: (1) reapplying the method used in the earlier study, and (2) using an improved approach made possible in part by having retrospective information on actual melanoma reductions following the *SunSmart* campaign. Refinements were also made to how reductions in NMSC were estimated. The updated method generally offered a more conservative, but arguably more reliable, set of results. Nonetheless, even on the basis of the second analytic method, maintaining the historic levels of spending for 20 years on a program like *SunSmart* was still projected to reduce cumulative melanoma cases by 20,000 and NSMC by 49,000. Furthermore, over 1,900 premature deaths would be avoided. This effort would be (modestly) cost saving for the medical system; incorporating many millions of dollars of indirect costs would naturally make the economic analysis even more attractive. The ultimate conclusion was that *SunSmart* "constitutes excellent value-for-money."[270] An actual cost-benefit ratio was quantified using a slightly different perspective, that is, comparing a low-level spending pattern (annual expenditures of $0.07 per capita) against an upgraded national prevention program with a sustained investment of $0.28 per capita (or about $120 million in total program costs over 20 years); on these terms, the additional number of skin cancer cases avoided was estimated to be 190,000, with a savings to the health care system of about $2.30 for each $1.00 invested in the prevention program.

Only one comparable study was located in the literature. An analysis of a school-based program in the U.S. known as *SunWise* estimated that it would avert 10,960 cases of skin cancer (including 51 deaths) between 1999 and 2015 among the approximately 12 million students exposed to the teaching material. The medical expenditures and productivity losses averted by the program were projected to outweigh program costs by a factor between 2 and 4.[271]

---

[269] Dobbinson SJ, Wakefield MA, Jamsen KM et al. Weekend sun protection and sunburn in Australia trends (1987-2002) and association with SunSmart television advertising. *American journal of preventive medicine.* 2008; 34(2): 94-101.

[270] Shih ST, Carter R, Sinclair C et al. Economic evaluation of a national SunSmart program. This report has been summarized in the article: Shih ST, Carter R, Sinclair C et al. Economic evaluation of skin cancer prevention in Australia. *Preventive Medicine.* 2009; Epublished ahead of print: 5 pp.

[271] Kyle JW, Hammitt JK, Lim HW et al. Economic evaluation of the US Environmental Protection Agency's SunWise program: sun protection education for young children. *Pediatrics.* 2008; 121(5): e1074-84.

## Appendix D: Cutaneous Melanoma in Canada

### 1. Estimating the Number of Cases in Canada in 2004

As a starting point in estimating the number of MSC cases in Canada, data available in the Public Health Agency's *Cancer Surveillance Online* data system were employed.[272] The number of melanoma cases (cancer incidence ICDO-3 C440:C449 (types 8720:8790)) was downloaded for each province in each of the five calendar years from 2000 to 2004 (2004 was the most recent year for which data was available at the time of this analysis; data for 2005 was made available in January 2009).

To be able to project the number of melanoma cases in the future (see section 3, *Projections*, below), it was necessary to generate incidence rates by province, age group, and gender. This data is available by 5-year age groups (0-4,....80-84, 85+) in Cancer Surveillance Online. This system, however, does not provide data for cells with 5 or fewer cases. This meant that, for many of the smaller provinces, data for a number of cells was not available. The number of cases in each of these "missing" cells was estimated as follows:

a. Determine the age- and gender-specific rate /100,000 population for Canada using data from 1994 to 2004. This yielded the following table:

Cutaneous Melanoma in Canada
By Age Group and Gender, 1994-2004
Rate per 100,000 Population

| Age | Canada | | |
|---|---|---|---|
| | Male | Female | Total |
| 0-4 | 0.05 | 0.06 | 0.05 |
| 5-9 | 0.05 | 0.07 | 0.06 |
| 10-14 | 0.20 | 0.20 | 0.20 |
| 15-19 | 0.69 | 1.21 | 0.94 |
| 20-24 | 1.74 | 3.34 | 2.52 |
| 25-29 | 3.27 | 5.68 | 4.46 |
| 30-34 | 4.64 | 7.55 | 6.08 |
| 35-39 | 6.66 | 9.60 | 8.12 |
| 40-44 | 9.47 | 11.11 | 10.29 |
| 45-49 | 12.59 | 14.59 | 13.59 |
| 50-54 | 18.26 | 15.96 | 17.10 |
| 55-59 | 22.84 | 16.84 | 19.82 |
| 60-64 | 28.62 | 17.25 | 22.83 |
| 65-69 | 35.00 | 20.58 | 27.47 |
| 70-74 | 41.49 | 23.55 | 31.67 |
| 75-79 | 47.03 | 26.50 | 35.06 |
| 80-84 | 53.03 | 26.04 | 36.16 |
| 85+ | 60.35 | 27.07 | 37.11 |
| Total | 11.22 | 10.07 | 10.64 |

b. Calculate age- and gender-specific incidence /100,000 population by province/territory based on five years of data (2000 to 2004) whenever this detailed data was available from Cancer Surveillance Online. As noted above, this detailed data was often missing for smaller provinces/territories. When the detailed data was missing, the calculated age- and gender-specific rates for Canada from 1994 to 2004 (see table above) were

[272] Available at http://dsol-smed.phac-aspc.gc.ca/dsol-smed/cancer/index_e.html

applied to the smaller provinces/territories age- and gender-specific populations with the following adjustment. The age- and gender-specific Canadian rates were uniformly increased or decreased so that the final total number of cases by gender equalled the total by gender for that province/territory as provided in Cancer Surveillance Online.

c. The number of total cases in the Territories (Yukon, Northwest Territories, and Nunavut) is generally 5 or fewer per year and therefore is missing from Cancer Surveillance Online. To address this missing data, the Canadian average age- and gender-specific rates for 2000-2004 was applied to the population in each of the cells for these parts of the country.

Based on the method outlined, the estimated number of melanoma cases by gender for each year from 2000 to 2004 by province/territory is indicated in the table below.

**Estimated New Cutaneous Melanoma Cases in Canada**
**Patient-based Incidence Approach**

| | 2000 | | | 2001 | | | 2002 | | | 2003 | | | 2004 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 280 | 249 | 529 | 357 | 305 | 662 | 332 | 299 | 631 | 355 | 287 | 643 | 359 | 304 | 663 |
| AB | 194 | 193 | 387 | 191 | 189 | 380 | 172 | 168 | 340 | 192 | 169 | 361 | 229 | 222 | 452 |
| SK | 61 | 58 | 119 | 57 | 64 | 122 | 53 | 62 | 115 | 59 | 56 | 115 | 52 | 60 | 112 |
| MB | 71 | 65 | 136 | 64 | 68 | 132 | 63 | 44 | 106 | 59 | 50 | 109 | 73 | 54 | 127 |
| ON | 867 | 723 | 1,590 | 905 | 768 | 1,673 | 893 | 798 | 1,691 | 994 | 827 | 1,821 | 978 | 885 | 1,863 |
| QC | 294 | 302 | 596 | 277 | 267 | 544 | 260 | 224 | 484 | 288 | 239 | 527 | 277 | 225 | 502 |
| NB | 49 | 62 | 111 | 58 | 44 | 103 | 58 | 60 | 118 | 56 | 59 | 115 | 56 | 51 | 107 |
| NF&L | 28 | 30 | 58 | 23 | 21 | 44 | 31 | 29 | 59 | 36 | 29 | 65 | 27 | 29 | 56 |
| PEI | 14 | 18 | 32 | 9 | 18 | 27 | 16 | 11 | 28 | 8 | 12 | 21 | 10 | 16 | 26 |
| NS | 86 | 86 | 172 | 82 | 82 | 164 | 95 | 87 | 183 | 101 | 101 | 202 | 94 | 99 | 193 |
| YK | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 2 | 3 | 2 | 2 | 4 |
| NWT | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 4 | 2 | 2 | 4 | 2 | 2 | 4 |
| NV | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 |
| **Canada** | **1,948** | **1,790** | **3,738** | **2,029** | **1,830** | **3,859** | **1,978** | **1,785** | **3,764** | **2,154** | **1,833** | **3,987** | **2,162** | **1,949** | **4,111** |

*Note: Quebec data is **unadjusted***

The report *Canadian Cancer Statistics 2008* notes that the number of melanoma cases in the Quebec cancer registry accessed by Cancer Surveillance Online is underestimated by 35%, due to that province's dependence on hospital data.[273,274]

To address this underestimate, the number of melanoma cases in Quebec was first increased by 35%. This approach raised the estimated melanoma cases in that province from 2,653 to 3,582 during the period from 2000 to 2004 (see following table). Alternatively, the ratio of incidence to mortality[275] in Canada was calculated (excluding data from Quebec from 2000 to 2004) and then applied to Quebec mortality data. This approach raised the estimated number of melanomas from 2,653 to 3,669 (or 38.3%). The results for the two approaches to adjusting Quebec data are detailed in the table below.

[273] Canadian Cancer Society/National Cancer Institute of Canada: *Canadian Cancer Statistics 2008*, Toronto, Canada, 2008. Available at http://www.cancer.ca/Canada-wide/About%20cancer/Cancer%20statistics/Canadian%20Cancer%20Statistics.aspx?sc_lang=en (accessed December, 2008)

[274] Brisson J, Major D, Pelletier E. *Evaluation of the completeness of the fichier des tumeurs du Québec*. Institut national de la santé publique du Québec, 2003.

[275] Mortality data was derived from the appropriate annual report on Canadian Cancer Statistics.

| Estimated Number of Melanoma Cases In Quebec, 2000 to 2004 | | | | | | |
|---|---|---|---|---|---|---|
| | 2000 | 2001 | 2002 | 2003 | 2004 | 5Yr Total |
| **Estimated Cases** | | | | | | |
| Quebec | 596 | 544 | 484 | 527 | 502 | 2,653 |
| All Other Provinces | 3,142 | 3,312 | 3,273 | 3,449 | 3,597 | 16,773 |
| **Total** | **3,738** | **3,856** | **3,757** | **3,976** | **4,099** | **19,426** |
| **Estimated Deaths as Per CCS** | | | | | | |
| Quebec | 130 | 145 | 135 | 125 | 130 | 665 |
| All Other Provinces | 575 | 565 | 615 | 625 | 660 | 3,040 |
| **Total** | **705** | **710** | **750** | **750** | **790** | **3,705** |
| Ratio of Deaths / Case in All Other Provinces | 0.183 | 0.171 | 0.188 | 0.181 | 0.183 | **0.181** |
| **Expected Cases in Quebec** | | | | | | |
| 35% Increase | 805 | 734 | 653 | 711 | 678 | **3,582** |
| Ratio of Deaths / Case | 824 | 752 | 669 | 729 | 694 | **3,669** |

Based on the second approach, the original estimate of new melanoma cases in Quebec was increased by 38.3%. The new results are indicated in the following table. Given this assumption, the estimated number of melanoma cases in Canada has increased from 3,966 in 2000 to 4,303 in 2004, an increase of 337 cases per year (or 8.5%).

| Estimated New Cutaneous Melanoma Cases in Canada Patient-based Incidence Approach | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2000 | | | 2001 | | | 2002 | | | 2003 | | | 2004 | | |
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 280 | 249 | 529 | 357 | 305 | 662 | 332 | 299 | 631 | 355 | 287 | 643 | 359 | 304 | 663 |
| AB | 194 | 193 | 387 | 191 | 189 | 380 | 172 | 168 | 340 | 192 | 169 | 361 | 229 | 222 | 452 |
| SK | 61 | 58 | 119 | 57 | 64 | 122 | 53 | 62 | 115 | 59 | 56 | 115 | 52 | 60 | 112 |
| MB | 71 | 65 | 136 | 64 | 68 | 132 | 63 | 44 | 106 | 59 | 50 | 109 | 73 | 54 | 127 |
| ON | 867 | 723 | 1,590 | 905 | 768 | 1,673 | 893 | 798 | 1,691 | 994 | 827 | 1,821 | 978 | 885 | 1,863 |
| QC | 407 | 418 | 824 | 383 | 369 | 752 | 360 | 310 | 669 | 398 | 331 | 729 | 383 | 311 | 694 |
| NB | 49 | 62 | 111 | 58 | 44 | 103 | 58 | 60 | 118 | 56 | 59 | 115 | 56 | 51 | 107 |
| NF&L | 28 | 30 | 58 | 23 | 21 | 44 | 31 | 29 | 59 | 36 | 29 | 65 | 27 | 29 | 56 |
| PEI | 14 | 18 | 32 | 9 | 18 | 27 | 16 | 11 | 28 | 8 | 12 | 21 | 10 | 16 | 26 |
| NS | 86 | 86 | 172 | 82 | 82 | 164 | 95 | 87 | 183 | 101 | 101 | 202 | 94 | 99 | 193 |
| YK | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 2 | 3 | 2 | 2 | 4 |
| NWT | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 4 | 2 | 2 | 4 | 2 | 2 | 4 |
| NV | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 |
| **Canada** | **2,061** | **1,905** | **3,966** | **2,135** | **1,933** | **4,068** | **2,078** | **1,871** | **3,949** | **2,264** | **1,925** | **4,188** | **2,268** | **2,035** | **4,303** |

*Note: Quebec data is **adjusted***

In Canada, counts of cancer incidence are kept by the various Provincial/Territorial Cancer Registries (PTCRs). The PTCRs obtain their counts from a variety of sources, and may use different approaches to coding and recording instances of, for example, multiple primaries and recurrences.[276] To address this variation, Statistics Canada prepares two files with the information it receives from the PTCRs. The first is the Canadian Cancer Registry tabulation

[276] Semenciw RM, Nhu DL, Marrett LD, et al. Methodological issues in the development of the Canadian Cancer Incidence Atlas. *Statistics in Medicine*. 2000; 19: 2437-49.

master file. This file includes data based on a mix of CCR and International Agency for Research on Cancer (IARC) rules for determining multiple tumours. The second file is the IARC master file. IARC coding rules are more conservative in terms of counting multiple primary cancers. In fact, it is information from this file that is used in preparing and disseminating Canadian cancer statistics (for example, those included in Cancer Surveillance Online).

Comparisons between the IARC approach and, for example, the Surveillance, Epidemiology and End Results (SEER) approach in the U.S. indicates that the differences in capturing multiple primary cancers has the greatest impact on breast, colon and melanoma cancer incidence rates.[277] Various researchers have found that using the SEER approach increases the number of melanoma cases by 2.0%,[278] 3.7%,[279] and 4.0%/5.2% (female/male).[280]

In addition, most cancer registries do not count recurrent cancers, including all those that use IARC or SEER coding rules. In a review of 72 articles published between 1985 and 2004, Francken and co-authors found that, on average, 6.6% of melanomas are in fact recurrences that would not be captured in cancer registries according to standard rules.[281]

The incidence results found in the earlier table, then, could be evaluated as conservative, first because they are generated using IARC coding rules for counting multiple primary cancers, and second because they do not include recurrent melanomas.

An important goal of this project is to estimate the economic burden of skin cancers in Canada. From this perspective, it would be important to include both second primary and recurring melanomas because they require treatment, and thus utilize resources. Stang and colleagues refer to this as a 'diagnosis-based incidence approach' compared to a 'patient-based incidence approach,' terminology which has been adopted for this report. They argue that a patient-based incidence approach tends to significantly underestimate the true burden of skin cancers in the population.[282]

To estimate the number of subsequent primary melanoma cases in Canada, the average percent increase (3.43%) of the three studies noted above was employed. The application of this adjustment increased the number of melanomas in the calendar year 2004 in Canada by 148 cases. In addition, the research by Francken et al. was used to estimate the number of recurrent melanoma cases in Canada. Based on this approach, an estimated 304 additional cases would be recurrent melanomas in 2004, or 6.6% of the new total of 4,607 (4,303 plus 304). The effective overall increase based on a diagnosis-based incidence approach that includes both subsequent

[277] Parkin DM and Plummer M. Chapter 5. Comparability and quality of data in Parkin DM, Whelan SL, Ferlay J, et al (eds). Cancer incidence in five continents. Volume VIII. *IARC Scientific Publications.* 2002; (155): 1-781.
[278] Ferrone CR, Porat LB, Panageas KS, et al. Clinicopathological features of and risk factors for multiple primary melanomas. *Journal of the American Medical Association.* 2005; 294(13): 1647-54.
[279] Freedman DM, Miller BA, Tucker MA. Chapter 13. New Malignancies Following Melanoma of the Skin, Eye Melanoma, and Non-melanoma Eye Cancer. In: Curtis RE, Freedman DM, Ron E et al., eds. *New Malignancies Among Cancer Survivors: SEER Cancer Registries, 1973-2000.* Bethesda, MD: National Cancer Institute 2006.
[280] Parkin DM and Plummer M. Chapter 5. Comparability and quality of data in Parkin DM, Whelan SL, Ferlay J, et al (eds). Cancer incidence in five continents. Volume VIII. *IARC Scientific Publications.* 2002; (155): 1-781.
[281] Francken AB, Bastiaannet E, Hoekstra HJ. Follow-up in patients with localised primary cutaneous melanoma. *Lancet Oncology.* 2005; 6(8): 608-21.
[282] Stang A, Ziegler S, Buchner U, et al. Malignant melanoma and nonmelanoma skin cancers in Northrhine-Westphalia, Germany: a patient- vs. diagnosis-based incidence approach. *International Journal of Dermatology*. 2007; 46: 564-70.

primary and recurrent melanomas would be 10.50%, generating an estimate of 4,755 melanomas in Canada in 2004 (see the following table; note that there may be minor discrepancies due to rounding).

**Estimated New & Recurrent Cutaneous Melanoma Cases in Canada**
**Diagnosis-based Incidence Approach**

| | 2000 | | | 2001 | | | 2002 | | | 2003 | | | 2004 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 309 | 275 | 585 | 395 | 337 | 732 | 367 | 330 | 697 | 393 | 317 | 710 | 397 | 336 | 733 |
| AB | 214 | 213 | 428 | 211 | 209 | 420 | 190 | 186 | 376 | 212 | 187 | 399 | 254 | 245 | 499 |
| SK | 67 | 64 | 131 | 63 | 71 | 134 | 59 | 68 | 127 | 65 | 62 | 127 | 58 | 66 | 124 |
| MB | 78 | 72 | 150 | 71 | 75 | 146 | 69 | 48 | 118 | 65 | 55 | 120 | 81 | 60 | 141 |
| ON | 958 | 799 | 1,757 | 1,000 | 848 | 1,848 | 987 | 882 | 1,868 | 1,099 | 914 | 2,012 | 1,081 | 978 | 2,058 |
| QC | 449 | 462 | 911 | 423 | 408 | 831 | 397 | 342 | 740 | 440 | 365 | 805 | 423 | 344 | 767 |
| NB | 54 | 69 | 123 | 64 | 49 | 114 | 65 | 66 | 130 | 62 | 65 | 127 | 62 | 56 | 118 |
| NF&L | 31 | 33 | 64 | 26 | 24 | 49 | 34 | 32 | 66 | 40 | 32 | 72 | 30 | 32 | 62 |
| PEI | 15 | 20 | 35 | 10 | 20 | 30 | 18 | 12 | 31 | 9 | 14 | 23 | 11 | 17 | 28 |
| NS | 95 | 95 | 190 | 91 | 91 | 182 | 105 | 97 | 202 | 112 | 111 | 223 | 104 | 109 | 213 |
| YK | 2 | 2 | 3 | 2 | 2 | 3 | 2 | 2 | 4 | 2 | 2 | 4 | 2 | 2 | 4 |
| NWT | 2 | 2 | 4 | 2 | 2 | 4 | 2 | 2 | 4 | 2 | 2 | 4 | 2 | 2 | 4 |
| NV | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 |
| **Canada** | **2,277** | **2,106** | **4,383** | **2,359** | **2,136** | **4,495** | **2,296** | **2,068** | **4,364** | **2,502** | **2,127** | **4,628** | **2,506** | **2,249** | **4,755** |

## 2. Estimating the Number of Deaths in Canada in 2004

To estimate the number of deaths due to melanoma in Canada, it was useful to begin with the data available for each province (as found in Appendix I, 'Actual Data for New Cases and Deaths,' of the appropriate Canadian Cancer Statistics publication) from 2000 to 2004. The following table provides this summarized information.

**Estimated Deaths Due to Cutaneous Melanoma in Canada**
**By Province/Territory and Gender**
2000 to 2004

| | 2000 | | | 2001 | | | 2002 | | | 2003 | | | 2004 | | | Five Year Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 60 | 40 | 100 | 65 | 35 | 100 | 50 | 40 | 90 | 60 | 55 | 115 | 80 | 50 | 130 | 315 | 220 | 535 |
| AB | 30 | 25 | 55 | 25 | 20 | 45 | 35 | 20 | 55 | 45 | 20 | 65 | 45 | 25 | 70 | 180 | 110 | 290 |
| SK | 10 | 10 | 20 | 15 | 10 | 25 | 15 | 10 | 25 | 15 | 10 | 25 | 15 | 10 | 25 | 70 | 50 | 120 |
| MB | 15 | 15 | 30 | 20 | 10 | 30 | 20 | 10 | 30 | 15 | 10 | 25 | 20 | 10 | 30 | 90 | 55 | 145 |
| ON | 200 | 130 | 330 | 200 | 120 | 320 | 230 | 130 | 360 | 210 | 110 | 320 | 210 | 140 | 350 | 1,050 | 630 | 1,680 |
| QC | 85 | 45 | 130 | 75 | 70 | 145 | 90 | 45 | 135 | 75 | 50 | 125 | 80 | 50 | 130 | 405 | 260 | 665 |
| NB | 10 | 5 | 15 | 5 | 5 | 10 | 5 | 10 | 15 | 10 | 15 | 25 | 15 | 5 | 20 | 45 | 40 | 85 |
| NF&L | 5 | 5 | 10 | 5 | 5 | 10 | 5 | 5 | 10 | 10 | 10 | 20 | 5 | | 5 | 30 | 25 | 55 |
| PEI | | | - | 5 | | 5 | | | - | | | - | | | - | 5 | - | 5 |
| NS | 10 | 5 | 15 | 15 | 5 | 20 | 15 | 15 | 30 | 15 | 15 | 30 | 15 | 15 | 30 | 70 | 55 | 125 |
| YK | | | - | | | - | | | - | | | - | | | - | - | - | - |
| NWT | | | - | | | - | | | - | | | - | | | - | - | - | - |
| NV | | | - | | | - | | | - | | | - | | | - | - | - | - |
| **Canada** | **425** | **280** | **705** | **430** | **280** | **710** | **465** | **285** | **750** | **455** | **295** | **750** | **485** | **305** | **790** | **2,260** | **1,445** | **3,705** |

To be able to project the number of deaths due to melanoma in the future (see subsection 3-b below), it was necessary to generate mortality rates by province, age group, and gender. These data are ***not available*** in the Canadian Cancer Statistics reports. In addition, that system rounds the number of deaths to the nearest '5,' as seen in the table above. This is particularly problematic for many of the smaller jurisdictions, as data for numerous years were not available or not very precise.

This was addressed by using the age- and gender-specific rates for deaths due to melanoma in Ontario between 1971 and 2005 (see following table).[283]

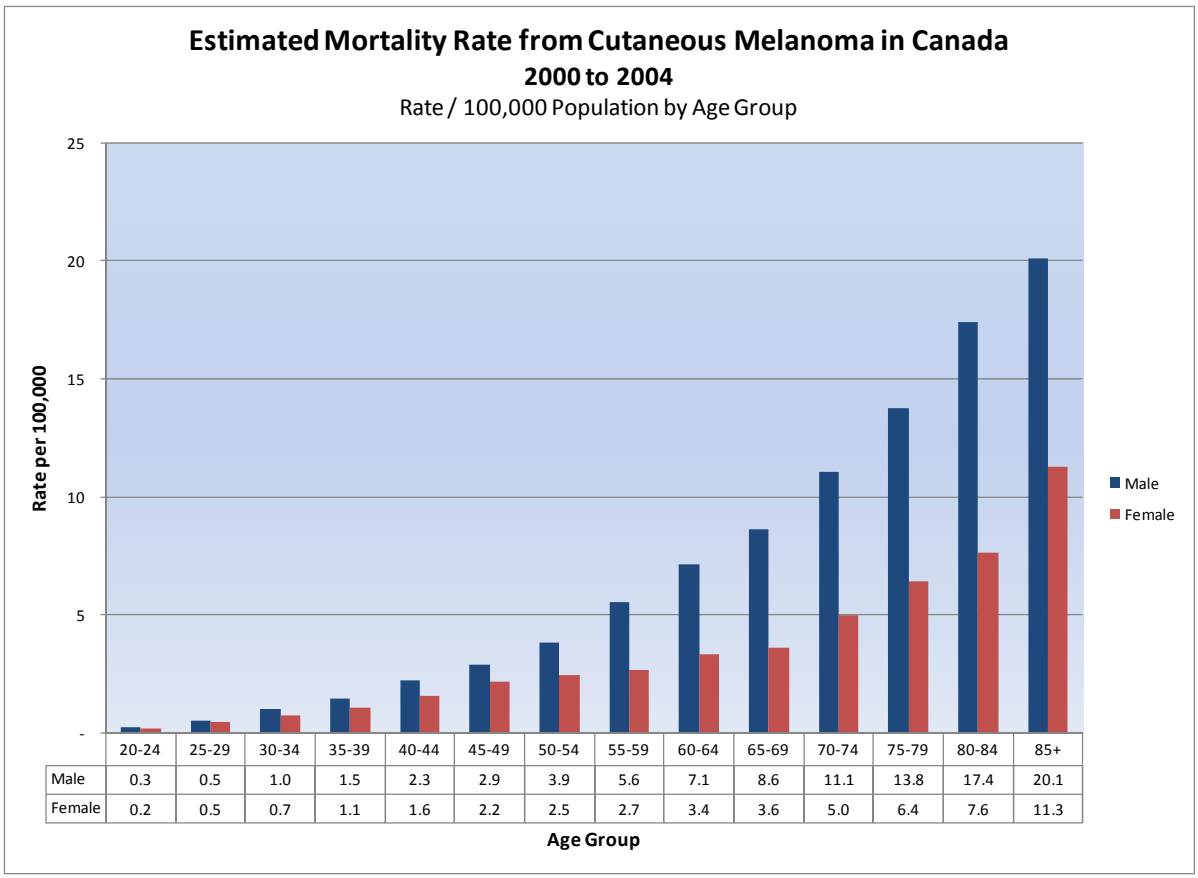
[283] Cancer Care Ontario - SEER**Stat Release 7* - OCRIS (February 2009) released March 2009; Population Data Source: *Demographic Estimates Compendium 2007*. Statistics Canada, April 2008 (1971–2005).

| Mortality Rate Due to Cutaneous Melanoma<br>Ontario, By Age Group and Gender<br>1971 to 2005 (per 100,000) | | | |
|---|---|---|---|
| **Age Group** | **Male** | **Female** | **Total** |
| 0-4 | 0.00 | 0.00 | 0.00 |
| 5-9 | 0.00 | 0.01 | 0.00 |
| 10-14 | 0.00 | 0.02 | 0.01 |
| 15-19 | 0.07 | 0.05 | 0.06 |
| 20-24 | 0.27 | 0.22 | 0.25 |
| 25-29 | 0.56 | 0.49 | 0.53 |
| 30-34 | 1.05 | 0.78 | 0.92 |
| 35-39 | 1.54 | 1.13 | 1.34 |
| 40-44 | 2.34 | 1.68 | 2.01 |
| 45-49 | 2.99 | 2.32 | 2.66 |
| 50-54 | 4.00 | 2.65 | 3.32 |
| 55-59 | 5.76 | 2.89 | 4.30 |
| 60-64 | 7.37 | 3.58 | 5.41 |
| 65-69 | 8.93 | 3.88 | 6.24 |
| 70-74 | 11.47 | 5.32 | 8.06 |
| 75-79 | 14.26 | 6.87 | 9.92 |
| 80-84 | 18.00 | 8.15 | 11.78 |
| 85+ | 20.78 | 12.05 | 14.65 |

The average age- and gender-specific mortality rates in Ontario between 1971 and 2005 were applied to apportion the actual number of deaths in the Canadian provinces into 5 year age groups. For example, the estimated 45 deaths in males in 2004 in Alberta were allocated into five-year age groups based on the relevant age-specific mortality rate calculated from Ontario data.

The exceptions to this approach were the smaller provinces/territories (PEI, YK, NWT, and NV). For each of these provinces/territories, the calculated average Ontario age- and gender-specific mortality rates were applied to the respective populations in order to estimate the number of deaths in these regions.

Based on 2000 to 2004 actual deaths, the estimated average age- and gender-specific mortality rates due to melanoma in Canada were calculated (see the following chart).




| | 20-24 | 25-29 | 30-34 | 35-39 | 40-44 | 45-49 | 50-54 | 55-59 | 60-64 | 65-69 | 70-74 | 75-79 | 80-84 | 85+ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Male | 0.3 | 0.5 | 1.0 | 1.5 | 2.3 | 2.9 | 3.9 | 5.6 | 7.1 | 8.6 | 11.1 | 13.8 | 17.4 | 20.1 |
| Female | 0.2 | 0.5 | 0.7 | 1.1 | 1.6 | 2.2 | 2.5 | 2.7 | 3.4 | 3.6 | 5.0 | 6.4 | 7.6 | 11.3 |

Further, the annual number of deaths due to melanoma was estimated for each year from 2000 to 2004 by province/territory and gender. The **five-year totals** were then divided by 5 to derive the **estimated annual number of deaths** in Canada due to melanoma (454 males, 291 females, for a total of 745, as reflected in the table below). The 745 deaths were used as the base for projecting future deaths due to melanoma.

**Estimated Deaths Due to Cutaneous Melanoma In Canada By Province/Territory and Gender**
2000 to 2004

| | Five Year Total | | |
|---|---|---|---|
| | Male | Female | Total |
| BC | 315 | 220 | 535 |
| AB | 180 | 110 | 290 |
| SK | 70 | 50 | 120 |
| MB | 90 | 55 | 145 |
| ON | 1,050 | 630 | 1,680 |
| QC | 405 | 260 | 665 |
| NB | 45 | 40 | 85 |
| NF&L | 30 | 25 | 55 |
| PEI | 10 | 7 | 17 |
| NS | 70 | 55 | 125 |
| YK | 2 | 1 | 3 |
| NWT | 2 | 1 | 3 |
| NV | 1 | 0 | 1 |
| **Canada** | **2,270** | **1,454** | **3,724** |

**Estimated Annual Deaths Due to Cutaneous Melanoma In Canada By Province/Territory and Gender**
2000 to 2004

| | Annual Estimate | | |
|---|---|---|---|
| | Male | Female | Total |
| BC | 63 | 44 | 107 |
| AB | 36 | 22 | 58 |
| SK | 14 | 10 | 24 |
| MB | 18 | 11 | 29 |
| ON | 210 | 126 | 336 |
| QC | 81 | 52 | 133 |
| NB | 9 | 8 | 17 |
| NF&L | 6 | 5 | 11 |
| PEI | 2 | 1 | 3 |
| NS | 14 | 11 | 25 |
| YK | 0 | 0 | 1 |
| NWT | 0 | 0 | 1 |
| NV | 0 | 0 | 0 |
| **Canada** | **454** | **291** | **745** |

## 3. Projections to 2031

### a. Number of Cases

In projecting the number of cases due to melanoma, the following approach was used:

i. Age-standardized incidence rates of melanomas in the Canadian population were downloaded from Cancer Surveillance Online for the years from 1992 to 2005 for both males and females (see the section in the Introduction on *Skin Cancer Rates and Trends: Melanoma – Trends*, pages 14-15).

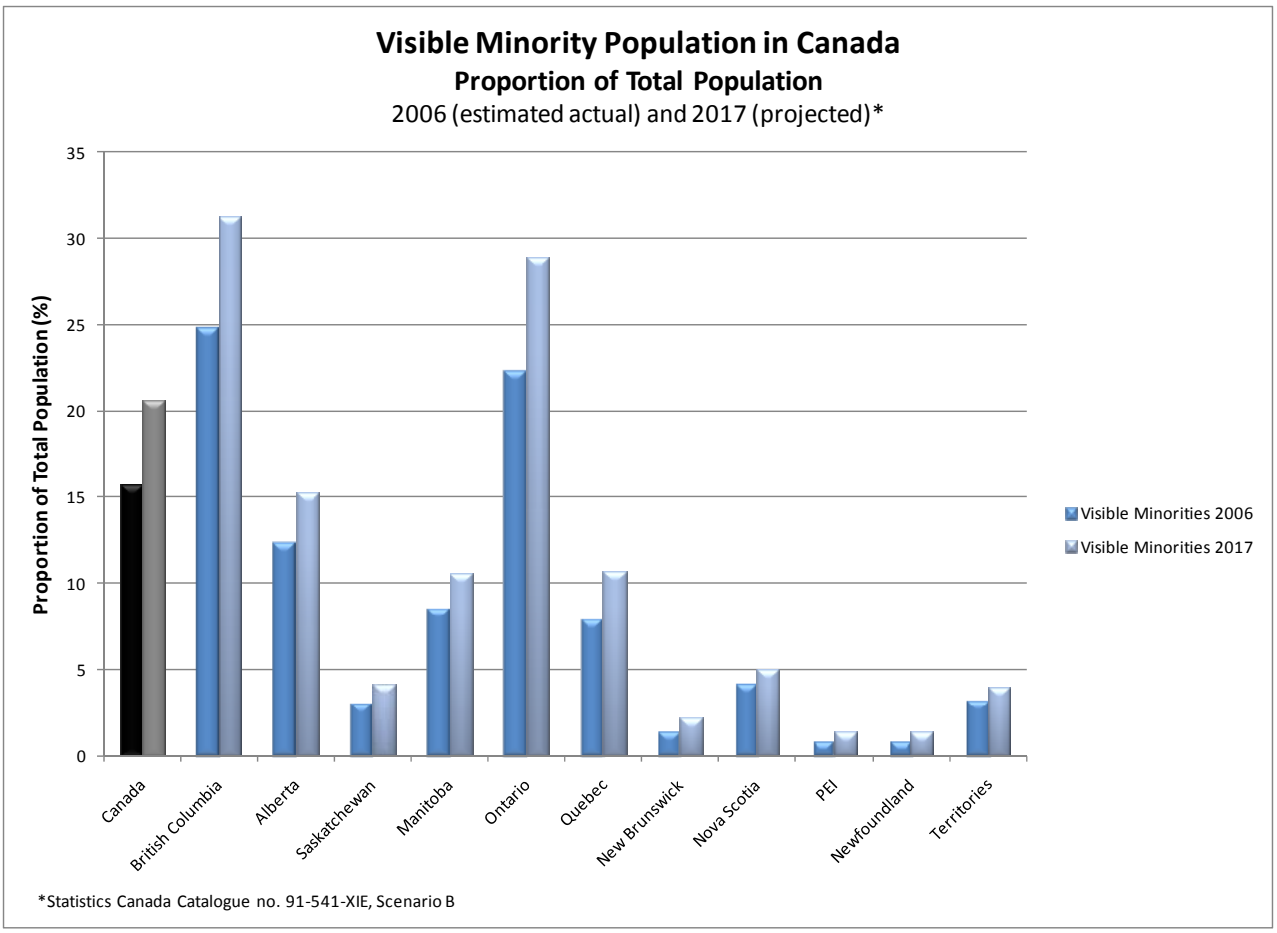
ii. This information was analyzed using the Joinpoint Regression Program (v2.7) to assess trends and annual percent change (APC) by gender and age (see the section in the Introduction on *Skin Cancer Rates and Trends: Melanoma – Trends*, pages 15-16).

iii. The preceding analysis of trends for melanoma was used to develop the following three scenarios for incidence changes in the future:

**Medium Annual Percent Change Scenario** – In this scenario, it was assumed that there was zero annual percent change (APC) in males or females under the age of 50. This 0% APC for younger age cohorts reflects the most recent Canadian trends in these cohorts, possibly reflecting changes in sun-safety behaviours in Canadian young people over the last several decades. The other age groups had an APC for males/females as indicated: 50-64 years: 1.31%/1.67%; 65-74 years: 2.79%/1.84%; 75+ years: 3.69%/3.27%.

**Low Annual Percent Change Scenario** – In this scenario, it was assumed that there was zero annual percent change (APC) in males or females under the age of 50 (as in the Medium APC Scenario). For age groups 50+ years, the APC was reduced by one-half for males/females as indicated: 50-64 years: 0.66%/0.84%; 65-74 years: 1.40%/0.92%; 75+ years: 1.85%/1.64%. This scenario was intended to reflect the possibility that some of the observed increases in rates may be partly related to improvements in case ascertainment over time, rather than being solely driven by true increases in incidence. In addition, as noted in the Introduction, a fair complexion is positively associated with the risk of skin cancers. As shown in the following chart, the proportion of the Canadian population that is from a visible minority (with a lower average risk of skin cancers) is expected to increase from 15.7% to 20.6% of the population between 2006 and 2017.[284] This expected change in population mix would also result in a lower APC.

[284] The chart is based on data taken from the following document: Statistics Canada-Demography Division, *Population projections of visible minorities, Canada, provinces and regions, 2001 – 2017*, Catalogue no. 91-541-XIE, 2005.



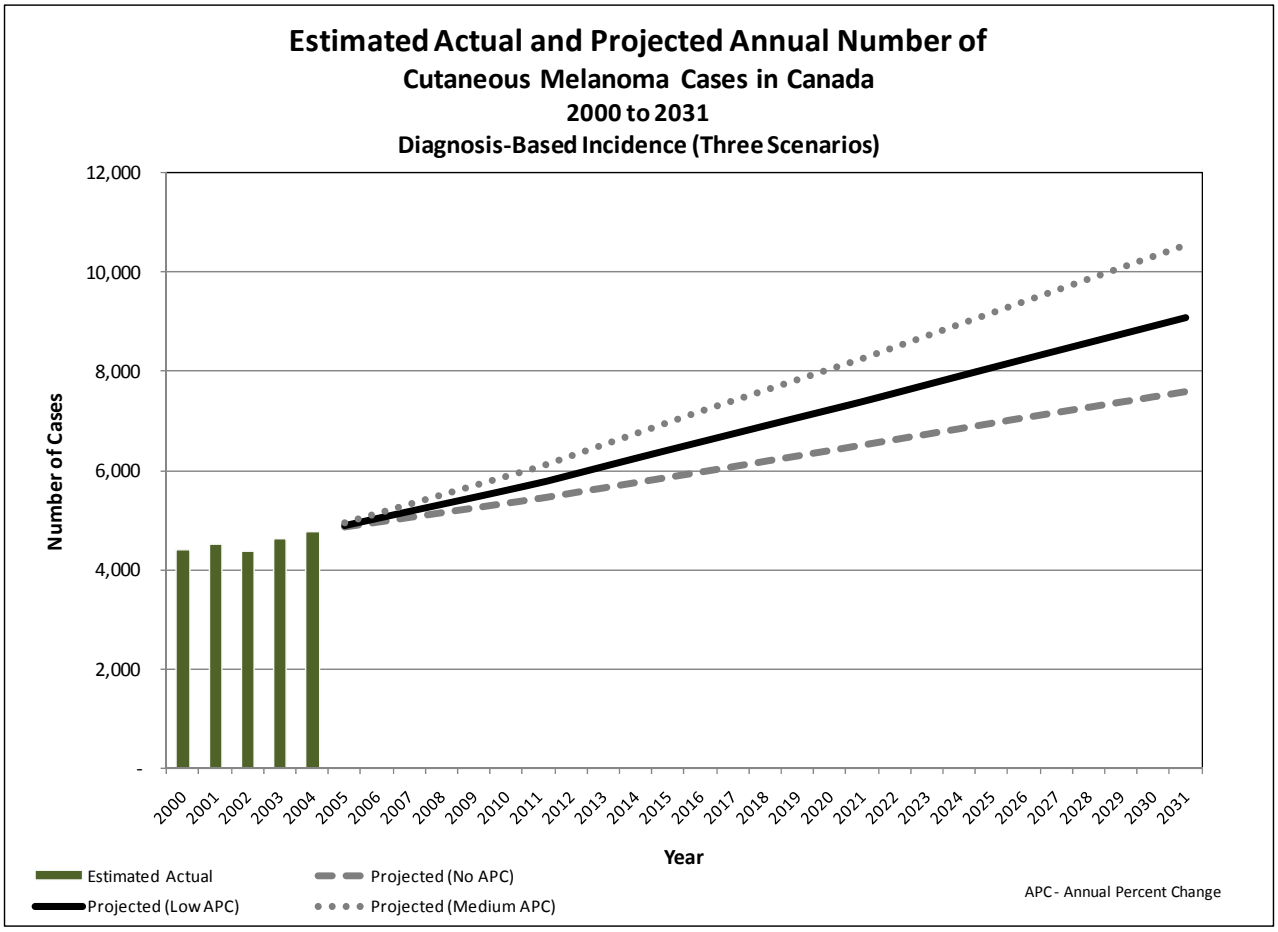

**No Annual Percent Change Scenario** – Estimates of future increases in annual cases based solely on population growth and ageing (i.e., zero APC assumed for all age groups). The No APC Scenario was chosen as a base estimate to assess the future impact of population growth and ageing only. It is not a realistic estimate of future melanoma cases as current observed increases in APC in older population cohorts are unlikely to approach 0% for at least several decades.

iv. Base incidence rates were calculated by province/territory, age, and gender using the five years (2000-2004) of data. The three scenarios were then used to modify the incidence rates calculated for the years 2011, 2016, 2021, 2026 and 2031 using an age-cohort based approach. That is, as younger cohorts aged, they maintained the lower APC appropriate for their age cohort in 2004, rather than shifting to the higher APC typical for older population groups. The age- and gender-specific incidence rates, adjusted as appropriate under the assumptions of each scenario, were applied to the projected age- and gender-specific populations for each of the provinces/territories. Population projections were based on Statistics Canada projections for medium (Scenario 3) population growth.[285]

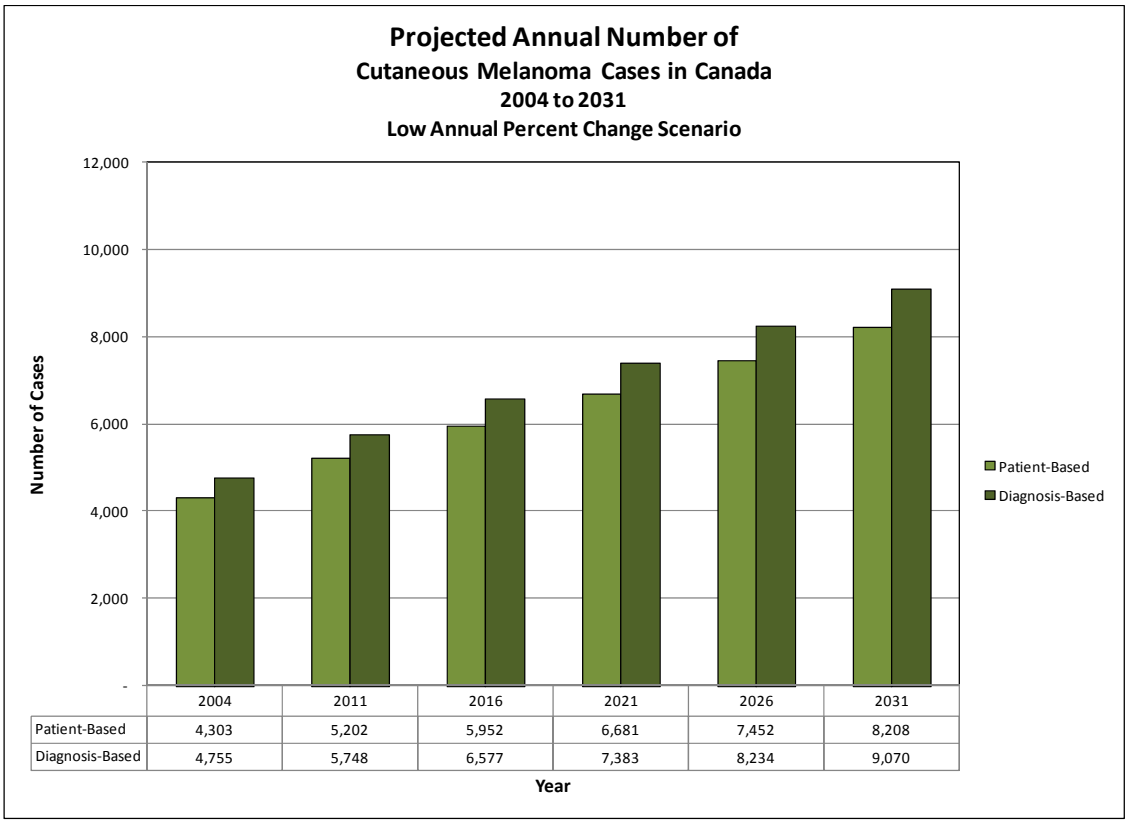
[285] Statistics Canada, *Population Projections for Canada, Provinces and Territories 2005-2031*. 2005. Catalogue no. 91-520-XIE. Pages 149-162 (for Scenario 3 – medium growth projections).

v. Projections were modelled for both the patient-based and diagnosis-based incidence approaches.

Using the diagnosis-based incidence approach, the **No Annual Percent Change Scenario** (No APC) would increase the number of melanoma cases from an estimated 4,755 in 2004 to 7,600 in 2031 (+60%). The estimated cases in 2031 based on the **Low Annual Percent Change Scenario** (Low APC) would be 9,070 (+91%) and, for the **Medium Annual Percent Change Scenario** (Medium APC), 10,540 (+122%), as indicated in the following chart.



The following chart provides a summary of the results for both the patient-based and diagnosis-based approaches using the **Low Annual Percent Change Scenario.**




| | 2004 | 2011 | 2016 | 2021 | 2026 | 2031 |
|---|---|---|---|---|---|---|
| Patient-Based | 4,303 | 5,202 | 5,952 | 6,681 | 7,452 | 8,208 |
| Diagnosis-Based | 4,755 | 5,748 | 6,577 | 7,383 | 8,234 | 9,070 |

The following two tables provide the detailed results by gender and province for the patient-based and the diagnosis-based approaches using the **Low Annual Percent Change Scenario.**

**Projected Annual Number of**
**Cutaneous Melanoma Cases in Canada**
**By Province, Gender and Year (2004 to 2031)**
**Patient-Based Incidence Approach (Low Annual Percent Change Scenario)**

| | 2004 | | | 2011 | | | 2016 | | | 2021 | | | 2026 | | | 2031 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 359 | 304 | 663 | 447 | 361 | 808 | 522 | 407 | 929 | 599 | 451 | 1,050 | 679 | 497 | 1,175 | 757 | 545 | 1,301 |
| AB | 229 | 222 | 452 | 267 | 238 | 505 | 316 | 268 | 585 | 366 | 299 | 665 | 420 | 334 | 753 | 474 | 370 | 843 |
| SK | 52 | 60 | 112 | 66 | 65 | 132 | 73 | 69 | 142 | 80 | 72 | 152 | 88 | 77 | 165 | 95 | 82 | 177 |
| MB | 73 | 54 | 127 | 81 | 65 | 146 | 92 | 71 | 163 | 103 | 77 | 180 | 114 | 84 | 198 | 124 | 91 | 215 |
| ON | 978 | 885 | 1,863 | 1,236 | 999 | 2,235 | 1,453 | 1,131 | 2,585 | 1,671 | 1,261 | 2,932 | 1,907 | 1,397 | 3,304 | 2,137 | 1,540 | 3,677 |
| QC | 383 | 311 | 694 | 494 | 412 | 907 | 567 | 453 | 1,020 | 631 | 489 | 1,120 | 696 | 523 | 1,219 | 758 | 552 | 1,310 |
| NB | 56 | 51 | 107 | 71 | 65 | 136 | 82 | 72 | 153 | 91 | 77 | 168 | 101 | 82 | 184 | 109 | 87 | 197 |
| NF&L | 27 | 29 | 56 | 36 | 32 | 68 | 40 | 35 | 76 | 44 | 38 | 82 | 48 | 41 | 89 | 52 | 43 | 95 |
| PEI | 10 | 16 | 26 | 15 | 18 | 32 | 17 | 19 | 36 | 19 | 21 | 40 | 21 | 23 | 44 | 23 | 25 | 47 |
| NS | 94 | 99 | 193 | 117 | 106 | 223 | 134 | 117 | 251 | 150 | 128 | 277 | 167 | 138 | 305 | 180 | 147 | 327 |
| YK | 2 | 2 | 4 | 2 | 2 | 4 | 3 | 2 | 5 | 3 | 2 | 5 | 3 | 2 | 6 | 4 | 3 | 6 |
| NWT | 2 | 2 | 4 | 3 | 2 | 5 | 3 | 3 | 6 | 3 | 3 | 6 | 4 | 3 | 7 | 4 | 4 | 8 |
| NV | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 1 | 3 |
| **Canada** | **2,268** | **2,035** | **4,303** | **2,835** | **2,367** | **5,202** | **3,303** | **2,649** | **5,952** | **3,762** | **2,919** | **6,681** | **4,249** | **3,203** | **7,452** | **4,717** | **3,491** | **8,208** |

*Note: Calculated numbers are not rounded and thus may appear not to add appropriately.*

**Projected Annual Number of**
**Cutaneous Melanoma Cases in Canada**
**By Province, Gender and Year (2004 to 2031)**
**Diagnosis-Based Incidence Approach (Low Annual Percent Change Scenario)**

| | 2004 | | | 2011 | | | 2016 | | | 2021 | | | 2026 | | | 2031 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 397 | 336 | 733 | 494 | 399 | 892 | 577 | 450 | 1,027 | 662 | 498 | 1,160 | 750 | 549 | 1,299 | 836 | 602 | 1,438 |
| AB | 254 | 245 | 499 | 295 | 263 | 558 | 350 | 297 | 646 | 404 | 330 | 735 | 464 | 369 | 833 | 524 | 409 | 932 |
| SK | 58 | 66 | 124 | 73 | 72 | 146 | 81 | 76 | 157 | 88 | 80 | 168 | 97 | 85 | 182 | 105 | 91 | 196 |
| MB | 81 | 60 | 141 | 89 | 72 | 161 | 101 | 79 | 180 | 114 | 85 | 199 | 126 | 92 | 218 | 137 | 101 | 238 |
| ON | 1,081 | 978 | 2,058 | 1,366 | 1,104 | 2,470 | 1,606 | 1,250 | 2,856 | 1,847 | 1,393 | 3,240 | 2,107 | 1,544 | 3,651 | 2,362 | 1,702 | 4,063 |
| QC | 423 | 344 | 767 | 546 | 455 | 1,002 | 626 | 501 | 1,127 | 697 | 540 | 1,237 | 769 | 578 | 1,347 | 837 | 610 | 1,448 |
| NB | 62 | 56 | 118 | 78 | 72 | 150 | 90 | 79 | 169 | 101 | 85 | 186 | 112 | 91 | 203 | 121 | 97 | 217 |
| NF&L | 30 | 32 | 62 | 39 | 36 | 75 | 44 | 39 | 83 | 49 | 42 | 91 | 54 | 45 | 99 | 57 | 48 | 105 |
| PEI | 11 | 17 | 28 | 16 | 19 | 35 | 18 | 21 | 40 | 21 | 23 | 44 | 23 | 25 | 48 | 25 | 27 | 52 |
| NS | 104 | 109 | 213 | 129 | 118 | 246 | 148 | 130 | 278 | 166 | 141 | 307 | 184 | 153 | 337 | 199 | 163 | 362 |
| YK | 2 | 2 | 4 | 3 | 2 | 5 | 3 | 2 | 5 | 3 | 3 | 6 | 4 | 3 | 6 | 4 | 3 | 7 |
| NWT | 2 | 2 | 4 | 3 | 2 | 5 | 3 | 3 | 6 | 4 | 3 | 7 | 4 | 4 | 8 | 5 | 4 | 9 |
| NV | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 1 | 3 |
| **Canada** | **2,506** | **2,249** | **4,755** | **3,132** | **2,616** | **5,748** | **3,650** | **2,927** | **6,577** | **4,157** | **3,226** | **7,383** | **4,695** | **3,539** | **8,234** | **5,213** | **3,857** | **9,070** |

*Note: Calculated numbers are not rounded and thus may appear not to add appropriately.*

There are a number of important caveats associated with the preceding analysis:

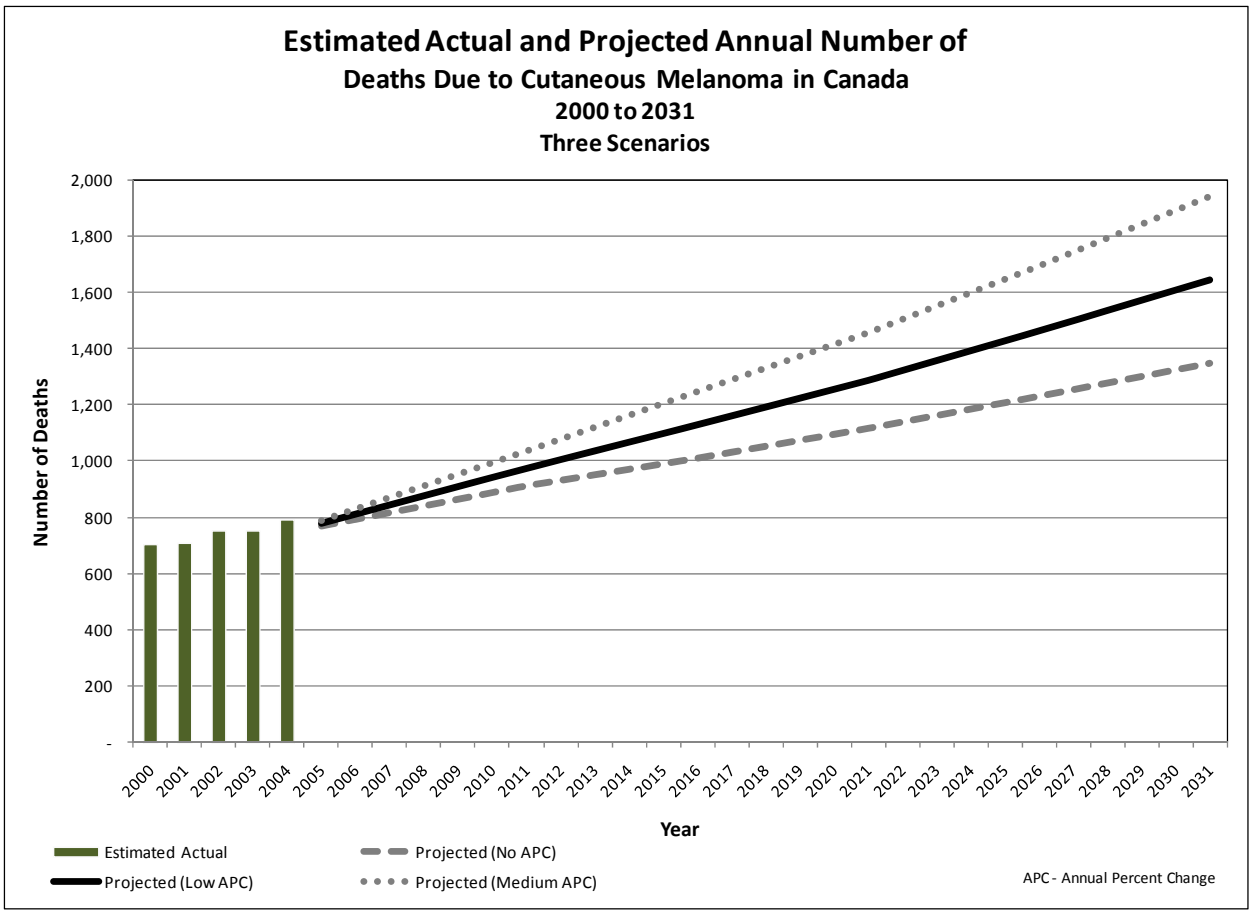
- While there has been an attempt to address issues of case ascertainment in Quebec, melanomas in other Canadian provinces also tend to be incompletely reported, leading to case under-ascertainment.[286,287]
- Cancers *in situ* are not included in the estimates.

### b. Number of Deaths

The approach to projecting the number of deaths is substantially equivalent to the one used in projecting the number of cases; the analysis incorporates the same three APC scenarios. Base mortality rates were calculated by province/territory, age, and gender using the five years (2000-2004) of mortality data. The three scenarios were then used to modify the mortality rates calculated for the years 2011, 2016, 2021, 2026 and 2031, in each case applying an age-cohort approach. That is, as younger cohorts aged, they maintained the lower APC appropriate for their age cohort in 2004. The age- and gender-specific mortality rates, adjusted as appropriate under the assumptions of each scenario, were applied to the projected age- and gender-specific populations for each of the provinces/territories. Population projections were based on Statistics Canada projections for medium (Scenario 3) population growth.[288]

Using the **No Annual Percent Change Scenario** (No APC) would increase the number of deaths due to melanoma from an estimated 790 in 2004 to 1,346 in 2031 (+70%). The estimated deaths in 2031 based on the **Low Annual Percent Change Scenario** (Low APC) would be 1,644 (+108%) and, for the **Medium Annual Percent Change Scenario** (Medium APC), 1,942 (+146%), as indicated in the following chart.

[286] Semenciw RM, Nhu DL, Marrett LD, et al. Methodological issues in the development of the Canadian Cancer Incidence Atlas. *Statistics in Medicine*. 2000; 19: 2437-49.
[287] Cockburn M, Swetter SM, Peng D et al. Melanoma underreporting: why does it happen, how big is the problem, and how do we fix it? *Journal of the American Academy of Dermatology*. 2008; 59(6): 1081-5.
[288] Statistics Canada, *Population Projections for Canada, Provinces and Territories 2005-2031*. 2005. Catalogue no. 91-520-XIE. Pages 149-162 (for Scenario 3 – medium growth projections).




As an illustration of the underlying detail, the following table summarizes the results based on the **Low Annual Percent Change Scenario.**

## Projected Annual Number of
### Deaths due to Cutaneous Melanoma in Canada
### By Province, Gender and Year (2004 to 2031)
### Low Annual Percent Change Scenario

| | Average 2000-2004 | | | 2011 | | | 2016 | | | 2021 | | | 2026 | | | 2031 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 63 | 44 | 107 | 85 | 57 | 142 | 100 | 66 | 166 | 116 | 75 | 191 | 134 | 85 | 219 | 152 | 96 | 248 |
| AB | 36 | 22 | 58 | 50 | 29 | 79 | 60 | 34 | 94 | 70 | 39 | 109 | 81 | 45 | 126 | 93 | 52 | 144 |
| SK | 14 | 10 | 24 | 16 | 11 | 28 | 18 | 12 | 30 | 20 | 13 | 33 | 22 | 14 | 37 | 24 | 16 | 40 |
| MB | 18 | 11 | 29 | 22 | 13 | 35 | 25 | 14 | 40 | 29 | 16 | 44 | 32 | 17 | 50 | 36 | 19 | 55 |
| ON | 210 | 126 | 336 | 282 | 163 | 445 | 332 | 187 | 519 | 384 | 211 | 595 | 442 | 239 | 681 | 500 | 271 | 771 |
| QC | 81 | 52 | 133 | 106 | 65 | 171 | 123 | 73 | 196 | 140 | 80 | 220 | 157 | 89 | 246 | 174 | 98 | 271 |
| NB | 9 | 8 | 17 | 11 | 10 | 21 | 13 | 11 | 24 | 15 | 12 | 27 | 17 | 13 | 30 | 19 | 15 | 33 |
| NF&L | 6 | 5 | 11 | 8 | 6 | 14 | 9 | 7 | 16 | 10 | 8 | 18 | 11 | 9 | 20 | 12 | 10 | 22 |
| PEI | 2 | 1 | 3 | 3 | 2 | 4 | 3 | 2 | 5 | 3 | 2 | 5 | 4 | 2 | 6 | 4 | 3 | 7 |
| NS | 14 | 11 | 25 | 18 | 13 | 31 | 21 | 15 | 35 | 23 | 16 | 40 | 26 | 18 | 44 | 29 | 20 | 49 |
| YK | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| NWT | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| NV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Canada** | **454** | **291** | **745** | **602** | **370** | **973** | **706** | **421** | **1,128** | **812** | **474** | **1,286** | **929** | **533** | **1,462** | **1,044** | **599** | **1,644** |

*Note: Calculated numbers are not rounded and thus may appear not to add appropriately.*

In the following table, information on both estimated actual and projected cases and deaths is combined to calculate the overall incidence-to-mortality ratio. Between 2000 and 2004, this ratio fell within the range 0.175 to 0.190. The projections used in this analysis would see the ratio increase over time. This is largely due to higher mortality rates (relative to incidence) in older populations compared with younger populations at the start of the modelling period. This is equivalent to saying that an increasing proportion of deaths would occur in the elderly. Thus, between 2000 and 2004, an estimated 54% of deaths occurred in individuals aged 65 and over. By 2031, this proportion would increase to an estimated 67%.

## Estimated Actual and Projected Ratio of Deaths to Cases
### Cutaneous Melanoma Cases in Canada
### 2000 to 2031

| | 2000 | 2001 | 2002 | 2003 | 2004 | 2011 | 2016 | 2021 | 2026 | 2031 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Cases** - Patient-Based Incidence Approach | | | | | | | | | | |
| Estimated Actual | 3,966 | 4,068 | 3,949 | 4,188 | 4,303 | | | | | |
| Projected (No APC) | | | | | | 4,914 | 5,398 | 5,895 | 6,396 | 6,878 |
| Projected (Low APC) | | | | | | 5,202 | 5,952 | 6,681 | 7,452 | 8,208 |
| Projected (Medium APC) | | | | | | 5,490 | 6,506 | 7,467 | 8,507 | 9,538 |
| **Deaths** - Patient-Based Incidence Approach | | | | | | | | | | |
| Estimated Actual | 705 | 710 | 750 | 750 | 790 | | | | | |
| Projected (No APC) | | | | | | 911 | 1,009 | 1,115 | 1,229 | 1,346 |
| Projected (Low APC) | | | | | | 973 | 1,128 | 1,286 | 1,462 | 1,644 |
| Projected (Medium APC) | | | | | | 1,034 | 1,246 | 1,456 | 1,694 | 1,942 |
| Ratio of Deaths to Cases | | | | | | | | | | |
| Estimated Actual | 0.178 | 0.175 | 0.190 | 0.179 | 0.184 | | | | | |
| Projected (No APC) | | | | | | 0.185 | 0.187 | 0.189 | 0.192 | 0.196 |
| Projected (Low APC) | | | | | | 0.187 | 0.190 | 0.192 | 0.196 | 0.200 |
| Projected (Medium APC) | | | | | | 0.188 | 0.192 | 0.195 | 0.199 | 0.204 |

## Appendix E: Non-Melanoma Skin Cancer in Canada

Information on the number of basal and squamous cell carcinomas is not routinely collected in all Canadian provinces. Manitoba and New Brunswick have routinely collected this information for some time. Annual age- and gender-specific data on the number of BCC and SCC cases for 2000 to 2004 was requested from these provinces.[289,290] The same information was obtained from Saskatchewan[291] and Alberta[292] for 2000-2004, as well as data for 2003 from British Columbia.[293] New Brunswick also provided information on mortality. Data from Manitoba included information on incidence (by tumour grade), prevalence, and mortality.

The data from Manitoba are based on the first reported diagnosis of BCC and SCC (ICD-9 173; ICD-10 C44) as recorded from January 1, 2000, to December 31, 2004. Therefore, a patient presenting with more than one lesion of the same cancer type is only counted once. BCC includes International Classification of Diseases for Oncology (ICD-O)-2 codes 8090.3-8093.3, 8097.3, 8098.3, and SCC includes ICD-O-2 codes 8052.3, 8070.3-8076.3, 8078.3 and 8084.3. *In situ* skin cancers, including Bowen's disease and erythroplasia of Queyrat, and skin cancer of the nasal cavity, oral cavity, lip, and genital organs are not included.[294,295]

Data from New Brunswick are also based on the first reported diagnosis of BCC and SCC as recorded from January 1, 2000, to December 31, 2004. Data are based on ICD-O-2 and -3 invasive or behaviour code 3 cases. BCC includes ICD-O-2/3 codes 8090 – 8110, and SCC includes ICD-O-2/3 codes 8051 - 8084. Only cases with a topography code of C44.0 to C44.9 were included (thus excluding skin cancers of the vulva, penis and scrotum). *In situ* skin cancers were not included.[296] As with Manitoba, in New Brunswick "only patients with newly incident tumours are registered in the database, and only one tumour of a particular type per lifetime is counted per patient. Recurrent and subsequent primary tumours of the same histologic type from individuals with a history of BCC or invasive SCC are excluded from the registry".[297]

Alberta and Saskatchewan used the Manitoba approach in generating their data.

---

[289] Personal communication, Cheryl Clague, Project Manager, Population Health & Research Epidemiology and Cancer Registry, CancerCare Manitoba, November 27, 2008.

[290] Personal communication, Suzanne Leonfellner, Coordinator- Cancer Diagnosis, Staging & Surgery, Manager New Brunswick Cancer Registry, March 8, 2009.

[291] Ms. Heather Stuart, Provincial Leader, Cancer Registry, Saskatchewan Cancer Agency, personal communication, March 15, 2009. Ms. Karen Robb, Cancer Registry Co-ordinator, Population Health Division, Saskatchewan Cancer Agency, personal communication, May 6, 2009.

[292] Ms. Angela Eckstrand, Assistant Program Analyst, Alberta Health Services - Cancer Epidemiology, Prevention and Screening, Alberta Cancer Board, personal communication, April 15, 2009.

[293] Mr. Rick Gallagher, Department Head, Cancer Control Research, BC Cancer Agency, personal communication, December 17, 2008.

[294] Demers AA, Nugent Z, Mihalcioiu C et al. Trends of nonmelanoma skin cancer from 1960 through 2000 in a Canadian population. *Journal of the American Academy of Dermatology.* 2005; 53(2): 320-8.

[295] Personal communication, Cheryl Clague, Project Manager, Population Health & Research Epidemiology and Cancer Registry, CancerCare Manitoba, November 27, 2008.

[296] Personal communication, Suzanne Leonfellner, Coordinator- Cancer Diagnosis, Staging & Surgery, Manager New Brunswick Cancer Registry, March 8, 2009.

[297] Hayes RC, Leonfellner S, Pilgrim W et al. Incidence of nonmelanoma skin cancer in New Brunswick, Canada, 1992 to 2001. *Journal of Cutaneous Medicine and Surgery.* 2007; 11(2): 45-52.

### 1. Estimated Number of Cases in Canada in 2004

In estimating the number of non-melanoma skin cancer cases in Canada in 2004, a three-phased approach was applied.

First, the age- and gender-specific incidence rates for BCC and SCC were calculated based on the five years of data (2000-2004) received from Manitoba, New Brunswick, Alberta, and Saskatchewan, plus data (for 2003 only) received from B.C. This information is summarized in the chart in the *Non-Melanoma Skin Cancer: Incidence* section of the *Introduction* (pg. 19).

Second, the combined average age- and gender-specific rates were applied to the populations living in the other provinces/territories in 2004. For Manitoba, New Brunswick, Alberta, and Saskatchewan, each province's calculated five-year age- and gender-specific incidence rates were used. For B.C., the 2003 age- and gender-specific incidence rates were used. The following table provides a summary of the results.

**Estimated Non-melanoma Skin Cancer Cases in Canada**
**By Province/Territory and Gender In 2004**
**Patient-Based Incidence Approach**

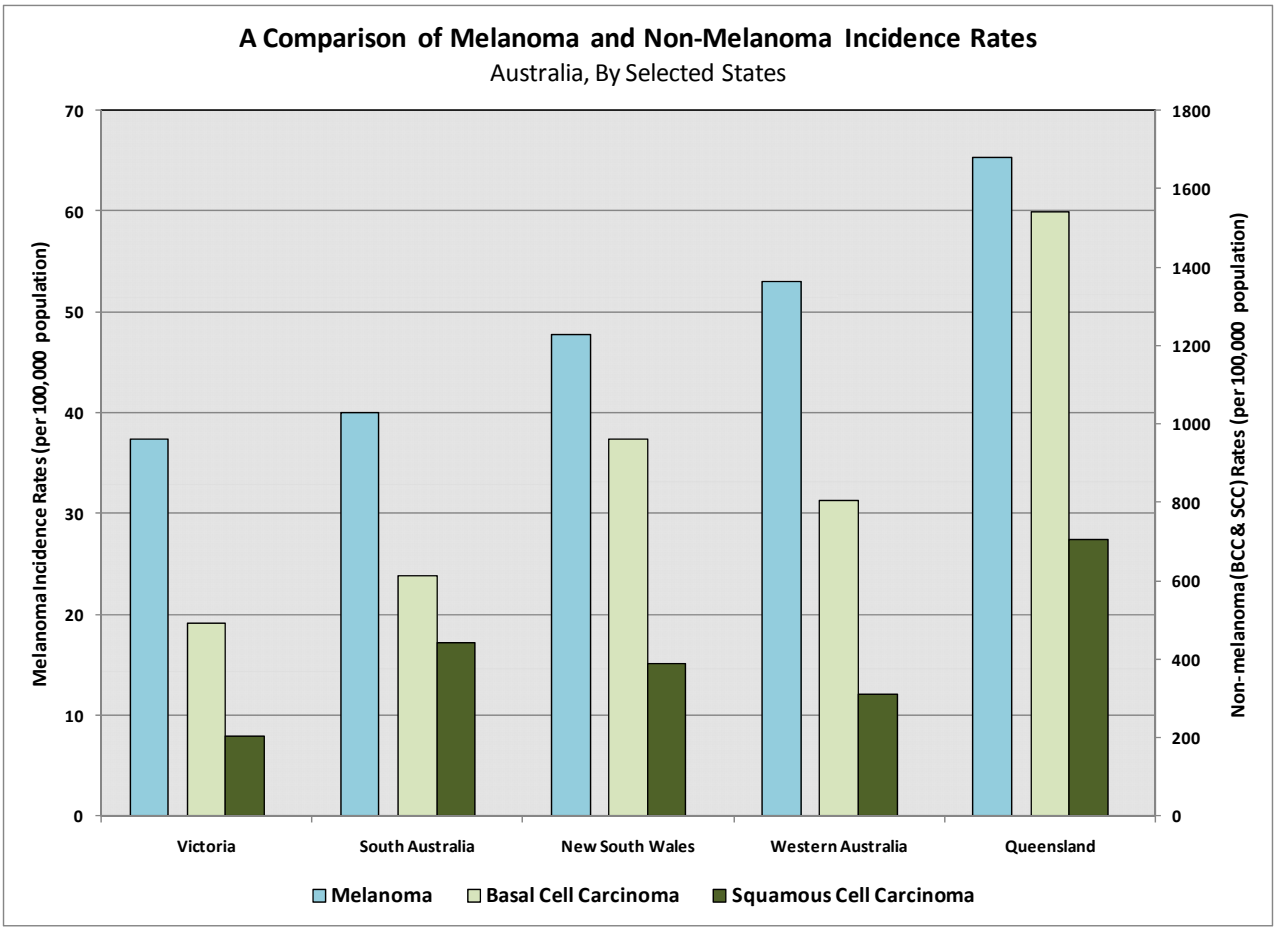
| | BCC | | | SCC | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 4,569 | 3,672 | 8,241 | 1,252 | 845 | 2,097 | 5,820 | 4,518 | 10,338 |
| AB | 2,154 | 1,903 | 4,057 | 759 | 494 | 1,253 | 2,913 | 2,397 | 5,310 |
| SK | 890 | 733 | 1,624 | 351 | 218 | 569 | 1,242 | 951 | 2,193 |
| MB | 817 | 771 | 1,587 | 206 | 145 | 351 | 1,023 | 915 | 1,938 |
| ON | 9,558 | 8,451 | 18,010 | 3,169 | 2,086 | 5,256 | 12,728 | 10,538 | 23,265 |
| QC | 6,083 | 5,586 | 11,669 | 1,976 | 1,390 | 3,366 | 8,059 | 6,976 | 15,035 |
| NB | 526 | 463 | 989 | 212 | 139 | 350 | 738 | 602 | 1,339 |
| NF&L | 427 | 367 | 794 | 138 | 88 | 226 | 566 | 455 | 1,021 |
| PEI | 114 | 102 | 216 | 38 | 26 | 65 | 152 | 128 | 280 |
| NS | 790 | 707 | 1,497 | 266 | 182 | 447 | 1,055 | 889 | 1,944 |
| YK | 20 | 15 | 35 | 5 | 3 | 8 | 25 | 17 | 43 |
| NWT | 20 | 15 | 35 | 5 | 3 | 8 | 25 | 17 | 43 |
| NV | 9 | 7 | 16 | 2 | 1 | 3 | 12 | 8 | 19 |
| **Canada** | **25,977** | **22,791** | **48,769** | **8,380** | **5,619** | **13,999** | **34,357** | **28,411** | **62,768** |

*Notes:*
*Based on actual age and gender specific rates (2000-2004) for the province.*
*Based on actual age and gender specific rates (2003) for the province.*
*Numbers are not rounded and thus may appear to not add appropriately.*

In the second phase, adjustments were applied based on information from the analysis of actual data for *melanomas*. The aim was to acknowledge differences in the age- and gender-specific rates in the various provinces/territories when compared with the combined information for the five reference provinces (i.e., Manitoba, New Brunswick, etc.), and then extrapolate this information to NMSC; the assumption is that common risk factors (especially sun exposure) for melanoma and NMSC would drive a similar province-specific epidemiologic pattern for the two categories of skin cancer.[298]

[298] This approach was suggested by Dr. Lorraine Marrett in an email to Dr. Hans Krueger, February 9, 2009. She suggested that "the incidence of melanoma in each province would be the best indicator of BCC and SCC incidence. This assumption could be tested in a limited way by examining jurisdictions capturing data on both types of skin cancer."

This assumption was tested by accessing regional information on both melanoma[299] and NMSC[300] from Australian states/territories. The following table is based on age-standardized incidence rates of melanoma, BCC and SCC by region in Australia.[301] The relationship between melanoma incidence rates and BCC incidence rates are strong with a correlation coefficient of 0.94. The correlation coefficient between melanoma and SCC is 0.78.

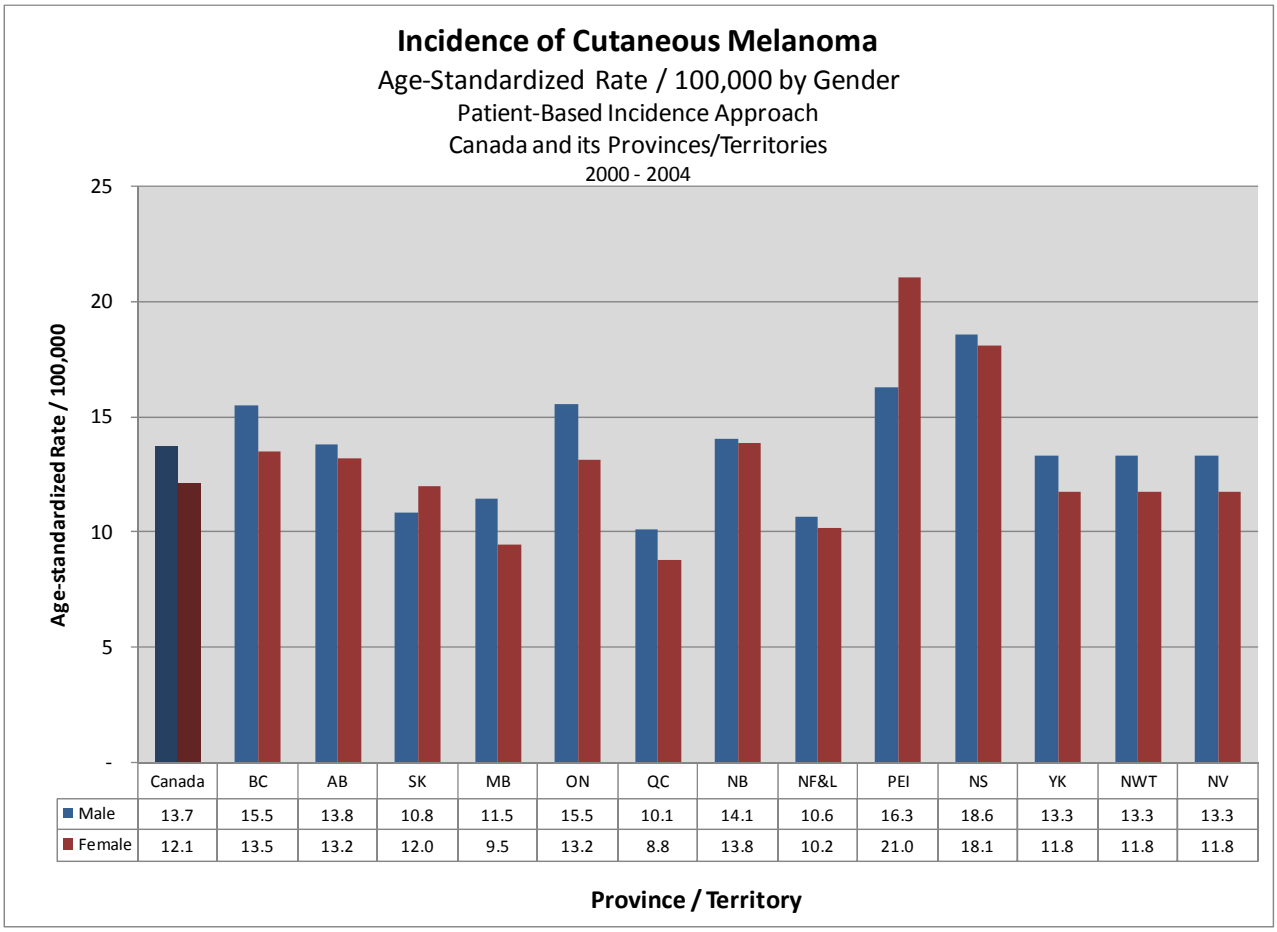



[299] Australian Institute of Health and Welfare. *Cancer in Australia: An overview, 2008.* Available online at http://www.aihw.gov.au/publications/index.cfm/title/10607 Average age-standardized rates for 2000-2004 (Accessed February, 2010)

[300] National Cancer Control Initiative 2003. *The 2002 national non-melanoma skin cancer survey.* A report by the NCCI Non-melanoma Skin Cancer Working Group. Edited by MP Stap[les. NCCI Melbouirne. Estimated age-standardized rates for 2002. Available online at http://www.canceraustralia.gov.au/media/3434/nmscreport.pdf (Accessed February, 2010).

[301] The Australian Capital Territory, the Northern Territory and Tasmania are not included in the table as the number of cases of NMSC was too small to allow for a reliable calculation of age-standardized rates. For example, the number of SCC cases for both males and females were just 4, 2, and 11, respectively, in each of these regions.

The initial step entailed standardizing the incidence rate for melanoma based on the 2001 Canadian population (see following chart).




| | Canada | BC | AB | SK | MB | ON | QC | NB | NF&L | PEI | NS | YK | NWT | NV |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Male | 13.7 | 15.5 | 13.8 | 10.8 | 11.5 | 15.5 | 10.1 | 14.1 | 10.6 | 16.3 | 18.6 | 13.3 | 13.3 | 13.3 |
| Female | 12.1 | 13.5 | 13.2 | 12.0 | 9.5 | 13.2 | 8.8 | 13.8 | 10.2 | 21.0 | 18.1 | 11.8 | 11.8 | 11.8 |

Five-year (2000-2004) data on MSC and population from Manitoba, New Brunswick, Alberta, Saskatchewan, and British Columbia were then combined to calculate a single age-standardized rate for males and for females (13.97 and 12.85/100,000 respectively) for these five provinces. Age- and gender-specific rates for BCC and SCC in all other provinces/territories were then modified based on each jurisdiction's variance from the calculated gender-specific age-standardized rate (note that it is the *adjusted* Quebec rates, as detailed in Appendix C, that are used here and at other points in the analysis).

As an example of the modification process, the Ontario age-standardized rate for MSC in males (at 15.53/100,000) is 11.1% higher than the combined rate of 13.97/100,000 for the five provinces with actual data. Therefore, the calculated age-specific rates for NMSC for males were increased by 11.1% in Ontario (from 12,728 to 14,144). The following table provides a summary of the results using this type of adjustment.

**Estimated Non-melanoma Skin Cancer Cases in Canada**
**By Province/Territory and Gender In 2004**
**Adjusted Patient-Based Incidence Approach**

| | BCC | | | SCC | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 4,569 | 3,672 | 8,241 | 1,252 | 845 | 2,097 | 5,820 | 4,518 | 10,338 |
| AB | 2,154 | 1,903 | 4,057 | 759 | 494 | 1,253 | 2,913 | 2,397 | 5,310 |
| SK | 890 | 733 | 1,624 | 351 | 218 | 569 | 1,242 | 951 | 2,193 |
| MB | 817 | 771 | 1,587 | 206 | 145 | 351 | 1,023 | 915 | 1,938 |
| ON | 10,622 | 8,656 | 19,278 | 3,522 | 2,137 | 5,659 | 14,144 | 10,793 | 24,937 |
| QC | 4,406 | 3,815 | 8,221 | 1,431 | 949 | 2,380 | 5,837 | 4,764 | 10,601 |
| NB | 526 | 463 | 989 | 212 | 139 | 350 | 738 | 602 | 1,339 |
| NF&L | 325 | 291 | 616 | 105 | 70 | 175 | 431 | 361 | 791 |
| PEI | 132 | 167 | 299 | 45 | 43 | 88 | 177 | 210 | 387 |
| NS | 1,052 | 997 | 2,049 | 354 | 256 | 610 | 1,405 | 1,253 | 2,658 |
| YK | 19 | 13 | 32 | 5 | 2 | 8 | 24 | 16 | 40 |
| NWT | 19 | 14 | 33 | 5 | 2 | 7 | 24 | 16 | 40 |
| NV | 9 | 6 | 15 | 2 | 1 | 3 | 11 | 7 | 18 |
| **Canada** | **25,540** | **21,501** | **47,041** | **8,248** | **5,302** | **13,550** | **33,788** | **26,803** | **60,591** |

*Notes:*
*Based on actual age and gender specific rates (2000-2004) for the province.*
*Based on actual age and gender specific rates (2003) for the province.*
*All other provincesd adjusted to reflect variances in age-standardized rates for MSC.*
*Numbers are not rounded and thus may appear to not add appropriately.*

As a consequence of modifying the estimated number of NMSC cases in certain provinces/territories, the total estimated number of NMSC decreased from 62,768 to 60,591 (a decline of 2,177, or 3.5%). This overall decrease reflects the fact that the combined age-standardized incidence rates for melanoma in the five provinces (Manitoba, New Brunswick, Alberta, Saskatchewan, and British Columbia), namely, 13.97 and 13.51/100,000 (male/female), are higher than the Canadian averages of 13.72 and 12.12 (male/female).

Up to this point, a patient-based incidence approach has been used in estimating the number of NMSC cases in Canada. The final phase of the analysis involves deriving data using a diagnosis-based incidence approach.

Stang and colleagues in Germany compared patient-based incidence rates and diagnosis-based incidence rates by gender and age group for both BCC and SCC.[302] The following table, based on their results, indicates the percentage difference between a patient-based incidence approach and a diagnosis-based incidence approach. The difference is particularly relevant in older populations, where as many as half of all NMSC may be a second or subsequent primary. These age- and gender-specific differences for BCC and SCC were used to adjust the Canadian patient-based incidence rates and thereby generate diagnosis-based incidence rates.

[302] Stang A, Ziegler S, Buchner U, et al. Malignant melanoma and nonmelanoma skin cancers in Northrhine-Westphalia, Germany: a patient- vs. diagnosis-based incidence approach. *International Journal of Dermatology*. 2007; 46: 564-70.

| Estimated Increase in BCC and SCC<br>Using a Diagnosis-Based Incidence Approach<br>By Gender and Age Group | | |
|---|---|---|
| Basal Cell Carcinoma | Male | Female |
| 0-39 | 0.0% | 0.0% |
| 40-59 | 2.4% | 18.6% |
| 60-79 | 36.5% | 41.8% |
| 80+ | 59.0% | 22.6% |
| All Ages | **32.7%** | **31.3%** |
| Squamous Cell Carcinoma | | |
| 0-39 | 0.0% | 0.0% |
| 40-59 | 0.0% | 0.0% |
| 60-79 | 0.0% | 0.0% |
| 80+ | 55.6% | 21.4% |
| All Ages | **17.2%** | **11.3%** |

The information was applied to the data already adjusted in phase two to reflect differences in the age-standardized rate for melanoma in each province/territory. On this basis, the estimated number of NMSC in Canada increased from 60,591 in 2004 (using the patient-based incidence approach) to 75,953, an increase of 25.4% (see following table). The estimated number of BCC cases in Canada increased from 47,041 to 60,587 (28.8%), while the number of SCC cases increased from 13,550 to 15,366 (13.4%).

**Estimated Non-melanoma Skin Cancer Cases in Canada**
**By Province/Territory and Gender In 2004**
**Diagnosis-Based Incidence Approach**

| | BCC | | | SCC | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Male** | **Female** | **Total** | **Male** | **Female** | **Total** | **Male** | **Female** | **Total** |
| BC | 5,949 | 4,718 | 10,667 | 1,482 | 916 | 2,398 | 7,431 | 5,633 | 13,064 |
| AB | 2,723 | 2,419 | 5,141 | 876 | 538 | 1,413 | 3,598 | 2,957 | 6,555 |
| SK | 1,194 | 944 | 2,139 | 427 | 241 | 669 | 1,622 | 1,186 | 2,808 |
| MB | 1,064 | 991 | 2,054 | 245 | 160 | 404 | 1,308 | 1,150 | 2,459 |
| ON | 13,713 | 11,110 | 24,824 | 4,084 | 2,322 | 6,406 | 17,797 | 13,432 | 31,229 |
| QC | 5,656 | 4,913 | 10,569 | 1,639 | 1,030 | 2,669 | 7,295 | 5,943 | 13,239 |
| NB | 681 | 596 | 1,277 | 244 | 151 | 396 | 925 | 747 | 1,672 |
| NF&L | 417 | 373 | 790 | 121 | 76 | 197 | 538 | 448 | 987 |
| PEI | 172 | 214 | 386 | 52 | 47 | 100 | 224 | 262 | 485 |
| NS | 1,363 | 1,280 | 2,643 | 415 | 280 | 695 | 1,778 | 1,560 | 3,338 |
| YK | 23 | 17 | 40 | 6 | 3 | 8 | 29 | 19 | 48 |
| NWT | 23 | 17 | 40 | 6 | 2 | 8 | 29 | 19 | 48 |
| NV | 11 | 8 | 18 | 2 | 1 | 3 | 13 | 8 | 21 |
| **Canada** | **32,989** | **27,598** | **60,587** | **9,597** | **5,768** | **15,366** | **42,586** | **33,367** | **75,953** |

*Note: Numbers are not rounded and thus may appear to not add appropriately.*

## 2. Estimated Number of Deaths in Canada in 2004

To estimate the number of deaths due to NMSC in Canada, the available mortality data from 1971 to 2005 in the province of Ontario was used to calculate age- and gender-specific mortality rates (see the section in the *Introduction* on *Skin Cancer Rates and Trends: Non-Melanoma – Mortality*, page 21). [303]

These age- and gender-specific rates were then applied to the 2004 population in each of the provinces /territories to estimate the total number of deaths due to NMSC in Canada that year. As indicated in the following table, an estimated 227 individuals (145 males and 82 females) died due to NMSC in Canada in 2004.

**Estimated Annual Number of Non-Melanoma Skin Cancer Deaths in Canada By Province and Gender (2004)**

| | Male | Female | Total |
|---|---|---|---|
| BC | 21 | 11 | 33 |
| AB | 12 | 7 | 19 |
| SK | 6 | 3 | 9 |
| MB | 6 | 3 | 9 |
| ON | 55 | 30 | 85 |
| QC | 33 | 20 | 54 |
| NB | 4 | 2 | 6 |
| NF&L | 2 | 1 | 4 |
| PEI | 1 | 0 | 1 |
| NS | 5 | 3 | 7 |
| YK | 0 | 0 | 0 |
| NWT | 0 | 0 | 0 |
| NV | 0 | 0 | 0 |
| **Canada** | **145** | **82** | **227** |

*Note: Based on Ontario age and gender specific rates (1971-2005).*
*Numbers are not rounded and thus may appear to not add appropriately.*

As seen in the earlier analysis of NMSC incidence (section B-1 above), these mortality data were adjusted based on the differences in age-standardized incidence rates for melanoma between Ontario and the other provinces/territories where NMSC mortality is not known.

Adjusting for differences in the age-standardized rate for MSC decreased the estimated number of deaths due to NMSC from 227 to 204 (a decrease of 23 deaths, or -10.2%). Estimated deaths in males decreased from 145 to 128 (18 deaths or -11.3%) while the estimated deaths in females decreased from 82 to 75 (7 deaths or -8.0%). These changes reflect the fact that the age-standardized incidence rates for melanoma in Ontario, namely, 15.53 and 13.16/100,000 (male/female), are higher than the Canadian average for males (13.72) and females (12.12).

[303] Cancer Care Ontario - SEER**Stat Release 7* - OCRIS (February 2009) released March 2009; Population Data Source: *Demographic Estimates Compendium 2007*. Statistics Canada, April 2008 (1971–2005).

**Adjusted Estimated Annual Number of Non-Melanoma Skin Cancer Deaths in Canada By Province and Gender (2004)**

| | Male | Female | Total |
|---|---|---|---|
| BC | 21 | 12 | 33 |
| AB | 11 | 7 | 17 |
| SK | 4 | 3 | 7 |
| MB | 4 | 2 | 7 |
| ON | 55 | 30 | 85 |
| QC | 22 | 14 | 35 |
| NB | 3 | 2 | 6 |
| NF&L | 2 | 1 | 3 |
| PEI | 1 | 1 | 1 |
| NS | 6 | 4 | 9 |
| YK | 0 | 0 | 0 |
| NWT | 0 | 0 | 0 |
| NV | 0 | 0 | 0 |
| **Canada** | **128** | **75** | **204** |

*Note: Based on Ontario age and gender specific rates (1971-2005) adjusted to reflect variances in age-standardized incidence rates for MSC.*
*Numbers are not rounded and thus may appear to not add appropriately.*

## 3. Projections

### a. Number of Cases

As noted in the Introduction, research on trends in NMSC has generated mixed information. Studies from most jurisdictions suggest ongoing increases in age-adjusted rates.[304,305,306,307] On the other hand, some areas have demonstrated stabilizing or even declining rates for certain types of NMSC, at least in specific age groups.[308,309,310]

As noted in the Introduction (section *Skin Cancer Rates and Trends: Non-Melanoma Skin Cancer – Trends*, pages 23-24), the most detailed trend information for NMSC in Canada is available from Manitoba.

The analysis of trends for NMSC in Manitoba was used to develop three scenarios similar to those used for melanoma projects:

**Medium Annual Percent Change Scenario** – In this scenario, assumptions were made about the annual percent change (APC) in males and females for BCC and SCC based on the analysis over multiple decades by Demers et al. in Manitoba.[311] The most recent trends based on that research are shown in the following table.

**Recent Trend in NMSC in Manitoba**
**Annual Percentage Change**
**By Type, Gender and Age Group**

| | | Age Group | | |
|---|---|---|---|---|
| | | 40-59 | 60-79 | 80+ |
| BCC | | | | |
| | Male | 4.8% | 2.9% | 1.3% |
| | Female | 1.6% | 3.0% | 1.3% |
| SCC | | | | |
| | Male | 0.5% | 2.9% | 3.4% |
| | Female | 1.8% | 3.3% | 2.3% |

**Low Annual Percent Change Scenario** – In this scenario, one-half of the APC noted in the Medium Annual Percent Change Scenario was applied. This scenario was intended to reflect the possibility that some of the observed increase in rates may be

[304] Hayes RC, Leonfellner S, Pilgrim W et al. Incidence of nonmelanoma skin cancer in New Brunswick, Canada, 1992 to 2001. *Journal of Cutaneous Medicine and Surgery.* 2007; 11(2): 45-52.
[305] Hannuksela-Svahn A, Pukkala E, Karvonen J. Basal cell skin carcinoma and other nonmelanoma skin cancers in Finland from 1956 through 1995. *Archives of Dermatology.* 1999; 135(7): 781-6.
[306] Brewster DH, Bhatti LA, Inglis JH et al. Recent trends in incidence of nonmelanoma skin cancers in the East of Scotland, 1992-2003. *British Journal of Dermatology.* 2007; 156(6): 1295-300.
[307] Athas WF, Hunt WC, Key CR. Changes in nonmelanoma skin cancer incidence between 1977-1978 and 1998-1999 in Northcentral New Mexico. *Cancer Epidemiology, Biomarkers and Prevention.* 2003; 12(10): 1105-8.
[308] Harris RB, Griffith K, Moon TE. Trends in the incidence of nonmelanoma skin cancers in southeastern Arizona, 1985-1996. *Journal of the American Academy of Dermatology.* 2001; 45(4): 528-36.
[309] Staples M, Marks R, Giles G. Trends in the incidence of non-melanocytic skin cancer (NMSC) treated in Australia 1985-1995: are primary prevention programs starting to have an effect? *International Journal of Cancer.* 1998; 78(2): 144-8.
[310] Staples MP, Elwood M, Burton RC et al. Non-melanoma skin cancer in Australia: the 2002 national survey and trends since 1985. *Medical Journal of Australia.* 2006; 184(1): 6-10.
[311] Demers AA, Nugent Z, Mihalcioiu C et al. Trends of nonmelanoma skin cancer from 1960 through 2000 in a Canadian population. *Journal of the American Academy of Dermatology.* 2005; 53(2): 320-8.

partly related to improvements in case ascertainment over time, rather than being solely driven by true increases in incidence. In addition, as with the melanoma scenarios, a further possible reason for a reduction in APC is the increasing proportion of the Canadian population that is from a visible minority.

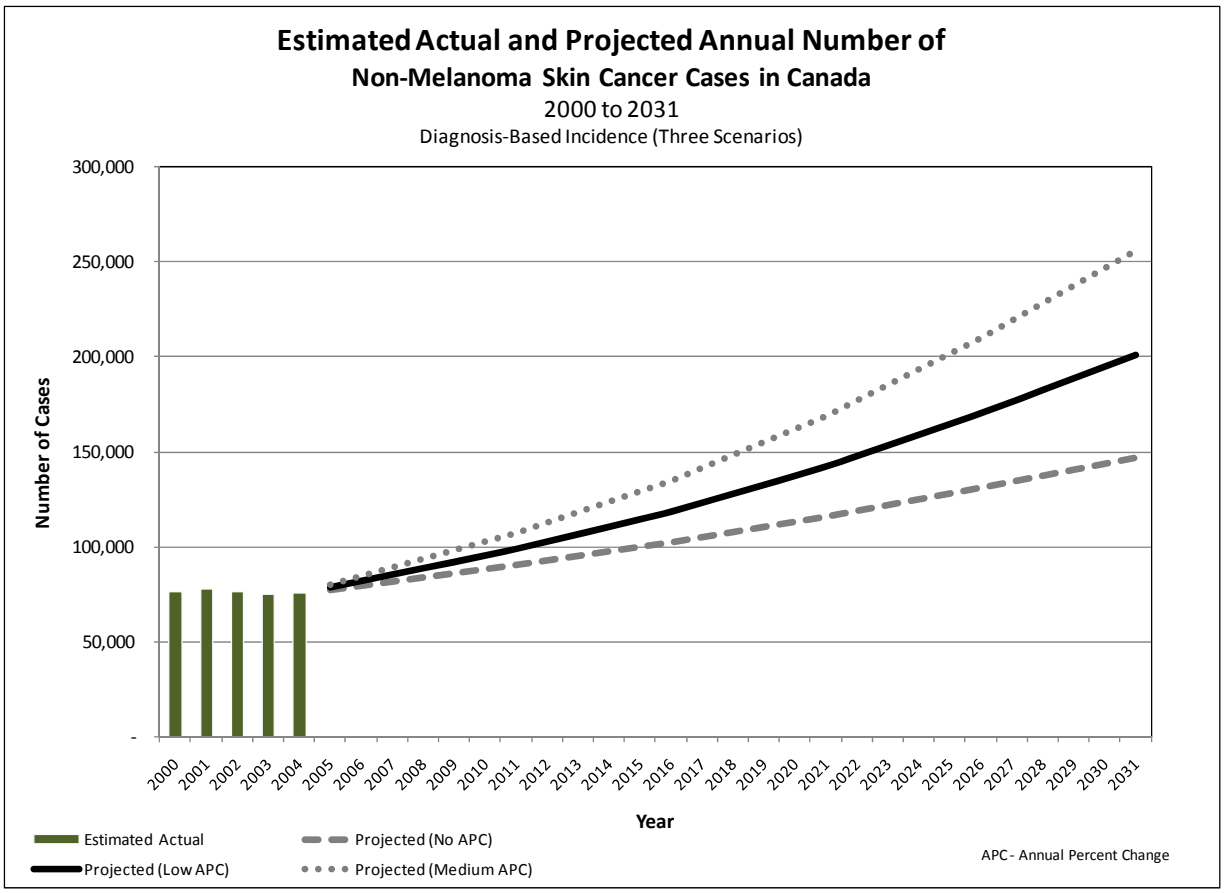
**No Annual Percent Change Scenario** –The assumption is that there would be zero APC for every age group. This scenario was included to estimate the number of NMSC cases based solely on population growth and ageing.

Base incidence rates were calculated by province/territory, age, and gender using the five years (2000-2004) of data available in the several reference provinces. The three scenarios described above were then used to modify the incidence rates calculated for the years 2011, 2016, 2021, 2026 and 2031 using an age-cohort based approach. That is, as younger cohorts aged, they maintained the lower APC appropriate for their age cohort in 2004, rather than shifting to the higher APC typical for older population groups. The age- and gender-specific incidence rates for each scenario were applied to the projected age- and gender-specific populations for each of the provinces/territories. Population projections were based on Statistics Canada projections for medium (Scenario 3) population growth.[312]

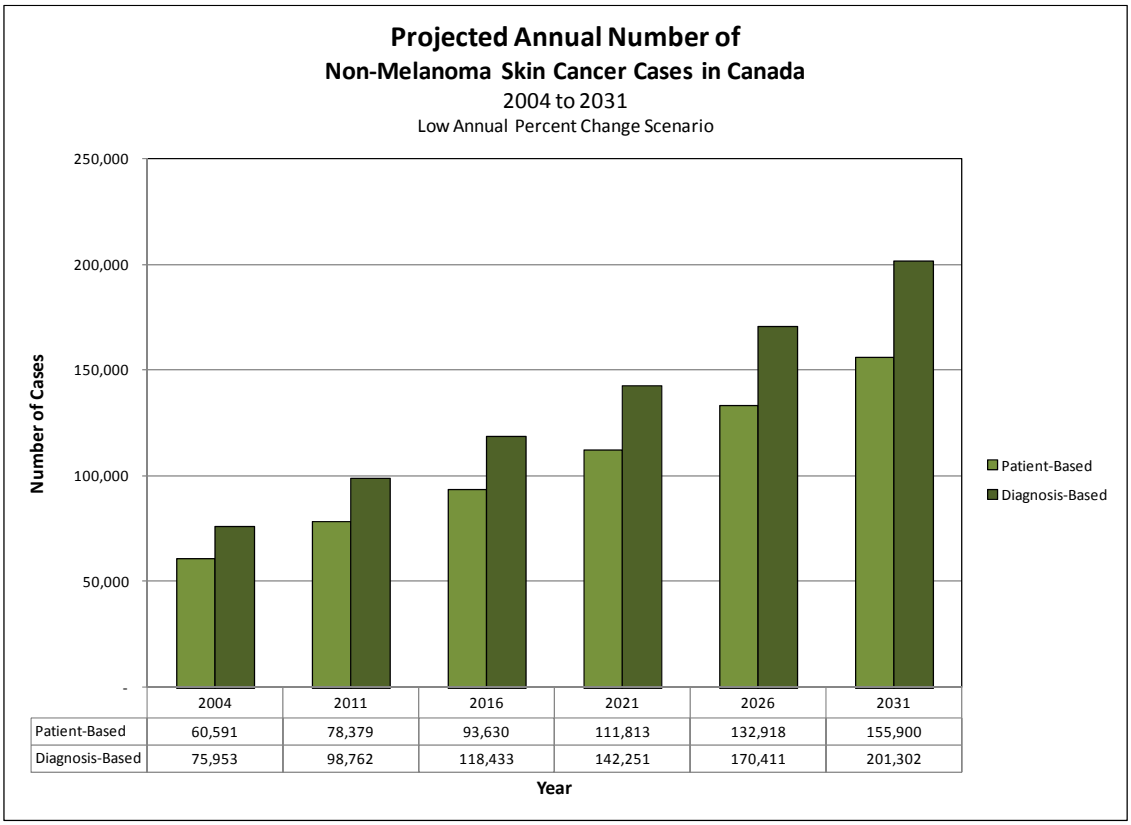
Projections were modelled for both the patient-based and diagnosis-based incidence approaches.

Using the diagnosis-based incidence approach, the **No Annual Percent Change Scenario** (No APC) would increase the number of NMSC cases from an estimated annual average of 75,953 between 2000 and 2004 to 147,000 in 2031 (+93%). The estimated cases in 2031 based on the **Low Annual Percent Change Scenario** (Low APC) would be 201,000 (+165%) and, for the **Medium Annual Percent Change Scenario**, 256,000 (+237%), as indicated in the following chart.

[312] Statistics Canada, *Population Projections for Canada, Provinces and Territories 2005-2031*. 2005. Catalogue no. 91-520-XIE. Pages 150-162 (for Scenario 3 – medium growth projections).


Estimated Actual and Projected Annual Number of
Non-Melanoma Skin Cancer Cases in Canada
2000 to 2031
Diagnosis-Based Incidence (Three Scenarios)
Number of Cases
300,000
250,000
200,000
150,000
100,000
50,000
-
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031
Year
Estimated Actual
Projected (No APC)
Projected (Low APC)
Projected (Medium APC)
APC - Annual Percent Change

The following chart provides a summary of the results for both the patient-based and diagnosis-based approaches using the **Low Annual Percent Change Scenario.**




| | 2004 | 2011 | 2016 | 2021 | 2026 | 2031 |
|---|---|---|---|---|---|---|
| Patient-Based | 60,591 | 78,379 | 93,630 | 111,813 | 132,918 | 155,900 |
| Diagnosis-Based | 75,953 | 98,762 | 118,433 | 142,251 | 170,411 | 201,302 |

The following two tables provide the detailed results by gender and province for the patient-based and the diagnosis-based approaches using the **Low Annual Percent Change Scenario.**

**Projected Annual Number of**
**Non-Melanoma Skin Cancer Cases in Canada**
**By Province, Gender and Year (2004 to 2031)**
**Patient-Based Incidence Approach (Low Annual Percent Change Scenario)**

| | | 2004 | | | 2011 | | | 2016 | | | 2021 | | | 2026 | | | 2031 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | BCC | 4,569 | 3,672 | **8,241** | 6,130 | 4,619 | **10,749** | 7,456 | 5,434 | **12,890** | 9,127 | 6,378 | **15,505** | 11,124 | 7,435 | **18,559** | 13,255 | 8,569 | **21,825** |
| | SCC | 1,252 | 845 | **2,097** | 1,700 | 1,105 | **2,805** | 2,086 | 1,329 | **3,415** | 2,528 | 1,603 | **4,131** | 3,043 | 1,938 | **4,981** | 3,644 | 2,328 | **5,972** |
| | **Total** | **5,820** | **4,518** | **10,338** | **7,829** | **5,724** | **13,554** | **9,542** | **6,763** | **16,305** | **11,655** | **7,981** | **19,636** | **14,167** | **9,373** | **23,540** | **16,899** | **10,897** | **27,796** |
| AB | BCC | 2,154 | 1,903 | **4,057** | 2,987 | 2,459 | **5,446** | 3,707 | 2,926 | **6,633** | 4,585 | 3,465 | **8,049** | 5,636 | 4,064 | **9,700** | 6,761 | 4,711 | **11,472** |
| | SCC | 759 | 494 | **1,253** | 1,066 | 669 | **1,735** | 1,358 | 823 | **2,181** | 1,683 | 1,010 | **2,693** | 2,053 | 1,241 | **3,293** | 2,479 | 1,530 | **4,009** |
| | **Total** | **2,913** | **2,397** | **5,310** | **4,053** | **3,129** | **7,182** | **5,064** | **3,749** | **8,813** | **6,267** | **4,475** | **10,742** | **7,688** | **5,305** | **12,993** | **9,240** | **6,241** | **15,481** |
| SK | BCC | 890 | 733 | **1,624** | 1,050 | 816 | **1,866** | 1,197 | 893 | **2,089** | 1,401 | 992 | **2,393** | 1,665 | 1,119 | **2,784** | 1,945 | 1,263 | **3,208** |
| | SCC | 351 | 218 | **569** | 412 | 247 | **659** | 472 | 272 | **744** | 540 | 304 | **844** | 625 | 348 | **973** | 725 | 406 | **1,131** |
| | **Total** | **1,242** | **951** | **2,193** | **1,462** | **1,063** | **2,526** | **1,669** | **1,165** | **2,833** | **1,941** | **1,296** | **3,238** | **2,290** | **1,466** | **3,756** | **2,670** | **1,669** | **4,339** |
| MB | BCC | 817 | 771 | **1,587** | 1,019 | 891 | **1,910** | 1,199 | 1,003 | **2,203** | 1,437 | 1,141 | **2,577** | 1,717 | 1,295 | **3,012** | 2,010 | 1,459 | **3,469** |
| | SCC | 206 | 145 | **351** | 256 | 170 | **426** | 304 | 191 | **495** | 359 | 220 | **578** | 421 | 258 | **679** | 494 | 305 | **799** |
| | **Total** | **1,023** | **915** | **1,938** | **1,274** | **1,061** | **2,335** | **1,503** | **1,194** | **2,697** | **1,795** | **1,361** | **3,156** | **2,139** | **1,553** | **3,691** | **2,503** | **1,764** | **4,268** |
| ON | BCC | 10,622 | 8,656 | **19,278** | 14,174 | 10,834 | **25,008** | 17,237 | 12,662 | **29,899** | 21,087 | 14,758 | **35,844** | 25,718 | 17,128 | **42,846** | 30,771 | 19,708 | **50,479** |
| | SCC | 3,522 | 2,137 | **5,659** | 4,754 | 2,783 | **7,537** | 5,855 | 3,323 | **9,178** | 7,078 | 3,968 | **11,046** | 8,469 | 4,764 | **13,233** | 10,091 | 5,743 | **15,835** |
| | **Total** | **14,144** | **10,793** | **24,937** | **18,929** | **13,617** | **32,545** | **23,092** | **15,985** | **39,077** | **28,164** | **18,726** | **46,891** | **34,188** | **21,891** | **56,079** | **40,862** | **25,451** | **66,314** |
| QC | BCC | 4,406 | 3,815 | **8,221** | 5,818 | 4,657 | **10,475** | 6,967 | 5,318 | **12,285** | 8,355 | 6,047 | **14,402** | 9,940 | 6,816 | **16,755** | 11,548 | 7,590 | **19,138** |
| | SCC | 1,431 | 949 | **2,380** | 1,927 | 1,219 | **3,147** | 2,363 | 1,438 | **3,801** | 2,831 | 1,686 | **4,517** | 3,331 | 1,978 | **5,309** | 3,869 | 2,322 | **6,191** |
| | **Total** | **5,837** | **4,764** | **10,601** | **7,746** | **5,876** | **13,622** | **9,330** | **6,757** | **16,086** | **11,186** | **7,733** | **18,919** | **13,271** | **8,794** | **22,064** | **15,417** | **9,912** | **25,329** |
| NB | BCC | 526 | 463 | **989** | 678 | 562 | **1,240** | 816 | 647 | **1,463** | 981 | 738 | **1,719** | 1,169 | 833 | **2,002** | 1,350 | 922 | **2,273** |
| | SCC | 212 | 139 | **350** | 272 | 172 | **443** | 332 | 202 | **534** | 398 | 238 | **636** | 469 | 284 | **753** | 543 | 337 | **880** |
| | **Total** | **738** | **602** | **1,339** | **950** | **734** | **1,684** | **1,148** | **849** | **1,997** | **1,379** | **977** | **2,356** | **1,638** | **1,117** | **2,755** | **1,893** | **1,260** | **3,153** |
| NF&L | BCC | 325 | 291 | **616** | 420 | 361 | **781** | 502 | 419 | **921** | 598 | 484 | **1,082** | 705 | 550 | **1,256** | 804 | 616 | **1,420** |
| | SCC | 105 | 70 | **175** | 137 | 91 | **228** | 169 | 110 | **279** | 202 | 133 | **335** | 238 | 160 | **398** | 273 | 190 | **463** |
| | **Total** | **431** | **361** | **791** | **557** | **452** | **1,008** | **671** | **529** | **1,199** | **801** | **617** | **1,417** | **943** | **710** | **1,653** | **1,077** | **806** | **1,883** |
| PEI | BCC | 132 | 167 | **299** | 171 | 197 | **368** | 203 | 228 | **431** | 246 | 261 | **507** | 290 | 299 | **589** | 336 | 335 | **671** |
| | SCC | 45 | 43 | **88** | 58 | 52 | **110** | 70 | 61 | **131** | 85 | 73 | **158** | 98 | 87 | **185** | 114 | 103 | **217** |
| | **Total** | **177** | **210** | **387** | **228** | **249** | **478** | **273** | **289** | **562** | **331** | **334** | **665** | **388** | **386** | **774** | **450** | **439** | **888** |
| NS | BCC | 1,052 | 997 | **2,049** | 1,352 | 1,189 | **2,541** | 1,616 | 1,359 | **2,974** | 1,937 | 1,554 | **3,491** | 2,303 | 1,766 | **4,070** | 2,662 | 1,980 | **4,642** |
| | SCC | 354 | 256 | **610** | 456 | 312 | **768** | 557 | 364 | **921** | 669 | 430 | **1,099** | 790 | 512 | **1,303** | 919 | 608 | **1,527** |
| | **Total** | **1,405** | **1,253** | **2,658** | **1,808** | **1,501** | **3,309** | **2,173** | **1,722** | **3,895** | **2,606** | **1,984** | **4,590** | **3,094** | **2,279** | **5,372** | **3,581** | **2,588** | **6,169** |
| YK/NWT/NV | BCC | 47 | 33 | **80** | 64 | 46 | **110** | 78 | 54 | **132** | 94 | 68 | **161** | 110 | 78 | **188** | 129 | 89 | **218** |
| | SCC | 12 | 6 | **18** | 18 | 9 | **27** | 22 | 11 | **34** | 27 | 16 | **43** | 32 | 19 | **51** | 39 | 23 | **62** |
| | **Total** | **59** | **39** | **98** | **82** | **55** | **137** | **100** | **65** | **165** | **121** | **83** | **204** | **142** | **97** | **239** | **168** | **113** | **280** |
| **Canada** | BCC | 25,540 | 21,501 | **47,041** | 33,863 | 26,633 | **60,495** | 40,977 | 30,943 | **71,920** | 49,848 | 35,885 | **85,733** | 60,377 | 41,382 | **101,760** | 71,572 | 47,243 | **118,815** |
| | SCC | 8,248 | 5,302 | **13,550** | 11,055 | 6,828 | **17,884** | 13,586 | 8,124 | **21,710** | 16,400 | 9,681 | **26,081** | 19,570 | 11,588 | **31,158** | 23,189 | 13,896 | **37,085** |
| | **Total** | **33,788** | **26,803** | **60,591** | **44,918** | **33,461** | **78,379** | **54,563** | **39,067** | **93,630** | **66,247** | **45,566** | **111,813** | **79,948** | **52,970** | **132,918** | **94,760** | **61,140** | **155,900** |

*Note: Calculated numbers are not rounded and thus may appear not to add appropriately.*

## Projected Annual Number of
## Non-Melanoma Skin Cancer Cases in Canada
### By Province, Gender and Year (2004 to 2031)
### Diagnosis-Based Incidence Approach (Low Annual Percent Change Scenario)

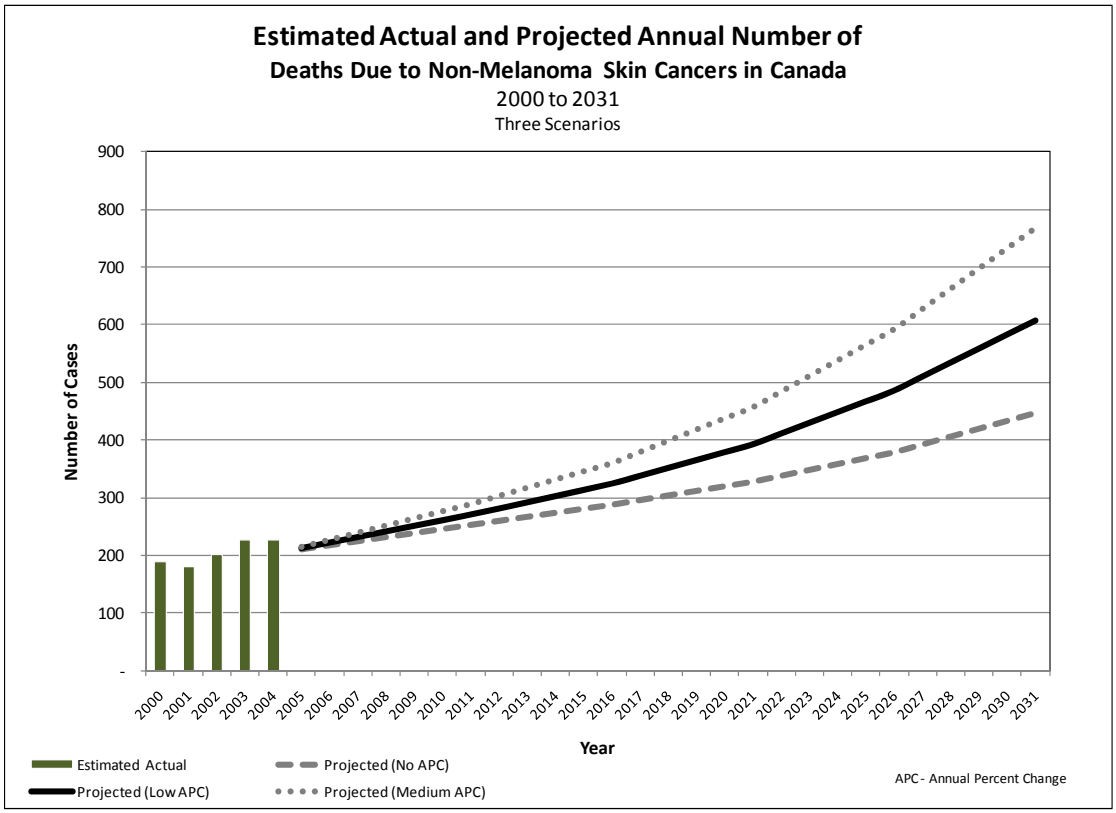
| | | 2004 | | | 2011 | | | 2016 | | | 2021 | | | 2026 | | | 2031 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **Male** | **Female** | **Total** | **Male** | **Female** | **Total** | **Male** | **Female** | **Total** | **Male** | **Female** | **Total** | **Male** | **Female** | **Total** | **Male** | **Female** | **Total** |
| BC | BCC | 5,949 | 4,718 | **10,667** | 8,009 | 5,970 | **13,979** | 9,782 | 7,078 | **16,860** | 12,056 | 8,367 | **20,424** | 14,831 | 9,786 | **24,617** | 17,834 | 11,252 | **29,086** |
| | SCC | 1,482 | 916 | **2,398** | 2,042 | 1,198 | **3,239** | 2,508 | 1,435 | **3,943** | 3,034 | 1,726 | **4,760** | 3,686 | 2,092 | **5,778** | 4,530 | 2,537 | **7,067** |
| | **Total** | **7,431** | **5,633** | **13,064** | **10,051** | **7,167** | **17,218** | **12,290** | **8,512** | **20,803** | **15,091** | **10,093** | **25,184** | **18,517** | **11,878** | **30,395** | **22,364** | **13,789** | **36,153** |
| AB | BCC | 2,723 | 2,419 | **5,141** | 3,791 | 3,147 | **6,938** | 4,742 | 3,778 | **8,519** | 5,934 | 4,514 | **10,449** | 7,382 | 5,322 | **12,704** | 8,942 | 6,161 | **15,103** |
| | SCC | 876 | 538 | **1,413** | 1,248 | 730 | **1,978** | 1,592 | 895 | **2,487** | 1,971 | 1,096 | **3,067** | 2,427 | 1,350 | **3,777** | 3,005 | 1,680 | **4,685** |
| | **Total** | **3,598** | **2,957** | **6,555** | **5,039** | **3,877** | **8,916** | **6,334** | **4,673** | **11,007** | **7,905** | **5,611** | **13,516** | **9,809** | **6,672** | **16,481** | **11,946** | **7,841** | **19,788** |
| SK | BCC | 1,194 | 944 | **2,139** | 1,400 | 1,054 | **2,454** | 1,597 | 1,162 | **2,758** | 1,881 | 1,302 | **3,182** | 2,253 | 1,474 | **3,727** | 2,652 | 1,659 | **4,312** |
| | SCC | 427 | 241 | **669** | 505 | 274 | **779** | 574 | 300 | **874** | 652 | 334 | **986** | 756 | 382 | **1,138** | 895 | 449 | **1,344** |
| | **Total** | **1,622** | **1,186** | **2,808** | **1,905** | **1,328** | **3,233** | **2,171** | **1,462** | **3,633** | **2,533** | **1,635** | **4,168** | **3,009** | **1,855** | **4,865** | **3,548** | **2,108** | **5,656** |
| MB | BCC | 1,064 | 991 | **2,054** | 1,324 | 1,151 | **2,476** | 1,563 | 1,306 | **2,868** | 1,885 | 1,496 | **3,381** | 2,275 | 1,706 | **3,981** | 2,684 | 1,917 | **4,601** |
| | SCC | 245 | 160 | **404** | 306 | 187 | **493** | 361 | 209 | **570** | 424 | 240 | **664** | 502 | 281 | **783** | 602 | 336 | **938** |
| | **Total** | **1,308** | **1,150** | **2,459** | **1,631** | **1,338** | **2,969** | **1,924** | **1,515** | **3,439** | **2,309** | **1,736** | **4,045** | **2,777** | **1,987** | **4,763** | **3,286** | **2,253** | **5,539** |
| ON | BCC | 13,713 | 11,110 | **24,824** | 18,357 | 13,966 | **32,323** | 22,376 | 16,430 | **38,806** | 27,569 | 19,281 | **46,850** | 33,988 | 22,473 | **56,461** | 41,032 | 25,825 | **66,857** |
| | SCC | 4,084 | 2,322 | **6,406** | 5,621 | 3,035 | **8,656** | 6,929 | 3,613 | **10,543** | 8,365 | 4,305 | **12,670** | 10,092 | 5,177 | **15,269** | 12,288 | 6,294 | **18,582** |
| | **Total** | **17,797** | **13,432** | **31,229** | **23,978** | **17,000** | **40,978** | **29,305** | **20,043** | **49,349** | **35,934** | **23,586** | **59,520** | **44,080** | **27,650** | **71,730** | **53,320** | **32,119** | **85,439** |
| QC | BCC | 5,656 | 4,913 | **10,569** | 7,524 | 6,031 | **13,555** | 9,060 | 6,936 | **15,996** | 10,976 | 7,943 | **18,919** | 13,216 | 8,971 | **22,187** | 15,473 | 9,958 | **25,431** |
| | SCC | 1,639 | 1,030 | **2,669** | 2,247 | 1,329 | **3,576** | 2,762 | 1,566 | **4,328** | 3,317 | 1,833 | **5,151** | 3,970 | 2,161 | **6,131** | 4,724 | 2,559 | **7,283** |
| | **Total** | **7,295** | **5,943** | **13,239** | **9,771** | **7,360** | **17,131** | **11,823** | **8,502** | **20,324** | **14,293** | **9,777** | **24,070** | **17,186** | **11,132** | **28,317** | **20,197** | **12,518** | **32,714** |
| NB | BCC | 681 | 596 | **1,277** | 881 | 730 | **1,611** | 1,066 | 848 | **1,914** | 1,295 | 975 | **2,270** | 1,563 | 1,104 | **2,667** | 1,825 | 1,218 | **3,043** |
| | SCC | 244 | 151 | **396** | 314 | 187 | **501** | 383 | 219 | **602** | 461 | 258 | **719** | 552 | 309 | **861** | 658 | 371 | **1,029** |
| | **Total** | **925** | **747** | **1,672** | **1,195** | **917** | **2,112** | **1,449** | **1,067** | **2,517** | **1,756** | **1,233** | **2,989** | **2,115** | **1,413** | **3,528** | **2,483** | **1,589** | **4,072** |
| NF&L | BCC | 417 | 373 | **790** | 542 | 468 | **1,009** | 654 | 549 | **1,202** | 788 | 638 | **1,426** | 941 | 728 | **1,669** | 1,084 | 811 | **1,896** |
| | SCC | 121 | 76 | **197** | 157 | 99 | **256** | 194 | 119 | **313** | 234 | 143 | **377** | 280 | 174 | **454** | 332 | 210 | **541** |
| | **Total** | **538** | **448** | **987** | **699** | **566** | **1,265** | **848** | **667** | **1,515** | **1,021** | **782** | **1,803** | **1,221** | **901** | **2,123** | **1,416** | **1,021** | **2,437** |
| PEI | BCC | 172 | 214 | **386** | 222 | 256 | **478** | 265 | 297 | **563** | 325 | 344 | **669** | 387 | 395 | **781** | 452 | 440 | **892** |
| | SCC | 52 | 47 | **100** | 67 | 56 | **124** | 81 | 67 | **147** | 100 | 79 | **179** | 116 | 95 | **211** | 139 | 114 | **253** |
| | **Total** | **224** | **262** | **485** | **289** | **312** | **602** | **346** | **364** | **710** | **425** | **422** | **848** | **503** | **489** | **992** | **590** | **554** | **1,145** |
| NS | BCC | 1,363 | 1,280 | **2,643** | 1,757 | 1,540 | **3,297** | 2,112 | 1,775 | **3,887** | 2,558 | 2,046 | **4,604** | 3,082 | 2,334 | **5,416** | 3,599 | 2,607 | **6,206** |
| | SCC | 415 | 280 | **695** | 535 | 340 | **875** | 652 | 395 | **1,047** | 785 | 466 | **1,252** | 943 | 558 | **1,501** | 1,128 | 669 | **1,797** |
| | **Total** | **1,778** | **1,560** | **3,338** | **2,292** | **1,880** | **4,172** | **2,764** | **2,170** | **4,934** | **3,343** | **2,513** | **5,856** | **4,025** | **2,892** | **6,916** | **4,727** | **3,276** | **8,003** |
| YK/NWT/NV | BCC | 57 | 41 | **98** | 79 | 59 | **138** | 97 | 70 | **167** | 119 | 88 | **207** | 141 | 102 | **244** | 168 | 116 | **284** |
| | SCC | 14 | 6 | **20** | 19 | 9 | **29** | 25 | 12 | **37** | 30 | 17 | **47** | 37 | 20 | **57** | 47 | 25 | **72** |
| | **Total** | **70** | **47** | **117** | **98** | **68** | **167** | **122** | **82** | **203** | **149** | **105** | **254** | **178** | **123** | **301** | **215** | **142** | **356** |
| **Canada** | BCC | 32,989 | 27,598 | **60,587** | 43,886 | 34,371 | **78,257** | 53,313 | 40,229 | **93,541** | 65,386 | 46,995 | **112,380** | 80,058 | 54,394 | **134,452** | 95,745 | 61,966 | **157,711** |
| | SCC | 9,597 | 5,768 | **15,366** | 13,061 | 7,444 | **20,505** | 16,063 | 8,829 | **24,892** | 19,374 | 10,496 | **29,870** | 23,361 | 12,598 | **35,958** | 28,347 | 15,244 | **43,591** |
| | **Total** | **42,586** | **33,367** | **75,953** | **56,947** | **41,815** | **98,762** | **69,376** | **49,057** | **118,433** | **84,760** | **57,491** | **142,251** | **103,419** | **66,991** | **170,411** | **124,092** | **77,210** | **201,302** |

*Note: Calculated numbers are not rounded and thus may appear not to add appropriately.*

### b. Number of Deaths

The approach to projecting the number of NMSC-associated deaths was substantially the same as the one used in projecting the number of incident cases; the same three scenarios were applied. Base mortality rates were calculated by province/territory, age, and gender using 1971-2005 Ontario mortality data (see Section 2 above).[313] The three scenarios (i.e., Medium, Low, and No APC) were then used to modify the mortality rates calculated for the years 2011, 2016, 2021, 2026 and 2031 using an age-cohort approach. That is, as younger cohorts aged, they maintained the lower APC appropriate for their age cohort in 2004. Since the information on NMSC deaths did not identify BCC or SCC as the cause of death, the pertinent APC for BCC was used (the more common of the two) . It should be acknowledged that using incidence-related APCs in this way requires an underlying assumption that a constant mortality-to-incidence ratio specific to each age group applies during the modelling period. The resulting age- and gender-specific mortality rates for each scenario were applied to the projected age- and gender-specific populations for each of the provinces/territories. Population projections were based on Statistics Canada projections for medium (Scenario 3) population growth.[314]

Using the **No Annual Percent Change Scenario** (No APC) would increase the number of deaths due to NMSC from an estimated annual average of 204 between 2000 and 2004 to 447 in 2031 (+120%). The estimated deaths in 2031 based on the **Low Annual Percent Change Scenario** (Low APC) would be 608 (+198%) and, for the **Medium Annual Percent Change Scenario**, 768 (+277%), as indicated in the following chart.




[313] Cancer Care Ontario - SEER**Stat Release 7* - OCRIS (February 2009) released March 2009; Population Data Source: *Demographic Estimates Compendium 2007*. Statistics Canada, April 2008 (1971–2005).
[314] Statistics Canada, *Population Projections for Canada, Provinces and Territories 2005-2031*. 2005. Catalogue no. 91-520-XIE. Pages 149-162 (for Scenario 3 – medium growth projections).

As an illustration of the underlying detail, the following table provides a summary of results based on the **Low Annual Percent Change Scenario.**

**Projected Annual Number of**
**Deaths Due to Non-Melanoma Skin Cancer in Canada**
**By Province, Gender and Year (2004 to 2031)**
**Low Annual Percent Change Scenario**

| | 2004 | | | 2011 | | | 2016 | | | 2021 | | | 2026 | | | 2031 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 21 | 12 | 33 | 29 | 15 | 44 | 35 | 18 | 53 | 44 | 21 | 65 | 55 | 25 | 80 | 70 | 31 | 101 |
| AB | 11 | 7 | 17 | 15 | 9 | 24 | 19 | 11 | 30 | 25 | 13 | 37 | 32 | 16 | 47 | 41 | 20 | 61 |
| SK | 4 | 3 | 7 | 5 | 3 | 8 | 5 | 4 | 9 | 6 | 4 | 10 | 7 | 4 | 11 | 9 | 5 | 14 |
| MB | 4 | 2 | 7 | 5 | 3 | 8 | 6 | 3 | 9 | 7 | 3 | 11 | 9 | 4 | 13 | 11 | 5 | 16 |
| ON | 55 | 30 | 85 | 75 | 40 | 115 | 92 | 47 | 139 | 113 | 55 | 168 | 142 | 66 | 208 | 180 | 81 | 261 |
| QC | 22 | 14 | 35 | 30 | 17 | 47 | 36 | 20 | 57 | 45 | 24 | 68 | 56 | 28 | 83 | 69 | 34 | 103 |
| NB | 3 | 2 | 6 | 4 | 3 | 7 | 5 | 3 | 8 | 6 | 4 | 10 | 8 | 4 | 12 | 10 | 5 | 15 |
| NF&L | 2 | 1 | 3 | 2 | 1 | 3 | 3 | 1 | 4 | 3 | 2 | 5 | 4 | 2 | 6 | 5 | 3 | 8 |
| PEI | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 1 | 3 |
| NS | 6 | 4 | 9 | 7 | 5 | 12 | 9 | 5 | 14 | 11 | 6 | 16 | 13 | 7 | 20 | 16 | 9 | 25 |
| YK/NWT/NV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| **Canada** | **128** | **75** | **204** | **174** | **97** | **271** | **212** | **113** | **325** | **261** | **132** | **393** | **328** | **158** | **486** | **413** | **195** | **608** |

*Note: Calculated numbers are not rounded and thus may appear not to add appropriately.*

In the following table, information on both estimated actual and projected cases and deaths is combined to calculate the incidence-to-mortality ratio. In 2004, this ratio was 0.0034. In 2031, it is projected to increase to 0.0039.

**Estimated Actual and Projected Ratio of Deaths to Cases**
**Non-Melanoma Skin Cancer Cases in Canada**
**2000 to 2031**

| | 2004 | 2011 | 2016 | 2021 | 2026 | 2031 |
|---|---|---|---|---|---|---|
| **Cases** - Patient-Based Incidence Approach | | | | | | |
| Estimated Actual | 60,591 | | | | | |
| Projected (No APC) | | 71,768 | 80,813 | 90,992 | 102,240 | 113,795 |
| Projected (Low APC) | | 78,379 | 93,630 | 111,813 | 132,918 | 155,900 |
| Projected (Medium APC) | | 84,990 | 106,448 | 132,635 | 163,595 | 198,005 |
| **Deaths** - Patient-Based Incidence Approach | | | | | | |
| Estimated Actual | 204 | | | | | |
| Projected (No APC) | | 253 | 288 | 328 | 379 | 447 |
| Projected (Low APC) | | 271 | 325 | 393 | 486 | 608 |
| Projected (Medium APC) | | 290 | 361 | 458 | 593 | 768 |
| Ratio of Deaths to Cases | | | | | | |
| Estimated Actual | 0.0034 | | | | | |
| Projected (No APC) | | 0.0035 | 0.0036 | 0.0036 | 0.0037 | 0.0039 |
| Projected (Low APC) | | 0.0035 | 0.0035 | 0.0035 | 0.0037 | 0.0039 |
| Projected (Medium APC) | | 0.0034 | 0.0034 | 0.0035 | 0.0036 | 0.0039 |

## Appendix F: Economic Burden of Skin Cancer in Canada

In estimating the economic burden of skin cancer in Canada, a cost-of-illness approach was employed that included three main components: direct costs, and two classic generators of indirect costs, namely, morbidity and mortality.[315]

In this Appendix, the process of developing direct and indirect costs will be summarized. The costs will initially be developed and summarized using the estimated annual number of new MSC and NMSC cases in 2004 based on the **diagnosis-based incidence** approach. Future projections of both new cases and deaths are based on the **Low APC Scenario**. These initial costs will not be discounted (i.e. applying an effective discount rate of 0%; further discussion on discount rates can be found in this Appendix on page 175). After detailing these costs, a section on sensitivity analysis will include a summary of costs based on each of the **No APC, Low APC** and **Medium APC Scenarios**, with discount rates of 0%, 3%, and 5%.

### Direct Costs

The first economic component, direct costs, was elucidated under three headings: expenditures related to primary care-based treatment, day surgery in outpatient clinics, and inpatient/hospital stays.

#### Primary Care-Based Treatment

While referred to as primary care-based treatment, it is convenient to include under this rubric the physician services that technically are provided in secondary and tertiary care platforms (i.e., care offered by specialists such as dermatologists). In estimating all such costs associated with skin cancers in Canada, the following approach and assumptions were used:

- All patients diagnosed with BCC or SCC and 90% of patients diagnosed with MSC (Stage I or II) receive the following care:[316]
    - An initial visit to a general practitioner
    - An initial consult with a dermatologist
    - A biopsy
    - Treatment of the cancer by excision in 50% of cases, by curettage electro-surgery in 40% of cases, and by Mohs micrographic surgery in 10% of cases
    - 10% of patients will require reconstruction and/or a skin graft
    - Two follow-up visits to a dermatologist in the year following the treatment
- The unit cost for the services was determined for each province based on the physician fee schedule for the province.
- Unit costs for the territories were based on New Brunswick costs as these costs are generally higher in this province than in other provinces (see following table). Given the challenges in providing care in remote northern areas of the country, it seems reasonable to use the highest provincial costs as an estimate for the unit costs in the territories.

[315] Brown ML, Lipscomb J, Snyder C. The burden of illness of cancer: economic cost and quality of life. *Annual Review of Public Health.* 2001; 22: 91-113.

[316] The care process was developed with input from Dr. Jason Rivers, a clinical professor in Dermatology at the University of British Columbia, combined with an analysis of the dermatology billing patterns in the British Columbia Medical Services Plan. As one point of "triangulation," the study Chen GJ, Yelverton CB, Polisetty SS, et al. Treatment patterns and costs of nonmelanoma skin cancer management. *Dermatologic Surgery*. 2006; 32: 1266-71 indicated that 10% of patients with NMSC received surgery with the Mohs procedure.

| Estimated Primary Care Based Treatment Cost per Skin Cancer<br>Canadian Provinces | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **BC** | **AB** | **SK** | **MB** | **ON** | **PQ** | **NB** | **NF&L** | **PEI** | **NS** |
| General Practitioner Visit | $ 30.66 | $ 30.55 | $ 28.22 | $ 23.55 | $ 20.40 | $ 20.60 | $ 26.60 | $ 27.27 | $ 28.00 | $ 31.11 |
| Initial Dermatologist Consult | $ 53.28 | $ 61.83 | $ 71.85 | $ 60.25 | $ 66.15 | $ 51.00 | $ 99.40 | $ 70.87 | $ 70.00 | $ 88.40 |
| Biopsy | $ 39.22 | $ 41.80 | $ 37.30 | $ 25.90 | $ 14.70 | $ 22.32 | $ 43.40 | $ 15.26 | $ 41.05 | $ 44.20 |
| Treatment | $ 165.46 | $ 174.68 | $ 206.25 | $ 132.03 | $ 114.89 | $ 138.47 | $ 138.72 | $ 151.80 | $ 166.80 | $ 177.63 |
| Reconstruction/Skin Graft | $ 36.12 | $ 37.81 | $ 28.05 | $ 28.28 | $ 34.74 | $ 20.19 | $ 36.15 | $ 32.63 | $ 30.40 | $ 27.56 |
| Dermatologist Follow-up | $ 106.57 | $ 123.66 | $ 143.70 | $ 120.50 | $ 132.30 | $ 102.00 | $ 198.80 | $ 141.74 | $ 140.00 | $ 176.80 |
| **Total Per Diagnosis** | **$ 431.32** | **$ 470.33** | **$ 515.37** | **$ 390.50** | **$ 383.18** | **$ 354.58** | **$ 543.06** | **$ 439.58** | **$ 476.25** | **$ 545.70** |

Based on these treatment costs, the following three tables itemize the estimated gender-specific expenditures according to the projected number of melanoma, BCC, and SCC cases by province (and the territories combined) at each of the index years up to 2031.

The total estimated annual costs in this area of care for melanoma patients increases from $1.76 million in 2004 to $3.35 million in 2031 (see following table).

| Estimated Primary Care Based Costs<br>Associated with Cutaneous Melanoma in Canada<br>By Province/Territory and Gender<br>2004 to 2031 (in $millions, 2004 Constant dollars) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Province** | **Gender** | **2004** | **2011** | **2016** | **2021** | **2026** | **2031** |
| BC | Male | $ 0.15 | $ 0.19 | $ 0.22 | $ 0.26 | $ 0.29 | $ 0.32 |
| | Female | $ 0.13 | $ 0.15 | $ 0.17 | $ 0.19 | $ 0.21 | $ 0.23 |
| | **Total** | **$ 0.28** | **$ 0.35** | **$ 0.40** | **$ 0.45** | **$ 0.50** | **$ 0.56** |
| AB | Male | $ 0.11 | $ 0.12 | $ 0.15 | $ 0.17 | $ 0.20 | $ 0.22 |
| | Female | $ 0.10 | $ 0.11 | $ 0.13 | $ 0.14 | $ 0.16 | $ 0.17 |
| | **Total** | **$ 0.21** | **$ 0.24** | **$ 0.27** | **$ 0.31** | **$ 0.35** | **$ 0.39** |
| SK | Male | $ 0.03 | $ 0.03 | $ 0.04 | $ 0.04 | $ 0.04 | $ 0.05 |
| | Female | $ 0.03 | $ 0.03 | $ 0.04 | $ 0.04 | $ 0.04 | $ 0.04 |
| | **Total** | **$ 0.06** | **$ 0.07** | **$ 0.07** | **$ 0.08** | **$ 0.08** | **$ 0.09** |
| MB | Male | $ 0.03 | $ 0.03 | $ 0.04 | $ 0.04 | $ 0.04 | $ 0.05 |
| | Female | $ 0.02 | $ 0.03 | $ 0.03 | $ 0.03 | $ 0.03 | $ 0.04 |
| | **Total** | **$ 0.05** | **$ 0.06** | **$ 0.06** | **$ 0.07** | **$ 0.08** | **$ 0.08** |
| ON | Male | $ 0.37 | $ 0.47 | $ 0.55 | $ 0.64 | $ 0.73 | $ 0.81 |
| | Female | $ 0.34 | $ 0.38 | $ 0.43 | $ 0.48 | $ 0.53 | $ 0.59 |
| | **Total** | **$ 0.71** | **$ 0.85** | **$ 0.98** | **$ 1.12** | **$ 1.26** | **$ 1.40** |
| QC | Male | $ 0.14 | $ 0.17 | $ 0.20 | $ 0.22 | $ 0.25 | $ 0.27 |
| | Female | $ 0.11 | $ 0.15 | $ 0.16 | $ 0.17 | $ 0.18 | $ 0.19 |
| | **Total** | **$ 0.24** | **$ 0.32** | **$ 0.36** | **$ 0.39** | **$ 0.43** | **$ 0.46** |
| NB | Male | $ 0.03 | $ 0.04 | $ 0.04 | $ 0.05 | $ 0.05 | $ 0.06 |
| | Female | $ 0.03 | $ 0.04 | $ 0.04 | $ 0.04 | $ 0.04 | $ 0.05 |
| | **Total** | **$ 0.06** | **$ 0.07** | **$ 0.08** | **$ 0.09** | **$ 0.10** | **$ 0.11** |
| NF&L | Male | $ 0.01 | $ 0.02 | $ 0.02 | $ 0.02 | $ 0.02 | $ 0.02 |
| | Female | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.02 | $ 0.02 | $ 0.02 |
| | **Total** | **$ 0.02** | **$ 0.03** | **$ 0.03** | **$ 0.04** | **$ 0.04** | **$ 0.04** |
| PEI | Male | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 |
| | Female | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 |
| | **Total** | **$ 0.01** | **$ 0.02** | **$ 0.02** | **$ 0.02** | **$ 0.02** | **$ 0.02** |
| NS | Male | $ 0.05 | $ 0.06 | $ 0.07 | $ 0.08 | $ 0.09 | $ 0.10 |
| | Female | $ 0.05 | $ 0.06 | $ 0.06 | $ 0.07 | $ 0.08 | $ 0.08 |
| | **Total** | **$ 0.10** | **$ 0.12** | **$ 0.14** | **$ 0.15** | **$ 0.17** | **$ 0.18** |
| YK/NWT/NV | Male | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.01 |
| | Female | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 |
| | **Total** | **$ 0.01** | **$ 0.01** | **$ 0.01** | **$ 0.01** | **$ 0.01** | **$ 0.01** |
| **Canada** | **Male** | **$ 0.93** | **$ 1.15** | **$ 1.34** | **$ 1.53** | **$ 1.73** | **$ 1.92** |
| | **Female** | **$ 0.84** | **$ 0.97** | **$ 1.08** | **$ 1.19** | **$ 1.31** | **$ 1.43** |
| | **Total** | **$ 1.76** | **$ 2.12** | **$ 2.43** | **$ 2.73** | **$ 3.04** | **$ 3.35** |

The total estimated annual costs in this area of care for BCC patients increases from $24.9 million in 2004 to $64.8 million in 2031 (see following table).

**Estimated Primary Care Based Costs**
Associated with Basal Cell Carcinoma in Canada
By Province/Territory and Gender
2004 to 2031 (in $millions, 2004 Constant dollars)

| Province | Gender | 2004 | 2011 | 2016 | 2021 | 2026 | 2031 |
|---|---|---|---|---|---|---|---|
| BC | Male | $ 2.57 | $ 3.45 | $ 4.22 | $ 5.20 | $ 6.40 | $ 7.69 |
| | Female | $ 2.03 | $ 2.57 | $ 3.05 | $ 3.61 | $ 4.22 | $ 4.85 |
| | **Total** | **$ 4.60** | **$ 6.03** | **$ 7.27** | **$ 8.81** | **$ 10.62** | **$ 12.55** |
| AB | Male | $ 1.28 | $ 1.78 | $ 2.23 | $ 2.79 | $ 3.47 | $ 4.21 |
| | Female | $ 1.14 | $ 1.48 | $ 1.78 | $ 2.12 | $ 2.50 | $ 2.90 |
| | **Total** | **$ 2.42** | **$ 3.26** | **$ 4.01** | **$ 4.91** | **$ 5.98** | **$ 7.10** |
| SK | Male | $ 0.62 | $ 0.72 | $ 0.82 | $ 0.97 | $ 1.16 | $ 1.37 |
| | Female | $ 0.49 | $ 0.54 | $ 0.60 | $ 0.67 | $ 0.76 | $ 0.86 |
| | **Total** | **$ 1.10** | **$ 1.26** | **$ 1.42** | **$ 1.64** | **$ 1.92** | **$ 2.22** |
| MB | Male | $ 0.42 | $ 0.52 | $ 0.61 | $ 0.74 | $ 0.89 | $ 1.05 |
| | Female | $ 0.39 | $ 0.45 | $ 0.51 | $ 0.58 | $ 0.67 | $ 0.75 |
| | **Total** | **$ 0.80** | **$ 0.97** | **$ 1.12** | **$ 1.32** | **$ 1.55** | **$ 1.80** |
| ON | Male | $ 5.25 | $ 7.03 | $ 8.57 | $ 10.56 | $ 13.02 | $ 15.72 |
| | Female | $ 4.26 | $ 5.35 | $ 6.30 | $ 7.39 | $ 8.61 | $ 9.90 |
| | **Total** | **$ 9.51** | **$ 12.39** | **$ 14.87** | **$ 17.95** | **$ 21.63** | **$ 25.62** |
| QC | Male | $ 2.01 | $ 2.67 | $ 3.21 | $ 3.89 | $ 4.69 | $ 5.49 |
| | Female | $ 1.74 | $ 2.14 | $ 2.46 | $ 2.82 | $ 3.18 | $ 3.53 |
| | **Total** | **$ 3.75** | **$ 4.81** | **$ 5.67** | **$ 6.71** | **$ 7.87** | **$ 9.02** |
| NB | Male | $ 0.37 | $ 0.48 | $ 0.58 | $ 0.70 | $ 0.85 | $ 0.99 |
| | Female | $ 0.32 | $ 0.40 | $ 0.46 | $ 0.53 | $ 0.60 | $ 0.66 |
| | **Total** | **$ 0.69** | **$ 0.87** | **$ 1.04** | **$ 1.23** | **$ 1.45** | **$ 1.65** |
| NF&L | Male | $ 0.18 | $ 0.24 | $ 0.29 | $ 0.35 | $ 0.41 | $ 0.48 |
| | Female | $ 0.16 | $ 0.21 | $ 0.24 | $ 0.28 | $ 0.32 | $ 0.36 |
| | **Total** | **$ 0.35** | **$ 0.44** | **$ 0.53** | **$ 0.63** | **$ 0.73** | **$ 0.83** |
| PEI | Male | $ 0.08 | $ 0.11 | $ 0.13 | $ 0.15 | $ 0.18 | $ 0.22 |
| | Female | $ 0.10 | $ 0.12 | $ 0.14 | $ 0.16 | $ 0.19 | $ 0.21 |
| | **Total** | **$ 0.18** | **$ 0.23** | **$ 0.27** | **$ 0.32** | **$ 0.37** | **$ 0.42** |
| NS | Male | $ 0.74 | $ 0.96 | $ 1.15 | $ 1.40 | $ 1.68 | $ 1.96 |
| | Female | $ 0.70 | $ 0.84 | $ 0.97 | $ 1.12 | $ 1.27 | $ 1.42 |
| | **Total** | **$ 1.44** | **$ 1.80** | **$ 2.12** | **$ 2.51** | **$ 2.96** | **$ 3.39** |
| YK/NWT/NV | Male | $ 0.03 | $ 0.04 | $ 0.05 | $ 0.07 | $ 0.08 | $ 0.09 |
| | Female | $ 0.02 | $ 0.02 | $ 0.04 | $ 0.05 | $ 0.06 | $ 0.06 |
| | **Total** | **$ 0.05** | **$ 0.07** | **$ 0.09** | **$ 0.11** | **$ 0.13** | **$ 0.16** |
| **Canada** | **Male** | **$ 13.55** | **$ 18.00** | **$ 21.87** | **$ 26.82** | **$ 32.83** | **$ 39.26** |
| | **Female** | **$ 11.36** | **$ 14.12** | **$ 16.54** | **$ 19.33** | **$ 22.38** | **$ 25.50** |
| | **Total** | **$ 24.90** | **$ 32.13** | **$ 38.41** | **$ 46.15** | **$ 55.21** | **$ 64.76** |

The total estimated annual costs in this area of care for SCC patients increases from $6.3 million in 2004 to $18.0 million in 2031 (see following table).

**Estimated Primary Care Based Costs**
Associated with Squamous Cell Carcinoma in Canada
By Province/Territory and Gender
2004 to 2031 (in $millions, 2004 Constant dollars)

| Province | Gender | 2004 | 2011 | 2016 | 2021 | 2026 | 2031 |
|---|---|---|---|---|---|---|---|
| BC | Male | $ 0.64 | $ 0.88 | $ 1.08 | $ 1.31 | $ 1.59 | $ 1.95 |
| | Female | $ 0.39 | $ 0.52 | $ 0.62 | $ 0.74 | $ 0.90 | $ 1.09 |
| | **Total** | **$ 1.03** | **$ 1.40** | **$ 1.70** | **$ 2.05** | **$ 2.49** | **$ 3.05** |
| AB | Male | $ 0.41 | $ 0.59 | $ 0.75 | $ 0.93 | $ 1.14 | $ 1.41 |
| | Female | $ 0.25 | $ 0.34 | $ 0.42 | $ 0.52 | $ 0.63 | $ 0.79 |
| | **Total** | **$ 0.66** | **$ 0.93** | **$ 1.17** | **$ 1.44** | **$ 1.78** | **$ 2.20** |
| SK | Male | $ 0.22 | $ 0.26 | $ 0.30 | $ 0.34 | $ 0.39 | $ 0.46 |
| | Female | $ 0.12 | $ 0.14 | $ 0.15 | $ 0.17 | $ 0.20 | $ 0.23 |
| | **Total** | **$ 0.34** | **$ 0.40** | **$ 0.45** | **$ 0.51** | **$ 0.59** | **$ 0.69** |
| MB | Male | $ 0.10 | $ 0.12 | $ 0.14 | $ 0.17 | $ 0.20 | $ 0.24 |
| | Female | $ 0.06 | $ 0.07 | $ 0.08 | $ 0.09 | $ 0.11 | $ 0.13 |
| | **Total** | **$ 0.16** | **$ 0.19** | **$ 0.22** | **$ 0.26** | **$ 0.31** | **$ 0.37** |
| ON | Male | $ 1.56 | $ 2.15 | $ 2.66 | $ 3.21 | $ 3.87 | $ 4.71 |
| | Female | $ 0.89 | $ 1.16 | $ 1.38 | $ 1.65 | $ 1.98 | $ 2.41 |
| | **Total** | **$ 2.45** | **$ 3.32** | **$ 4.04** | **$ 4.85** | **$ 5.85** | **$ 7.12** |
| QC | Male | $ 0.58 | $ 0.80 | $ 0.98 | $ 1.18 | $ 1.41 | $ 1.67 |
| | Female | $ 0.37 | $ 0.47 | $ 0.56 | $ 0.65 | $ 0.77 | $ 0.91 |
| | **Total** | **$ 0.95** | **$ 1.27** | **$ 1.53** | **$ 1.83** | **$ 2.17** | **$ 2.58** |
| NB | Male | $ 0.13 | $ 0.17 | $ 0.21 | $ 0.25 | $ 0.30 | $ 0.36 |
| | Female | $ 0.08 | $ 0.10 | $ 0.12 | $ 0.14 | $ 0.17 | $ 0.20 |
| | **Total** | **$ 0.21** | **$ 0.27** | **$ 0.33** | **$ 0.39** | **$ 0.47** | **$ 0.56** |
| NF&L | Male | $ 0.05 | $ 0.07 | $ 0.09 | $ 0.10 | $ 0.12 | $ 0.15 |
| | Female | $ 0.03 | $ 0.04 | $ 0.05 | $ 0.06 | $ 0.08 | $ 0.09 |
| | **Total** | **$ 0.09** | **$ 0.11** | **$ 0.14** | **$ 0.17** | **$ 0.20** | **$ 0.24** |
| PEI | Male | $ 0.02 | $ 0.03 | $ 0.04 | $ 0.05 | $ 0.06 | $ 0.07 |
| | Female | $ 0.02 | $ 0.03 | $ 0.03 | $ 0.04 | $ 0.05 | $ 0.05 |
| | **Total** | **$ 0.05** | **$ 0.06** | **$ 0.07** | **$ 0.09** | **$ 0.10** | **$ 0.12** |
| NS | Male | $ 0.23 | $ 0.29 | $ 0.36 | $ 0.43 | $ 0.51 | $ 0.62 |
| | Female | $ 0.15 | $ 0.19 | $ 0.22 | $ 0.25 | $ 0.30 | $ 0.37 |
| | **Total** | **$ 0.38** | **$ 0.48** | **$ 0.57** | **$ 0.68** | **$ 0.82** | **$ 0.98** |
| YK/NWT/NV | Male | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.02 | $ 0.03 |
| | Female | $ 0.00 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 |
| | **Total** | **$ 0.01** | **$ 0.01** | **$ 0.02** | **$ 0.03** | **$ 0.03** | **$ 0.04** |
| **Canada** | **Male** | **$ 3.96** | **$ 5.37** | **$ 6.60** | **$ 7.96** | **$ 9.60** | **$ 11.66** |
| | **Female** | **$ 2.38** | **$ 3.07** | **$ 3.64** | **$ 4.33** | **$ 5.20** | **$ 6.29** |
| | **Total** | **$ 6.34** | **$ 8.44** | **$ 10.24** | **$ 12.29** | **$ 14.80** | **$ 17.95** |

## Day Surgery/Outpatient Clinic

Actual data on the utilization of outpatient services by skin cancer patients in Canada is limited. The province of B.C. does provide information on the number of patients with a "melanoma or other malignant neoplasm" who receive day care surgery in a given fiscal year, as well as the number of acute care admissions, stratified by age group (see table below).[317] This information was used to calculate the ratio of day surgery cases to acute care admissions. This ratio, averaged over four fiscal years, was 5.21. This average ratio for day surgery procedures to inpatient admissions appears to be in reasonable alignment with information from other jurisdictions, for example, the U.S. (7.59)[318] and England (3.50).[319]

**Melanoma and Other Malignant Neoplasms**
**British Columbia**

| | 2001/02 | 2002/03 | 2003/04 | 2004/05 | Mean |
|---|---|---|---|---|---|
| **Acute Care Cases by Age** | | | | | |
| 0-44 | 13 | 20 | 15 | 12 | **15** |
| 45-64 | 38 | 65 | 43 | 49 | **49** |
| 65-74 | 37 | 32 | 34 | 29 | **33** |
| 75-84 | 54 | 51 | 45 | 60 | **53** |
| 85+ | 27 | 14 | 29 | 33 | **26** |
| **Total** | **169** | **182** | **166** | **183** | **175** |
| **Day Care Surgery Cases by Age** | | | | | |
| 0-44 | 72 | 78 | 67 | 82 | **75** |
| 45-64 | 226 | 239 | 289 | 316 | **268** |
| 65-74 | 200 | 178 | 207 | 213 | **200** |
| 75-84 | 261 | 251 | 248 | 278 | **260** |
| 85+ | 107 | 95 | 113 | 127 | **111** |
| **Total** | **866** | **841** | **924** | **1,016** | **912** |
| **Ratio of Day Surgery to Acute Care** | | | | | |
| 0-44 | 5.54 | 3.90 | 4.47 | 6.83 | **4.98** |
| 45-64 | 5.95 | 3.68 | 6.72 | 6.45 | **5.49** |
| 65-74 | 5.41 | 5.56 | 6.09 | 7.34 | **6.05** |
| 75-84 | 4.83 | 4.92 | 5.51 | 4.63 | **4.94** |
| 85+ | 3.96 | 6.79 | 3.90 | 3.85 | **4.29** |
| **Total** | **5.12** | **4.62** | **5.57** | **5.55** | **5.21** |

*Source: British Columbia Ministry of Health* Health Ideas *database*

This ratio, stratified by age group, was used to estimate the volume of day surgery procedures in other provinces using known data on hospital separations from other provinces, stratified across the three main types of skin malignancy (see the next section of the appendix for details).

As well as limited data on utilization, there is little available data on the actual costs of day care surgery for skin cancer patients. One source is cost information from the Ontario Case Costing Initiative. Based on data from this system, a day surgery procedure for melanoma or other malignant neoplasm costs approximately $2,085 (see following table).

[317] Derived from the Health Ideas database of the B.C. Ministry of Health.
[318] Lewin Group Inc. *The Burden of Skin Diseases 2004.* 2006. Society for Investigative Dermatology and American Academy of Dermatology Association. Available at http://www.lewin.com/content/publications/april2005skindisease.pdf. Accessed January 2009.
[319] Morris S, Cox B, Bosanquet N. Cost of skin cancer in England. *European Journal of Health Economics.* 2008: Epublished ahead of print.

| Melanoma and Other Malignant Neoplasms<br>Cost of Treatment<br>Ontario | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2002/03 | 2003/04 | 2004/05 | 2005/06 | 2006/07 | 2007/08 | Mean |
| **Day Surgery** | | | | | | | |
| Cases | 168 | 89 | 104 | 117 | 124 | 114 | **119** |
| Cost | $ 2,068 | $ 1,849 | $ 1,735 | $ 1,919 | $ 2,322 | $ 2,524 | **$ 2,085** |
| *Source: Ontario Case Costing Initiative Diagnsosis C43x* | | | | | | | |

Day surgery costs vary by province/territory based on the unit cost of production, most closely associated with differences in labour rates paid to health care workers. Labour costs are the largest single components of day surgery costs; further, the costs of nursing staff are the largest proportion of total labour costs.

Differences in the annual salary of general duty nurses in each of the provinces were thus used as a proxy for differences in the unit cost of production in the acute care setting. Data on the annual salary of a general duty nurse were used to determine differences in pay rates between the provinces.[320] Based on this approach, the unit costs of production in Alberta are 1.91% higher than those in Ontario. Other than the province of Alberta, the unit cost of production is lower than that of Ontario in all other provinces, as indicated in the following table.

| Variance in Annual Salary of a General Duty Registered Nurse<br>By Province in 2007/08 | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Dollars per Hour | | | Annual | Annual Income | | | |
| Union | Province | Min | Max | Mid | Hours | Min | Max | ***Mid*** | ***% Var*** |
| ONA | Ontario | $26.80 | $38.74 | $32.77 | 1,950.00 | $52,260.00 | $75,543.00 | ***$63,901.50*** | |
| UNA | Alberta | $29.33 | $38.50 | $33.92 | 1,920.75 | $56,337.52 | $73,950.80 | ***$65,144.16*** | ***1.91%*** |
| BCNU | British Columbia | $26.91 | $35.32 | $31.12 | 1,879.20 | $50,569.27 | $66,373.34 | ***$58,471.31*** | ***-9.29%*** |
| SUN | Saskatchewan | $26.90 | $32.96 | $29.93 | 1,948.80 | $52,422.72 | $64,232.45 | ***$58,327.58*** | ***-9.56%*** |
| MNU | Manitoba | $26.80 | $31.59 | $29.20 | 2,015.00 | $53,997.22 | $63,658.27 | ***$58,827.75*** | ***-8.62%*** |
| NBNU | New Brunswick | $26.38 | $31.49 | $28.94 | 1,957.50 | $51,638.85 | $61,641.68 | ***$56,640.26*** | ***-12.82%*** |
| NSNU | Nova Scotia | $26.28 | $30.72 | $28.50 | 1,950.00 | $51,252.00 | $59,895.00 | ***$55,573.50*** | ***-14.99%*** |
| FIQ | Quebec | $20.58 | $30.65 | $25.62 | 1,891.50 | $38,927.07 | $57,974.48 | ***$48,450.77*** | ***-31.89%*** |
| PEINU | PEI | $25.13 | $30.62 | $27.88 | 1,950.00 | $49,003.50 | $59,709.00 | ***$54,356.25*** | ***-17.56%*** |
| NLNU | Newfoundland + Labrador | $23.48 | $30.00 | $26.74 | 1,950.00 | $45,782.21 | $58,503.90 | ***$52,143.06*** | ***-22.55%*** |

Combining Ontario day surgery costs and the variation in nursing salaries across the provinces yields the estimated cost for a day surgery episode in different parts of the country (see the following table).

[320] Manitoba Nurses' Union , *CFNU Contract Comparison Document. Nurse's Union Affiliates of CFNU and Other Unions Representing Nurses*. Updated December 17, 2007. Available at http://www.nursesunions.ca/media.php?mid=335 (Accessed April, 2009).

| Melanoma and Other Malignant Neoplasms<br>Estimated Cost per Day Surgery<br>By Province | | | |
|---|---|---|---|
| **Province** | ***% Var*** | | **Cost** |
| ***Ontario Average*** | | ***$*** | ***2,085*** |
| British Columbia | -9.29% | $ | 1,891 |
| Alberta | 1.91% | $ | 2,125 |
| Saskatchewan | -9.56% | $ | 1,886 |
| Manitoba | -8.62% | $ | 1,905 |
| Quebec | -31.89% | $ | 1,420 |
| New Brunswick | -12.82% | $ | 1,818 |
| Newfoundland + Labrador | -22.55% | $ | 1,615 |
| PEI | -17.56% | $ | 1,719 |
| Nova Scotia | -14.99% | $ | 1,773 |

One final adjustment involved estimating the number of day surgery cases associated with MSC vs. NMSC. To this point, the data has been based on all "melanoma and other malignant neoplasm" which includes both MSC and NMSC. Research in New Zealand suggests a ratio of 0.694 hospital admissions per new melanoma case and 0.130 hospital admissions per new NMSC case.[321] That is, an estimated 84.2% of hospitalizations were for melanoma and 15.8% for NMSC. This ratio was used to apportion day surgery cases into MSC and NMSC.

NMSC cases were then allocated into BCC and SCC based on research by Lucas and colleagues which suggests that in 1% of new BCC and 0.1% of new SCC cases, the cancer is disseminated and that these patients would require hospital-based care.[322] Based on the estimated volume of new BCC and SCC cases in Canada in 2004, we calculated that the 28.3% of the NMSC hospital-based care would be for BCC and 71.7% for SCC.

Combining the estimated number of day surgeries with the estimated provincial costs per surgery yields the projected total costs for each of melanoma, BCC and SCC, as outlined below.

The total estimated annual day surgery costs for **melanoma** patients increases from $17.0 million in 2004 to $36.8 million in 2031 (see following table).

[321] New Zealand Cancer Society. The Cost of Skin Cancer in New Zealand, *Cancer Update in Practice*, Issue 2, 2000.
[322] Lucas R, McMichael T, Smith W et al. *Solar ultraviolet radiation: global burden or disease from solar ultraviolet radiation*. 2006. World Health Organization. Available at http://www.who.int/uv/health/solaruvradfull_180706.pdf. Accessed January 2009.

**Estimated Day Surgery Costs**
Associated with Cutaneous Melanoma in Canada
By Province/Territory and Gender
2004 to 2031 (in $millions, 2004 Constant dollars)

| Province | Gender | 2004 | 2011 | 2016 | 2021 | 2026 | 2031 |
|---|---|---|---|---|---|---|---|
| BC | Male | $ 0.89 | $ 1.13 | $ 1.35 | $ 1.58 | $ 1.83 | $ 2.07 |
| | Female | $ 0.79 | $ 0.95 | $ 1.10 | $ 1.27 | $ 1.47 | $ 1.66 |
| | **Total** | **$ 1.68** | **$ 2.07** | **$ 2.45** | **$ 2.85** | **$ 3.29** | **$ 3.73** |
| AB | Male | $ 0.89 | $ 1.05 | $ 1.27 | $ 1.51 | $ 1.79 | $ 2.06 |
| | Female | $ 0.72 | $ 0.85 | $ 1.00 | $ 1.16 | $ 1.37 | $ 1.58 |
| | **Total** | **$ 1.61** | **$ 1.90** | **$ 2.27** | **$ 2.67** | **$ 3.15** | **$ 3.63** |
| SK | Male | $ 0.38 | $ 0.49 | $ 0.55 | $ 0.62 | $ 0.69 | $ 0.76 |
| | Female | $ 0.28 | $ 0.31 | $ 0.33 | $ 0.36 | $ 0.40 | $ 0.45 |
| | **Total** | **$ 0.66** | **$ 0.80** | **$ 0.88** | **$ 0.98** | **$ 1.10** | **$ 1.21** |
| MB | Male | $ 0.36 | $ 0.41 | $ 0.47 | $ 0.54 | $ 0.61 | $ 0.68 |
| | Female | $ 0.25 | $ 0.30 | $ 0.34 | $ 0.38 | $ 0.42 | $ 0.47 |
| | **Total** | **$ 0.62** | **$ 0.70** | **$ 0.81** | **$ 0.91** | **$ 1.03** | **$ 1.15** |
| ON | Male | $ 3.78 | $ 4.77 | $ 5.71 | $ 6.68 | $ 7.79 | $ 8.90 |
| | Female | $ 2.84 | $ 3.22 | $ 3.76 | $ 4.34 | $ 5.01 | $ 5.72 |
| | **Total** | **$ 6.62** | **$ 8.00** | **$ 9.46** | **$ 11.01** | **$ 12.80** | **$ 14.62** |
| QC | Male | $ 2.17 | $ 2.82 | $ 3.30 | $ 3.75 | $ 4.24 | $ 4.69 |
| | Female | $ 1.56 | $ 2.23 | $ 2.54 | $ 2.85 | $ 3.18 | $ 3.47 |
| | **Total** | **$ 3.73** | **$ 5.04** | **$ 5.84** | **$ 6.60** | **$ 7.43** | **$ 8.16** |
| NB | Male | $ 0.27 | $ 0.32 | $ 0.38 | $ 0.43 | $ 0.49 | $ 0.54 |
| | Female | $ 0.25 | $ 0.34 | $ 0.40 | $ 0.45 | $ 0.50 | $ 0.55 |
| | **Total** | **$ 0.52** | **$ 0.66** | **$ 0.77** | **$ 0.88** | **$ 1.00** | **$ 1.10** |
| NF&L | Male | $ 0.25 | $ 0.35 | $ 0.41 | $ 0.46 | $ 0.52 | $ 0.56 |
| | Female | $ 0.19 | $ 0.22 | $ 0.25 | $ 0.29 | $ 0.33 | $ 0.36 |
| | **Total** | **$ 0.44** | **$ 0.57** | **$ 0.66** | **$ 0.75** | **$ 0.84** | **$ 0.92** |
| PEI | Male | $ 0.04 | $ 0.06 | $ 0.07 | $ 0.08 | $ 0.09 | $ 0.10 |
| | Female | $ 0.05 | $ 0.06 | $ 0.07 | $ 0.08 | $ 0.09 | $ 0.10 |
| | **Total** | **$ 0.09** | **$ 0.12** | **$ 0.14** | **$ 0.16** | **$ 0.18** | **$ 0.20** |
| NS | Male | $ 0.62 | $ 0.77 | $ 0.91 | $ 1.04 | $ 1.19 | $ 1.31 |
| | Female | $ 0.38 | $ 0.39 | $ 0.44 | $ 0.51 | $ 0.58 | $ 0.64 |
| | **Total** | **$ 1.01** | **$ 1.16** | **$ 1.36** | **$ 1.55** | **$ 1.76** | **$ 1.94** |
| YK/NWT/NV | Male | $ 0.02 | $ 0.03 | $ 0.03 | $ 0.04 | $ 0.04 | $ 0.05 |
| | Female | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.03 | $ 0.03 | $ 0.03 |
| | **Total** | **$ 0.04** | **$ 0.04** | **$ 0.05** | **$ 0.06** | **$ 0.07** | **$ 0.08** |
| **Canada** | **Male** | **$ 9.68** | **$ 12.20** | **$ 14.44** | **$ 16.73** | **$ 19.29** | **$ 21.71** |
| | **Female** | **$ 7.33** | **$ 8.88** | **$ 10.25** | **$ 11.71** | **$ 13.38** | **$ 15.03** |
| | **Total** | **$ 17.01** | **$ 21.08** | **$ 24.70** | **$ 28.43** | **$ 32.66** | **$ 36.75** |

The total estimated annual day surgery costs for **BCC** patients increases from $0.9 million in 2004 to $2.5 million in 2031 (see following table).

**Estimated Day Surgery Costs**
Associated with Basal Cell Carcinoma in Canada
By Province/Territory and Gender
2004 to 2031 (in $millions, 2004 Constant dollars)

| Province | Gender | 2004 | 2011 | 2016 | 2021 | 2026 | 2031 |
|---|---|---|---|---|---|---|---|
| BC | Male | $ 0.09 | $ 0.12 | $ 0.15 | $ 0.19 | $ 0.23 | $ 0.27 |
| | Female | $ 0.07 | $ 0.09 | $ 0.11 | $ 0.13 | $ 0.15 | $ 0.17 |
| | **Total** | **$ 0.16** | **$ 0.22** | **$ 0.26** | **$ 0.32** | **$ 0.38** | **$ 0.45** |
| AB | Male | $ 0.05 | $ 0.07 | $ 0.08 | $ 0.10 | $ 0.13 | $ 0.16 |
| | Female | $ 0.04 | $ 0.05 | $ 0.07 | $ 0.08 | $ 0.09 | $ 0.11 |
| | **Total** | **$ 0.09** | **$ 0.12** | **$ 0.15** | **$ 0.18** | **$ 0.22** | **$ 0.26** |
| SK | Male | $ 0.02 | $ 0.02 | $ 0.02 | $ 0.03 | $ 0.03 | $ 0.04 |
| | Female | $ 0.01 | $ 0.02 | $ 0.02 | $ 0.02 | $ 0.02 | $ 0.03 |
| | **Total** | **$ 0.03** | **$ 0.04** | **$ 0.04** | **$ 0.05** | **$ 0.06** | **$ 0.07** |
| MB | Male | $ 0.02 | $ 0.02 | $ 0.02 | $ 0.03 | $ 0.04 | $ 0.04 |
| | Female | $ 0.02 | $ 0.02 | $ 0.02 | $ 0.02 | $ 0.03 | $ 0.03 |
| | **Total** | **$ 0.03** | **$ 0.04** | **$ 0.04** | **$ 0.05** | **$ 0.06** | **$ 0.07** |
| ON | Male | $ 0.23 | $ 0.31 | $ 0.38 | $ 0.47 | $ 0.58 | $ 0.70 |
| | Female | $ 0.19 | $ 0.24 | $ 0.28 | $ 0.33 | $ 0.38 | $ 0.44 |
| | **Total** | **$ 0.42** | **$ 0.55** | **$ 0.66** | **$ 0.80** | **$ 0.96** | **$ 1.14** |
| QC | Male | $ 0.07 | $ 0.09 | $ 0.11 | $ 0.13 | $ 0.15 | $ 0.18 |
| | Female | $ 0.06 | $ 0.07 | $ 0.08 | $ 0.09 | $ 0.10 | $ 0.11 |
| | **Total** | **$ 0.12** | **$ 0.16** | **$ 0.19** | **$ 0.22** | **$ 0.26** | **$ 0.29** |
| NB | Male | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.02 | $ 0.02 | $ 0.03 |
| | Female | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.02 |
| | **Total** | **$ 0.02** | **$ 0.02** | **$ 0.03** | **$ 0.03** | **$ 0.04** | **$ 0.04** |
| NF&L | Male | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 |
| | Female | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 |
| | **Total** | **$ 0.01** | **$ 0.01** | **$ 0.02** | **$ 0.02** | **$ 0.02** | **$ 0.02** |
| PEI | Male | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.01 | $ 0.01 |
| | Female | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.01 | $ 0.01 |
| | **Total** | **$ 0.01** | **$ 0.01** | **$ 0.01** | **$ 0.01** | **$ 0.01** | **$ 0.01** |
| NS | Male | $ 0.02 | $ 0.03 | $ 0.03 | $ 0.04 | $ 0.04 | $ 0.05 |
| | Female | $ 0.02 | $ 0.02 | $ 0.03 | $ 0.03 | $ 0.03 | $ 0.04 |
| | **Total** | **$ 0.04** | **$ 0.05** | **$ 0.06** | **$ 0.07** | **$ 0.08** | **$ 0.09** |
| YK/NWT/NV | Male | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 |
| | Female | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 |
| | **Total** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** |
| **Canada** | **Male** | **$ 0.51** | **$ 0.68** | **$ 0.83** | **$ 1.03** | **$ 1.25** | **$ 1.49** |
| | **Female** | **$ 0.42** | **$ 0.53** | **$ 0.62** | **$ 0.73** | **$ 0.85** | **$ 0.96** |
| | **Total** | **$ 0.94** | **$ 1.21** | **$ 1.46** | **$ 1.76** | **$ 2.10** | **$ 2.45** |

The total estimated annual day surgery costs for **SCC** patients increases from $2.3 million in 2004 to $6.4 million in 2031 (see following table).

**Estimated Day Surgery Costs**
Associated with Squamous Cell Carcinoma in Canada
By Province/Territory and Gender
2004 to 2031 (in $millions, 2004 Constant dollars)

| Province | Gender | 2004 | 2011 | 2016 | 2021 | 2026 | 2031 |
|---|---|---|---|---|---|---|---|
| BC | Male | $ 0.22 | $ 0.30 | $ 0.37 | $ 0.45 | $ 0.54 | $ 0.66 |
| | Female | $ 0.13 | $ 0.18 | $ 0.21 | $ 0.26 | $ 0.31 | $ 0.37 |
| | **Total** | **$ 0.35** | **$ 0.48** | **$ 0.58** | **$ 0.70** | **$ 0.85** | **$ 1.03** |
| AB | Male | $ 0.15 | $ 0.21 | $ 0.27 | $ 0.33 | $ 0.41 | $ 0.50 |
| | Female | $ 0.09 | $ 0.12 | $ 0.15 | $ 0.18 | $ 0.22 | $ 0.27 |
| | **Total** | **$ 0.24** | **$ 0.33** | **$ 0.41** | **$ 0.51** | **$ 0.63** | **$ 0.77** |
| SK | Male | $ 0.06 | $ 0.07 | $ 0.08 | $ 0.10 | $ 0.11 | $ 0.13 |
| | Female | $ 0.03 | $ 0.04 | $ 0.04 | $ 0.05 | $ 0.06 | $ 0.06 |
| | **Total** | **$ 0.10** | **$ 0.11** | **$ 0.13** | **$ 0.14** | **$ 0.17** | **$ 0.19** |
| MB | Male | $ 0.04 | $ 0.05 | $ 0.05 | $ 0.06 | $ 0.07 | $ 0.09 |
| | Female | $ 0.02 | $ 0.03 | $ 0.03 | $ 0.04 | $ 0.04 | $ 0.05 |
| | **Total** | **$ 0.06** | **$ 0.07** | **$ 0.08** | **$ 0.10** | **$ 0.12** | **$ 0.14** |
| ON | Male | $ 0.67 | $ 0.92 | $ 1.13 | $ 1.37 | $ 1.64 | $ 1.99 |
| | Female | $ 0.38 | $ 0.49 | $ 0.58 | $ 0.70 | $ 0.84 | $ 1.01 |
| | **Total** | **$ 1.05** | **$ 1.41** | **$ 1.72** | **$ 2.07** | **$ 2.48** | **$ 3.00** |
| QC | Male | $ 0.19 | $ 0.25 | $ 0.31 | $ 0.37 | $ 0.44 | $ 0.52 |
| | Female | $ 0.11 | $ 0.15 | $ 0.17 | $ 0.20 | $ 0.24 | $ 0.28 |
| | **Total** | **$ 0.30** | **$ 0.40** | **$ 0.48** | **$ 0.57** | **$ 0.68** | **$ 0.80** |
| NB | Male | $ 0.04 | $ 0.05 | $ 0.06 | $ 0.07 | $ 0.08 | $ 0.09 |
| | Female | $ 0.02 | $ 0.03 | $ 0.03 | $ 0.04 | $ 0.04 | $ 0.05 |
| | **Total** | **$ 0.06** | **$ 0.07** | **$ 0.09** | **$ 0.10** | **$ 0.12** | **$ 0.14** |
| NF&L | Male | $ 0.02 | $ 0.02 | $ 0.03 | $ 0.03 | $ 0.04 | $ 0.04 |
| | Female | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.02 | $ 0.03 |
| | **Total** | **$ 0.03** | **$ 0.03** | **$ 0.04** | **$ 0.05** | **$ 0.06** | **$ 0.07** |
| PEI | Male | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.02 |
| | Female | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 |
| | **Total** | **$ 0.01** | **$ 0.02** | **$ 0.02** | **$ 0.02** | **$ 0.03** | **$ 0.03** |
| NS | Male | $ 0.05 | $ 0.07 | $ 0.08 | $ 0.10 | $ 0.11 | $ 0.12 |
| | Female | $ 0.03 | $ 0.04 | $ 0.05 | $ 0.06 | $ 0.07 | $ 0.08 |
| | **Total** | **$ 0.08** | **$ 0.11** | **$ 0.13** | **$ 0.16** | **$ 0.18** | **$ 0.20** |
| YK/NWT/NV | Male | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.01 |
| | Female | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 |
| | **Total** | **$ 0.00** | **$ 0.00** | **$ 0.01** | **$ 0.01** | **$ 0.01** | **$ 0.01** |
| **Canada** | **Male** | **$ 1.44** | **$ 1.94** | **$ 2.39** | **$ 2.89** | **$ 3.46** | **$ 4.16** |
| | **Female** | **$ 0.84** | **$ 1.08** | **$ 1.30** | **$ 1.55** | **$ 1.85** | **$ 2.22** |
| | **Total** | **$ 2.28** | **$ 3.03** | **$ 3.69** | **$ 4.44** | **$ 5.31** | **$ 6.38** |

## Inpatient Hospital Stays

The final element of direct costing comprises hospital stays. In Canada, the Canadian Institute for Health Information (CIHI) produced a series of *Tabular Reports* from their Hospital Morbidity Database that included information on the number of hospital separations and days by Canadian Diagnosis List, including '27-Malignant Neoplasms of Skin.'[323] These reports provided data by gender, age group, and province/territory. Unfortunately, publication of this information ended following the 2000/01 fiscal year. The most recent data available from this source is summarized in the following two tables, as introduced below.

The following table provides information on the number of separations, days, and average length of hospital stay (ALOS) by province/territory and gender for the four years from 1997/98 to 2000/01. On average, individuals with diagnosed skin cancers in Canada generated 2,076 acute care hospital separations per year, at an ALOS of 6.28 days. Males generated 1,176 hospital separations per year, at an ALOS of 6.14 days. Females, on the other hand, generated 901 hospital separations per year, at an ALOS of 6.46 days.

**Malignant Neoplasms of Skin**
**Hospital Separations, Days and Average Length of Stay**
**By Province/Territory and Gender**
**1997/98 to 2000/01**

| | | Separations | | | | | Days | | | | | Average Length of Stay | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 1997/98 | 1998/99 | 1999/00 | 2000/01 | Mean | 1997/98 | 1998/99 | 1999/00 | 2000/01 | Mean | 1997/98 | 1998/99 | 1999/00 | 2000/01 | Mean |
| BC | Male | 104 | 113 | 112 | 94 | 106 | 425 | 560 | 562 | 437 | 496 | 4.09 | 4.96 | 5.02 | 4.65 | 4.69 |
| | Female | 102 | 110 | 82 | 86 | 95 | 599 | 481 | 384 | 643 | 527 | 5.87 | 4.37 | 4.68 | 7.48 | 5.54 |
| | **Total** | **206** | **223** | **194** | **180** | **201** | **1,024** | **1,041** | **946** | **1,080** | **1,023** | **4.97** | **4.67** | **4.88** | **6.00** | **5.09** |
| AB | Male | 93 | 104 | 87 | 88 | 93 | 416 | 409 | 393 | 395 | 403 | 4.47 | 3.93 | 4.52 | 4.49 | 4.34 |
| | Female | 79 | 80 | 69 | 82 | 78 | 368 | 479 | 425 | 430 | 426 | 4.66 | 5.99 | 6.16 | 5.24 | 5.49 |
| | **Total** | **172** | **184** | **156** | **170** | **171** | **784** | **888** | **818** | **825** | **829** | **4.56** | **4.83** | **5.24** | **4.85** | **4.86** |
| SK | Male | 49 | 36 | 42 | 55 | 46 | 380 | 204 | 165 | 376 | 281 | 7.76 | 5.67 | 3.93 | 6.84 | 6.18 |
| | Female | 39 | 29 | 33 | 34 | 34 | 234 | 249 | 174 | 171 | 207 | 6.00 | 8.59 | 5.27 | 5.03 | 6.13 |
| | **Total** | **88** | **65** | **75** | **89** | **79** | **614** | **453** | **339** | **547** | **488** | **6.98** | **6.97** | **4.52** | **6.15** | **6.16** |
| MB | Male | 43 | 37 | 41 | 46 | 42 | 205 | 223 | 265 | 281 | 244 | 4.77 | 6.03 | 6.46 | 6.11 | 5.83 |
| | Female | 38 | 25 | 29 | 29 | 30 | 535 | 250 | 398 | 214 | 349 | 14.08 | 10.00 | 13.72 | 7.38 | 11.55 |
| | **Total** | **81** | **62** | **70** | **75** | **72** | **740** | **473** | **663** | **495** | **593** | **9.14** | **7.63** | **9.47** | **6.60** | **8.23** |
| ON | Male | 396 | 394 | 437 | 392 | 405 | 1,939 | 1,906 | 2,311 | 1,659 | 1,954 | 4.90 | 4.84 | 5.29 | 4.23 | 4.83 |
| | Female | 313 | 316 | 315 | 281 | 306 | 1,994 | 1,722 | 1,540 | 1,362 | 1,655 | 6.37 | 5.45 | 4.89 | 4.85 | 5.40 |
| | **Total** | **709** | **710** | **752** | **673** | **711** | **3,933** | **3,628** | **3,851** | **3,021** | **3,608** | **5.55** | **5.11** | **5.12** | **4.49** | **5.07** |
| QC | Male | 339 | 317 | 348 | 339 | 336 | 2,591 | 2,512 | 3,093 | 3,189 | 2,846 | 7.64 | 7.92 | 8.89 | 9.41 | 8.48 |
| | Female | 209 | 275 | 270 | 228 | 246 | 1,499 | 1,907 | 2,346 | 1,827 | 1,895 | 7.17 | 6.93 | 8.69 | 8.01 | 7.72 |
| | **Total** | **548** | **592** | **618** | **567** | **581** | **4,090** | **4,419** | **5,439** | **5,016** | **4,741** | **7.46** | **7.46** | **8.80** | **8.85** | **8.16** |
| NB | Male | 35 | 26 | 40 | 29 | 33 | 408 | 207 | 262 | 99 | 244 | 11.66 | 7.96 | 6.55 | 3.41 | 7.51 |
| | Female | 33 | 34 | 31 | 31 | 32 | 137 | 183 | 274 | 237 | 208 | 4.15 | 5.38 | 8.84 | 7.65 | 6.44 |
| | **Total** | **68** | **60** | **71** | **60** | **65** | **545** | **390** | **536** | **336** | **452** | **8.01** | **6.50** | **7.55** | **5.60** | **6.98** |
| NF&L | Male | 42 | 42 | 28 | 26 | 35 | 305 | 381 | 129 | 352 | 292 | 7.26 | 9.07 | 4.61 | 13.54 | 8.46 |
| | Female | 33 | 31 | 21 | 21 | 27 | 244 | 307 | 199 | 171 | 230 | 7.39 | 9.90 | 9.48 | 8.14 | 8.69 |
| | **Total** | **75** | **73** | **49** | **47** | **61** | **549** | **688** | **328** | **523** | **522** | **7.32** | **9.42** | **6.69** | **11.13** | **8.56** |
| PEI | Male | 8 | | | | 8 | 97 | 45 | - | 18 | 40 | | | | | |
| | Female | | | 10 | | 10 | 7 | 15 | 58 | 8 | 22 | | | | | |
| | **Total** | **8** | **-** | **10** | **-** | **5** | **104** | **60** | **58** | **26** | **62** | | | | | |
| NS | Male | 71 | 74 | 90 | 74 | 77 | 604 | 354 | 400 | 288 | 412 | 8.51 | 4.78 | 4.44 | 3.89 | 5.33 |
| | Female | 49 | 53 | 44 | 52 | 50 | 322 | 189 | 155 | 232 | 225 | 6.57 | 3.57 | 3.52 | 4.46 | 4.54 |
| | **Total** | **120** | **127** | **134** | **126** | **127** | **926** | **543** | **555** | **520** | **636** | **7.72** | **4.28** | **4.14** | **4.13** | **5.02** |
| YK/NWT/NV | Male | - | - | - | - | - | - | | - | - | - | | | | | |
| | Female | - | - | - | - | - | - | - | - | 374 | 94 | | | | | |
| | **Total** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **-** | **374** | **94** | | | | | |
| **Canada** | Male | **1,181** | **1,146** | **1,226** | **1,149** | **1,176** | **7,373** | **6,801** | **7,589** | **7,096** | **7,215** | 6.24 | 5.93 | 6.19 | 6.18 | 6.14 |
| | Female | **898** | **954** | **905** | **846** | **901** | **5,939** | **5,722** | **5,957** | **5,669** | **5,822** | 6.61 | 6.00 | 6.58 | 6.70 | 6.46 |
| | **Total** | **2,079** | **2,100** | **2,131** | **1,995** | **2,076** | **13,312** | **12,523** | **13,546** | **12,765** | **13,037** | **6.40** | **5.96** | **6.36** | **6.40** | **6.28** |

*Source: Hospital Morbidity Database 1997/98 to 2000/01 - Tabular Reports. Canadian Institute for Health Information.*

[323] Canadian Institute for Health Information. *Hospital Morbidity Database 1997/98 – 2000/01 Tabular Reports*. Available at http://secure.cihi.ca/cihiweb/products/HospitalMorbidityTabularReports[*fiscal year*].pdf

The following table provides the same information on the number of separations, days, and average length of hospital stay (ALOS) by age group (and gender) for the four years from 1997/98 to 2000/01. Of the total separations, 12.7% were for patients from 0-44 years of age, 29.8% from 45-64 years of age, 23.1% from 65-74 years of age, and 34.4% for age 75+. Average length of stay tends to increase with advanced age, from 4.84 days for those under age 45 to 7.35 days for those aged 75+.

**Malignant Neoplasms of Skin**
**Hospital Separations, Days and ALOS**
**Canada By Age Group**
**1997/98 to 2000/01**

| | By Age group | | | | |
|---|---|---|---|---|---|
| | **0-44** | **45-64** | **65-74** | **75+** | **All** |
| **1997/98** | | | | | |
| ***Males*** | | | | | |
| Separations | 127 | 374 | 309 | 371 | **1,181** |
| ALOS | 6.25 | 5.55 | 6.10 | 7.06 | **6.24** |
| Days | 794 | 2,075 | 1,885 | 2,619 | **7,373** |
| ***Females*** | | | | | |
| Separations | 120 | 247 | 210 | 321 | **898** |
| ALOS | 4.03 | 6.13 | 7.25 | 7.54 | **6.61** |
| Days | 484 | 1,514 | 1,522 | 2,419 | **5,939** |
| ***Total*** | | | | | |
| **Separations** | **247** | **621** | **519** | **692** | **2,079** |
| **ALOS** | **5.17** | **5.78** | **6.56** | **7.28** | **6.40** |
| **Days** | **1,278** | **3,589** | **3,407** | **5,038** | **13,312** |
| **1998/99** | | | | | |
| ***Males*** | | | | | |
| Separations | 158 | 350 | 281 | 357 | **1,146** |
| ALOS | 4.21 | 5.22 | 6.26 | 7.14 | **5.93** |
| Days | 665 | 1,827 | 1,759 | 2,550 | **6,801** |
| ***Females*** | | | | | |
| Separations | 127 | 260 | 246 | 321 | **954** |
| ALOS | 4.32 | 4.77 | 6.70 | 7.12 | **6.00** |
| Days | 549 | 1,241 | 1,647 | 2,285 | **5,722** |
| ***Total*** | | | | | |
| **Separations** | **285** | **610** | **527** | **678** | **2,100** |
| **ALOS** | **4.26** | **5.03** | **6.46** | **7.13** | **5.96** |
| **Days** | **1,214** | **3,068** | **3,406** | **4,835** | **12,523** |
| **1999/00** | | | | | |
| ***Males*** | | | | | |
| Separations | 169 | 377 | 283 | 397 | **1,226** |
| ALOS | 5.83 | 5.29 | 6.80 | 6.76 | **6.19** |
| Days | 986 | 1,995 | 1,925 | 2,683 | **7,589** |
| ***Females*** | | | | | |
| Separations | 133 | 254 | 176 | 342 | **905** |
| ALOS | 4.18 | 5.36 | 8.09 | 7.65 | **6.58** |
| Days | 556 | 1,362 | 1,424 | 2,615 | **5,957** |
| ***Total*** | | | | | |
| **Separations** | **302** | **631** | **459** | **739** | **2,131** |
| **ALOS** | **5.11** | **5.32** | **7.30** | **7.17** | **6.36** |
| **Days** | **1,542** | **3,357** | **3,349** | **5,298** | **13,546** |
| **2000/01** | | | | | |
| ***Males*** | | | | | |
| Separations | 110 | 366 | 277 | 396 | **1,149** |
| ALOS | 6.35 | 4.71 | 6.80 | 7.05 | **6.18** |
| Days | 699 | 1,724 | 1,883 | 2,790 | **7,096** |
| ***Females*** | | | | | |
| Separations | 110 | 246 | 135 | 355 | **846** |
| ALOS | 3.32 | 5.91 | 5.96 | 8.58 | **6.70** |
| Days | 365 | 1,453 | 804 | 3,047 | **5,669** |
| ***Total*** | | | | | |
| **Separations** | **220** | **612** | **412** | **751** | **1,995** |
| **ALOS** | **4.84** | **5.19** | **6.52** | **7.77** | **6.40** |
| **Days** | **1,064** | **3,177** | **2,687** | **5,837** | **12,765** |
| ***Five Year Total*** | | | | | |
| Males | | | | | |
| Separations | 564 | 1,467 | 1,150 | 1,521 | **4,702** |
| ALOS | 5.57 | 5.19 | 6.48 | 7.00 | **6.14** |
| Days | 3,144 | 7,621 | 7,452 | 10,642 | **28,859** |
| Females | | | | | |
| Separations | 490 | 1,007 | 767 | 1,339 | **3,603** |
| ALOS | 3.99 | 5.53 | 7.04 | 7.74 | **6.46** |
| Days | 1,954 | 5,570 | 5,397 | 10,366 | **23,287** |
| **Total** | | | | | |
| **Separations** | **1,054** | **2,474** | **1,917** | **2,860** | **8,305** |
| **ALOS** | **4.84** | **5.33** | **6.70** | **7.35** | **6.28** |
| **Days** | **5,098** | **13,191** | **12,849** | **21,008** | **52,146** |

The Canadian Diagnosis List category '*27-Malignant Neoplasms of Skin*' includes hospitalizations for both melanoma and non-melanoma skin cancers. As noted above, research in New Zealand was used to estimate the proportion of hospitalizations for MSC, BCC, and SCC (84.2%, 4.5% and 11.3%, respectively).[324] Thus, of the 2,067 hospitalizations for malignant neoplasm of the skin in Canada during the four-year period, 1,741 (84.2%) were allocated to MSC, 234 (11.3%) to SCC, and 92 (4.5%) to BCC, as indicated in the following table.

**Estimated Hospitalizations in Canada**
**For Malignant Neoplasm of Skin**
**Average based on 1997/98 to 2000/01 Fiscal Years**

| | Average Annual Hospitalizations | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Total | | | Melanoma | | | SCC | | | BCC | | |
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 106 | 95 | 201 | 89 | 80 | 169 | 12 | 11 | 23 | 5 | 4 | 9 |
| AB | 93 | 78 | 171 | 78 | 65 | 144 | 11 | 9 | 19 | 4 | 3 | 8 |
| SK | 46 | 34 | 79 | 38 | 28 | 67 | 5 | 4 | 9 | 2 | 2 | 4 |
| MB | 42 | 30 | 72 | 35 | 25 | 61 | 5 | 3 | 8 | 2 | 1 | 3 |
| ON | 405 | 306 | 711 | 341 | 258 | 599 | 46 | 35 | 80 | 18 | 14 | 32 |
| QC | 336 | 246 | 581 | 283 | 207 | 490 | 38 | 28 | 66 | 15 | 11 | 26 |
| NB | 33 | 32 | 65 | 27 | 27 | 55 | 4 | 4 | 7 | 1 | 1 | 3 |
| NF&L | 35 | 27 | 61 | 29 | 22 | 51 | 4 | 3 | 7 | 2 | 1 | 3 |
| PEI | | | NA | | | | | | | | | |
| NS | 77 | 50 | 127 | 65 | 42 | 107 | 9 | 6 | 14 | 3 | 2 | 6 |
| YK | | | NA | | | | | | | | | |
| NWT | | | NA | | | | | | | | | |
| NV | | | NA | | | | | | | | | |
| **Canada** | **1,171** | **897** | **2,067** | **986** | **755** | **1,741** | **132** | **101** | **234** | **52** | **40** | **92** |

[324] New Zealand Cancer Society. The Cost of Skin Cancer in New Zealand, *Cancer Update in Practice*, Issue 2, 2000.

This information was then combined with the estimated number of new melanoma, BCC, and SCC cases in 2004 (using the diagnosis-based incidence approach) to calculate the proportion of new cases that would be hospitalized. As seen in the following table, the ratio of hospitalizations to new melanomas is substantially higher than the ratio of hospitalizations to new NMSCs. On average, 36.6% of new melanoma patients are admitted to hospital while only 1.52% of new SCC patients and 0.15% of new BCC patients are admitted to hospital. These proportions vary by both gender and province. This is a key difference in the economic model. Once admitted, however, we assumed that the length of stay and cost per day in hospital for a new NMSC (either SCC or BCC) would be the same as the age- and gender-equivalent length of stay and cost per day for a new melanoma.

**Estimated Ratio of Hospitalizations per New Case in Canada**
**For Malignant Neoplasm of Skin**
**Average based on 1997/98 to 2000/01 Fiscal Years**

| | Ratio of Hospitalizations to New Cases | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Melanoma | | | SCC | | | BCC | | |
| | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 0.224 | 0.238 | 0.231 | 0.0081 | 0.0117 | 0.0095 | 0.0008 | 0.0009 | 0.0008 |
| AB | 0.309 | 0.266 | 0.288 | 0.0120 | 0.0163 | 0.0136 | 0.0015 | 0.0014 | 0.0015 |
| SK | 0.663 | 0.428 | 0.537 | 0.0120 | 0.0158 | 0.0134 | 0.0017 | 0.0016 | 0.0017 |
| MB | 0.436 | 0.424 | 0.431 | 0.0193 | 0.0214 | 0.0202 | 0.0018 | 0.0014 | 0.0016 |
| ON | 0.315 | 0.264 | 0.291 | 0.0112 | 0.0149 | 0.0126 | 0.0013 | 0.0012 | 0.0013 |
| QC | 0.668 | 0.601 | 0.638 | 0.0232 | 0.0270 | 0.0246 | 0.0026 | 0.0022 | 0.0025 |
| NB | 0.440 | 0.484 | 0.461 | 0.0151 | 0.0241 | 0.0185 | 0.0021 | 0.0024 | 0.0023 |
| NF&L | 0.980 | 0.690 | 0.829 | 0.0322 | 0.0397 | 0.0351 | 0.0037 | 0.0032 | 0.0034 |
| PEI | | | | | | | | | |
| NS | 0.623 | 0.383 | 0.500 | 0.0211 | 0.0200 | 0.0206 | 0.0025 | 0.0017 | 0.0021 |
| YK | | | | | | | | | |
| NWT | | | | | | | | | |
| NV | | | | | | | | | |
| **Canada** | **0.393** | **0.336** | **0.366** | **0.0138** | **0.0176** | **0.0152** | **0.0016** | **0.0014** | **0.0015** |

The relevant information from the previous four tables was then combined to generate the following table of the estimated number of hospital separations for melanoma by age group, gender, and province/ territory in 2004. In addition to the 1,741 annual separations, an additional 14 separations were included for the province of PEI and the territories, for a total of 1,755 separations.

**Estimated Hospitalizations for Melanoma**
**By Age Group, Gender and Province/Territory**
**2004 (Diagnosis-based Incidence Approach)**

**Melanoma**

| | 0-44 | | | 45-64 | | | 65-74 | | | 75+ | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 14 | 11 | 25 | 29 | 23 | 52 | 16 | 16 | 32 | 30 | 30 | 61 | 89 | 80 | 169 |
| AB | 14 | 15 | 30 | 26 | 19 | 46 | 19 | 9 | 28 | 19 | 22 | 41 | 78 | 65 | 144 |
| SK | 4 | 4 | 7 | 13 | 8 | 21 | 7 | 5 | 12 | 14 | 13 | 27 | 38 | 28 | 67 |
| MB | 3 | 3 | 6 | 13 | 6 | 19 | 11 | 6 | 16 | 8 | 11 | 20 | 35 | 25 | 61 |
| ON | 43 | 36 | 79 | 100 | 65 | 165 | 80 | 60 | 140 | 118 | 96 | 215 | 341 | 258 | 599 |
| QC | 35 | 32 | 67 | 97 | 67 | 164 | 81 | 47 | 127 | 70 | 61 | 131 | 283 | 207 | 489 |
| NB | 3 | 3 | 6 | 7 | 9 | 15 | 8 | 2 | 10 | 10 | 13 | 23 | 27 | 27 | 55 |
| NF&L | 3 | 3 | 7 | 13 | 7 | 20 | 6 | 5 | 11 | 7 | 7 | 14 | 29 | 22 | 51 |
| PEI | 1 | 1 | 1 | 1 | 2 | 3 | 1 | 1 | 2 | 1 | 2 | 3 | 5 | 6 | 11 |
| NS | 7 | 4 | 11 | 21 | 8 | 29 | 19 | 9 | 28 | 18 | 20 | 38 | 65 | 42 | 107 |
| YK | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 |
| NWT | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| NV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **Canada** | **128** | **113** | **240** | **321** | **214** | **535** | **248** | **159** | **407** | **296** | **276** | **572** | **993** | **762** | **1,755** |

*Note: Numbers are not rounded and thus may appear to not add appropriately.*

Data on new melanomas and hospital separation were combined to create a province/territory-, gender-, and age-specific ratio of hospitalizations to new melanomas (see following table); this information was the basis for projecting admissions according to estimated incidence numbers over the modelling period. This ratio varies substantially by age group, gender, and province/territory. Note that for some age groups in some jurisdictions (e.g., Newfoundland/Labrador for both males and females aged 65+), the analysis suggests more than one hospitalization on average per case per year.

**Estimated Ratio of Hospitalizations to New Cases for Melanoma**
**By Age Group, Gender and Province/Territory**
**2004 (Diagnosis-based Incidence Approach)**

**Melanoma**

| | 0-44 | | | 45-64 | | | 65-74 | | | 75+ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Male** | **Female** | **Total** | **Male** | **Female** | **Total** | **Male** | **Female** | **Total** | **Male** | **Female** | **Total** |
| BC | 0.19 | 0.13 | 0.16 | 0.18 | 0.17 | 0.17 | 0.25 | 0.34 | 0.29 | 0.31 | 0.43 | 0.36 |
| AB | 0.27 | 0.16 | 0.20 | 0.25 | 0.22 | 0.23 | 0.36 | 0.42 | 0.38 | 0.44 | 0.54 | 0.49 |
| SK | 0.56 | 0.22 | 0.32 | 0.51 | 0.30 | 0.40 | 0.74 | 0.58 | 0.67 | 0.91 | 0.75 | 0.83 |
| MB | 0.38 | 0.21 | 0.28 | 0.35 | 0.28 | 0.32 | 0.50 | 0.54 | 0.52 | 0.62 | 0.70 | 0.66 |
| ON | 0.26 | 0.14 | 0.19 | 0.24 | 0.19 | 0.22 | 0.35 | 0.37 | 0.36 | 0.43 | 0.47 | 0.45 |
| QC | 0.58 | 0.34 | 0.44 | 0.53 | 0.46 | 0.50 | 0.77 | 0.90 | 0.81 | 0.95 | 1.15 | 1.03 |
| NB | 0.35 | 0.26 | 0.29 | 0.32 | 0.35 | 0.34 | 0.47 | 0.68 | 0.50 | 0.58 | 0.87 | 0.71 |
| NF&L | 0.88 | 0.39 | 0.54 | 0.81 | 0.52 | 0.67 | 1.17 | 1.01 | 1.09 | 1.44 | 1.29 | 1.36 |
| PEI | 0.33 | 0.18 | 0.22 | 0.31 | 0.24 | 0.27 | 0.45 | 0.48 | 0.46 | 0.55 | 0.61 | 0.59 |
| NS | 0.53 | 0.18 | 0.32 | 0.49 | 0.24 | 0.38 | 0.70 | 0.47 | 0.60 | 0.87 | 0.61 | 0.71 |
| YK | 0.33 | 0.18 | 0.24 | 0.31 | 0.24 | 0.28 | 0.45 | 0.48 | 0.46 | 0.55 | 0.61 | 0.57 |
| NWT | 0.33 | 0.18 | 0.25 | 0.31 | 0.24 | 0.28 | 0.45 | 0.48 | 0.46 | 0.55 | 0.61 | 0.57 |
| NV | 0.33 | 0.18 | 0.25 | 0.31 | 0.24 | 0.28 | 0.45 | 0.48 | 0.46 | 0.55 | 0.61 | 0.56 |
| **Canada** | **0.32** | **0.18** | **0.24** | **0.32** | **0.25** | **0.29** | **0.47** | **0.48** | **0.47** | **0.53** | **0.60** | **0.56** |

A similar approach was taken to estimate both the number of hospital days and ALOS for melanoma by province/territory, gender, and age group. Following the pattern for hospitalizations per se, it was estimated that 84.2% of the estimated annual hospital days were for melanoma (10,941 of 13,347) and 15.8% for NMSC. The information on hospital days and ALOS for melanoma is included in the following two tables.

**Estimated Hospital Days for Melanoma**
**By Age Group, Gender and Province/Territory**
**2004 (Diagnosis-based Incidence Approach)**

**Melanoma**

| | 0-44 | | | 45-64 | | | 65-74 | | | 75+ | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 60 | 38 | 98 | 114 | 111 | 225 | 80 | 95 | 174 | 164 | 200 | 364 | 418 | 444 | 861 |
| AB | 57 | 56 | 113 | 99 | 96 | 195 | 87 | 56 | 144 | 96 | 150 | 246 | 340 | 358 | 698 |
| SK | 21 | 13 | 35 | 68 | 39 | 108 | 48 | 31 | 79 | 99 | 91 | 190 | 237 | 174 | 411 |
| MB | 18 | 18 | 36 | 66 | 55 | 121 | 66 | 69 | 135 | 55 | 152 | 207 | 205 | 294 | 499 |
| ON | 187 | 121 | 308 | 406 | 301 | 707 | 405 | 351 | 756 | 647 | 621 | 1,268 | 1,646 | 1,393 | 3,039 |
| QC | 275 | 155 | 430 | 707 | 456 | 1,162 | 734 | 402 | 1,136 | 681 | 583 | 1,264 | 2,397 | 1,596 | 3,993 |
| NB | 18 | 14 | 31 | 41 | 48 | 89 | 60 | 14 | 74 | 87 | 99 | 186 | 205 | 175 | 380 |
| NF&L | 26 | 18 | 44 | 94 | 53 | 147 | 58 | 48 | 106 | 67 | 75 | 143 | 246 | 194 | 440 |
| PEI | 3 | 3 | 6 | 7 | 9 | 16 | 7 | 9 | 16 | 9 | 17 | 26 | 26 | 38 | 65 |
| NS | 35 | 10 | 46 | 95 | 31 | 125 | 105 | 44 | 150 | 111 | 104 | 215 | 347 | 189 | 536 |
| YK | 1 | 0 | 1 | 2 | 1 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 4 | 3 | 7 |
| NWT | 1 | 1 | 2 | 2 | 1 | 3 | 1 | 1 | 2 | 1 | 1 | 1 | 5 | 3 | 8 |
| NV | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 2 | 1 | 4 |
| **Canada** | **704** | **447** | **1,151** | **1,701** | **1,201** | **2,902** | **1,654** | **1,121** | **2,775** | **2,019** | **2,094** | **4,113** | **6,078** | **4,863** | **10,941** |

*Note: Numbers are not rounded and thus may appear to not add appropriately.*

**Estimated Average Length of Stay for Melanoma**
**By Age Group, Gender and Province/Territory**
**2004 (Diagnosis-based Incidence Approach)**

**Melanoma**

| | 0-44 | | | 45-64 | | | 65-74 | | | 75+ | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 4.28 | 3.43 | 3.91 | 3.99 | 4.76 | 4.34 | 4.98 | 6.06 | 5.51 | 5.38 | 6.67 | 6.02 | 4.69 | 5.55 | 5.09 |
| AB | 4.02 | 3.59 | 3.80 | 3.75 | 4.98 | 4.27 | 4.68 | 6.33 | 5.21 | 5.05 | 6.97 | 6.07 | 4.33 | 5.49 | 4.86 |
| SK | 5.62 | 3.72 | 4.69 | 5.23 | 5.16 | 5.21 | 6.53 | 6.57 | 6.54 | 7.05 | 7.23 | 7.13 | 6.19 | 6.12 | 6.16 |
| MB | 5.39 | 6.87 | 6.03 | 5.02 | 9.53 | 6.40 | 6.26 | 12.13 | 8.32 | 6.76 | 13.34 | 10.60 | 5.83 | 11.54 | 8.23 |
| ON | 4.36 | 3.32 | 3.88 | 4.07 | 4.61 | 4.28 | 5.07 | 5.86 | 5.41 | 5.48 | 6.45 | 5.91 | 4.83 | 5.40 | 5.08 |
| QC | 7.81 | 4.89 | 6.43 | 7.28 | 6.79 | 7.08 | 9.08 | 8.63 | 8.91 | 9.80 | 9.50 | 9.66 | 8.48 | 7.72 | 8.16 |
| NB | 6.66 | 3.95 | 5.12 | 6.21 | 5.48 | 5.79 | 7.74 | 6.97 | 7.58 | 8.36 | 7.66 | 7.97 | 7.51 | 6.44 | 6.97 |
| NF&L | 7.94 | 5.46 | 6.71 | 7.40 | 7.58 | 7.46 | 9.23 | 9.64 | 9.41 | 9.97 | 10.61 | 10.29 | 8.45 | 8.69 | 8.56 |
| PEI | 5.57 | 3.99 | 4.63 | 5.19 | 5.53 | 5.38 | 6.48 | 7.04 | 6.78 | 7.00 | 7.74 | 7.47 | 5.74 | 6.47 | 6.15 |
| NS | 4.86 | 2.66 | 4.10 | 4.53 | 3.70 | 4.29 | 5.65 | 4.70 | 5.33 | 6.10 | 5.17 | 5.61 | 5.32 | 4.54 | 5.02 |
| YK | 5.57 | 3.99 | 4.84 | 5.19 | 5.53 | 5.32 | 6.48 | 7.04 | 6.67 | 7.00 | 7.74 | 7.30 | 5.80 | 5.78 | 5.79 |
| NWT | 5.57 | 3.99 | 4.88 | 5.19 | 5.53 | 5.32 | 6.48 | 7.04 | 6.67 | 7.00 | 7.74 | 7.28 | 5.78 | 5.58 | 5.71 |
| NV | 5.57 | 3.99 | 4.89 | 5.19 | 5.53 | 5.32 | 6.48 | 7.04 | 6.65 | 7.00 | 7.74 | 7.18 | 5.74 | 5.25 | 5.56 |
| **Canada** | **5.51** | **3.97** | **4.79** | **5.31** | **5.60** | **5.42** | **6.68** | **7.04** | **6.82** | **6.81** | **7.59** | **7.19** | **6.12** | **6.38** | **6.23** |

The analysis to this point provides a ratio of hospitalizations to new MSC, BCC, and SCC cases together with an estimated length of stay once the patient is hospitalized. This data was generated by age group, gender, and province/territory, providing key input for the economic model for generating the number of hospitalizations and patient days in hospital.

A further key input for the economic model is the estimated unit cost of a day in hospital for patients being treated for skin cancers. Data available from CIHI offered a starting point to estimate the cost of an acute care stay for patients admitted with melanoma and other malignant neoplasms.[325] The following table summarizes the information on estimated costs per hospital stay for all skin cancers by age group and gender.

**Acute Care Cases and Costs**
**Melanoma and Other Malignant Neoplasms**
**Canada in 2004/05**

| | By Age group | | | | | |
|---|---|---|---|---|---|---|
| | **0-44** | **45-64** | **65-74** | **75-84** | **85+** | **All** |
| Males | | | | | | |
| Cases | 67 | 242 | 163 | 202 | 82 | **756** |
| Unit Cost | $ 4,892 | $ 5,836 | $ 7,414 | $ 7,021 | $ 7,808 | **$ 6,561** |
| Females | | | | | | |
| Cases | 56 | 166 | 121 | 145 | 82 | **570** |
| Unit Cost | $ 5,660 | $ 4,675 | $ 7,488 | $ 16,207 | $ 4,334 | **$ 7,153** |
| **Total** | | | | | | |
| **Cases** | **123** | **408** | **284** | **347** | **164** | **1,326** |
| **Unit Cost** | **$ 5,314** | **$ 5,336** | **$ 7,442** | **$ 10,043** | **$ 6,399** | **$ 6,805** |

*Source: Canadian Institute for Health Information, The Cost of Acute Care Hospital Stays by Medical Condition in Canada, 2004-2005 (Ottawa: CIHI, 2008)*

Health care costs tend to be highly variable, with statistical outliers significantly influencing average (mean) costs. For example, in the 75-84 and 85+ female age groups, average costs are likely influenced by long-stay patients (75-84 year-old age group) and possibly by early deaths after hospitalization (85+ year-old age group). To reduce this variability, the average cost was used for both males and females for the 0-44, 45-64, and 65-74 age groups, and the average weighted cost for males for the 75+ year-old male and female age group ($7,248).

As noted in a previous table, these four age groups spent an average of 4.79 (0-44 years), 5.42 (45-64 years), 6.92 (64-74 years), and 7.19 days in hospital (75+ years). The average calculated cost per patient day is thus $1,109 (0-44 year-old), $985 (45-64 year-old), $1,075 (64-74 year-old), and $1,008 (75+ year old).

As noted earlier, acute care costs also vary by province/territory based on the unit cost of production, most closely associated with differences in labour rates paid to health care workers. The estimated average cost per patient day by age group was adjusted (see section on *Day Surgery/Outpatient Clinic* above) to reflect these variances in the unit cost of production for each province (see following table). The variance for Alberta, with the highest labour-driven costs, was used to adjust the unit cost of production in the Territories; the relevant argument is that labour rates tend to be higher than average in these remote regions of the country.

[325] Canadian Institute for Health Information, *The Cost of Acute Care Hospital Stays by Medical Condition in Canada, 2004-2005*. Ottawa: CIHI, 2008.

| Melanoma and Other Malignant Neoplasms<br>Estimated Cost per Acute Care Day<br>By Province and Age Group | | | | | |
|---|---|---|---|---|---|
| | | Age Group | | | |
| **Province** | ***% Var*** | **0-44** | **45-64** | **65-74** | **75+** |
| ***Canadian Average*** | | ***$ 1,109*** | ***$ 985*** | ***$ 1,075*** | ***$ 1,008*** |
| British Columbia | ***1.06%*** | $ 1,121 | $ 995 | $ 1,086 | $ 1,019 |
| Alberta | ***11.20%*** | $ 1,233 | $ 1,095 | $ 1,195 | $ 1,121 |
| Saskatchewan | ***0.82%*** | $ 1,118 | $ 993 | $ 1,084 | $ 1,016 |
| Manitoba | ***1.66%*** | $ 1,127 | $ 1,001 | $ 1,093 | $ 1,025 |
| Ontario | ***9.47%*** | $ 1,214 | $ 1,078 | $ 1,177 | $ 1,103 |
| Quebec | ***-19.40%*** | $ 894 | $ 794 | $ 866 | $ 812 |
| New Brunswick | ***-2.13%*** | $ 1,085 | $ 964 | $ 1,052 | $ 986 |
| Newfoundland + Labrador | ***-10.94%*** | $ 988 | $ 877 | $ 957 | $ 898 |
| PEI | ***-6.43%*** | $ 1,038 | $ 922 | $ 1,006 | $ 943 |
| Nova Scotia | ***-4.09%*** | $ 1,064 | $ 945 | $ 1,031 | $ 967 |

Finally, combining the estimated cost per acute care day, the average length of stay, and the number of hospitalizations for melanoma, BCC, and SCC yielded the projected total acute care costs for each type of skin cancer, by province and gender (as outlined below).

The total estimated annual costs for hospitalizations for **melanoma** patients increases from $10.8 million in 2004 to $24.6 million in 2031 (see following table).

**Estimated Acute Care Inpatient Costs**
Associated with Cutaneous Melanoma in Canada
By Province/Territory and Gender
2004 to 2031 (in $millions, 2004 Constant dollars)

| Province | Gender | 2004 | 2011 | 2016 | 2021 | 2026 | 2031 |
|---|---|---|---|---|---|---|---|
| BC | Male | $ 0.43 | $ 0.55 | $ 0.66 | $ 0.78 | $ 0.92 | $ 1.06 |
| | Female | $ 0.46 | $ 0.55 | $ 0.64 | $ 0.75 | $ 0.88 | $ 1.02 |
| | **Total** | **$ 0.89** | **$ 1.09** | **$ 1.30** | **$ 1.53** | **$ 1.80** | **$ 2.08** |
| AB | Male | $ 0.39 | $ 0.47 | $ 0.57 | $ 0.68 | $ 0.82 | $ 0.97 |
| | Female | $ 0.41 | $ 0.50 | $ 0.59 | $ 0.70 | $ 0.85 | $ 1.00 |
| | **Total** | **$ 0.80** | **$ 0.97** | **$ 1.16** | **$ 1.39** | **$ 1.67** | **$ 1.97** |
| SK | Male | $ 0.24 | $ 0.31 | $ 0.35 | $ 0.40 | $ 0.46 | $ 0.51 |
| | Female | $ 0.18 | $ 0.20 | $ 0.21 | $ 0.23 | $ 0.27 | $ 0.30 |
| | **Total** | **$ 0.42** | **$ 0.51** | **$ 0.57** | **$ 0.63** | **$ 0.72** | **$ 0.81** |
| MB | Male | $ 0.22 | $ 0.24 | $ 0.28 | $ 0.33 | $ 0.38 | $ 0.42 |
| | Female | $ 0.31 | $ 0.36 | $ 0.41 | $ 0.46 | $ 0.52 | $ 0.59 |
| | **Total** | **$ 0.52** | **$ 0.61** | **$ 0.69** | **$ 0.79** | **$ 0.90** | **$ 1.02** |
| ON | Male | $ 1.86 | $ 2.33 | $ 2.80 | $ 3.30 | $ 3.92 | $ 4.54 |
| | Female | $ 1.57 | $ 1.78 | $ 2.09 | $ 2.44 | $ 2.87 | $ 3.34 |
| | **Total** | **$ 3.43** | **$ 4.11** | **$ 4.89** | **$ 5.74** | **$ 6.78** | **$ 7.88** |
| QC | Male | $ 2.00 | $ 2.62 | $ 3.10 | $ 3.58 | $ 4.12 | $ 4.64 |
| | Female | $ 1.32 | $ 1.93 | $ 2.22 | $ 2.53 | $ 2.89 | $ 3.20 |
| | **Total** | **$ 3.32** | **$ 4.55** | **$ 5.33** | **$ 6.11** | **$ 7.00** | **$ 7.83** |
| NB | Male | $ 0.21 | $ 0.24 | $ 0.29 | $ 0.34 | $ 0.39 | $ 0.44 |
| | Female | $ 0.17 | $ 0.23 | $ 0.27 | $ 0.31 | $ 0.36 | $ 0.40 |
| | **Total** | **$ 0.38** | **$ 0.47** | **$ 0.56** | **$ 0.64** | **$ 0.75** | **$ 0.84** |
| NF&L | Male | $ 0.22 | $ 0.32 | $ 0.37 | $ 0.43 | $ 0.50 | $ 0.55 |
| | Female | $ 0.18 | $ 0.21 | $ 0.24 | $ 0.28 | $ 0.33 | $ 0.37 |
| | **Total** | **$ 0.40** | **$ 0.52** | **$ 0.62** | **$ 0.71** | **$ 0.82** | **$ 0.92** |
| PEI | Male | $ 0.03 | $ 0.04 | $ 0.05 | $ 0.05 | $ 0.06 | $ 0.07 |
| | Female | $ 0.04 | $ 0.04 | $ 0.05 | $ 0.06 | $ 0.07 | $ 0.08 |
| | **Total** | **$ 0.06** | **$ 0.08** | **$ 0.09** | **$ 0.11** | **$ 0.13** | **$ 0.14** |
| NS | Male | $ 0.34 | $ 0.43 | $ 0.51 | $ 0.59 | $ 0.69 | $ 0.77 |
| | Female | $ 0.19 | $ 0.18 | $ 0.21 | $ 0.24 | $ 0.28 | $ 0.31 |
| | **Total** | **$ 0.53** | **$ 0.61** | **$ 0.72** | **$ 0.83** | **$ 0.96** | **$ 1.08** |
| YK/NWT/NV | Male | $ 0.01 | $ 0.02 | $ 0.02 | $ 0.02 | $ 0.03 | $ 0.03 |
| | Female | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.02 | $ 0.02 |
| | **Total** | **$ 0.02** | **$ 0.02** | **$ 0.03** | **$ 0.04** | **$ 0.05** | **$ 0.05** |
| **Canada** | **Male** | **$ 5.95** | **$ 7.57** | **$ 9.00** | **$ 10.50** | **$ 12.27** | **$ 13.99** |
| | **Female** | **$ 4.83** | **$ 5.98** | **$ 6.96** | **$ 8.02** | **$ 9.32** | **$ 10.63** |
| | **Total** | **$ 10.78** | **$ 13.55** | **$ 15.96** | **$ 18.53** | **$ 21.59** | **$ 24.62** |

The total estimated annual costs in this area of care for **BCC** patients increases from $0.6 million in 2004 to $1.5 million in 2031 (see following table).

**Estimated Acute Care Inpatient Costs**
Associated with Basal Cell Carcinoma in Canada
By Province/Territory and Gender
2004 to 2031 (in $millions, 2004 Constant dollars)

| Province | Gender | 2004 | 2011 | 2016 | 2021 | 2026 | 2031 |
|---|---|---|---|---|---|---|---|
| BC | Male | $ 0.04 | $ 0.06 | $ 0.07 | $ 0.09 | $ 0.11 | $ 0.14 |
| | Female | $ 0.04 | $ 0.05 | $ 0.06 | $ 0.08 | $ 0.09 | $ 0.10 |
| | **Total** | **$ 0.09** | **$ 0.11** | **$ 0.14** | **$ 0.17** | **$ 0.20** | **$ 0.24** |
| AB | Male | $ 0.02 | $ 0.03 | $ 0.04 | $ 0.05 | $ 0.06 | $ 0.07 |
| | Female | $ 0.02 | $ 0.03 | $ 0.04 | $ 0.05 | $ 0.06 | $ 0.07 |
| | **Total** | **$ 0.04** | **$ 0.06** | **$ 0.07** | **$ 0.09** | **$ 0.11** | **$ 0.14** |
| SK | Male | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.02 | $ 0.02 | $ 0.03 |
| | Female | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.02 |
| | **Total** | **$ 0.02** | **$ 0.02** | **$ 0.03** | **$ 0.03** | **$ 0.04** | **$ 0.04** |
| MB | Male | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.02 | $ 0.03 |
| | Female | $ 0.02 | $ 0.02 | $ 0.02 | $ 0.03 | $ 0.03 | $ 0.04 |
| | **Total** | **$ 0.03** | **$ 0.03** | **$ 0.04** | **$ 0.05** | **$ 0.05** | **$ 0.06** |
| ON | Male | $ 0.11 | $ 0.15 | $ 0.19 | $ 0.23 | $ 0.29 | $ 0.35 |
| | Female | $ 0.10 | $ 0.13 | $ 0.15 | $ 0.18 | $ 0.21 | $ 0.25 |
| | **Total** | **$ 0.22** | **$ 0.28** | **$ 0.34** | **$ 0.41** | **$ 0.50** | **$ 0.60** |
| QC | Male | $ 0.06 | $ 0.08 | $ 0.10 | $ 0.12 | $ 0.15 | $ 0.17 |
| | Female | $ 0.05 | $ 0.06 | $ 0.07 | $ 0.08 | $ 0.09 | $ 0.11 |
| | **Total** | **$ 0.11** | **$ 0.14** | **$ 0.17** | **$ 0.20** | **$ 0.24** | **$ 0.28** |
| NB | Male | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.02 |
| | Female | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 |
| | **Total** | **$ 0.01** | **$ 0.02** | **$ 0.02** | **$ 0.02** | **$ 0.03** | **$ 0.03** |
| NF&L | Male | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 |
| | Female | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 |
| | **Total** | **$ 0.01** | **$ 0.01** | **$ 0.01** | **$ 0.02** | **$ 0.02** | **$ 0.02** |
| PEI | Male | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 |
| | Female | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 |
| | **Total** | **$ 0.00** | **$ 0.00** | **$ 0.01** | **$ 0.01** | **$ 0.01** | **$ 0.01** |
| NS | Male | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.02 | $ 0.03 | $ 0.03 |
| | Female | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.02 |
| | **Total** | **$ 0.02** | **$ 0.03** | **$ 0.03** | **$ 0.04** | **$ 0.04** | **$ 0.05** |
| YK/NWT/NV | Male | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 |
| | Female | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 |
| | **Total** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** |
| **Canada** | **Male** | **$ 0.29** | **$ 0.38** | **$ 0.47** | **$ 0.58** | **$ 0.71** | **$ 0.86** |
| | **Female** | **$ 0.27** | **$ 0.33** | **$ 0.39** | **$ 0.46** | **$ 0.54** | **$ 0.62** |
| | **Total** | **$ 0.55** | **$ 0.71** | **$ 0.86** | **$ 1.04** | **$ 1.25** | **$ 1.48** |

The total estimated annual costs in this area of care for **SCC** patients increases from $1.5 million in 2004 to $4.3 million in 2031 (see following table).

**Estimated Acute Care Inpatient Costs**
Associated with Squamous Cell Carcinoma in Canada
By Province/Territory and Gender
2004 to 2031 (in $millions, 2004 Constant dollars)

| Province | Gender | 2004 | 2011 | 2016 | 2021 | 2026 | 2031 |
|---|---|---|---|---|---|---|---|
| BC | Male | $ 0.12 | $ 0.16 | $ 0.20 | $ 0.24 | $ 0.30 | $ 0.37 |
| | Female | $ 0.09 | $ 0.11 | $ 0.14 | $ 0.17 | $ 0.20 | $ 0.25 |
| | **Total** | **$ 0.20** | **$ 0.28** | **$ 0.34** | **$ 0.41** | **$ 0.50** | **$ 0.62** |
| AB | Male | $ 0.07 | $ 0.10 | $ 0.13 | $ 0.16 | $ 0.20 | $ 0.25 |
| | Female | $ 0.06 | $ 0.08 | $ 0.10 | $ 0.12 | $ 0.15 | $ 0.19 |
| | **Total** | **$ 0.13** | **$ 0.18** | **$ 0.23** | **$ 0.28** | **$ 0.35** | **$ 0.44** |
| SK | Male | $ 0.04 | $ 0.05 | $ 0.06 | $ 0.07 | $ 0.08 | $ 0.10 |
| | Female | $ 0.03 | $ 0.03 | $ 0.03 | $ 0.04 | $ 0.04 | $ 0.05 |
| | **Total** | **$ 0.07** | **$ 0.08** | **$ 0.09** | **$ 0.10** | **$ 0.12** | **$ 0.14** |
| MB | Male | $ 0.02 | $ 0.03 | $ 0.04 | $ 0.04 | $ 0.05 | $ 0.06 |
| | Female | $ 0.03 | $ 0.04 | $ 0.04 | $ 0.05 | $ 0.06 | $ 0.07 |
| | **Total** | **$ 0.06** | **$ 0.07** | **$ 0.08** | **$ 0.09** | **$ 0.11** | **$ 0.13** |
| ON | Male | $ 0.35 | $ 0.49 | $ 0.61 | $ 0.73 | $ 0.89 | $ 1.09 |
| | Female | $ 0.23 | $ 0.31 | $ 0.36 | $ 0.44 | $ 0.53 | $ 0.65 |
| | **Total** | **$ 0.59** | **$ 0.79** | **$ 0.97** | **$ 1.17** | **$ 1.42** | **$ 1.74** |
| QC | Male | $ 0.19 | $ 0.26 | $ 0.32 | $ 0.38 | $ 0.46 | $ 0.56 |
| | Female | $ 0.11 | $ 0.15 | $ 0.17 | $ 0.20 | $ 0.24 | $ 0.29 |
| | **Total** | **$ 0.30** | **$ 0.40** | **$ 0.49** | **$ 0.59** | **$ 0.70** | **$ 0.84** |
| NB | Male | $ 0.03 | $ 0.04 | $ 0.05 | $ 0.06 | $ 0.07 | $ 0.08 |
| | Female | $ 0.01 | $ 0.02 | $ 0.02 | $ 0.02 | $ 0.03 | $ 0.04 |
| | **Total** | **$ 0.04** | **$ 0.05** | **$ 0.07** | **$ 0.08** | **$ 0.10** | **$ 0.12** |
| NF&L | Male | $ 0.02 | $ 0.02 | $ 0.03 | $ 0.03 | $ 0.04 | $ 0.04 |
| | Female | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.02 | $ 0.02 | $ 0.03 |
| | **Total** | **$ 0.03** | **$ 0.03** | **$ 0.04** | **$ 0.05** | **$ 0.06** | **$ 0.07** |
| PEI | Male | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 |
| | Female | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 |
| | **Total** | **$ 0.01** | **$ 0.01** | **$ 0.01** | **$ 0.02** | **$ 0.02** | **$ 0.03** |
| NS | Male | $ 0.03 | $ 0.04 | $ 0.05 | $ 0.06 | $ 0.07 | $ 0.08 |
| | Female | $ 0.02 | $ 0.02 | $ 0.03 | $ 0.03 | $ 0.03 | $ 0.04 |
| | **Total** | **$ 0.05** | **$ 0.06** | **$ 0.07** | **$ 0.09** | **$ 0.10** | **$ 0.12** |
| YK/NWT/NV | Male | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.01 |
| | Female | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 |
| | **Total** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.01** | **$ 0.01** | **$ 0.01** |
| **Canada** | **Male** | **$ 0.88** | **$ 1.20** | **$ 1.48** | **$ 1.79** | **$ 2.17** | **$ 2.64** |
| | **Female** | **$ 0.60** | **$ 0.77** | **$ 0.92** | **$ 1.09** | **$ 1.32** | **$ 1.61** |
| | **Total** | **$ 1.48** | **$ 1.97** | **$ 2.39** | **$ 2.88** | **$ 3.49** | **$ 4.25** |

### Indirect Costs

The most commonly used method in valuing indirect costs is the human-capital approach. In this approach, gender- and age-specific average earnings are combined with productivity trends and years of life lost due to a specific disease/condition to estimate unrealized lifetime earnings. An important criticism of this method is that it places a higher value on the years of life lost for someone with higher earning potential (e.g., males aged 35-55) than someone with lower earning potential (e.g. females aged 75+).[326] In particular, unpaid work and leisure time are not explicitly accounted for in the human-capital approach.[327,328] Another concern raised is that it values potential rather than actual productivity losses. That is, long-term absentees from the work force (whether due to death or long-term disability) are eventually replaced; from a societal perspective, this means that productivity is restored rather than permanently lost.

Some of the concerns associated with the human-capital model are addressed in the willingness-to-pay approach.[329] It involves valuing years of life lost by estimating the average amount that an individual is willing to pay to gain an additional year of life, regardless of earning potential. Yabroff, for example, implements this approach by applying a value of $150,000 (USD) to each year of life lost, regardless of the gender or earning potential of the individual that died.[330] A key challenge of this approach involves determining how precisely to estimate this value.[331]

There is a final concern associated with the human-capital approach related to accounting for the reality of unproductive workers being replaced. This is addressed by the friction-cost method,[332] an approach that "advocates measuring actual production losses to society during the friction period between the start of an absence from work (resulting from short-term absence, long-term absence, disability, and mortality) and the time at which original productivity levels are restored."[333] The focus of this method is on lost production from the "perspective of firms, consumers and society, without accounting for the potential income lost on an individual basis."[334]

A major challenge of the various models of indirect costing is that they each generate very different results when applied to the same population. Using the willingness-to-pay approach in the United States, Yabroff found that the estimated economic costs of premature mortality due

[326] Yabroff KR, Bradley CJ, Mariotto AB et al. Estimates and projections of value of life lost from cancer deaths in the United States. *Journal of the National Cancer Institute.* 2008; 100(24): 1755-62.
[327] Tranmer JE, Guerriere DN, Ungar WJ et al. Valuing patient and caregiver time: a review of the literature. *Pharmacoeconomics.* 2005; 23(5): 449-59.
[328] Morris S, Cox B, Bosanquet N. Cost of skin cancer in England. *European Journal of Health Economics.* 2008: Epublished ahead of print.
[329] Koopmanschap MA, Rutten FF, van Ineveld BM et al. The friction cost method for measuring indirect costs of disease. *Journal of Health Economics.* 1995; 14(2): 171-89.
[330] Yabroff KR, Bradley CJ, Mariotto AB et al. Estimates and projections of value of life lost from cancer deaths in the United States. *Journal of the National Cancer Institute.* 2008; 100(24): 1755-62.
[331] Hirth RA, Chernew ME, Miller E et al. Willingness to pay for a quality-adjusted life year: in search of a standard. *Medical Decision Making.* 2000; 20(3): 332-42.
[332] Brouwer WB, Koopmanschap MA. The friction-cost method : replacement for nothing and leisure for free? *Pharmacoeconomics.* 2005; 23(2): 105-11.
[333] Birnbaum H. Friction-cost method as an alternative to the human-capital approach in calculating indirect costs. *Pharmacoeconomics.* 2005; 23(2): 103-4.
[334] Tranmer JE, Guerriere DN, Ungar WJ et al. Valuing patient and caregiver time: a review of the literature. *Pharmacoeconomics.* 2005; 23(5): 449-59.

to cancer were eight times higher than those based on the human-capital approach.[335] The largest differences, of course, were in the population age 65+ years; this is because, in contrast with the willingness-to-pay method, the human-capital approach does not value 'non-productive' time. On the other hand, the friction-cost method tends to generate indirect costs that are approximately one-third those of the human-capital approach.[336] This wide variation, together with the fact that calculated indirect costs often dominate total direct costs, have generated substantial controversy among health economists and policy planners. As a consequence, indirect costs have often been explicitly excluded from formal economic evaluations.[337]

In this report, a modified human-capital approach was employed that attempts to address some of the issues involved with valuing non-productive time. The details are elucidated in the following sections related to losses associated with mortality and morbidity.

## Mortality

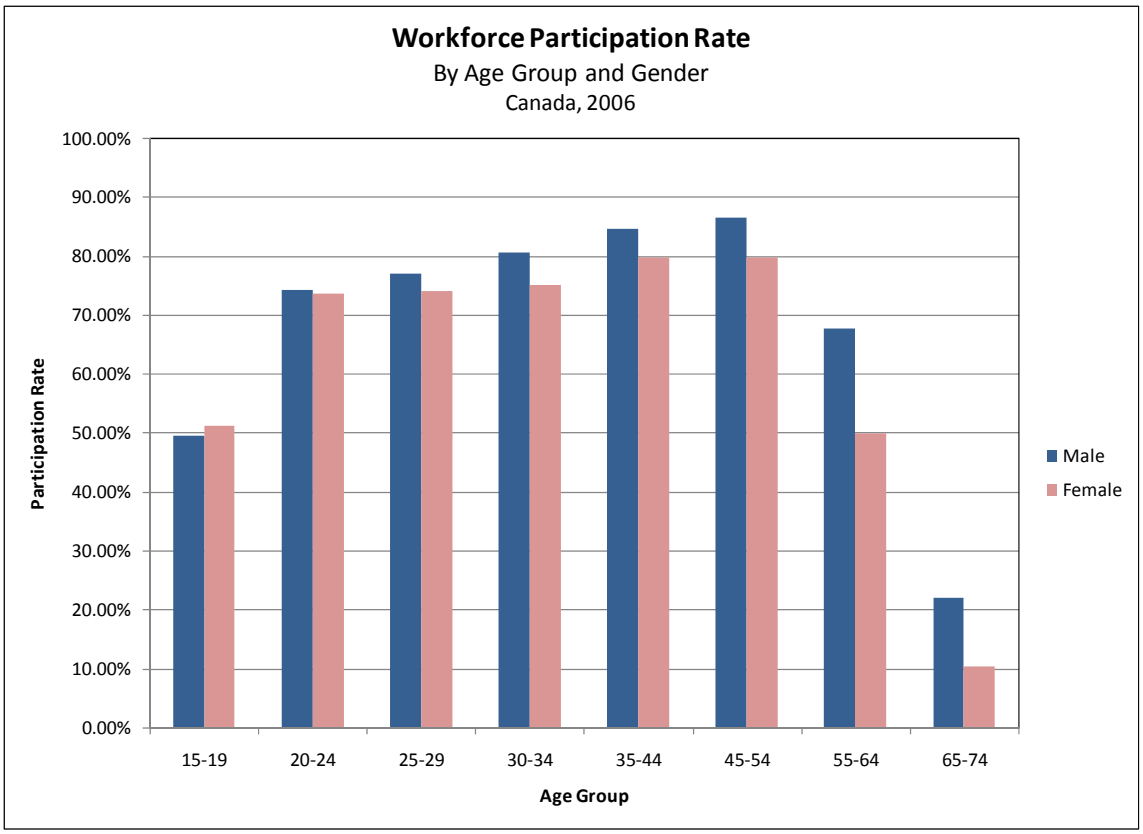
### Cutaneous Melanoma

In applying the human-capital approach to skin cancer mortality, three key pieces of information are required, as follows.

1. *Potential Years of Life Lost* – To generate this data, the number of deaths (i.e., an average of 745 annual deaths due to melanoma in 2000-2004) and the estimated age at death were used as a starting point. Life tables for 2000 to 2002 from Statistics Canada were then employed to generate province/territory-, gender-, and age-specific expected years of life remaining at the time of death.[338] The number of deaths in each cell was multiplied by the expected years of life remaining for the gender/age cohort, assuming that the deaths were evenly distributed over the five-year time period, to derive the potential years of life lost (PYLL) for the age/gender cohorts in each province/territory.

2. *Workforce Participation Rate* – Information on the workforce participation rate was calculated based on the total number of individuals by age, gender, and province/territory in the labour force in 2006[339] divided by the total age-, gender-, and province/territory-specific population in 2006.[340] The average results for Canada are shown in the following chart.

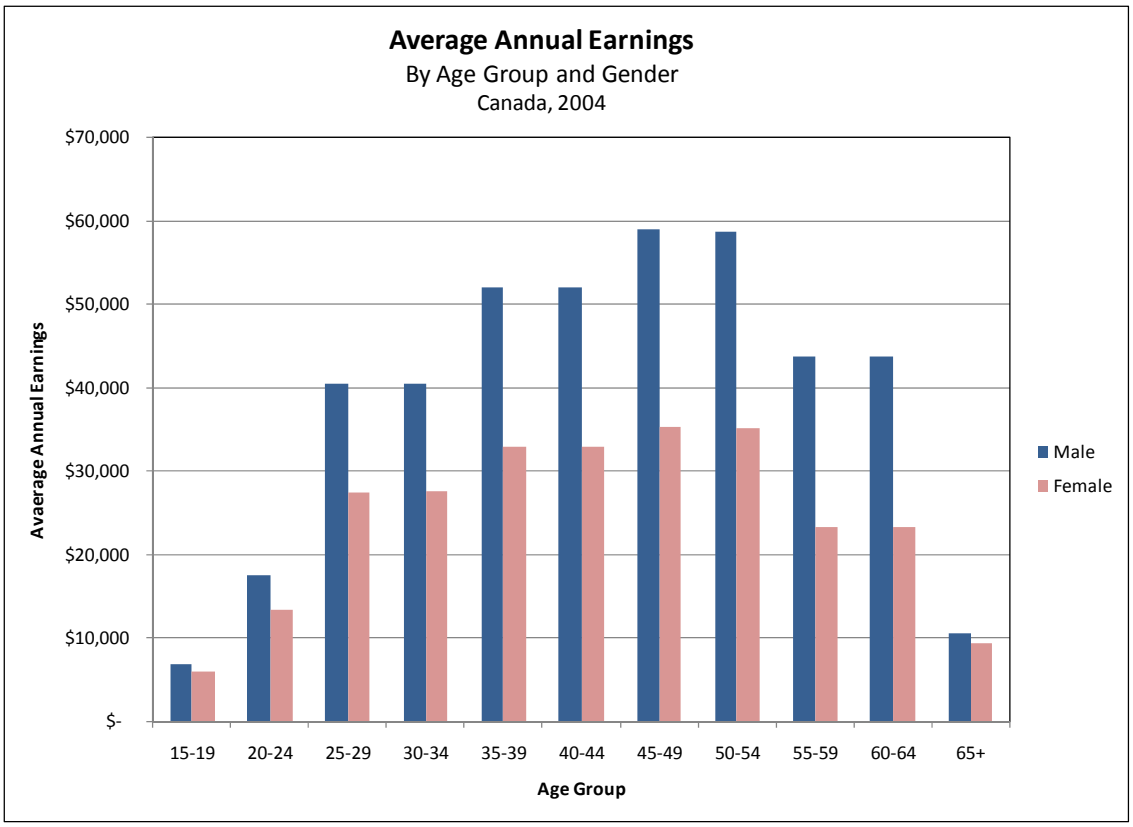
[335] Yabroff KR, Bradley CJ, Mariotto AB et al. Estimates and projections of value of life lost from cancer deaths in the United States. *Journal of the National Cancer Institute.* 2008; 100(24): 1755-62.
[336] Hutubessy RC, van Tulder MW, Vondeling H et al. Indirect costs of back pain in the Netherlands: a comparison of the human capital method with the friction cost method. *Pain.* 1999; 80(1-2): 201-7.
[337] Tranmer JE, Guerriere DN, Ungar WJ et al. Valuing patient and caregiver time: a review of the literature. *Pharmacoeconomics.* 2005; 23(5): 449-59.
[338] See Tables 2a/b to 13a/b available at http://www.statcan.gc.ca/pub/84-537-x/4064441-eng.htm (accessed March 2009).
[339] Statistics Canada. *Class of Worker (12), Age Groups (12A) and Sex (3) for the Labour Force 15 Years and Over of Canada, Provinces, Territories, Census Divisions and Census Subdivisions, 2006 Census - 20% Sample Data.* Catalogue no. 97-559-XWE2006026.
[340] Statistics Canada. Population Projections for Canada, Provinces and Territories 2005-2031. 2005. Catalogue no. 91-520. pgs. 149-162




3. *Average Annual Earnings* – Average annual earnings for 2004 by age group, gender and province were derived from Statistics Canada Table 202-0407 *Income of individuals, by sex, age group and income source.* Data were not available for the territories. To estimate the average annual earnings in the territories, the Canadian average was adjusted using the difference in average weekly earnings in the Yukon ($781), Northwest Territories ($926), and Nunavut ($776) when compared against the Canadian average ($703).[341]

   The following table provides the average annual earnings by age group and gender for all Canadians in 2004.

[341] Statistics Canada Table 281-0044 available at http://www40.statcan.gc.ca/101/cst01/labr79-eng.htm (accessed March 2009).




Using the component information described, the process of estimating the indirect costs associated with deaths due to melanoma was as follows:

- Calculate the expected number of deaths by age group, gender, and province/territory for each year in the modelling period. Projections are based on the Low APC Scenario outlined earlier.

- For each age-, gender-, and province/territory-specific cell, calculate the future lost earnings by multiplying number of life years lost in that cell by the expected annual earnings adjusted according to the workforce participation rate; further, assume that the death rate in each age group is constant.

Based on this approach, the indirect costs associated with deaths due to melanoma were estimated to be $195.5 million in Canada in 2004 (see following table). The 745 deaths that year resulted in 16,440 potential years of life lost (PYLL), or an average of 22.1 PYLL per death. This compares to 19.6 PYLL per death in New Zealand and 18.5 PYLL in the United States; in other words, it represents a reasonable alignment with other national studies.[342,343] By 2031, the expected indirect costs (in undiscounted 2004 Canadian dollars) would increase to $232.7 million.

[342] New Zealand Cancer Society. The Cost of Skin Cancer in New Zealand, *Cancer Update in Practice*, Issue 2, 2000.
[343] National Cancer Institute. *2006 Fact Book*. 2006. Available at http://obf.cancer.gov/financial/attachments/06Factbk.pdf. Accessed March 2009.

While males, at 20.9 years in 2004, have a lower PYLL than females, the majority of indirect costs are assigned to males ($146.5 of the $195.5 million, or 74.9%). This seeming anomaly reflects one of the key assumptions behind the human-capital approach, namely that PYLL for individuals who are not in the formal workforce are not assigned a monetary value. A lower percentage of females than males are in the workforce. In addition, females on average tend to have lower annual earnings than males, as indicated in the chart above.

**Estimated Indirect Costs Associated with Deaths Due to Cutaneous Melanoma in Canada**
**By Province/Territory and Gender**
2004 to 2031 (in $millions, 2004 constant dollars, costs undiscounted)

| | | 2004 | | | | 2011 | | | | 2016 | | | | 2021 | | | | 2026 | | | | 2031 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Deaths | Total PYLL | PYLL / Death | Indirect Cost | Deaths | Total PYLL | PYLL / Death | Indirect Cost | Deaths | Total PYLL | PYLL / Death | Indirect Cost | Deaths | Total PYLL | PYLL / Death | Indirect Cost | Deaths | Total PYLL | PYLL / Death | Indirect Cost | Deaths | Total PYLL | PYLL / Death | Indirect Cost |
| BC | Male | 63 | 1,336 | 21.2 | $ 18.48 | 85 | 1,673 | 19.7 | $ 20.60 | 100 | 1,889 | 18.8 | $ 21.52 | 116 | 2,085 | 17.9 | $ 22.15 | 134 | 2,273 | 17.0 | $ 22.63 | 152 | 2,439 | 16.1 | $ 23.14 |
| | Female | 44 | 1,068 | 24.3 | $ 6.67 | 57 | 1,301 | 22.8 | $ 7.24 | 66 | 1,442 | 22.0 | $ 7.47 | 75 | 1,575 | 21.1 | $ 7.66 | 85 | 1,705 | 20.1 | $ 7.86 | 96 | 1,832 | 19.0 | $ 8.06 |
| | **Total** | **107** | **2,404** | **22.5** | **$ 25.14** | **142** | **2,974** | **20.9** | **$ 27.84** | **166** | **3,331** | **20.1** | **$ 28.99** | **191** | **3,660** | **19.2** | **$ 29.81** | **219** | **3,978** | **18.2** | **$ 30.49** | **248** | **4,270** | **17.2** | **$ 31.20** |
| AB | Male | 36 | 804 | 22.3 | $ 16.54 | 50 | 1,031 | 20.6 | $ 18.92 | 60 | 1,170 | 19.5 | $ 19.72 | 70 | 1,294 | 18.5 | $ 20.15 | 81 | 1,408 | 17.3 | $ 20.40 | 93 | 1,509 | 16.3 | $ 20.67 |
| | Female | 22 | 566 | 25.7 | $ 5.00 | 29 | 706 | 24.0 | $ 5.60 | 34 | 787 | 23.0 | $ 5.79 | 39 | 862 | 21.9 | $ 5.93 | 45 | 935 | 20.7 | $ 6.05 | 52 | 1,005 | 19.5 | $ 6.16 |
| | **Total** | **58** | **1,371** | **23.6** | **$ 21.54** | **79** | **1,737** | **21.9** | **$ 24.52** | **94** | **1,957** | **20.8** | **$ 25.52** | **109** | **2,156** | **19.7** | **$ 26.08** | **126** | **2,343** | **18.6** | **$ 26.44** | **144** | **2,514** | **17.4** | **$ 26.83** |
| SK | Male | 14 | 268 | 19.2 | $ 3.36 | 16 | 301 | 18.4 | $ 3.42 | 18 | 324 | 17.8 | $ 3.39 | 20 | 342 | 17.0 | $ 3.32 | 22 | 359 | 16.1 | $ 3.24 | 24 | 371 | 15.2 | $ 3.18 |
| | Female | 10 | 223 | 22.3 | $ 1.40 | 11 | 243 | 21.5 | $ 1.39 | 12 | 256 | 20.9 | $ 1.36 | 13 | 266 | 20.4 | $ 1.32 | 14 | 277 | 19.5 | $ 1.30 | 16 | 287 | 18.5 | $ 1.28 |
| | **Total** | **24** | **491** | **20.5** | **$ 4.76** | **28** | **544** | **19.7** | **$ 4.81** | **30** | **579** | **19.0** | **$ 4.75** | **33** | **608** | **18.3** | **$ 4.64** | **37** | **636** | **17.4** | **$ 4.54** | **40** | **659** | **16.5** | **$ 4.46** |
| MB | Male | 18 | 353 | 19.6 | $ 4.59 | 22 | 415 | 18.7 | $ 4.90 | 25 | 457 | 18.0 | $ 5.02 | 29 | 493 | 17.2 | $ 5.08 | 32 | 527 | 16.3 | $ 5.11 | 36 | 556 | 15.5 | $ 5.16 |
| | Female | 11 | 245 | 22.3 | $ 1.75 | 13 | 278 | 21.5 | $ 1.83 | 14 | 299 | 21.1 | $ 1.85 | 16 | 319 | 20.5 | $ 1.88 | 17 | 338 | 19.6 | $ 1.90 | 19 | 357 | 18.6 | $ 1.92 |
| | **Total** | **29** | **598** | **20.6** | **$ 6.33** | **35** | **693** | **19.7** | **$ 6.73** | **40** | **756** | **19.1** | **$ 6.88** | **44** | **812** | **18.4** | **$ 6.95** | **50** | **865** | **17.5** | **$ 7.00** | **55** | **913** | **16.6** | **$ 7.08** |
| ON | Male | 210 | 4,412 | 21.0 | $ 74.91 | 282 | 5,513 | 19.6 | $ 84.46 | 332 | 6,217 | 18.7 | $ 88.27 | 384 | 6,863 | 17.9 | $ 90.90 | 442 | 7,474 | 16.9 | $ 92.81 | 500 | 8,026 | 16.0 | $ 94.91 |
| | Female | 126 | 3,020 | 24.0 | $ 23.63 | 163 | 3,681 | 22.6 | $ 26.19 | 187 | 4,072 | 21.8 | $ 27.12 | 211 | 4,436 | 21.0 | $ 27.88 | 239 | 4,791 | 20.0 | $ 28.60 | 271 | 5,137 | 19.0 | $ 29.35 |
| | **Total** | **336** | **7,432** | **22.1** | **$ 98.53** | **445** | **9,194** | **20.7** | **$110.65** | **519** | **10,289** | **19.8** | **$115.39** | **595** | **11,298** | **19.0** | **$ 118.78** | **681** | **12,265** | **18.0** | **$121.41** | **771** | **13,163** | **17.1** | **$124.26** |
| QC | Male | 81 | 1,673 | 20.7 | $ 21.09 | 106 | 2,009 | 18.9 | $ 22.08 | 123 | 2,209 | 17.9 | $ 22.24 | 140 | 2,371 | 16.9 | $ 22.15 | 157 | 2,507 | 15.9 | $ 21.92 | 174 | 2,613 | 15.1 | $ 21.78 |
| | Female | 52 | 1,228 | 23.6 | $ 7.37 | 65 | 1,414 | 21.8 | $ 7.43 | 73 | 1,515 | 20.8 | $ 7.37 | 80 | 1,600 | 19.9 | $ 7.30 | 89 | 1,675 | 18.9 | $ 7.24 | 98 | 1,740 | 17.8 | $ 7.18 |
| | **Total** | **133** | **2,901** | **21.8** | **$ 28.46** | **171** | **3,423** | **20.0** | **$ 29.50** | **196** | **3,724** | **19.0** | **$ 29.61** | **220** | **3,971** | **18.0** | **$ 29.45** | **246** | **4,182** | **17.0** | **$ 29.17** | **271** | **4,353** | **16.0** | **$ 28.96** |
| NB | Male | 9 | 181 | 20.1 | $ 1.93 | 11 | 212 | 18.6 | $ 1.95 | 13 | 232 | 17.6 | $ 1.93 | 15 | 247 | 16.5 | $ 1.88 | 17 | 260 | 15.4 | $ 1.82 | 19 | 269 | 14.4 | $ 1.77 |
| | Female | 8 | 192 | 23.9 | $ 0.96 | 10 | 217 | 22.3 | $ 0.94 | 11 | 232 | 21.3 | $ 0.91 | 12 | 245 | 20.4 | $ 0.88 | 13 | 258 | 19.3 | $ 0.85 | 15 | 271 | 18.3 | $ 0.83 |
| | **Total** | **17** | **372** | **21.9** | **$ 2.89** | **21** | **429** | **20.3** | **$ 2.89** | **24** | **464** | **19.3** | **$ 2.84** | **27** | **492** | **18.2** | **$ 2.76** | **30** | **518** | **17.1** | **$ 2.67** | **33** | **540** | **16.2** | **$ 2.59** |
| NF&L | Male | 6 | 116 | 19.3 | $ 1.26 | 8 | 133 | 17.7 | $ 1.23 | 9 | 144 | 16.5 | $ 1.19 | 10 | 151 | 15.4 | $ 1.14 | 11 | 156 | 14.3 | $ 1.09 | 12 | 159 | 13.3 | $ 1.05 |
| | Female | 5 | 120 | 23.9 | $ 0.52 | 6 | 136 | 21.9 | $ 0.49 | 7 | 145 | 20.6 | $ 0.47 | 8 | 152 | 19.3 | $ 0.45 | 9 | 158 | 18.0 | $ 0.43 | 10 | 163 | 16.8 | $ 0.41 |
| | **Total** | **11** | **236** | **21.4** | **$ 1.78** | **14** | **269** | **19.6** | **$ 1.72** | **16** | **288** | **18.3** | **$ 1.66** | **18** | **303** | **17.2** | **$ 1.59** | **20** | **314** | **15.9** | **$ 1.52** | **22** | **322** | **14.9** | **$ 1.47** |
| PEI | Male | 2 | 42 | 20.6 | $ 0.41 | 3 | 50 | 19.3 | $ 0.43 | 3 | 55 | 18.4 | $ 0.43 | 3 | 60 | 17.3 | $ 0.43 | 4 | 63 | 16.5 | $ 0.43 | 4 | 66 | 15.6 | $ 0.43 |
| | Female | 1 | 32 | 23.9 | $ 0.19 | 2 | 37 | 22.9 | $ 0.19 | 2 | 40 | 21.9 | $ 0.19 | 2 | 42 | 20.9 | $ 0.19 | 2 | 45 | 19.7 | $ 0.18 | 3 | 46 | 18.5 | $ 0.18 |
| | **Total** | **3** | **74** | **21.9** | **$ 0.60** | **4** | **87** | **20.7** | **$ 0.62** | **5** | **95** | **19.7** | **$ 0.62** | **5** | **102** | **18.7** | **$ 0.62** | **6** | **108** | **17.7** | **$ 0.61** | **7** | **113** | **16.7** | **$ 0.61** |
| NS | Male | 14 | 274 | 19.6 | $ 3.32 | 18 | 321 | 18.1 | $ 3.38 | 21 | 352 | 17.1 | $ 3.35 | 23 | 375 | 16.1 | $ 3.29 | 26 | 395 | 15.0 | $ 3.20 | 29 | 408 | 14.1 | $ 3.14 |
| | Female | 11 | 247 | 22.5 | $ 1.34 | 13 | 280 | 21.2 | $ 1.32 | 15 | 299 | 20.3 | $ 1.29 | 16 | 315 | 19.3 | $ 1.25 | 18 | 329 | 18.1 | $ 1.22 | 20 | 341 | 17.0 | $ 1.19 |
| | **Total** | **25** | **522** | **20.9** | **$ 4.66** | **31** | **601** | **19.4** | **$ 4.70** | **35** | **651** | **18.5** | **$ 4.65** | **40** | **690** | **17.4** | **$ 4.54** | **44** | **724** | **16.3** | **$ 4.42** | **49** | **749** | **15.3** | **$ 4.33** |
| YK/NWT/NV | Male | 1 | 24 | 25.2 | $ 0.60 | 1 | 29 | 22.8 | $ 0.63 | 1 | 31 | 21.4 | $ 0.64 | 2 | 34 | 20.3 | $ 0.65 | 2 | 35 | 19.2 | $ 0.66 | 2 | 31 | 15.2 | $ 0.67 |
| | Female | 1 | 16 | 30.4 | $ 0.20 | 1 | 19 | 27.0 | $ 0.22 | 1 | 20 | 25.6 | $ 0.22 | 1 | 22 | 23.4 | $ 0.23 | 1 | 24 | 22.1 | $ 0.23 | 1 | 20 | 16.9 | $ 0.23 |
| | **Total** | **1** | **40** | **27.0** | **$ 0.80** | **2** | **48** | **24.3** | **$ 0.85** | **2** | **52** | **22.9** | **$ 0.86** | **3** | **56** | **21.4** | **$ 0.88** | **3** | **59** | **20.3** | **$ 0.89** | **3** | **51** | **15.8** | **$ 0.90** |
| **Canada** | Male | **454** | **9,483** | **20.9** | **$146.48** | **602** | **11,687** | **19.4** | **$161.99** | **706** | **13,078** | **18.5** | **$167.71** | **812** | **14,316** | **17.6** | **$ 171.13** | **929** | **15,457** | **16.6** | **$173.30** | **1,044** | **16,446** | **15.7** | **$175.90** |
| | Female | **291** | **6,957** | **23.9** | **$ 49.02** | **370** | **8,312** | **22.5** | **$ 52.84** | **421** | **9,108** | **21.6** | **$ 54.05** | **474** | **9,834** | **20.8** | **$ 54.98** | **533** | **10,535** | **19.8** | **$ 55.86** | **599** | **11,201** | **18.7** | **$ 56.80** |
| | **Total** | **745** | **16,440** | **22.1** | **$195.50** | **973** | **19,999** | **20.6** | **$214.83** | **1,128** | **22,186** | **19.7** | **$221.77** | **1,286** | **24,150** | **18.8** | **$ 226.11** | **1,462** | **25,992** | **17.8** | **$229.16** | **1,644** | **27,647** | **16.8** | **$232.70** |

To address the implied issues, the standard human-capital approach was modified by placing a value on all years of life lost. For those not in the formal workforce, the minimum wage for each province/territory was used to assign a value to a year of life lost. The minimum wage in 2004 ranged from a low of $5.90 per hour in Alberta to a high of $8.00 per hour in British Columbia.[344]

The results of this modification are summarized in the following table. Note that the indirect costs assigned to individuals not in the workforce are higher in total than the indirect costs based on those in the workforce. Thus, by using the minimum wage for valuation, the indirect costs, including those associated with individuals who are not in the workforce, totalled $410.1 million in 2004 (compared to $195.5 million if only those in the workforce are included). These costs are projected to increase to almost $624.8 million by 2031.

[344] Statistics Canada, *Fact Sheet on Minimum Wage*, September 2005.

**Estimated Indirect Costs Associated with Deaths Due to Melanoma Skin Cancer in Canada**
**By Province/Territory and Gender**
2004 to 2031 (in $millions, 2004 constant dollars, costs undiscounted)

| | | 2004 Indirect Cost | | | 2011 Indirect Cost | | | 2016 Indirect Cost | | | 2021 Indirect Cost | | | 2026 Indirect Cost | | | 2031 Indirect Cost | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total |
| BC | Male | $ 18.48 | $ 19.68 | $ 38.16 | $ 20.60 | $ 25.48 | $ 46.08 | $ 21.52 | $ 29.37 | $ 50.89 | $ 22.15 | $ 33.00 | $ 55.14 | $ 22.63 | $ 36.38 | $ 59.00 | $ 23.14 | $ 39.21 | $ 62.35 |
| | Female | $ 6.67 | $ 15.12 | $ 21.79 | $ 7.24 | $ 18.88 | $ 26.12 | $ 7.47 | $ 21.24 | $ 28.71 | $ 7.66 | $ 23.43 | $ 31.09 | $ 7.86 | $ 25.52 | $ 33.38 | $ 8.06 | $ 27.48 | $ 35.55 |
| | **Total** | **$ 25.14** | **$ 34.80** | **$ 59.95** | **$ 27.84** | **$ 44.36** | **$ 72.20** | **$ 28.99** | **$ 50.61** | **$ 79.60** | **$ 29.81** | **$ 56.43** | **$ 86.24** | **$ 30.49** | **$ 61.90** | **$ 92.38** | **$ 31.20** | **$ 66.69** | **$ 97.89** |
| AB | Male | $ 16.54 | $ 7.88 | $ 24.42 | $ 18.92 | $ 10.55 | $ 29.46 | $ 19.72 | $ 12.34 | $ 32.07 | $ 20.15 | $ 14.02 | $ 34.17 | $ 20.40 | $ 15.58 | $ 35.98 | $ 20.67 | $ 16.89 | $ 37.57 |
| | Female | $ 5.00 | $ 5.47 | $ 10.47 | $ 5.60 | $ 7.05 | $ 12.65 | $ 5.79 | $ 8.02 | $ 13.82 | $ 5.93 | $ 8.94 | $ 14.87 | $ 6.05 | $ 9.81 | $ 15.86 | $ 6.16 | $ 10.62 | $ 16.78 |
| | **Total** | **$ 21.54** | **$ 13.35** | **$ 34.89** | **$ 24.52** | **$ 17.60** | **$ 42.11** | **$ 25.52** | **$ 20.37** | **$ 45.88** | **$ 26.08** | **$ 22.96** | **$ 49.03** | **$ 26.44** | **$ 25.39** | **$ 51.84** | **$ 26.83** | **$ 27.52** | **$ 54.35** |
| SK | Male | $ 3.36 | $ 3.22 | $ 6.58 | $ 3.42 | $ 3.72 | $ 7.13 | $ 3.39 | $ 4.10 | $ 7.49 | $ 3.32 | $ 4.44 | $ 7.76 | $ 3.24 | $ 4.74 | $ 7.98 | $ 3.18 | $ 4.95 | $ 8.13 |
| | Female | $ 1.40 | $ 2.53 | $ 3.93 | $ 1.39 | $ 2.82 | $ 4.21 | $ 1.36 | $ 3.02 | $ 4.38 | $ 1.32 | $ 3.19 | $ 4.51 | $ 1.30 | $ 3.35 | $ 4.65 | $ 1.28 | $ 3.49 | $ 4.77 |
| | **Total** | **$ 4.76** | **$ 5.75** | **$ 10.51** | **$ 4.81** | **$ 6.54** | **$ 11.35** | **$ 4.75** | **$ 7.12** | **$ 11.88** | **$ 4.64** | **$ 7.63** | **$ 12.28** | **$ 4.54** | **$ 8.10** | **$ 12.63** | **$ 4.46** | **$ 8.45** | **$ 12.90** |
| MB | Male | $ 4.59 | $ 4.64 | $ 9.22 | $ 4.90 | $ 5.61 | $ 10.51 | $ 5.02 | $ 6.32 | $ 11.34 | $ 5.08 | $ 6.96 | $ 12.04 | $ 5.11 | $ 7.53 | $ 12.64 | $ 5.16 | $ 7.99 | $ 13.14 |
| | Female | $ 1.75 | $ 3.00 | $ 4.75 | $ 1.83 | $ 3.48 | $ 5.31 | $ 1.85 | $ 3.80 | $ 5.65 | $ 1.88 | $ 4.10 | $ 5.97 | $ 1.90 | $ 4.38 | $ 6.27 | $ 1.92 | $ 4.63 | $ 6.55 |
| | **Total** | **$ 6.33** | **$ 7.64** | **$ 13.97** | **$ 6.73** | **$ 9.09** | **$ 15.82** | **$ 6.88** | **$ 10.12** | **$ 17.00** | **$ 6.95** | **$ 11.06** | **$ 18.01** | **$ 7.00** | **$ 11.91** | **$ 18.91** | **$ 7.08** | **$ 12.62** | **$ 19.69** |
| ON | Male | $ 74.91 | $ 58.60 | $ 133.51 | $ 84.46 | $ 75.47 | $ 159.93 | $ 88.27 | $ 86.98 | $ 175.25 | $ 90.90 | $ 97.81 | $ 188.71 | $ 92.81 | $ 108.01 | $ 200.82 | $ 94.91 | $ 116.85 | $ 211.77 |
| | Female | $ 23.63 | $ 37.95 | $ 61.57 | $ 26.19 | $ 47.30 | $ 73.49 | $ 27.12 | $ 53.15 | $ 80.27 | $ 27.88 | $ 58.62 | $ 86.50 | $ 28.60 | $ 63.84 | $ 92.45 | $ 29.35 | $ 68.75 | $ 98.09 |
| | **Total** | **$ 98.53** | **$ 96.55** | **$ 195.08** | **$ 110.65** | **$ 122.77** | **$ 233.43** | **$ 115.39** | **$ 140.13** | **$ 255.52** | **$ 118.78** | **$ 156.43** | **$ 275.21** | **$ 121.41** | **$ 171.85** | **$ 293.26** | **$ 124.26** | **$ 185.60** | **$ 309.86** |
| QC | Male | $ 21.09 | $ 24.65 | $ 45.74 | $ 22.08 | $ 30.79 | $ 52.87 | $ 22.24 | $ 34.63 | $ 56.88 | $ 22.15 | $ 37.82 | $ 59.97 | $ 21.92 | $ 40.41 | $ 62.34 | $ 21.78 | $ 42.30 | $ 64.08 |
| | Female | $ 7.37 | $ 16.71 | $ 24.08 | $ 7.43 | $ 19.74 | $ 27.17 | $ 7.37 | $ 21.46 | $ 28.83 | $ 7.30 | $ 22.89 | $ 30.20 | $ 7.24 | $ 24.08 | $ 31.33 | $ 7.18 | $ 25.07 | $ 32.25 |
| | **Total** | **$ 28.46** | **$ 41.36** | **$ 69.82** | **$ 29.50** | **$ 50.53** | **$ 80.03** | **$ 29.61** | **$ 56.10** | **$ 85.71** | **$ 29.45** | **$ 60.71** | **$ 90.17** | **$ 29.17** | **$ 64.50** | **$ 93.66** | **$ 28.96** | **$ 67.37** | **$ 96.33** |
| NB | Male | $ 1.93 | $ 2.29 | $ 4.22 | $ 1.95 | $ 2.80 | $ 4.75 | $ 1.93 | $ 3.15 | $ 5.08 | $ 1.88 | $ 3.42 | $ 5.30 | $ 1.82 | $ 3.64 | $ 5.45 | $ 1.77 | $ 3.77 | $ 5.54 |
| | Female | $ 0.96 | $ 2.12 | $ 3.07 | $ 0.94 | $ 2.48 | $ 3.42 | $ 0.91 | $ 2.69 | $ 3.61 | $ 0.88 | $ 2.86 | $ 3.75 | $ 0.85 | $ 3.01 | $ 3.86 | $ 0.83 | $ 3.11 | $ 3.94 |
| | **Total** | **$ 2.89** | **$ 4.40** | **$ 7.29** | **$ 2.89** | **$ 5.28** | **$ 8.17** | **$ 2.84** | **$ 5.84** | **$ 8.68** | **$ 2.76** | **$ 6.28** | **$ 9.04** | **$ 2.67** | **$ 6.64** | **$ 9.31** | **$ 2.59** | **$ 6.88** | **$ 9.47** |
| NF&L | Male | $ 1.26 | $ 1.47 | $ 2.73 | $ 1.23 | $ 1.78 | $ 3.01 | $ 1.19 | $ 1.97 | $ 3.16 | $ 1.14 | $ 2.11 | $ 3.25 | $ 1.09 | $ 2.20 | $ 3.29 | $ 1.05 | $ 2.24 | $ 3.29 |
| | Female | $ 0.52 | $ 1.41 | $ 1.93 | $ 0.49 | $ 1.66 | $ 2.16 | $ 0.47 | $ 1.81 | $ 2.28 | $ 0.45 | $ 1.92 | $ 2.37 | $ 0.43 | $ 2.01 | $ 2.44 | $ 0.41 | $ 2.07 | $ 2.49 |
| | **Total** | **$ 1.78** | **$ 2.88** | **$ 4.66** | **$ 1.72** | **$ 3.44** | **$ 5.17** | **$ 1.66** | **$ 3.77** | **$ 5.44** | **$ 1.59** | **$ 4.03** | **$ 5.62** | **$ 1.52** | **$ 4.21** | **$ 5.73** | **$ 1.47** | **$ 4.32** | **$ 5.78** |
| PEI | Male | $ 0.41 | $ 0.52 | $ 0.93 | $ 0.43 | $ 0.64 | $ 1.07 | $ 0.43 | $ 0.72 | $ 1.16 | $ 0.43 | $ 0.80 | $ 1.23 | $ 0.43 | $ 0.85 | $ 1.28 | $ 0.43 | $ 0.89 | $ 1.32 |
| | Female | $ 0.19 | $ 0.36 | $ 0.54 | $ 0.19 | $ 0.42 | $ 0.61 | $ 0.19 | $ 0.46 | $ 0.65 | $ 0.19 | $ 0.50 | $ 0.68 | $ 0.18 | $ 0.53 | $ 0.71 | $ 0.18 | $ 0.55 | $ 0.74 |
| | **Total** | **$ 0.60** | **$ 0.88** | **$ 1.47** | **$ 0.62** | **$ 1.06** | **$ 1.68** | **$ 0.62** | **$ 1.19** | **$ 1.81** | **$ 0.62** | **$ 1.29** | **$ 1.91** | **$ 0.61** | **$ 1.38** | **$ 2.00** | **$ 0.61** | **$ 1.45** | **$ 2.06** |
| NS | Male | $ 3.32 | $ 3.55 | $ 6.87 | $ 3.38 | $ 4.35 | $ 7.72 | $ 3.35 | $ 4.87 | $ 8.23 | $ 3.29 | $ 5.29 | $ 8.58 | $ 3.20 | $ 5.63 | $ 8.83 | $ 3.14 | $ 5.83 | $ 8.97 |
| | Female | $ 1.34 | $ 2.99 | $ 4.34 | $ 1.32 | $ 3.50 | $ 4.82 | $ 1.29 | $ 3.80 | $ 5.09 | $ 1.25 | $ 4.05 | $ 5.31 | $ 1.22 | $ 4.26 | $ 5.48 | $ 1.19 | $ 4.42 | $ 5.62 |
| | **Total** | **$ 4.66** | **$ 6.55** | **$ 11.21** | **$ 4.70** | **$ 7.84** | **$ 12.54** | **$ 4.65** | **$ 8.67** | **$ 13.32** | **$ 4.54** | **$ 9.35** | **$ 13.89** | **$ 4.42** | **$ 9.89** | **$ 14.31** | **$ 4.33** | **$ 10.25** | **$ 14.58** |
| YK/NWT/NV | Male | $ 0.60 | $ 0.21 | $ 0.81 | $ 0.63 | $ 0.43 | $ 1.07 | $ 0.64 | $ 0.49 | $ 1.13 | $ 0.65 | $ 0.53 | $ 1.18 | $ 0.66 | $ 0.56 | $ 1.22 | $ 0.67 | $ 0.59 | $ 1.26 |
| | Female | $ 0.20 | $ 0.20 | $ 0.41 | $ 0.22 | $ 0.27 | $ 0.48 | $ 0.22 | $ 0.29 | $ 0.51 | $ 0.23 | $ 0.33 | $ 0.55 | $ 0.23 | $ 0.35 | $ 0.58 | $ 0.23 | $ 0.37 | $ 0.60 |
| | **Total** | **$ 0.80** | **$ 0.41** | **$ 1.22** | **$ 0.85** | **$ 0.70** | **$ 1.55** | **$ 0.86** | **$ 0.78** | **$ 1.64** | **$ 0.88** | **$ 0.86** | **$ 1.74** | **$ 0.89** | **$ 0.91** | **$ 1.80** | **$ 0.90** | **$ 0.96** | **$ 1.86** |
| **Canada** | Male | **$ 146.48** | **$ 126.71** | **$ 273.19** | **$ 161.99** | **$ 161.62** | **$ 323.61** | **$ 167.71** | **$ 184.95** | **$ 352.66** | **$ 171.13** | **$ 206.20** | **$ 377.33** | **$ 173.30** | **$ 225.53** | **$ 398.82** | **$ 175.90** | **$ 241.51** | **$ 417.42** |
| | Female | **$ 49.02** | **$ 87.86** | **$ 136.88** | **$ 52.84** | **$ 107.60** | **$ 160.45** | **$ 54.05** | **$ 119.75** | **$ 173.80** | **$ 54.98** | **$ 130.83** | **$ 185.81** | **$ 55.86** | **$ 141.15** | **$ 197.01** | **$ 56.80** | **$ 150.57** | **$ 207.37** |
| | **Total** | **$ 195.50** | **$ 214.58** | **$ 410.07** | **$ 214.83** | **$ 269.22** | **$ 484.05** | **$ 221.77** | **$ 304.70** | **$ 526.46** | **$ 226.11** | **$ 337.03** | **$ 563.14** | **$ 229.16** | **$ 366.68** | **$ 595.83** | **$ 232.70** | **$ 392.08** | **$ 624.78** |

*Note: WFP=Workforce Participation, NWFP=Non-Workforce Participation*

Using the minimum wage to value a life year lost for those individuals who are not actively participating in the workforce represents a conservative approach to modifying the human-capital approach. Other economists have used a higher average wage. For example, Guerriere et al. adopted the average hourly wage of a homemaker ($15.69 CAD in 2005) to value caregiver time in domestic settings.[345] By applying $15.69 per hour rather than the minimum wage, the indirect costs assigned to those not participating in the formal workforce would be adjusted upward from $214.6 million to $470.8 million in 2004 (and from $392.1 million to $860.1 million in 2031).

[345] Guerriere DN, Tranmer JE, Ungar WJ et al. Valuing care recipient and family caregiver time: a comparison of methods. *International Journal of Technology Assessment in Health Care.* 2008; 24(1): 52-9.

**Non-Melanoma Skin Cancer**

In estimating the indirect costs associated with mortality due to non-melanoma skin cancer, an approach was adopted that was a parallel to the one employed for melanoma.

For NMSC, the indirect costs associated with mortality were estimated to be $11.6 million in Canada in 2004 (see following table). The 204 deaths that year resulted in 2,363 potential years of life lost (PYLL), or an average of 11.6 PYLL per death. This compares to an average of 10.7 PYLL per death in New Zealand.[346] By 2031, the expected indirect costs (in undiscounted 2004 Canadian dollars) would increase to $20.8 million.

**Estimated Indirect Costs Associated with Deaths Due to Non-Melanoma Skin Cancer in Canada**
**By Province/Territory and Gender**
2004 to 2031 (in $millions, 2004 Constant dollars, costs undiscounted)

| | | 2004 | | | | 2011 | | | | 2016 | | | | 2021 | | | | 2026 | | | | 2031 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Deaths | Total PYLL | PYLL / Death | Indirect Cost | Deaths | Total PYLL | PYLL / Death | Indirect Cost | Deaths | Total PYLL | PYLL / Death | Indirect Cost | Deaths | Total PYLL | PYLL / Death | Indirect Cost | Deaths | Total PYLL | PYLL / Death | Indirect Cost | Deaths | Total PYLL | PYLL / Death | Indirect Cost |
| BC | Male | 21 | 250 | 11.8 | $ 1.43 | 29 | 336 | 11.6 | $ 1.82 | 35 | 408 | 11.5 | $ 2.08 | 44 | 498 | 11.4 | $ 2.31 | 55 | 609 | 11.1 | $ 2.55 | 70 | 732 | 10.5 | $ 2.80 |
| | Female | 12 | 137 | 11.8 | $ 0.28 | 15 | 175 | 11.5 | $ 0.32 | 18 | 205 | 11.6 | $ 0.34 | 21 | 240 | 11.5 | $ 0.36 | 25 | 282 | 11.2 | $ 0.39 | 31 | 332 | 10.6 | $ 0.41 |
| | **Total** | **33** | **387** | **11.8** | **$ 1.71** | **44** | **511** | **11.5** | **$ 2.15** | **53** | **613** | **11.5** | **$ 2.42** | **65** | **738** | **11.4** | **$ 2.67** | **80** | **891** | **11.1** | **$ 2.93** | **101** | **1,065** | **10.5** | **$ 3.21** |
| AB | Male | 11 | 132 | 12.2 | $ 1.21 | 15 | 184 | 11.9 | $ 1.58 | 19 | 229 | 11.8 | $ 1.81 | 25 | 284 | 11.6 | $ 2.01 | 32 | 352 | 11.1 | $ 2.20 | 41 | 426 | 10.5 | $ 2.40 |
| | Female | 7 | 81 | 12.3 | $ 0.26 | 9 | 107 | 12.1 | $ 0.31 | 11 | 128 | 12.0 | $ 0.34 | 13 | 153 | 11.9 | $ 0.36 | 16 | 181 | 11.5 | $ 0.38 | 20 | 216 | 10.8 | $ 0.41 |
| | **Total** | **17** | **213** | **12.2** | **$ 1.47** | **24** | **290** | **12.0** | **$ 1.89** | **30** | **357** | **11.9** | **$ 2.15** | **37** | **437** | **11.7** | **$ 2.37** | **47** | **533** | **11.3** | **$ 2.58** | **61** | **642** | **10.6** | **$ 2.81** |
| SK | Male | 4 | 41 | 10.4 | $ 0.19 | 5 | 48 | 10.6 | $ 0.23 | 5 | 55 | 10.8 | $ 0.25 | 6 | 64 | 10.9 | $ 0.26 | 7 | 75 | 10.6 | $ 0.28 | 9 | 88 | 10.1 | $ 0.29 |
| | Female | 3 | 32 | 10.9 | $ 0.06 | 3 | 36 | 10.9 | $ 0.06 | 4 | 39 | 11.2 | $ 0.06 | 4 | 43 | 11.3 | $ 0.06 | 4 | 48 | 11.2 | $ 0.06 | 5 | 55 | 10.7 | $ 0.07 |
| | **Total** | **7** | **73** | **10.6** | **$ 0.25** | **8** | **84** | **10.7** | **$ 0.29** | **9** | **94** | **10.9** | **$ 0.31** | **10** | **107** | **11.0** | **$ 0.33** | **11** | **124** | **10.8** | **$ 0.34** | **14** | **142** | **10.4** | **$ 0.36** |
| MB | Male | 4 | 45 | 10.6 | $ 0.24 | 5 | 56 | 10.7 | $ 0.29 | 6 | 66 | 10.8 | $ 0.32 | 7 | 79 | 10.8 | $ 0.35 | 9 | 94 | 10.5 | $ 0.38 | 11 | 111 | 10.0 | $ 0.41 |
| | Female | 2 | 26 | 10.6 | $ 0.06 | 3 | 31 | 10.7 | $ 0.07 | 3 | 34 | 10.9 | $ 0.07 | 3 | 38 | 11.0 | $ 0.07 | 4 | 44 | 10.9 | $ 0.07 | 5 | 50 | 10.3 | $ 0.08 |
| | **Total** | **7** | **72** | **10.6** | **$ 0.29** | **8** | **87** | **10.7** | **$ 0.36** | **9** | **100** | **10.9** | **$ 0.39** | **11** | **117** | **10.9** | **$ 0.42** | **13** | **138** | **10.6** | **$ 0.46** | **16** | **162** | **10.1** | **$ 0.49** |
| ON | Male | 55 | 636 | 11.6 | $ 4.51 | 75 | 852 | 11.3 | $ 5.77 | 92 | 1,036 | 11.3 | $ 6.58 | 113 | 1,265 | 11.2 | $ 7.35 | 142 | 1,547 | 10.9 | $ 8.08 | 180 | 1,861 | 10.4 | $ 8.86 |
| | Female | 30 | 354 | 11.6 | $ 0.94 | 40 | 453 | 11.3 | $ 1.11 | 47 | 529 | 11.3 | $ 1.19 | 55 | 617 | 11.3 | $ 1.27 | 66 | 721 | 11.0 | $ 1.35 | 81 | 844 | 10.4 | $ 1.43 |
| | **Total** | **85** | **990** | **11.6** | **$ 5.46** | **115** | **1,305** | **11.3** | **$ 6.88** | **139** | **1,565** | **11.3** | **$ 7.78** | **168** | **1,882** | **11.2** | **$ 8.62** | **208** | **2,268** | **10.9** | **$ 9.43** | **261** | **2,706** | **10.4** | **$10.29** |
| QC | Male | 22 | 255 | 11.7 | $ 1.35 | 30 | 338 | 11.4 | $ 1.63 | 36 | 405 | 11.2 | $ 1.78 | 45 | 486 | 10.9 | $ 1.92 | 56 | 581 | 10.4 | $ 2.05 | 69 | 680 | 9.9 | $ 2.18 |
| | Female | 14 | 158 | 11.7 | $ 0.30 | 17 | 197 | 11.3 | $ 0.32 | 20 | 226 | 11.1 | $ 0.33 | 24 | 258 | 11.0 | $ 0.34 | 28 | 294 | 10.6 | $ 0.35 | 34 | 335 | 9.9 | $ 0.35 |
| | **Total** | **35** | **413** | **11.7** | **$ 1.65** | **47** | **535** | **11.3** | **$ 1.95** | **57** | **631** | **11.1** | **$ 2.11** | **68** | **744** | **10.9** | **$ 2.26** | **83** | **875** | **10.5** | **$ 2.39** | **103** | **1,016** | **9.9** | **$ 2.53** |
| NB | Male | 3 | 37 | 11.2 | $ 0.16 | 4 | 48 | 11.2 | $ 0.19 | 5 | 57 | 11.1 | $ 0.21 | 6 | 69 | 10.9 | $ 0.22 | 8 | 82 | 10.3 | $ 0.23 | 10 | 97 | 9.7 | $ 0.24 |
| | Female | 2 | 29 | 12.7 | $ 0.04 | 3 | 35 | 12.4 | $ 0.05 | 3 | 39 | 12.3 | $ 0.05 | 4 | 45 | 12.3 | $ 0.05 | 4 | 53 | 12.0 | $ 0.05 | 5 | 62 | 11.5 | $ 0.05 |
| | **Total** | **6** | **66** | **11.8** | **$ 0.21** | **7** | **83** | **11.7** | **$ 0.24** | **8** | **97** | **11.6** | **$ 0.26** | **10** | **114** | **11.4** | **$ 0.27** | **12** | **135** | **10.9** | **$ 0.28** | **15** | **159** | **10.4** | **$ 0.29** |
| NF&L | Male | 2 | 17 | 10.7 | $ 0.08 | 2 | 22 | 10.8 | $ 0.10 | 3 | 26 | 10.5 | $ 0.10 | 3 | 31 | 10.2 | $ 0.11 | 4 | 37 | 9.5 | $ 0.11 | 5 | 43 | 8.9 | $ 0.11 |
| | Female | 1 | 12 | 12.1 | $ 0.02 | 1 | 15 | 11.9 | $ 0.02 | 1 | 18 | 11.7 | $ 0.02 | 2 | 20 | 11.4 | $ 0.02 | 2 | 24 | 10.8 | $ 0.02 | 3 | 28 | 10.1 | $ 0.02 |
| | **Total** | **3** | **29** | **11.2** | **$ 0.10** | **3** | **37** | **11.2** | **$ 0.11** | **4** | **44** | **11.0** | **$ 0.12** | **5** | **52** | **10.6** | **$ 0.12** | **6** | **61** | **10.0** | **$ 0.13** | **8** | **70** | **9.3** | **$ 0.13** |
| PEI | Male | 1 | 8 | 11.7 | $ 0.03 | 1 | 11 | 11.8 | $ 0.04 | 1 | 13 | 11.9 | $ 0.04 | 1 | 15 | 11.3 | $ 0.05 | 2 | 18 | 11.1 | $ 0.05 | 2 | 21 | 10.5 | $ 0.05 |
| | Female | 1 | 8 | 11.7 | $ 0.01 | 1 | 9 | 11.9 | $ 0.02 | 1 | 10 | 12.0 | $ 0.02 | 1 | 12 | 11.8 | $ 0.02 | 1 | 14 | 11.3 | $ 0.02 | 1 | 16 | 10.7 | $ 0.02 |
| | **Total** | **1** | **16** | **11.7** | **$ 0.05** | **2** | **20** | **11.8** | **$ 0.05** | **2** | **23** | **11.9** | **$ 0.06** | **2** | **27** | **11.5** | **$ 0.06** | **3** | **32** | **11.2** | **$ 0.07** | **3** | **37** | **10.6** | **$ 0.07** |
| NS | Male | 6 | 60 | 10.6 | $ 0.31 | 7 | 77 | 10.7 | $ 0.37 | 9 | 91 | 10.7 | $ 0.40 | 11 | 109 | 10.4 | $ 0.42 | 13 | 131 | 9.9 | $ 0.44 | 16 | 152 | 9.3 | $ 0.47 |
| | Female | 4 | 41 | 10.8 | $ 0.07 | 5 | 49 | 10.9 | $ 0.08 | 5 | 56 | 11.0 | $ 0.08 | 6 | 64 | 10.9 | $ 0.08 | 7 | 74 | 10.4 | $ 0.08 | 9 | 85 | 9.8 | $ 0.08 |
| | **Total** | **9** | **101** | **10.7** | **$ 0.38** | **12** | **126** | **10.8** | **$ 0.44** | **14** | **147** | **10.8** | **$ 0.48** | **16** | **174** | **10.6** | **$ 0.50** | **20** | **205** | **10.1** | **$ 0.52** | **25** | **238** | **9.5** | **$ 0.55** |
| YK/NWT/NV | Male | 0 | 3 | 15.3 | $ 0.04 | 0 | 4 | 14.6 | $ 0.04 | 0 | 5 | 14.1 | $ 0.05 | 0 | 5 | 13.7 | $ 0.05 | 1 | 6 | 12.7 | $ 0.05 | 1 | 8 | 11.5 | $ 0.06 |
| | Female | 0 | 1 | 16.6 | $ 0.01 | 0 | 2 | 15.9 | $ 0.01 | 0 | 2 | 14.9 | $ 0.01 | 0 | 2 | 13.2 | $ 0.01 | 0 | 3 | 12.5 | $ 0.01 | 0 | 3 | 11.6 | $ 0.01 |
| | **Total** | **0** | **4** | **15.7** | **$ 0.04** | **0** | **5** | **15.0** | **$ 0.05** | **0** | **6** | **14.3** | **$ 0.06** | **1** | **8** | **13.5** | **$ 0.06** | **1** | **9** | **12.6** | **$ 0.06** | **1** | **11** | **11.5** | **$ 0.07** |
| **Canada** | Male | **128** | **1,483** | **11.6** | **$ 9.55** | **174** | **1,975** | **11.4** | **$12.05** | **212** | **2,391** | **11.3** | **$13.62** | **261** | **2,907** | **11.1** | **$15.05** | **328** | **3,533** | **10.8** | **$16.42** | **413** | **4,220** | **10.2** | **$17.88** |
| | Female | **75** | **880** | **11.7** | **$ 2.05** | **97** | **1,109** | **11.4** | **$ 2.36** | **113** | **1,286** | **11.4** | **$ 2.50** | **132** | **1,493** | **11.3** | **$ 2.64** | **158** | **1,738** | **11.0** | **$ 2.77** | **195** | **2,027** | **10.4** | **$ 2.92** |
| | **Total** | **204** | **2,363** | **11.6** | **$11.61** | **271** | **3,084** | **11.4** | **$14.42** | **325** | **3,677** | **11.3** | **$16.12** | **393** | **4,400** | **11.2** | **$17.69** | **486** | **5,270** | **10.8** | **$19.19** | **608** | **6,247** | **10.28** | **$20.80** |

[346] New Zealand Cancer Society. The Cost of Skin Cancer in New Zealand, *Cancer Update in Practice*, Issue 2, 2000.

As with the indirect costs associated with mortality due to melanoma, the minimum wage for each province/territory was used to assign a value to a year of life lost.

The results of this modification are summarized in the following table. Note that once again the indirect costs assigned to individuals not in the workforce are higher in total than the indirect costs based on those in the workforce. Thus, the indirect costs associated with individuals who are not in the workforce totalled $35.3 million in 2004 (compared to $11.6 million for those in the workforce), projected to increase to $96.4 million by 2031.

Combining the indirect costs assigned to those in and out of the workforce, indirect costs associated with mortality due to NMSC totalled $46.9 million in 2004, projected to increase to $117.2 million by 2031.

**Estimated Indirect Costs Associated with Deaths Due to Non-Melanoma Skin Cancer in Canada**
**By Province/Territory and Gender**
2004 to 2031 (in $millions, 2004 Constant dollars, costs undiscounted)

| | | 2004 Indirect Cost | | | 2011 Indirect Cost | | | 2016 Indirect Cost | | | 2021 Indirect Cost | | | 2026 Indirect Cost | | | 2031 Indirect Cost | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total |
| BC | Male | $ 1.43 | $ 4.21 | $ 5.64 | $ 1.82 | $ 5.68 | $ 7.51 | $ 2.08 | $ 6.98 | $ 9.06 | $ 2.31 | $ 8.62 | $ 10.93 | $ 2.55 | $ 10.60 | $ 13.15 | $ 2.80 | $ 12.72 | $ 15.52 |
| | Female | $ 0.28 | $ 2.15 | $ 2.42 | $ 0.32 | $ 2.78 | $ 3.10 | $ 0.34 | $ 3.27 | $ 3.62 | $ 0.36 | $ 3.85 | $ 4.21 | $ 0.39 | $ 4.53 | $ 4.91 | $ 0.41 | $ 5.31 | $ 5.72 |
| | **Total** | **$ 1.71** | **$ 6.36** | **$ 8.07** | **$ 2.15** | **$ 8.46** | **$10.61** | **$ 2.42** | **$ 10.25** | **$ 12.67** | **$ 2.67** | **$12.47** | **$ 15.14** | **$ 2.93** | **$ 15.12** | **$ 18.06** | **$ 3.21** | **$ 18.02** | **$ 21.24** |
| AB | Male | $ 1.21 | $ 1.57 | $ 2.78 | $ 1.58 | $ 2.20 | $ 3.78 | $ 1.81 | $ 2.78 | $ 4.58 | $ 2.01 | $ 3.51 | $ 5.51 | $ 2.20 | $ 4.40 | $ 6.59 | $ 2.40 | $ 5.35 | $ 7.75 |
| | Female | $ 0.26 | $ 0.91 | $ 1.17 | $ 0.31 | $ 1.22 | $ 1.53 | $ 0.34 | $ 1.47 | $ 1.81 | $ 0.36 | $ 1.77 | $ 2.14 | $ 0.38 | $ 2.12 | $ 2.50 | $ 0.41 | $ 2.51 | $ 2.92 |
| | **Total** | **$ 1.47** | **$ 2.48** | **$ 3.96** | **$ 1.89** | **$ 3.41** | **$ 5.31** | **$ 2.15** | **$ 4.25** | **$ 6.40** | **$ 2.37** | **$ 5.28** | **$ 7.65** | **$ 2.58** | **$ 6.51** | **$ 9.09** | **$ 2.81** | **$ 7.86** | **$ 10.67** |
| SK | Male | $ 0.19 | $ 0.57 | $ 0.77 | $ 0.23 | $ 0.68 | $ 0.91 | $ 0.25 | $ 0.78 | $ 1.03 | $ 0.26 | $ 0.92 | $ 1.19 | $ 0.28 | $ 1.10 | $ 1.38 | $ 0.29 | $ 1.28 | $ 1.57 |
| | Female | $ 0.06 | $ 0.41 | $ 0.47 | $ 0.06 | $ 0.47 | $ 0.53 | $ 0.06 | $ 0.51 | $ 0.57 | $ 0.06 | $ 0.57 | $ 0.63 | $ 0.06 | $ 0.64 | $ 0.70 | $ 0.07 | $ 0.72 | $ 0.78 |
| | **Total** | **$ 0.25** | **$ 0.99** | **$ 1.23** | **$ 0.29** | **$ 1.14** | **$ 1.44** | **$ 0.31** | **$ 1.29** | **$ 1.61** | **$ 0.33** | **$ 1.49** | **$ 1.82** | **$ 0.34** | **$ 1.74** | **$ 2.08** | **$ 0.36** | **$ 2.00** | **$ 2.36** |
| MB | Male | $ 0.24 | $ 0.68 | $ 0.92 | $ 0.29 | $ 0.86 | $ 1.15 | $ 0.32 | $ 1.02 | $ 1.34 | $ 0.35 | $ 1.23 | $ 1.58 | $ 0.38 | $ 1.48 | $ 1.86 | $ 0.41 | $ 1.75 | $ 2.16 |
| | Female | $ 0.06 | $ 0.36 | $ 0.42 | $ 0.07 | $ 0.43 | $ 0.49 | $ 0.07 | $ 0.48 | $ 0.55 | $ 0.07 | $ 0.54 | $ 0.61 | $ 0.07 | $ 0.62 | $ 0.69 | $ 0.08 | $ 0.71 | $ 0.79 |
| | **Total** | **$ 0.29** | **$ 1.05** | **$ 1.34** | **$ 0.36** | **$ 1.28** | **$ 1.64** | **$ 0.39** | **$ 1.49** | **$ 1.89** | **$ 0.42** | **$ 1.77** | **$ 2.19** | **$ 0.46** | **$ 2.10** | **$ 2.55** | **$ 0.49** | **$ 2.46** | **$ 2.95** |
| ON | Male | $ 4.51 | $ 9.79 | $14.30 | $ 5.77 | $13.14 | $18.91 | $ 6.58 | $ 16.13 | $ 22.72 | $ 7.35 | $19.93 | $ 27.29 | $ 8.08 | $ 24.57 | $ 32.65 | $ 8.86 | $ 29.60 | $ 38.46 |
| | Female | $ 0.94 | $ 5.02 | $ 5.96 | $ 1.11 | $ 6.46 | $ 7.57 | $ 1.19 | $ 7.61 | $ 8.80 | $ 1.27 | $ 8.94 | $ 10.21 | $ 1.35 | $ 10.46 | $ 11.81 | $ 1.43 | $ 12.21 | $ 13.64 |
| | **Total** | **$ 5.46** | **$14.80** | **$20.26** | **$ 6.88** | **$19.60** | **$26.48** | **$ 7.78** | **$ 23.74** | **$ 31.52** | **$ 8.62** | **$28.87** | **$ 37.49** | **$ 9.43** | **$ 35.03** | **$ 44.46** | **$10.29** | **$ 41.80** | **$ 52.10** |
| QC | Male | $ 1.35 | $ 4.31 | $ 5.66 | $ 1.63 | $ 5.76 | $ 7.39 | $ 1.78 | $ 6.97 | $ 8.75 | $ 1.92 | $ 8.46 | $ 10.38 | $ 2.05 | $ 10.15 | $ 12.19 | $ 2.18 | $ 11.84 | $ 14.02 |
| | Female | $ 0.30 | $ 2.38 | $ 2.68 | $ 0.32 | $ 2.99 | $ 3.31 | $ 0.33 | $ 3.46 | $ 3.78 | $ 0.34 | $ 3.97 | $ 4.30 | $ 0.35 | $ 4.50 | $ 4.85 | $ 0.35 | $ 5.11 | $ 5.46 |
| | **Total** | **$ 1.65** | **$ 6.69** | **$ 8.34** | **$ 1.95** | **$ 8.75** | **$10.70** | **$ 2.11** | **$ 10.43** | **$ 12.53** | **$ 2.26** | **$12.42** | **$ 14.68** | **$ 2.39** | **$ 14.65** | **$ 17.04** | **$ 2.53** | **$ 16.95** | **$ 19.48** |
| NB | Male | $ 0.16 | $ 0.53 | $ 0.70 | $ 0.19 | $ 0.69 | $ 0.89 | $ 0.21 | $ 0.84 | $ 1.05 | $ 0.22 | $ 1.02 | $ 1.24 | $ 0.23 | $ 1.23 | $ 1.46 | $ 0.24 | $ 1.43 | $ 1.67 |
| | Female | $ 0.04 | $ 0.32 | $ 0.36 | $ 0.05 | $ 0.40 | $ 0.44 | $ 0.05 | $ 0.46 | $ 0.50 | $ 0.05 | $ 0.52 | $ 0.57 | $ 0.05 | $ 0.60 | $ 0.65 | $ 0.05 | $ 0.69 | $ 0.73 |
| | **Total** | **$ 0.21** | **$ 0.86** | **$ 1.06** | **$ 0.24** | **$ 1.09** | **$ 1.33** | **$ 0.26** | **$ 1.30** | **$ 1.56** | **$ 0.27** | **$ 1.55** | **$ 1.81** | **$ 0.28** | **$ 1.83** | **$ 2.11** | **$ 0.29** | **$ 2.12** | **$ 2.41** |
| NF&L | Male | $ 0.08 | $ 0.25 | $ 0.33 | $ 0.10 | $ 0.32 | $ 0.42 | $ 0.10 | $ 0.39 | $ 0.50 | $ 0.11 | $ 0.47 | $ 0.58 | $ 0.11 | $ 0.56 | $ 0.67 | $ 0.11 | $ 0.64 | $ 0.75 |
| | Female | $ 0.02 | $ 0.15 | $ 0.17 | $ 0.02 | $ 0.20 | $ 0.21 | $ 0.02 | $ 0.23 | $ 0.25 | $ 0.02 | $ 0.27 | $ 0.29 | $ 0.02 | $ 0.31 | $ 0.33 | $ 0.02 | $ 0.36 | $ 0.38 |
| | **Total** | **$ 0.10** | **$ 0.40** | **$ 0.50** | **$ 0.11** | **$ 0.52** | **$ 0.64** | **$ 0.12** | **$ 0.62** | **$ 0.74** | **$ 0.12** | **$ 0.74** | **$ 0.86** | **$ 0.13** | **$ 0.87** | **$ 1.00** | **$ 0.13** | **$ 0.99** | **$ 1.13** |
| PEI | Male | $ 0.03 | $ 0.12 | $ 0.15 | $ 0.04 | $ 0.15 | $ 0.19 | $ 0.04 | $ 0.18 | $ 0.22 | $ 0.05 | $ 0.22 | $ 0.27 | $ 0.05 | $ 0.26 | $ 0.31 | $ 0.05 | $ 0.31 | $ 0.36 |
| | Female | $ 0.01 | $ 0.10 | $ 0.11 | $ 0.02 | $ 0.11 | $ 0.13 | $ 0.02 | $ 0.13 | $ 0.15 | $ 0.02 | $ 0.15 | $ 0.17 | $ 0.02 | $ 0.18 | $ 0.19 | $ 0.02 | $ 0.20 | $ 0.22 |
| | **Total** | **$ 0.05** | **$ 0.21** | **$ 0.26** | **$ 0.05** | **$ 0.27** | **$ 0.32** | **$ 0.06** | **$ 0.31** | **$ 0.37** | **$ 0.06** | **$ 0.38** | **$ 0.44** | **$ 0.07** | **$ 0.44** | **$ 0.51** | **$ 0.07** | **$ 0.51** | **$ 0.58** |
| NS | Male | $ 0.31 | $ 0.88 | $ 1.19 | $ 0.37 | $ 1.14 | $ 1.51 | $ 0.40 | $ 1.38 | $ 1.78 | $ 0.42 | $ 1.66 | $ 2.09 | $ 0.44 | $ 2.00 | $ 2.44 | $ 0.47 | $ 2.31 | $ 2.78 |
| | Female | $ 0.07 | $ 0.55 | $ 0.62 | $ 0.08 | $ 0.67 | $ 0.74 | $ 0.08 | $ 0.76 | $ 0.84 | $ 0.08 | $ 0.88 | $ 0.96 | $ 0.08 | $ 1.01 | $ 1.09 | $ 0.08 | $ 1.15 | $ 1.23 |
| | **Total** | **$ 0.38** | **$ 1.43** | **$ 1.81** | **$ 0.44** | **$ 1.80** | **$ 2.25** | **$ 0.48** | **$ 2.14** | **$ 2.62** | **$ 0.50** | **$ 2.54** | **$ 3.05** | **$ 0.52** | **$ 3.01** | **$ 3.53** | **$ 0.55** | **$ 3.47** | **$ 4.01** |
| YK/NWT/NV | Male | $ 0.04 | $ 0.05 | $ 0.08 | $ 0.04 | $ 0.07 | $ 0.11 | $ 0.05 | $ 0.08 | $ 0.13 | $ 0.05 | $ 0.10 | $ 0.15 | $ 0.05 | $ 0.12 | $ 0.17 | $ 0.06 | $ 0.14 | $ 0.20 |
| | Female | $ 0.01 | $ 0.02 | $ 0.03 | $ 0.01 | $ 0.03 | $ 0.04 | $ 0.01 | $ 0.03 | $ 0.04 | $ 0.01 | $ 0.04 | $ 0.05 | $ 0.01 | $ 0.05 | $ 0.06 | $ 0.01 | $ 0.06 | $ 0.07 |
| | **Total** | **$ 0.04** | **$ 0.06** | **$ 0.11** | **$ 0.05** | **$ 0.09** | **$ 0.14** | **$ 0.06** | **$ 0.11** | **$ 0.17** | **$ 0.06** | **$ 0.14** | **$ 0.20** | **$ 0.06** | **$ 0.17** | **$ 0.23** | **$ 0.07** | **$ 0.20** | **$ 0.27** |
| **Canada** | Male | **$ 9.55** | **$22.96** | **$32.51** | **$12.05** | **$30.70** | **$42.75** | **$13.62** | **$ 37.53** | **$ 51.15** | **$15.05** | **$46.15** | **$ 61.21** | **$16.42** | **$ 56.46** | **$ 72.88** | **$17.88** | **$ 67.37** | **$ 85.24** |
| | Female | **$ 2.05** | **$12.37** | **$14.42** | **$ 2.36** | **$15.73** | **$18.10** | **$ 2.50** | **$ 18.42** | **$ 20.92** | **$ 2.64** | **$21.50** | **$ 24.14** | **$ 2.77** | **$ 25.01** | **$ 27.79** | **$ 2.92** | **$ 29.02** | **$ 31.94** |
| | **Total** | **$11.61** | **$35.32** | **$46.93** | **$14.42** | **$46.43** | **$60.85** | **$16.12** | **$ 55.95** | **$ 72.07** | **$17.69** | **$67.66** | **$ 85.35** | **$19.19** | **$ 81.47** | **$100.66** | **$20.80** | **$ 96.38** | **$ 117.18** |

*Note: WFP=Workforce Participation, NWFP=Non-Workforce Participation*

Guerriere et al. have suggested using an average hourly wage of a homemaker ($15.69 CAD in 2005) to value caregiver time.[347] Using this pay rate rather than the minimum wage, the indirect costs assigned to those not participating in the formal workforce would be adjusted upward from $35.3 million to $77.6 million in 2004 (and from $96.4 million to $211.9 million in 2031).

## Morbidity

### Cutaneous Melanoma

In estimating the indirect morbidity costs associated with melanoma, the same modified human-capital approach used in estimating mortality costs was applied.

To determine the level of disability following a diagnosis of melanoma, an estimate of the annual number of lost days from work following a diagnosis of melanoma was used as a starting point. Research in Korea suggests an average annual number of lost work days of 26 for melanoma patients.[348] In the U.K., the equivalent number is 36 days.[349] Finally, in the United States, annual lost days from work for 'all other tumour sites' (which includes melanoma) is estimated at 21.9 days.[350] The mean from these three countries (28 days) offered the basis for a Canadian analysis.

In estimating the annual indirect costs associated with a diagnosis of melanoma, the following process was applied:

1. Assume, on average, that an individual with melanoma would generate 28 work loss days in the year following their diagnosis. This includes days for hospitalization, non-hospital appointments for follow-up, and recovery time after treatment.

2. On average, a patient with melanoma that is hospitalized will spend 6.23 days in hospital per separation (see section on *Inpatient Hospital Stays* earlier in this Appendix for a detailed analysis of hospitalization data). The remaining 21.8 work-loss days are associated with at-home and out-patient care, recovery, and other follow-up appointments.

3. Younger patients tend to spend fewer days in hospital per separation than the average 6.23 days across the whole population, while older patients will generally spend longer in hospital. This difference may serve as a proxy for the ability to recover either more rapidly (for younger patients) or more slowly (for older patients). Thus, patients aged 75+ years stay in hospital, on average, for 7.19 days, or 13% more than the population average of 6.23 days. The non-hospital work-loss days for this older cohort were thus increased by 13%, from 21.8 days to 24.7 days. Arguing in similar fashion, the non-hospital work-loss days for the 0-44 year-old cohort was 15.2 days, for the 45-64 year-old cohort – 18.5 days, and for the 65-74 year-old cohort – 23.6 days.

[347] Guerriere DN, Tranmer JE, Ungar WJ et al. Valuing care recipient and family caregiver time: a comparison of methods. *International Journal of Technology Assessment in Health Care.* 2008; 24(1): 52-9.
[348] Kim SG, Hahm MI, Choi KS et al. The economic burden of cancer in Korea in 2002. *European Journal of Cancer Care (English Language Edition).* 2008; 17(2): 136-44.
[349] Morris S, Cox B, Bosanquet N. Cost of skin cancer in England. *European Journal of Health Economics.* 2008: Epublished ahead of print.
[350] Yabroff KR, Lawrence WF, Clauser S et al. Burden of illness in cancer survivors: findings from a population-based national sample. *Journal of the National Cancer Institute.* 2004; 96(17): 1322-30.

4. The preceding figures offer a suitable guide for the morbidity impact in *non-hospitalized patients*. Thus, assume 15.2 work-loss days for the 0-44 years cohort, 18.5 work loss days for the 45-64 years cohort, 23.6 work-loss days for the 65-74 years cohort, and 24.7 work-loss days for the 75+ years cohort. These work-loss days were assigned a disability weight of 0.5, following the approach used by the *Economic Burden of Illness in Canada, 1998* report for short-term disability.[351]

5. *For hospitalized patients*, the work-loss days as indicated in #4 above were added to the average days stay in hospital by age group, gender, and province/territory (see the following table). Days in hospital were assigned a disability weight of 1.0.

**Estimated Work Loss Activity Days**
**For Hospitalized Melanoma Patients**
**By Age Group, Gender and Province/Territorty**
**2004 (Diagnosis-based Incidence Approach)**

**Melanoma**

| | 0-44 | | 45-64 | | 65-74 | | 75+ | |
|---|---|---|---|---|---|---|---|---|
| | Male | Female | Male | Female | Male | Female | Male | Female |
| BC | 19.47 | 18.62 | 22.50 | 23.27 | 28.61 | 29.69 | 30.03 | 31.32 |
| AB | 19.21 | 18.78 | 22.26 | 23.49 | 28.31 | 29.96 | 29.70 | 31.62 |
| SK | 20.80 | 18.91 | 23.74 | 23.67 | 30.16 | 30.20 | 31.70 | 31.88 |
| MB | 20.57 | 22.06 | 23.53 | 28.04 | 29.89 | 35.76 | 31.42 | 38.00 |
| ON | 19.55 | 18.51 | 22.57 | 23.11 | 28.70 | 29.49 | 30.13 | 31.10 |
| QC | 22.99 | 20.08 | 25.78 | 25.29 | 32.71 | 32.27 | 34.45 | 34.15 |
| NB | 21.85 | 19.14 | 24.72 | 23.98 | 31.38 | 30.60 | 33.02 | 32.32 |
| NF&L | 23.13 | 20.65 | 25.91 | 26.08 | 32.86 | 33.27 | 34.62 | 35.26 |
| PEI | 20.76 | 19.17 | 23.70 | 24.04 | 30.11 | 30.67 | 31.65 | 32.40 |
| NS | 20.05 | 17.85 | 23.03 | 22.20 | 29.28 | 28.33 | 30.75 | 29.83 |
| YK | 20.76 | 19.17 | 23.70 | 24.04 | 30.11 | 30.67 | 31.65 | 32.40 |
| NWT | 20.76 | 19.17 | 23.70 | 24.04 | 30.11 | 30.67 | 31.65 | 32.40 |
| NV | 20.76 | 19.17 | 23.70 | 24.04 | 30.11 | 30.67 | 31.65 | 32.40 |

6. *Workforce Participation Rate* – Information on the workforce participation rate was calculated based on the total number of individuals by age, gender, and province/territory in the labour force in 2006[352] divided by the total age-, gender-, and province/territory-specific population in 2006.[353]

7. *Average Annual Earnings* – Average annual earnings for 2004 by age group, gender, and province were derived from Statistics Canada Table 202-0407 *Income of individuals, by sex, age group and income source.* Data were not available for the territories. To estimate the average annual earnings in the territories, the Canadian average was adjusted using the difference in average weekly earnings in the Yukon

[351] Health Canada, *The Economic Burden of Illness in Canada, 1998* Available at http://www.hc-sc.gc.ca. Accessed March 2009.
[352] Statistics Canada. *Class of Worker (12), Age Groups (12A) and Sex (3) for the Labour Force 15 Years and Over of Canada, Provinces, Territories, Census Divisions and Census Subdivisions, 2006 Census - 20% Sample Data.* Catalogue no. 97-559-XWE2006026.
[353] Statistics Canada. Population Projections for Canada, Provinces and Territories 2005-2031. 2005. Catalogue no. 91-520. pgs. 149-162

($781), Northwest Territories ($926), and Nunavut ($776) when compared against the Canadian average ($703).[354]

8. For those who were not in the formal workforce, the minimum wage for each province/territory was used to assign a value to a lost work day. The minimum wage in 2004 ranged from a low of $5.90 per hour in Alberta to a high of $8.00 per hour in British Columbia.[355]

The results according to this process are shown in the following table.

**Estimated Indirect Costs Associated with Morbidity Due to Cutaneous Melanoma in Canada**
**By Province/Territory and Gender**
2004 to 2031 (in $millions, 2004 Constant dollars, costs undiscounted)

| | | 2004 Indirect Cost | | | 2011 Indirect Cost | | | 2016 Indirect Cost | | | 2021 Indirect Cost | | | 2026 Indirect Cost | | | 2031 Indirect Cost | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total |
| BC | Male | $0.28 | $0.12 | $0.39 | $ 0.32 | $0.15 | $ 0.47 | $ 0.34 | $ 0.19 | $ 0.53 | $ 0.36 | $0.23 | $ 0.59 | $ 0.36 | $0.28 | $ 0.64 | $ 0.37 | $ 0.33 | $ 0.70 |
| | Female | $0.13 | $0.10 | $0.23 | $ 0.15 | $0.12 | $ 0.28 | $ 0.16 | $ 0.15 | $ 0.31 | $ 0.17 | $0.17 | $ 0.34 | $ 0.17 | $0.20 | $ 0.37 | $ 0.17 | $ 0.23 | $ 0.40 |
| | **Total** | **$0.41** | **$0.22** | **$0.63** | **$ 0.47** | **$0.28** | **$ 0.75** | **$ 0.50** | **$ 0.34** | **$ 0.84** | **$ 0.52** | **$0.40** | **$ 0.92** | **$ 0.53** | **$0.48** | **$ 1.01** | **$ 0.54** | **$ 0.56** | **$ 1.10** |
| AB | Male | $0.24 | $0.04 | $0.28 | $ 0.26 | $0.05 | $ 0.31 | $ 0.28 | $ 0.06 | $ 0.35 | $ 0.29 | $0.08 | $ 0.37 | $ 0.30 | $0.10 | $ 0.40 | $ 0.30 | $ 0.12 | $ 0.42 |
| | Female | $0.14 | $0.04 | $0.17 | $ 0.13 | $0.05 | $ 0.18 | $ 0.14 | $ 0.06 | $ 0.20 | $ 0.14 | $0.07 | $ 0.21 | $ 0.14 | $0.08 | $ 0.23 | $ 0.15 | $ 0.10 | $ 0.25 |
| | **Total** | **$0.37** | **$0.08** | **$0.45** | **$ 0.39** | **$0.10** | **$ 0.49** | **$ 0.42** | **$ 0.12** | **$ 0.54** | **$ 0.44** | **$0.15** | **$ 0.58** | **$ 0.44** | **$0.18** | **$ 0.63** | **$ 0.45** | **$ 0.22** | **$ 0.67** |
| SK | Male | $0.03 | $0.01 | $0.04 | $ 0.04 | $0.01 | $ 0.05 | $ 0.04 | $ 0.02 | $ 0.05 | $ 0.04 | $0.02 | $ 0.05 | $ 0.04 | $0.02 | $ 0.06 | $ 0.04 | $ 0.02 | $ 0.06 |
| | Female | $0.03 | $0.01 | $0.04 | $ 0.03 | $0.02 | $ 0.04 | $ 0.03 | $ 0.02 | $ 0.04 | $ 0.03 | $0.02 | $ 0.04 | $ 0.03 | $0.02 | $ 0.05 | $ 0.03 | $ 0.02 | $ 0.05 |
| | **Total** | **$0.06** | **$0.02** | **$0.08** | **$ 0.06** | **$0.03** | **$ 0.09** | **$ 0.07** | **$ 0.03** | **$ 0.10** | **$ 0.06** | **$0.04** | **$ 0.10** | **$ 0.06** | **$0.04** | **$ 0.10** | **$ 0.06** | **$ 0.05** | **$ 0.11** |
| MB | Male | $0.05 | $0.02 | $0.06 | $ 0.05 | $0.02 | $ 0.07 | $ 0.05 | $ 0.02 | $ 0.08 | $ 0.05 | $0.03 | $ 0.08 | $ 0.05 | $0.03 | $ 0.09 | $ 0.05 | $ 0.04 | $ 0.09 |
| | Female | $0.03 | $0.02 | $0.05 | $ 0.03 | $0.03 | $ 0.06 | $ 0.03 | $ 0.03 | $ 0.06 | $ 0.03 | $0.03 | $ 0.06 | $ 0.03 | $0.04 | $ 0.07 | $ 0.03 | $ 0.04 | $ 0.07 |
| | **Total** | **$0.07** | **$0.04** | **$0.11** | **$ 0.08** | **$0.05** | **$ 0.13** | **$ 0.08** | **$ 0.05** | **$ 0.14** | **$ 0.08** | **$0.06** | **$ 0.15** | **$ 0.09** | **$0.07** | **$ 0.16** | **$ 0.09** | **$ 0.08** | **$ 0.17** |
| ON | Male | $0.75 | $0.29 | $1.04 | $ 0.96 | $0.36 | $ 1.32 | $ 1.04 | $ 0.45 | $ 1.49 | $ 1.10 | $0.54 | $ 1.64 | $ 1.12 | $0.66 | $ 1.78 | $ 1.13 | $ 0.78 | $ 1.91 |
| | Female | $0.43 | $0.26 | $0.69 | $ 0.48 | $0.30 | $ 0.78 | $ 0.51 | $ 0.35 | $ 0.86 | $ 0.53 | $0.41 | $ 0.94 | $ 0.54 | $0.48 | $ 1.02 | $ 0.55 | $ 0.56 | $ 1.11 |
| | **Total** | **$1.18** | **$0.55** | **$1.73** | **$ 1.44** | **$0.66** | **$ 2.10** | **$ 1.56** | **$ 0.80** | **$ 2.35** | **$ 1.62** | **$0.95** | **$ 2.57** | **$ 1.66** | **$1.14** | **$ 2.80** | **$ 1.68** | **$ 1.33** | **$ 3.02** |
| QC | Male | $0.26 | $0.12 | $0.38 | $ 0.32 | $0.15 | $ 0.47 | $ 0.33 | $ 0.19 | $ 0.52 | $ 0.33 | $0.23 | $ 0.55 | $ 0.33 | $0.27 | $ 0.59 | $ 0.32 | $ 0.31 | $ 0.63 |
| | Female | $0.14 | $0.08 | $0.22 | $ 0.16 | $0.12 | $ 0.28 | $ 0.16 | $ 0.15 | $ 0.31 | $ 0.16 | $0.17 | $ 0.32 | $ 0.16 | $0.19 | $ 0.34 | $ 0.16 | $ 0.20 | $ 0.36 |
| | **Total** | **$0.40** | **$0.20** | **$0.60** | **$ 0.48** | **$0.28** | **$ 0.76** | **$ 0.49** | **$ 0.34** | **$ 0.82** | **$ 0.49** | **$0.39** | **$ 0.88** | **$ 0.48** | **$0.45** | **$ 0.94** | **$ 0.48** | **$ 0.51** | **$ 0.99** |
| NB | Male | $0.02 | $0.02 | $0.04 | $ 0.04 | $0.02 | $ 0.06 | $ 0.04 | $ 0.02 | $ 0.06 | $ 0.04 | $0.03 | $ 0.07 | $ 0.04 | $0.04 | $ 0.07 | $ 0.03 | $ 0.04 | $ 0.07 |
| | Female | $0.02 | $0.01 | $0.03 | $ 0.02 | $0.02 | $ 0.04 | $ 0.02 | $ 0.02 | $ 0.04 | $ 0.02 | $0.02 | $ 0.04 | $ 0.02 | $0.02 | $ 0.04 | $ 0.02 | $ 0.03 | $ 0.04 |
| | **Total** | **$0.04** | **$0.03** | **$0.07** | **$ 0.06** | **$0.04** | **$ 0.09** | **$ 0.06** | **$ 0.04** | **$ 0.10** | **$ 0.06** | **$0.05** | **$ 0.11** | **$ 0.05** | **$0.06** | **$ 0.11** | **$ 0.05** | **$ 0.07** | **$ 0.12** |
| NF&L | Male | $0.02 | $0.01 | $0.02 | $ 0.02 | $0.01 | $ 0.03 | $ 0.02 | $ 0.01 | $ 0.03 | $ 0.02 | $0.01 | $ 0.03 | $ 0.02 | $0.01 | $ 0.03 | $ 0.02 | $ 0.02 | $ 0.03 |
| | Female | $0.01 | $0.01 | $0.02 | $ 0.01 | $0.01 | $ 0.02 | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.01 | $0.01 | $ 0.02 | $ 0.01 | $0.01 | $ 0.02 | $ 0.01 | $ 0.02 | $ 0.02 |
| | **Total** | **$0.03** | **$0.01** | **$0.04** | **$ 0.03** | **$0.02** | **$ 0.05** | **$ 0.03** | **$ 0.02** | **$ 0.05** | **$ 0.03** | **$0.02** | **$ 0.05** | **$ 0.03** | **$0.03** | **$ 0.05** | **$ 0.02** | **$ 0.03** | **$ 0.06** |
| PEI | Male | $0.01 | $0.00 | $0.01 | $ 0.01 | $0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 | $0.01 | $ 0.01 | $ 0.01 | $0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 |
| | Female | $0.01 | $0.00 | $0.01 | $ 0.01 | $0.00 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $0.01 | $ 0.01 | $ 0.01 | $0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 |
| | **Total** | **$0.01** | **$0.01** | **$0.02** | **$ 0.01** | **$0.01** | **$ 0.02** | **$ 0.01** | **$ 0.01** | **$ 0.02** | **$ 0.01** | **$0.01** | **$ 0.03** | **$ 0.01** | **$0.01** | **$ 0.03** | **$ 0.01** | **$ 0.02** | **$ 0.03** |
| NS | Male | $0.05 | $0.02 | $0.07 | $ 0.06 | $0.03 | $ 0.08 | $ 0.06 | $ 0.03 | $ 0.09 | $ 0.06 | $0.04 | $ 0.09 | $ 0.06 | $0.04 | $ 0.10 | $ 0.05 | $ 0.05 | $ 0.10 |
| | Female | $0.03 | $0.03 | $0.05 | $ 0.03 | $0.03 | $ 0.06 | $ 0.03 | $ 0.03 | $ 0.07 | $ 0.03 | $0.04 | $ 0.07 | $ 0.03 | $0.04 | $ 0.07 | $ 0.03 | $ 0.05 | $ 0.08 |
| | **Total** | **$0.07** | **$0.05** | **$0.12** | **$ 0.09** | **$0.05** | **$ 0.14** | **$ 0.09** | **$ 0.06** | **$ 0.16** | **$ 0.09** | **$0.07** | **$ 0.16** | **$ 0.09** | **$0.09** | **$ 0.17** | **$ 0.09** | **$ 0.10** | **$ 0.18** |
| YK/NWT/NV | Male | $0.01 | $0.00 | $0.01 | $ 0.01 | $0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 | $0.00 | $ 0.01 | $ 0.01 | $0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 |
| | Female | $0.00 | $0.00 | $0.00 | $ 0.00 | $0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.01 | $ 0.00 | $0.00 | $ 0.01 | $ 0.00 | $0.00 | $ 0.01 | $ 0.00 | $ 0.00 | $ 0.01 |
| | **Total** | **$0.01** | **$0.00** | **$0.01** | **$ 0.01** | **$0.00** | **$ 0.01** | **$ 0.01** | **$ 0.00** | **$ 0.01** | **$ 0.01** | **$0.00** | **$ 0.02** | **$ 0.01** | **$0.00** | **$ 0.02** | **$ 0.01** | **$ 0.01** | **$ 0.02** |
| **Canada** | Male | **$1.71** | **$0.63** | **$2.34** | **$ 2.06** | **$0.81** | **$ 2.88** | **$ 2.21** | **$ 1.00** | **$ 3.22** | **$ 2.29** | **$1.21** | **$ 3.50** | **$ 2.32** | **$1.47** | **$ 3.78** | **$ 2.34** | **$ 1.72** | **$ 4.05** |
| | Female | **$0.95** | **$0.57** | **$1.52** | **$ 1.06** | **$0.69** | **$ 1.75** | **$ 1.10** | **$ 0.81** | **$ 1.92** | **$ 1.12** | **$0.95** | **$ 2.07** | **$ 1.13** | **$1.10** | **$ 2.23** | **$ 1.16** | **$ 1.25** | **$ 2.41** |
| | **Total** | **$2.66** | **$1.20** | **$3.86** | **$ 3.12** | **$1.50** | **$ 4.63** | **$ 3.32** | **$ 1.82** | **$ 5.14** | **$ 3.41** | **$2.16** | **$ 5.57** | **$ 3.45** | **$2.57** | **$ 6.02** | **$ 3.49** | **$ 2.97** | **$ 6.46** |

*Notes: WFP = Workforce Participation; NWFP = Non-Workforce Participation*

The indirect costs assigned to individuals in the workforce totalled $2.7 million, while the indirect costs assigned to those not in the workforce totalled $1.2 million in 2004. Total indirect costs related to morbidity increased from $3.9 million in 2004 to $6.5 million in 2031.

[354] Statistics Canada Table 281-0044 available at http://www40.statcan.gc.ca/101/cst01/labr79-eng.htm (accessed March 2009).
[355] Statistics Canada, *Fact Sheet on Minimum Wage*, September 2005.

Using the minimum wage to value a disability day for those individuals that are not participating in the formal workforce is a conservative modification of the traditional human-capital approach. Others have used a higher average wage. For example, Guerriere et al. used the average hourly wage of a homemaker ($15.69 CAD in 2005) to value caregiver time in a domestic setting.[356] Using this pay rate rather than the minimum wage, the indirect costs assigned to those not actively participating in the workforce would be adjusted upward from $1.2 million to $2.6 million in 2004 (and from $3.0 million to $6.5 million in 2031).

#### Non-Melanoma Skin Cancer

In estimating the indirect costs associated with morbidity due to non-melanoma skin cancer, an approach was adopted that included elements parallel to those employed for melanoma. To determine the level of disability following a diagnosis of BCC or SCC, the algorithm developed by Lucas et al. was used.[357,358] For BCC, their algorithm suggests that 99.98% of incident cases are treated for local disease with curative results. For these patients, they assumed 14 days of disability, with a disability weight of 0.05. The remainder of BCC patients (0.02%) develop disseminated disease. For these patients, they assumed 2.4 years (876 days) of disability, with a disability weight of 0.2. For SCC, their algorithm suggests that 99.0% of incident cases that are treated have no lymph node involvement. For these patients, 14 days of disability are assumed, with a disability weight of 0.07. The remainder of SCC patients (1.0%) have lymph node involvement. For these patients, 21 days of disability are assumed, with a disability weight of 0.3.

These disease-specific algorithms were applied to the volume of BCC and SCC cases estimated in 2004 using the disease-based incidence approach. Future projections were based on the Low APC Scenario.

The results for BCC are summarized in the following table. Indirect costs assigned to individuals in the workforce in 2004 total $2.1 million, and indirect costs for those not in the formal workforce total $1.6 million, for combined indirect costs of $3.7 million. Total indirect costs for BCC are projected to increase to $8.7 million in 2031.

[356] Guerriere DN, Tranmer JE, Ungar WJ et al. Valuing care recipient and family caregiver time: a comparison of methods. *International Journal of Technology Assessment in Health Care.* 2008; 24(1): 52-9.
[357] Lucas R, McMichael T, Smith W et al. *Solar ultraviolet radiation: global burden or disease from solar ultraviolet radiation.* 2006. World Health Organization. Available at http://www.who.int/uv/health/solaruvradfull_180706.pdf. Accessed January 2009.
[358] Lucas RM, McMichael AJ, Armstrong BK et al. Estimating the global disease burden due to ultraviolet radiation exposure. *International Journal of Epidemiology.* 2008; 37(3): 654-67.

**Estimated Indirect Costs Associated with Morbidity Due to BCC in Canada**
**By Province/Territory and Gender**
2004 to 2031 (in $millions, 2004 Constant dollars, costs undiscounted)

| | | 2004 Indirect Cost | | | 2011 Indirect Cost | | | 2016 Indirect Cost | | | 2021 Indirect Cost | | | 2026 Indirect Cost | | | 2031 Indirect Cost | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total |
| BC | Male | $ 0.23 | $ 0.18 | $ 0.41 | $ 0.32 | $ 0.24 | $ 0.56 | $ 0.37 | $ 0.29 | $ 0.67 | $ 0.42 | $ 0.37 | $ 0.79 | $ 0.47 | $ 0.47 | $ 0.94 | $ 0.51 | $ 0.59 | $ 1.10 |
| | Female | $ 0.11 | $ 0.15 | $ 0.26 | $ 0.13 | $ 0.19 | $ 0.32 | $ 0.14 | $ 0.23 | $ 0.37 | $ 0.15 | $ 0.28 | $ 0.43 | $ 0.16 | $ 0.34 | $ 0.50 | $ 0.16 | $ 0.40 | $ 0.57 |
| | **Total** | **$ 0.34** | **$ 0.33** | **$ 0.67** | **$ 0.45** | **$ 0.43** | **$ 0.88** | **$ 0.51** | **$ 0.53** | **$ 1.04** | **$ 0.57** | **$ 0.65** | **$ 1.23** | **$ 0.62** | **$ 0.82** | **$ 1.44** | **$ 0.68** | **$ 0.99** | **$ 1.67** |
| AB | Male | $ 0.17 | $ 0.05 | $ 0.22 | $ 0.24 | $ 0.07 | $ 0.31 | $ 0.28 | $ 0.09 | $ 0.37 | $ 0.32 | $ 0.11 | $ 0.44 | $ 0.36 | $ 0.15 | $ 0.50 | $ 0.39 | $ 0.19 | $ 0.58 |
| | Female | $ 0.08 | $ 0.05 | $ 0.13 | $ 0.10 | $ 0.06 | $ 0.17 | $ 0.11 | $ 0.08 | $ 0.19 | $ 0.12 | $ 0.10 | $ 0.22 | $ 0.13 | $ 0.12 | $ 0.25 | $ 0.13 | $ 0.15 | $ 0.28 |
| | **Total** | **$ 0.25** | **$ 0.10** | **$ 0.35** | **$ 0.34** | **$ 0.13** | **$ 0.47** | **$ 0.40** | **$ 0.16** | **$ 0.56** | **$ 0.44** | **$ 0.21** | **$ 0.65** | **$ 0.48** | **$ 0.27** | **$ 0.75** | **$ 0.52** | **$ 0.33** | **$ 0.86** |
| SK | Male | $ 0.03 | $ 0.03 | $ 0.06 | $ 0.04 | $ 0.03 | $ 0.08 | $ 0.05 | $ 0.04 | $ 0.09 | $ 0.05 | $ 0.05 | $ 0.10 | $ 0.05 | $ 0.06 | $ 0.11 | $ 0.06 | $ 0.07 | $ 0.13 |
| | Female | $ 0.02 | $ 0.03 | $ 0.04 | $ 0.02 | $ 0.03 | $ 0.05 | $ 0.02 | $ 0.03 | $ 0.05 | $ 0.02 | $ 0.04 | $ 0.06 | $ 0.02 | $ 0.04 | $ 0.06 | $ 0.02 | $ 0.05 | $ 0.07 |
| | **Total** | **$ 0.05** | **$ 0.06** | **$ 0.11** | **$ 0.06** | **$ 0.06** | **$ 0.12** | **$ 0.07** | **$ 0.07** | **$ 0.14** | **$ 0.07** | **$ 0.08** | **$ 0.15** | **$ 0.07** | **$ 0.10** | **$ 0.17** | **$ 0.08** | **$ 0.12** | **$ 0.20** |
| MB | Male | $ 0.04 | $ 0.03 | $ 0.06 | $ 0.05 | $ 0.03 | $ 0.08 | $ 0.05 | $ 0.04 | $ 0.09 | $ 0.06 | $ 0.05 | $ 0.11 | $ 0.07 | $ 0.06 | $ 0.13 | $ 0.07 | $ 0.07 | $ 0.15 |
| | Female | $ 0.02 | $ 0.03 | $ 0.05 | $ 0.03 | $ 0.03 | $ 0.06 | $ 0.03 | $ 0.04 | $ 0.06 | $ 0.03 | $ 0.04 | $ 0.07 | $ 0.03 | $ 0.05 | $ 0.08 | $ 0.03 | $ 0.06 | $ 0.09 |
| | **Total** | **$ 0.06** | **$ 0.05** | **$ 0.11** | **$ 0.08** | **$ 0.06** | **$ 0.14** | **$ 0.08** | **$ 0.07** | **$ 0.16** | **$ 0.09** | **$ 0.09** | **$ 0.18** | **$ 0.10** | **$ 0.11** | **$ 0.21** | **$ 0.10** | **$ 0.13** | **$ 0.23** |
| ON | Male | $ 0.65 | $ 0.36 | $ 1.01 | $ 0.89 | $ 0.48 | $ 1.37 | $ 1.04 | $ 0.58 | $ 1.63 | $ 1.19 | $ 0.74 | $ 1.93 | $ 1.33 | $ 0.94 | $ 2.27 | $ 1.44 | $ 1.18 | $ 2.62 |
| | Female | $ 0.31 | $ 0.31 | $ 0.61 | $ 0.38 | $ 0.39 | $ 0.76 | $ 0.41 | $ 0.46 | $ 0.87 | $ 0.44 | $ 0.56 | $ 1.00 | $ 0.46 | $ 0.67 | $ 1.14 | $ 0.49 | $ 0.79 | $ 1.28 |
| | **Total** | **$ 0.96** | **$ 0.66** | **$ 1.62** | **$ 1.27** | **$ 0.86** | **$ 2.13** | **$ 1.45** | **$ 1.05** | **$ 2.50** | **$ 1.63** | **$ 1.29** | **$ 2.93** | **$ 1.79** | **$ 1.61** | **$ 3.40** | **$ 1.93** | **$ 1.97** | **$ 3.90** |
| QC | Male | $ 0.21 | $ 0.16 | $ 0.36 | $ 0.26 | $ 0.21 | $ 0.47 | $ 0.30 | $ 0.26 | $ 0.55 | $ 0.32 | $ 0.32 | $ 0.65 | $ 0.35 | $ 0.40 | $ 0.75 | $ 0.37 | $ 0.49 | $ 0.86 |
| | Female | $ 0.11 | $ 0.15 | $ 0.25 | $ 0.12 | $ 0.18 | $ 0.30 | $ 0.13 | $ 0.22 | $ 0.34 | $ 0.13 | $ 0.26 | $ 0.38 | $ 0.13 | $ 0.30 | $ 0.43 | $ 0.13 | $ 0.34 | $ 0.47 |
| | **Total** | **$ 0.31** | **$ 0.30** | **$ 0.62** | **$ 0.39** | **$ 0.39** | **$ 0.78** | **$ 0.42** | **$ 0.48** | **$ 0.90** | **$ 0.45** | **$ 0.58** | **$ 1.03** | **$ 0.48** | **$ 0.70** | **$ 1.18** | **$ 0.50** | **$ 0.83** | **$ 1.33** |
| NB | Male | $ 0.02 | $ 0.02 | $ 0.04 | $ 0.03 | $ 0.02 | $ 0.05 | $ 0.03 | $ 0.03 | $ 0.05 | $ 0.03 | $ 0.03 | $ 0.06 | $ 0.03 | $ 0.04 | $ 0.07 | $ 0.03 | $ 0.05 | $ 0.08 |
| | Female | $ 0.01 | $ 0.01 | $ 0.03 | $ 0.01 | $ 0.02 | $ 0.03 | $ 0.01 | $ 0.02 | $ 0.04 | $ 0.01 | $ 0.03 | $ 0.04 | $ 0.01 | $ 0.03 | $ 0.04 | $ 0.01 | $ 0.03 | $ 0.05 |
| | **Total** | **$ 0.03** | **$ 0.03** | **$ 0.06** | **$ 0.04** | **$ 0.04** | **$ 0.08** | **$ 0.04** | **$ 0.05** | **$ 0.09** | **$ 0.04** | **$ 0.06** | **$ 0.10** | **$ 0.05** | **$ 0.07** | **$ 0.12** | **$ 0.05** | **$ 0.08** | **$ 0.13** |
| NF&L | Male | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.02 | $ 0.01 | $ 0.03 | $ 0.02 | $ 0.02 | $ 0.03 | $ 0.02 | $ 0.02 | $ 0.04 | $ 0.02 | $ 0.02 | $ 0.04 | $ 0.02 | $ 0.03 | $ 0.05 |
| | Female | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.01 | $ 0.02 | $ 0.02 | $ 0.01 | $ 0.02 | $ 0.03 | $ 0.01 | $ 0.02 | $ 0.03 |
| | **Total** | **$ 0.02** | **$ 0.02** | **$ 0.04** | **$ 0.02** | **$ 0.02** | **$ 0.05** | **$ 0.02** | **$ 0.03** | **$ 0.05** | **$ 0.03** | **$ 0.04** | **$ 0.06** | **$ 0.03** | **$ 0.05** | **$ 0.07** | **$ 0.03** | **$ 0.05** | **$ 0.08** |
| PEI | Male | $ 0.00 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.01 | $ 0.01 | $ 0.02 |
| | Female | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.01 | $ 0.01 | $ 0.02 |
| | **Total** | **$ 0.01** | **$ 0.01** | **$ 0.02** | **$ 0.01** | **$ 0.01** | **$ 0.02** | **$ 0.01** | **$ 0.01** | **$ 0.03** | **$ 0.01** | **$ 0.02** | **$ 0.03** | **$ 0.01** | **$ 0.02** | **$ 0.04** | **$ 0.01** | **$ 0.02** | **$ 0.04** |
| NS | Male | $ 0.05 | $ 0.03 | $ 0.08 | $ 0.06 | $ 0.04 | $ 0.10 | $ 0.06 | $ 0.05 | $ 0.12 | $ 0.07 | $ 0.07 | $ 0.14 | $ 0.07 | $ 0.08 | $ 0.16 | $ 0.08 | $ 0.10 | $ 0.18 |
| | Female | $ 0.02 | $ 0.03 | $ 0.06 | $ 0.03 | $ 0.04 | $ 0.07 | $ 0.03 | $ 0.05 | $ 0.08 | $ 0.03 | $ 0.06 | $ 0.09 | $ 0.03 | $ 0.07 | $ 0.10 | $ 0.03 | $ 0.08 | $ 0.11 |
| | **Total** | **$ 0.07** | **$ 0.07** | **$ 0.14** | **$ 0.09** | **$ 0.08** | **$ 0.17** | **$ 0.09** | **$ 0.10** | **$ 0.20** | **$ 0.10** | **$ 0.13** | **$ 0.22** | **$ 0.10** | **$ 0.15** | **$ 0.26** | **$ 0.11** | **$ 0.18** | **$ 0.29** |
| YK/NWT/NV | Male | $ 0.00 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 |
| | Female | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.01 | $ 0.00 | $ 0.00 | $ 0.01 | $ 0.00 | $ 0.00 | $ 0.01 |
| | **Total** | **$ 0.01** | **$ 0.00** | **$ 0.01** | **$ 0.01** | **$ 0.00** | **$ 0.01** | **$ 0.01** | **$ 0.00** | **$ 0.01** | **$ 0.01** | **$ 0.01** | **$ 0.02** | **$ 0.01** | **$ 0.01** | **$ 0.02** | **$ 0.01** | **$ 0.01** | **$ 0.02** |
| **Canada** | Male | **$ 1.42** | **$ 0.86** | **$ 2.28** | **$ 1.92** | **$ 1.14** | **$ 3.06** | **$ 2.22** | **$ 1.40** | **$ 3.62** | **$ 2.51** | **$ 1.77** | **$ 4.28** | **$ 2.76** | **$ 2.25** | **$ 5.01** | **$ 2.98** | **$ 2.79** | **$ 5.76** |
| | Female | **$ 0.69** | **$ 0.77** | **$ 1.46** | **$ 0.83** | **$ 0.96** | **$ 1.79** | **$ 0.89** | **$ 1.15** | **$ 2.05** | **$ 0.94** | **$ 1.39** | **$ 2.33** | **$ 0.99** | **$ 1.66** | **$ 2.64** | **$ 1.03** | **$ 1.94** | **$ 2.97** |
| | **Total** | **$ 2.11** | **$ 1.63** | **$ 3.74** | **$ 2.75** | **$ 2.10** | **$ 4.85** | **$ 3.11** | **$ 2.56** | **$ 5.67** | **$ 3.45** | **$ 3.15** | **$ 6.60** | **$ 3.75** | **$ 3.91** | **$ 7.65** | **$ 4.01** | **$ 4.72** | **$ 8.73** |

*Notes: WFP = Workforce Participation; NWFP = Non-Workforce Participation*

As noted earlier, other researchers have used an average wage higher than minimum wage in such calculations. If, for example, $15.69 per hour (as suggested by Guerriere et al.) was applied, the indirect costs assigned to BCC patients not participating in the formal workforce would be adjusted upward from $1.6 million to $3.6 million in 2004 (and from $4.7 million to $10.3 million in 2031).[359]

The results for SCC are summarized in the following table. Indirect costs assigned to individuals in the workforce in 2004 total $0.4 million, and indirect costs for those not in the workforce total $0.7 million, for combined indirect costs of $1.1 million. Total indirect costs for SCC are projected to increase to $2.8 million in 2031.

[359] Guerriere DN, Tranmer JE, Ungar WJ et al. Valuing care recipient and family caregiver time: a comparison of methods. *International Journal of Technology Assessment in Health Care.* 2008; 24(1): 52-9.

**Estimated Indirect Costs Associated with Morbidity Due to SCC in Canada**
**By Province/Territory and Gender**
2004 to 2031 (in $millions, costs undiscounted)

| | | 2004 Indirect Cost | | | 2011 Indirect Cost | | | 2016 Indirect Cost | | | 2021 Indirect Cost | | | 2026 Indirect Cost | | | 2031 Indirect Cost | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total | WFP | NWFP | Total |
| BC | Male | $ 0.04 | $ 0.08 | $ 0.12 | $ 0.06 | $ 0.11 | $ 0.16 | $ 0.07 | $ 0.13 | $ 0.20 | $ 0.07 | $ 0.16 | $ 0.23 | $ 0.07 | $ 0.20 | $ 0.27 | $ 0.07 | $ 0.25 | $ 0.33 |
| | Female | $ 0.01 | $ 0.05 | $ 0.06 | $ 0.02 | $ 0.06 | $ 0.08 | $ 0.02 | $ 0.08 | $ 0.10 | $ 0.02 | $ 0.09 | $ 0.11 | $ 0.02 | $ 0.12 | $ 0.14 | $ 0.02 | $ 0.14 | $ 0.17 |
| | **Total** | **$ 0.06** | **$ 0.13** | **$ 0.18** | **$ 0.07** | **$ 0.17** | **$ 0.24** | **$ 0.08** | **$ 0.21** | **$ 0.29** | **$ 0.09** | **$ 0.25** | **$ 0.35** | **$ 0.09** | **$ 0.32** | **$ 0.41** | **$ 0.10** | **$ 0.39** | **$ 0.49** |
| AB | Male | $ 0.04 | $ 0.03 | $ 0.07 | $ 0.05 | $ 0.04 | $ 0.10 | $ 0.06 | $ 0.06 | $ 0.12 | $ 0.07 | $ 0.07 | $ 0.14 | $ 0.07 | $ 0.09 | $ 0.16 | $ 0.07 | $ 0.11 | $ 0.19 |
| | Female | $ 0.01 | $ 0.02 | $ 0.03 | $ 0.01 | $ 0.03 | $ 0.04 | $ 0.02 | $ 0.03 | $ 0.05 | $ 0.02 | $ 0.04 | $ 0.06 | $ 0.02 | $ 0.05 | $ 0.07 | $ 0.02 | $ 0.07 | $ 0.09 |
| | **Total** | **$ 0.05** | **$ 0.05** | **$ 0.10** | **$ 0.07** | **$ 0.07** | **$ 0.14** | **$ 0.08** | **$ 0.09** | **$ 0.17** | **$ 0.09** | **$ 0.11** | **$ 0.20** | **$ 0.09** | **$ 0.14** | **$ 0.23** | **$ 0.09** | **$ 0.18** | **$ 0.27** |
| SK | Male | $ 0.01 | $ 0.02 | $ 0.03 | $ 0.01 | $ 0.02 | $ 0.03 | $ 0.01 | $ 0.02 | $ 0.04 | $ 0.01 | $ 0.03 | $ 0.04 | $ 0.01 | $ 0.03 | $ 0.04 | $ 0.01 | $ 0.04 | $ 0.05 |
| | Female | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.02 | $ 0.00 | $ 0.01 | $ 0.02 | $ 0.00 | $ 0.01 | $ 0.02 | $ 0.00 | $ 0.02 | $ 0.02 | $ 0.00 | $ 0.02 | $ 0.02 |
| | **Total** | **$ 0.01** | **$ 0.03** | **$ 0.04** | **$ 0.01** | **$ 0.03** | **$ 0.05** | **$ 0.02** | **$ 0.04** | **$ 0.05** | **$ 0.02** | **$ 0.04** | **$ 0.06** | **$ 0.02** | **$ 0.05** | **$ 0.07** | **$ 0.02** | **$ 0.06** | **$ 0.08** |
| MB | Male | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.01 | $ 0.02 | $ 0.02 | $ 0.01 | $ 0.02 | $ 0.03 | $ 0.01 | $ 0.02 | $ 0.03 | $ 0.01 | $ 0.03 | $ 0.04 |
| | Female | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.02 | $ 0.00 | $ 0.02 | $ 0.02 |
| | **Total** | **$ 0.01** | **$ 0.02** | **$ 0.03** | **$ 0.01** | **$ 0.02** | **$ 0.03** | **$ 0.01** | **$ 0.03** | **$ 0.04** | **$ 0.01** | **$ 0.03** | **$ 0.04** | **$ 0.01** | **$ 0.04** | **$ 0.05** | **$ 0.01** | **$ 0.05** | **$ 0.06** |
| ON | Male | $ 0.14 | $ 0.18 | $ 0.33 | $ 0.18 | $ 0.25 | $ 0.44 | $ 0.21 | $ 0.32 | $ 0.53 | $ 0.23 | $ 0.39 | $ 0.62 | $ 0.24 | $ 0.48 | $ 0.72 | $ 0.24 | $ 0.60 | $ 0.84 |
| | Female | $ 0.04 | $ 0.11 | $ 0.15 | $ 0.05 | $ 0.14 | $ 0.20 | $ 0.06 | $ 0.17 | $ 0.23 | $ 0.06 | $ 0.21 | $ 0.27 | $ 0.07 | $ 0.25 | $ 0.32 | $ 0.07 | $ 0.32 | $ 0.39 |
| | **Total** | **$ 0.18** | **$ 0.29** | **$ 0.48** | **$ 0.24** | **$ 0.40** | **$ 0.64** | **$ 0.27** | **$ 0.49** | **$ 0.76** | **$ 0.29** | **$ 0.59** | **$ 0.89** | **$ 0.31** | **$ 0.73** | **$ 1.04** | **$ 0.31** | **$ 0.91** | **$ 1.22** |
| QC | Male | $ 0.04 | $ 0.08 | $ 0.12 | $ 0.05 | $ 0.11 | $ 0.16 | $ 0.06 | $ 0.13 | $ 0.19 | $ 0.06 | $ 0.16 | $ 0.23 | $ 0.06 | $ 0.20 | $ 0.26 | $ 0.06 | $ 0.25 | $ 0.31 |
| | Female | $ 0.01 | $ 0.05 | $ 0.07 | $ 0.02 | $ 0.07 | $ 0.08 | $ 0.02 | $ 0.08 | $ 0.10 | $ 0.02 | $ 0.10 | $ 0.11 | $ 0.02 | $ 0.11 | $ 0.13 | $ 0.02 | $ 0.14 | $ 0.16 |
| | **Total** | **$ 0.06** | **$ 0.13** | **$ 0.19** | **$ 0.07** | **$ 0.18** | **$ 0.25** | **$ 0.08** | **$ 0.21** | **$ 0.29** | **$ 0.08** | **$ 0.26** | **$ 0.34** | **$ 0.08** | **$ 0.32** | **$ 0.40** | **$ 0.08** | **$ 0.38** | **$ 0.46** |
| NB | Male | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.01 | $ 0.01 | $ 0.02 | $ 0.01 | $ 0.02 | $ 0.02 | $ 0.01 | $ 0.02 | $ 0.03 | $ 0.01 | $ 0.02 | $ 0.03 | $ 0.01 | $ 0.03 | $ 0.04 |
| | Female | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.02 | $ 0.00 | $ 0.02 | $ 0.02 |
| | **Total** | **$ 0.01** | **$ 0.02** | **$ 0.02** | **$ 0.01** | **$ 0.02** | **$ 0.03** | **$ 0.01** | **$ 0.02** | **$ 0.03** | **$ 0.01** | **$ 0.03** | **$ 0.04** | **$ 0.01** | **$ 0.04** | **$ 0.05** | **$ 0.01** | **$ 0.05** | **$ 0.06** |
| NF&L | Male | $ 0.00 | $ 0.00 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.02 | $ 0.00 | $ 0.01 | $ 0.02 |
| | Female | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 |
| | **Total** | **$ 0.00** | **$ 0.01** | **$ 0.01** | **$ 0.00** | **$ 0.01** | **$ 0.01** | **$ 0.00** | **$ 0.01** | **$ 0.02** | **$ 0.00** | **$ 0.02** | **$ 0.02** | **$ 0.00** | **$ 0.02** | **$ 0.02** | **$ 0.00** | **$ 0.02** | **$ 0.03** |
| PEI | Male | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 |
| | Female | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.01 | $ 0.00 | $ 0.01 | $ 0.01 |
| | **Total** | **$ 0.00** | **$ 0.00** | **$ 0.01** | **$ 0.00** | **$ 0.01** | **$ 0.01** | **$ 0.00** | **$ 0.01** | **$ 0.01** | **$ 0.00** | **$ 0.01** | **$ 0.01** | **$ 0.00** | **$ 0.01** | **$ 0.01** | **$ 0.00** | **$ 0.01** | **$ 0.01** |
| NS | Male | $ 0.01 | $ 0.02 | $ 0.03 | $ 0.01 | $ 0.02 | $ 0.04 | $ 0.01 | $ 0.03 | $ 0.04 | $ 0.01 | $ 0.03 | $ 0.05 | $ 0.01 | $ 0.04 | $ 0.06 | $ 0.01 | $ 0.05 | $ 0.07 |
| | Female | $ 0.00 | $ 0.01 | $ 0.02 | $ 0.00 | $ 0.02 | $ 0.02 | $ 0.00 | $ 0.02 | $ 0.02 | $ 0.00 | $ 0.02 | $ 0.03 | $ 0.00 | $ 0.03 | $ 0.03 | $ 0.00 | $ 0.03 | $ 0.04 |
| | **Total** | **$ 0.01** | **$ 0.03** | **$ 0.04** | **$ 0.02** | **$ 0.04** | **$ 0.05** | **$ 0.02** | **$ 0.05** | **$ 0.06** | **$ 0.02** | **$ 0.06** | **$ 0.07** | **$ 0.02** | **$ 0.07** | **$ 0.09** | **$ 0.02** | **$ 0.08** | **$ 0.10** |
| YK/NWT/NV | Male | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 |
| | Female | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 | $ 0.00 |
| | **Total** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.00** | **$ 0.01** |
| **Canada** | Male | **$ 0.31** | **$ 0.43** | **$ 0.73** | **$ 0.39** | **$ 0.59** | **$ 0.98** | **$ 0.45** | **$ 0.73** | **$ 1.18** | **$ 0.48** | **$ 0.89** | **$ 1.38** | **$ 0.50** | **$ 1.11** | **$ 1.60** | **$ 0.50** | **$ 1.38** | **$ 1.88** |
| | Female | **$ 0.09** | **$ 0.28** | **$ 0.36** | **$ 0.11** | **$ 0.36** | **$ 0.47** | **$ 0.13** | **$ 0.42** | **$ 0.55** | **$ 0.13** | **$ 0.51** | **$ 0.64** | **$ 0.14** | **$ 0.62** | **$ 0.76** | **$ 0.15** | **$ 0.77** | **$ 0.91** |
| | **Total** | **$ 0.39** | **$ 0.70** | **$ 1.10** | **$ 0.51** | **$ 0.94** | **$ 1.45** | **$ 0.57** | **$ 1.16** | **$ 1.73** | **$ 0.62** | **$ 1.40** | **$ 2.02** | **$ 0.64** | **$ 1.73** | **$ 2.37** | **$ 0.64** | **$ 2.14** | **$ 2.79** |

*Notes: WFP = Workforce Participation; NWFP = Non-Workforce Participation*

Once again, other researchers have used an average wage higher than minimum wage in such calculations. If, for example, $15.69 per hour (as suggested by Guerriere et al.) was applied, the indirect costs assigned to SCC patients not participating in the formal workforce would be adjusted upward from $0.7 million to $1.6 million in 2004 (and from $2.1 million to $4.7 million in 2031).[360]

[360] Guerriere DN, Tranmer JE, Ungar WJ et al. Valuing care recipient and family caregiver time: a comparison of methods. *International Journal of Technology Assessment in Health Care.* 2008; 24(1): 52-9.

### Summary of the Economic Burden of Skin Cancer in Canada

The economic analysis detailed to this point is summarized in the following tables, providing direct and indirect costing information for each skin cancer type at the two ends of the modelling period. Note that indirect costs associated with mortality for BCC and SCC (which were combined in the detailed analysis earlier in this Appendix) are here stratified by a formula based on Manitoba data, suggesting that the proportion of total NMSC deaths is 61% for SCC and 39% for BCC.

**Annual Direct and Indirect Costs of Skin Cancers in Canada**
**2004** (in $millions, 2004 constant dollars, undiscounted)

| Type of Cost | MM | % | BCC | % | SCC | % | Total | % |
|---|---|---|---|---|---|---|---|---|
| Primary care | 1.76 | 0.4% | 24.90 | 51.5% | 6.34 | 15.9% | 33.00 | 6.2% |
| Hospital-based day surgery | 17.01 | 3.8% | 0.91 | 1.9% | 2.22 | 5.5% | 20.14 | 3.8% |
| Hospital inpatient care | 10.78 | 2.4% | 0.58 | 1.2% | 1.56 | 3.9% | 12.92 | 2.4% |
| **Total direct costs** | **29.55** | **6.7%** | **26.39** | **54.6%** | **10.12** | **25.3%** | **66.05** | **12.4%** |
| Mortality | 410.07 | 92.5% | 18.20 | 37.7% | 28.73 | 71.9% | 457.00 | 85.9% |
| Morbidity | 3.86 | 0.9% | 3.74 | 7.7% | 1.10 | 2.8% | 8.70 | 1.6% |
| **Total indirect costs** | **413.93** | **93.3%** | **21.94** | **45.4%** | **29.83** | **74.7%** | **465.70** | **87.6%** |
| **Total costs** | **443.48** | **100%** | **48.32** | **100%** | **39.95** | **100.0%** | **531.75** | **100%** |

*Note:* MM, malignant melanoma; BCC, basal cell carcinoma; SCC, squamous cell carcinoma.

In 2004, the total estimated economic burden of skin cancer in Canada would be $532 million, the majority being attributable to melanoma (83.4%), and the balance distributed between BCC (9.1%) and SCC (7.5%). Of the $532 million, $66 million (12.4%) is associated with direct costs and $466 million (87.6%) with indirect costs.

The total economic burden of skin cancer in Canada would rise to $922 million annually by 2031. The distribution across the three cancer types would also have shifted: melanoma (75.5%); BCC (13.3%); and SCC (11.2%). A higher proportion of total costs are also associated with direct costs (17.6% in 2031 vs. 12.4% in 2004). Other internal patterns at the start and end of the modelling period reveal comparisons that help to explain the change in the economic drivers. For example, the cost related to mortality caused by melanoma is 6 times higher than the equivalent estimate for NMSC in 2004, but only about 4 times higher in 2031. This may be explained by the ageing of the population over the modelling period, which creates a proportionally higher increase in NMSC cases. By contrast, the base indirect costs related to *morbidity* are much closer for melanoma and NMSC. The average health and economic impact of a more serious cancer such as melanoma is balanced by the much larger incidence of BCC and SCC cases, which in turn drives total work-loss time. Once again, an ageing population tended to accelerate NMSC morbidity costs at a higher rate. Thus, while melanoma-related morbidity costs increased from $3.9 million in 2004 to $6.5 million 2031, the total for BCC would have more than doubled in the same timeframe, to $8.7 million.

**Annual Direct and Indirect Costs of Skin Cancers in Canada**
Low APC Scenario
**2031** (in $millions, 2004 constant dollars, undiscounted)

| Type of Cost | MM | % | BCC | % | SCC | % | Total | % |
|---|---|---|---|---|---|---|---|---|
| Primary care | 3.35 | 0.5% | 64.76 | 52.7% | 17.95 | 17.4% | 86.06 | 9.3% |
| Hospital-based day surgery | 36.75 | 5.3% | 2.45 | 2.0% | 6.38 | 6.2% | 45.58 | 4.9% |
| Hospital inpatient care | 24.62 | 3.5% | 1.48 | 1.2% | 4.25 | 4.1% | 30.35 | 3.3% |
| **Total direct costs** | **64.72** | **9.3%** | **68.69** | **55.9%** | **28.58** | **27.7%** | **161.99** | **17.6%** |
| Mortality | 624.78 | 89.8% | 45.44 | 37.0% | 71.74 | 69.6% | 741.96 | 80.5% |
| Morbidity | 6.46 | 0.9% | 8.73 | 7.1% | 2.79 | 2.7% | 17.98 | 2.0% |
| **Total indirect costs** | **631.24** | **90.7%** | **54.17** | **44.1%** | **74.53** | **72.3%** | **759.94** | **82.4%** |
| **Total costs** | **695.96** | **100%** | **122.86** | **100.0%** | **103.11** | **100.0%** | **921.93** | **100%** |

*Note:* MM, malignant melanoma; BCC, basal cell carcinoma; SCC, squamous cell carcinoma.

## Total Costs per Patient

Combining incidence and mortality with costing information allows the cost per case to be calculated for the various economic categories. The results for 2004 and 2031 (based on the Low APC projection scenario and using 2004 constant, undiscounted dollars) are summarized in the following two tables.

The direct cost per melanoma case is estimated to be $6,215 in 2004, increasing to $7,136 by 2031 due to increased inpatient and outpatient hospital costs per case. The economic component of the model assumes that the rate of hospitalization, the length of stay in hospital and the average cost per day in hospital all increase with increasing age at diagnosis. A higher proportion of melanoma patients are older in 2031 compared to 2004. By contrast, direct costs per NMSC case remained fixed over the modelling period because the vast majority of these costs are physician office-based costs which do not tend to change significantly based on the age of the patient treated. The drop in unit mortality and morbidity costs for all three skin cancer types is also explicable in terms of an ageing population; since a higher proportion of patients are older in 2031, the impact related to lost income decreases. First, a higher average age at death generates lower potential years of life lost (e.g., for melanoma, 22.07 years in 2004 versus 16.82 years in 2031); this directly translates into reduced mortality costs (e.g., for melanoma, $550,000 per death in 2004 versus $380,000 per death in 2031). Second, morbidity costs are less in older patients because their work-generated income is generally reduced after age 60-65; in most analyses using the human-capital approach, lost time in retired and non-employed persons is valued at zero. The current model assumes a value equivalent to the province's minimum wage in these cases. Despite this modification to the human-capital approach, the estimated value of time lost in older persons is still considerably lower than in an employed population.

## Economic Burden of Skin Cancers in Canada
### Cost per Case in 2004 (2004 constant dollars, undiscounted)

| | MM | % | BCC | % | SCC | % | Total | % |
|---|---|---|---|---|---|---|---|---|
| **Cases in 2004** | **4,755** | | **60,587** | | **15,366** | | **80,708** | |
| **Deaths in 2004** | **745** | | **80** | | **124** | | **949** | |
| **Direct Costs / Case** | | | | | | | | |
| Primary care | $370 | 6.0% | $411 | 94.4% | $413 | 62.8% | $409 | 50.0% |
| Hospital-based day surgery | $3,577 | 57.6% | $16 | 3.6% | $148 | 22.6% | $251 | 30.6% |
| Hospital inpatient care | $2,267 | 36.5% | $9 | 2.1% | $96 | 14.7% | $159 | 19.4% |
| **Total direct costs** | **$6,215** | **100.0%** | **$436** | **100.0%** | **$657** | **100.0%** | **$818** | **100.0%** |
| **Indirect Costs** | | | | | | | | |
| Mortality cost per death | $550,430 | | $228,725 | | $230,896 | | $481,560 | |
| PYLL per death | 22.07 | | 11.61 | | 11.61 | | 19.82 | |
| Mortality cost per PYLL | $24,940 | | $19,701 | | $19,888 | | $24,295 | |
| Morbidity cost per case | $1,359 | | $144 | | $182 | | $223 | |

*Note:* MM, malignant melanoma; BCC, basal cell carcinoma; SCC, squamous cell carcinoma.

## Economic Burden of Skin Cancers in Canada
### Cost per Case in 2031 (2004 constant dollars, undiscounted)

| | MM | % | BCC | % | SCC | % | Total | % |
|---|---|---|---|---|---|---|---|---|
| **Cases in 2031 (Low APC)** | **9,070** | | **157,711** | | **43,591** | | **210,372** | |
| **Deaths in 2031 (Low APC)** | **1,644** | | **237** | | **371** | | **2,252** | |
| **Direct Costs / Case** | | | | | | | | |
| Primary care | $369 | 5.2% | $411 | 94.3% | $412 | 62.8% | $409 | 53.1% |
| Hospital-based day surgery | $4,052 | 56.8% | $16 | 3.6% | $146 | 22.3% | $217 | 28.1% |
| Hospital inpatient care | $2,714 | 38.0% | $9 | 2.2% | $97 | 14.9% | $144 | 18.7% |
| **Total direct costs** | **$7,136** | **100.0%** | **$436** | **100.0%** | **$656** | **100.0%** | **$770** | **100.0%** |
| **Indirect Costs** | | | | | | | | |
| Mortality cost per death | $380,036 | | $191,621 | | $193,440 | | $329,467 | |
| PYLL per death | 16.82 | | 10.28 | | 10.28 | | 15.05 | |
| Mortality cost per PYLL | $22,594 | | $18,640 | | $18,817 | | $21,885 | |
| Morbidity cost per case | $712 | | $55 | | $64 | | $85 | |

*Note:* MM, malignant melanoma; BCC, basal cell carcinoma; SCC, squamous cell carcinoma.

## Costs by Province / Territory and Gender

The $532 million total cost for skin cancer in Canada for 2004 is broken down by province and gender in the following three tables.

**Annual Direct and Indirect Costs of Skin Cancers in Canada**
**By Province/Territory in 2004** (in $millions, 2004 constant dollars, undiscounted)

**Total Population**

| | Britsh Columbia | | | Alberta | | | Saskatchewan | | | Manitoba | | | Ontario | | | Quebec | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Type of Cost** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** |
| Primary care | 0.285 | 5.635 | 5.919 | 0.211 | 3.083 | 3.294 | 0.058 | 1.447 | 1.505 | 0.049 | 0.960 | 1.010 | 0.710 | 11.966 | 12.676 | 0.245 | 4.694 | 4.939 |
| Hospital-based day surgery | 1.679 | 0.518 | 2.197 | 1.612 | 0.325 | 1.937 | 0.658 | 0.129 | 0.787 | 0.615 | 0.091 | 0.706 | 6.619 | 1.471 | 8.090 | 3.729 | 0.422 | 4.150 |
| Hospital inpatient care | 0.894 | 0.291 | 1.186 | 0.801 | 0.175 | 0.976 | 0.424 | 0.092 | 0.516 | 0.522 | 0.084 | 0.606 | 3.425 | 0.805 | 4.231 | 3.319 | 0.410 | 3.729 |
| **Total direct costs** | **2.858** | **6.444** | **9.302** | **2.624** | **3.583** | **6.207** | **1.140** | **1.667** | **2.807** | **1.186** | **1.135** | **2.322** | **10.754** | **14.243** | **24.997** | **7.292** | **5.526** | **12.818** |
| Mortality | 59.948 | 8.068 | 68.015 | 34.893 | 3.956 | 38.849 | 10.512 | 1.234 | 11.746 | 13.970 | 1.343 | 15.313 | 195.081 | 20.258 | 215.339 | 69.821 | 8.338 | 78.158 |
| Morbidity | 0.626 | 0.849 | 1.475 | 0.450 | 0.450 | 0.901 | 0.082 | 0.146 | 0.228 | 0.110 | 0.140 | 0.251 | 1.730 | 2.097 | 3.827 | 0.599 | 0.804 | 1.403 |
| **Total indirect costs** | **60.573** | **8.916** | **69.490** | **35.344** | **4.406** | **39.750** | **10.594** | **1.381** | **11.974** | **14.081** | **1.483** | **15.564** | **196.811** | **22.355** | **219.166** | **70.420** | **9.141** | **79.561** |
| **Total costs** | **63.431** | **15.361** | **78.792** | **37.968** | **7.989** | **45.957** | **11.733** | **3.048** | **14.781** | **15.267** | **2.618** | **17.885** | **207.565** | **36.598** | **244.163** | **77.712** | **14.667** | **92.380** |

**Annual Direct and Indirect Costs of Skin Cancers in Canada**
**By Province/Territory in 2004 (in $millions, 2004 constant dollars, undiscounted)**

**Total Population (Continued)**

| | New Brunswick | | | Newfoundland | | | Prince Edward Island | | | Nova Scotia | | | Territories | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Type of Cost** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** |
| Primary care | 0.058 | 0.908 | 0.966 | 0.025 | 0.434 | 0.458 | 0.012 | 0.231 | 0.243 | 0.105 | 1.821 | 1.926 | 0.005 | 0.064 | 0.069 | 1.762 | 31.244 | 32.996 |
| Hospital-based day surgery | 0.521 | 0.075 | 0.596 | 0.444 | 0.035 | 0.480 | 0.093 | 0.019 | 0.112 | 1.008 | 0.121 | 1.129 | 0.036 | 0.005 | 0.041 | 17.014 | 3.212 | 20.226 |
| Hospital inpatient care | 0.381 | 0.056 | 0.437 | 0.402 | 0.035 | 0.437 | 0.062 | 0.013 | 0.076 | 0.529 | 0.066 | 0.596 | 0.021 | 0.003 | 0.024 | 10.781 | 2.031 | 12.813 |
| **Total direct costs** | **0.960** | **1.039** | **2.000** | **0.871** | **0.504** | **1.375** | **0.168** | **0.263** | **0.431** | **1.642** | **2.009** | **3.651** | **0.063** | **0.072** | **0.135** | **29.557** | **36.487** | **66.034** |
| Mortality | 7.292 | 1.061 | 8.353 | 4.661 | 0.501 | 5.162 | 1.471 | 0.259 | 1.729 | 11.205 | 1.806 | 13.011 | 1.218 | 0.108 | 1.326 | 410.073 | 46.930 | 457.013 |
| Morbidity | 0.072 | 0.086 | 0.158 | 0.040 | 0.049 | 0.089 | 0.018 | 0.025 | 0.042 | 0.122 | 0.181 | 0.303 | 0.012 | 0.011 | 0.023 | 3.861 | 4.838 | 8.699 |
| **Total indirect costs** | **7.365** | **1.146** | **8.511** | **4.701** | **0.550** | **5.251** | **1.489** | **0.283** | **1.772** | **11.328** | **1.986** | **13.314** | **1.230** | **0.119** | **1.349** | **413.934** | **51.768** | **465.712** |
| **Total costs** | **8.325** | **2.186** | **10.511** | **5.571** | **1.054** | **6.626** | **1.656** | **0.547** | **2.203** | **12.970** | **3.995** | **16.965** | **1.292** | **0.191** | **1.484** | **443.491** | **88.255** | **531.746** |

*Note:* MM, malignant melanoma; NMSC, non-melanoma skin cancer

**Annual Direct and Indirect Costs of Skin Cancers in Canada**
**By Province/Territory in 2004** (in $millions, 2004 constant dollars, undiscounted)

**Males**

| | Britsh Columbia | | | Alberta | | | Saskatchewan | | | Manitoba | | | Ontario | | | Quebec | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Type of Cost** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** |
| Primary care | 0.154 | 3.205 | 3.359 | 0.107 | 1.692 | 1.800 | 0.027 | 0.836 | 0.863 | 0.028 | 0.511 | 0.539 | 0.373 | 6.819 | 7.192 | 0.135 | 2.587 | 2.722 |
| Hospital-based day surgery | 0.885 | 0.311 | 1.197 | 0.895 | 0.195 | 1.090 | 0.378 | 0.080 | 0.459 | 0.365 | 0.053 | 0.417 | 3.781 | 0.908 | 4.689 | 2.172 | 0.251 | 2.423 |
| Hospital inpatient care | 0.434 | 0.162 | 0.596 | 0.391 | 0.092 | 0.483 | 0.245 | 0.057 | 0.301 | 0.215 | 0.035 | 0.250 | 1.856 | 0.469 | 2.325 | 1.997 | 0.248 | 2.245 |
| **Total direct costs** | **1.474** | **3.678** | **5.152** | **1.393** | **1.979** | **3.372** | **0.650** | **0.973** | **1.623** | **0.608** | **0.598** | **1.206** | **6.010** | **8.197** | **14.206** | **4.303** | **3.086** | **7.390** |
| Mortality | 38.160 | 5.643 | 43.803 | 24.424 | 2.781 | 27.204 | 6.580 | 0.765 | 7.346 | 9.222 | 0.920 | 10.142 | 133.508 | 14.300 | 147.808 | 45.742 | 5.655 | 51.398 |
| Morbidity | 0.392 | 0.531 | 0.922 | 0.276 | 0.290 | 0.565 | 0.041 | 0.090 | 0.131 | 0.064 | 0.080 | 0.145 | 1.041 | 1.334 | 2.375 | 0.377 | 0.484 | 0.861 |
| **Total indirect costs** | **38.552** | **6.173** | **44.725** | **24.699** | **3.071** | **27.770** | **6.621** | **0.855** | **7.477** | **9.286** | **1.000** | **10.287** | **134.549** | **15.634** | **150.183** | **46.119** | **6.139** | **52.259** |
| **Total costs** | **40.026** | **9.851** | **49.878** | **26.092** | **5.050** | **31.142** | **7.271** | **1.828** | **9.099** | **9.894** | **1.599** | **11.493** | **140.559** | **23.831** | **164.390** | **50.423** | **9.225** | **59.648** |

**Annual Direct and Indirect Costs of Skin Cancers in Canada**
**By Province/Territory in 2004 (in $millions, 2004 constant dollars, undiscounted)**

**Males (Continued)**

| | New Brunswick | | | Newfoundland | | | Prince Edward Island | | | Nova Scotia | | | Territories | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Type of Cost** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** |
| Primary care | 0.030 | 0.502 | 0.533 | 0.012 | 0.237 | 0.248 | 0.005 | 0.107 | 0.111 | 0.051 | 0.970 | 1.021 | 0.003 | 0.038 | 0.041 | 0.925 | 17.504 | 18.430 |
| Hospital-based day surgery | 0.267 | 0.045 | 0.312 | 0.253 | 0.021 | 0.274 | 0.040 | 0.009 | 0.049 | 0.623 | 0.070 | 0.694 | 0.022 | 0.003 | 0.026 | 9.681 | 1.948 | 11.630 |
| Hospital inpatient care | 0.207 | 0.036 | 0.244 | 0.224 | 0.021 | 0.245 | 0.025 | 0.007 | 0.032 | 0.343 | 0.041 | 0.384 | 0.013 | 0.002 | 0.015 | 5.952 | 1.169 | 7.120 |
| **Total direct costs** | **0.504** | **0.584** | **1.088** | **0.489** | **0.278** | **0.768** | **0.070** | **0.123** | **0.193** | **1.018** | **1.082** | **2.099** | **0.039** | **0.044** | **0.082** | **16.558** | **20.621** | **37.180** |
| Mortality | 4.219 | 0.697 | 4.916 | 2.730 | 0.331 | 3.061 | 0.926 | 0.149 | 1.075 | 6.869 | 1.185 | 8.055 | 0.810 | 0.082 | 0.892 | 273.191 | 32.509 | 305.700 |
| Morbidity | 0.043 | 0.052 | 0.094 | 0.023 | 0.030 | 0.053 | 0.007 | 0.012 | 0.020 | 0.069 | 0.107 | 0.175 | 0.007 | 0.008 | 0.015 | 2.340 | 3.017 | 5.357 |
| **Total indirect costs** | **4.261** | **0.749** | **5.010** | **2.753** | **0.361** | **3.114** | **0.934** | **0.161** | **1.095** | **6.938** | **1.292** | **8.230** | **0.817** | **0.090** | **0.907** | **275.531** | **35.526** | **311.057** |
| **Total costs** | **4.766** | **1.333** | **6.098** | **3.242** | **0.639** | **3.881** | **1.004** | **0.284** | **1.287** | **7.956** | **2.374** | **10.330** | **0.856** | **0.134** | **0.989** | **292.089** | **56.147** | **348.236** |

*Note:* MM, malignant melanoma; NMSC, non-melanoma skin cancer

**Annual Direct and Indirect Costs of Skin Cancers in Canada**
**By Province/Territory in 2004** (in $millions, 2004 constant dollars, undiscounted)

**Females**

| | Britsh Columbia | | | Alberta | | | Saskatchewan | | | Manitoba | | | Ontario | | | Quebec | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Type of Cost** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** |
| Primary care | 0.130 | 2.430 | 2.560 | 0.104 | 1.391 | 1.494 | 0.031 | 0.611 | 0.642 | 0.021 | 0.449 | 0.470 | 0.337 | 5.147 | 5.484 | 0.110 | 2.107 | 2.217 |
| Hospital-based day surgery | 0.793 | 0.207 | 1.000 | 0.717 | 0.130 | 0.847 | 0.280 | 0.048 | 0.328 | 0.251 | 0.038 | 0.289 | 2.837 | 0.563 | 3.401 | 1.557 | 0.170 | 1.727 |
| Hospital inpatient care | 0.460 | 0.130 | 0.589 | 0.410 | 0.083 | 0.493 | 0.180 | 0.035 | 0.215 | 0.307 | 0.049 | 0.356 | 1.569 | 0.337 | 1.906 | 1.322 | 0.162 | 1.484 |
| **Total direct costs** | **1.383** | **2.766** | **4.150** | **1.230** | **1.604** | **2.834** | **0.490** | **0.695** | **1.185** | **0.578** | **0.537** | **1.115** | **4.744** | **6.047** | **10.791** | **2.989** | **2.439** | **5.428** |
| Mortality | 21.787 | 2.425 | 24.212 | 10.470 | 1.175 | 11.645 | 3.932 | 0.469 | 4.401 | 4.748 | 0.423 | 5.171 | 61.573 | 5.958 | 67.531 | 24.078 | 2.682 | 26.760 |
| Morbidity | 0.234 | 0.318 | 0.552 | 0.175 | 0.161 | 0.335 | 0.040 | 0.057 | 0.097 | 0.046 | 0.060 | 0.106 | 0.689 | 0.763 | 1.452 | 0.222 | 0.320 | 0.542 |
| **Total indirect costs** | **22.021** | **2.743** | **24.764** | **10.645** | **1.336** | **11.980** | **3.972** | **0.525** | **4.498** | **4.794** | **0.483** | **5.277** | **62.262** | **6.721** | **68.983** | **24.301** | **3.002** | **27.303** |
| **Total costs** | **23.405** | **5.509** | **28.914** | **11.875** | **2.939** | **14.815** | **4.462** | **1.220** | **5.682** | **5.373** | **1.019** | **6.392** | **67.006** | **12.768** | **79.773** | **27.290** | **5.442** | **32.731** |

**Annual Direct and Indirect Costs of Skin Cancers in Canada**
**By Province/Territory in 2004 (in $millions, 2004 constant dollars, undiscounted)**

**Females (Continued)**

| | New Brunswick | | | Newfoundland | | | Prince Edward Island | | | Nova Scotia | | | Territories | | | Total | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Type of Cost** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** | **MM** | **NMSC** | **Total** |
| Primary care | 0.027 | 0.406 | 0.433 | 0.013 | 0.197 | 0.210 | 0.007 | 0.125 | 0.132 | 0.053 | 0.851 | 0.905 | 0.002 | 0.026 | 0.028 | 0.837 | 13.740 | 14.576 |
| Hospital-based day surgery | 0.255 | 0.030 | 0.285 | 0.191 | 0.014 | 0.206 | 0.054 | 0.009 | 0.063 | 0.385 | 0.051 | 0.436 | 0.014 | 0.002 | 0.016 | 7.333 | 1.263 | 8.596 |
| Hospital inpatient care | 0.174 | 0.019 | 0.193 | 0.177 | 0.015 | 0.192 | 0.037 | 0.007 | 0.044 | 0.186 | 0.025 | 0.211 | 0.008 | 0.001 | 0.009 | 4.829 | 0.863 | 5.692 |
| **Total direct costs** | **0.456** | **0.455** | **0.911** | **0.381** | **0.226** | **0.608** | **0.098** | **0.141** | **0.239** | **0.624** | **0.928** | **1.552** | **0.024** | **0.029** | **0.053** | **12.999** | **15.866** | **28.865** |
| Mortality | 3.074 | 0.364 | 3.437 | 1.931 | 0.170 | 2.102 | 0.545 | 0.110 | 0.654 | 4.336 | 0.620 | 4.956 | 0.408 | 0.026 | 0.434 | 136.882 | 14.421 | 151.304 |
| Morbidity | 0.030 | 0.034 | 0.064 | 0.016 | 0.019 | 0.035 | 0.010 | 0.013 | 0.023 | 0.054 | 0.074 | 0.127 | 0.004 | 0.004 | 0.008 | 1.521 | 1.821 | 3.342 |
| **Total indirect costs** | **3.103** | **0.398** | **3.501** | **1.948** | **0.189** | **2.137** | **0.555** | **0.122** | **0.677** | **4.390** | **0.694** | **5.084** | **0.413** | **0.029** | **0.442** | **138.403** | **16.242** | **154.645** |
| **Total costs** | **3.559** | **0.853** | **4.412** | **2.329** | **0.415** | **2.745** | **0.653** | **0.263** | **0.916** | **5.014** | **1.622** | **6.636** | **0.437** | **0.058** | **0.495** | **151.402** | **32.108** | **183.510** |

*Note:* MM, malignant melanoma; NMSC, non-melanoma skin cancer

The range of skin cancer costs is driven largely by differences in absolute incidence in the various regions of the country. There are variations, however, that are explained by other factors. For instance, the Ontario costs represent 45.9% of the total national costs, but the province only accounts for 41.2% of skin cancer cases. The discrepancy is generally explained by the higher unit costs in that province compared to other provinces. For example, the average cost per day in hospital in Ontario and the average wages in that province were calculated to be the second highest of any province in the country (following Alberta). Throughout the model, province-specific unit values were used in estimating both direct and indirect costs.

The total costs are consistently lower for females compared to males across the country, reflecting the generally lower incidence of all three types of skin cancer and, with respect to indirect costs, both lower average incomes for females and lower average workforce participation. Despite the modifications applied to the human-capital approach used in the model to address this issue, this phenomenon still creates a substantial impact. While females account for 44.1% of skin cancer cases in 2004, they only generated 33.2% of the total ***indirect*** costs; by contrast, the total ***direct*** costs followed the incidence pattern very closely (i.e., 43.7% generated by females and 56.3% by males).

### Comparison of Costs to That in Other Countries

Comparing cost estimates from Canada to those from other countries is complicated for a number of reasons. These include differences in the time periods when costs are generated, health system practices, unit costs of production, and so on. The following summary comparison is thus a high level comparison to assess whether the costs generated by the foregoing economic analysis are within a reasonable range.

In the current analysis, the average direct cost per episode of care for a BCC was $436 in 2004 while that for an SCC was $657. In the United States in the late 1990s, the average cost per episode of NMSC care has been estimated at between $330 and $470 (US$). [361,362] In Ontario, the direct treatment costs for a ***complex*** *primary* facial BCC using Mohs surgery was $881 and that of a complex *recurrent* facial BCC, $1,011.[363]

In the current analysis, the average direct cost per episode of care for an MSC was $6,215 in 2004. In Australia, the direct costs for melanoma are estimated to be AUS$3,341[364] while in the U.S. they average $12,500 (1997 US$).[365] This variance likely reflects differences in health system practices between the two countries, unit costs, and the stage at which the majority of melanoma cases are treated.

[361] Joseph AK, Mark TL, Mueller C. The period prevalence and costs of treating nonmelanoma skin cancers in patients over 65 years of age covered by Medicare. *Dermatologic Surgery.* 2001; 27(11): 955-9.
[362] Housman TS, Williford PM, Feldman SR et al. Nonmelanoma skin cancer: an episode of care management approach. *Dermatologic Surgery.* 2003; 29(7): 700-11.
[363] Lear W, Mittmann N, Barnes E et al. Cost comparisons of managing complex facial basal cell carcinoma: Canadian study. *Journal of Cutaneous Medicine and Surgery.* 2008; 12(2): 82-7.
[364] Australian Institute of Health and Welfare. *Health system expenditures on cancer and other neoplasms in Australia, 2000-01*. 2005. Available at http://www.aihw.gov.au/publications/hwe/hsecna00-01/hsecna00-01.pdf. Accessed January 2009.
[365] Tsao H, Rogers GS, Sober AJ. An estimate of the annual direct cost of treating cutaneous melanoma. *Journal of the American Academy of Dermatology.* 1998; 38(5 Pt 1): 669-80.

In the current analysis, the direct costs associated with MSC, BCC and SCC are 6.7%, 54.6% and 25.3% of the total costs. A U.S. study[366] estimated that the direct costs associated with melanoma were 9.0% of total costs while a study in England[367] estimated these to be 14.7% of total costs. These same two studies estimated the direct costs associated with NMSC to be 39.4% and 80.0%, respectively, of total costs. As noted earlier, the assumptions used in valuing indirect costs can dramatically alter the results. Since we modified the standard human capital approach by valuing "non-productive" time lost (using each province's minimum wage), the indirect costs in the current study are somewhat higher than in some other studies.

### Sensitivity Analysis

There are a number of potential economic costs that have not been included in the current study. For example, the U.S. study noted earlier found that prescription drugs accounted for 28% of direct costs for MSC and 1.3% for NMSC.[368] The study from England estimated patient costs (e.g. transport and economic inactivity costs while attending appointments) as 2.6% of total costs for melanoma and 15.4% of total costs for NMSC.[369]

In our base case, the economic burden of skin cancers in Canada in 2004 totals $532 million ($66/$466 million direct/indirect). Including costs for prescription drugs based on the ratio of costs in the U.S. study would increase direct costs by $8.75 million. Including patient costs based on the ratio of costs in the study from England would increase indirect costs by $25.12 million.

As noted earlier, the standard human capital approach was modified by valuing "non-productive" time lost (using each province's minimum wage). This approach was taken to address an important criticism of the human capital approach, namely, that it does not value unpaid work and leisure time. This modification, however, significantly alters the total indirect costs. Using the standard human capital approach (in which non-workforce participation costs are excluded, see following table), would reduce the estimated indirect costs in 2004 from $466 to $216 million.

[366] Lewin Group Inc. *The Burden of Skin Diseases 2004.* 2006. Society for Investigative Dermatology and American Academy of Dermatology Association. Available at http://www.lewin.com/content/publications/april2005skindisease.pdf. Accessed January 2009.
[367] Morris S, Cox B, Bosanquet N. Cost of skin cancer in England. *European Journal of Health Economics.* 2008: Epublished ahead of print.
[368] Lewin Group Inc. *The Burden of Skin Diseases 2004.* 2006. Society for Investigative Dermatology and American Academy of Dermatology Association. Available at http://www.lewin.com/content/publications/april2005skindisease.pdf. Accessed January 2009.
[369] Morris S, Cox B, Bosanquet N. Cost of skin cancer in England. *European Journal of Health Economics.* 2008: Epublished ahead of print.

| Annual Direct and Indirect Costs of Skin Cancers in Canada<br>Excluding Non-Workforce Participation Costs<br>**2004** (in $millions, 2004 constant dollars, undiscounted) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Type of Cost** | **MM** | **%** | **BCC** | **%** | **SCC** | **%** | **Total** | **%** |
| Primary care | 1.76 | 0.8% | 24.90 | 71.9% | 6.34 | 34.6% | 33.00 | 11.7% |
| Hospital-based day surgery | 17.01 | 7.4% | 0.91 | 2.6% | 2.22 | 12.1% | 20.14 | 7.1% |
| Hospital inpatient care | 10.78 | 4.7% | 0.58 | 1.7% | 1.56 | 8.5% | 12.92 | 4.6% |
| **Total direct costs** | **29.55** | **12.9%** | **26.39** | **76.2%** | **10.12** | **55.2%** | **66.05** | **23.4%** |
| Mortality | 195.50 | 85.4% | 4.50 | 13.0% | 7.11 | 38.8% | 207.10 | 73.5% |
| Morbidity | 3.86 | 1.7% | 3.74 | 10.8% | 1.10 | 6.0% | 8.70 | 3.1% |
| **Total indirect costs** | **199.36** | **87.1%** | **8.24** | **23.8%** | **8.21** | **44.8%** | **215.80** | **76.6%** |
| **Total costs** | **228.91** | **100%** | **34.63** | **100%** | **18.32** | **100.0%** | **281.86** | **100%** |
| *Note:* MM, malignant melanoma; BCC, basal cell carcinoma; SCC, squamous cell carcinoma. | | | | | | | | |

## Projected Cost Based on APC Scenario

Attempting to predict the future is always a challenge and filled with uncertainties. These uncertainties multiply the further into the future one attempts to forecast. To partially address this uncertainty, three alternate projection scenarios were developed. The future economic burden of skin cancer in Canada is sensitive to these projection scenarios.

To review, in the **Medium APC Scenario**, assumptions were made about the annual percent change (APC) in males and females based on recent trends in age-standardized incidence rates. In the **Low APC Scenario**, a more conservative approach was used by halving the APC noted in the Medium APC Scenario. This scenario was intended to reflect the possibility that some of the observed increase in rates may be partly related to improvements in case ascertainment over time, rather than being solely driven by true increases in incidence. In addition, a further possible reason for a reduction in APC is the increasing proportion of the Canadian population that is from a visible minority. The **No APC Scenario** assumed that age-standardized incidence rates would remain stable and thus future changes are based solely on population growth and ageing.

In the base case scenario (Low APC), the economic burden of skin cancer in Canada in 2031was estimated at $922 million, as indicated in the following table(s). The economic burden was estimated at $784 million for the No APC Scenario and $1,060 million for the Medium APC Scenario.

**Annual Direct and Indirect Costs of Skin Cancers in Canada**
Low APC Scenario
**2031** (in $millions, 2004 constant dollars, undiscounted)

| Type of Cost | MM | % | BCC | % | SCC | % | Total | % |
|---|---|---|---|---|---|---|---|---|
| Primary care | 3.35 | 0.5% | 64.76 | 52.7% | 17.95 | 17.4% | 86.06 | 9.3% |
| Hospital-based day surgery | 36.75 | 5.3% | 2.35 | 1.9% | 6.12 | 5.9% | 45.22 | 4.9% |
| Hospital inpatient care | 24.62 | 3.5% | 1.53 | 1.2% | 4.43 | 4.3% | 30.58 | 3.3% |
| **Total direct costs** | **64.72** | **9.3%** | **68.64** | **55.9%** | **28.50** | **27.7%** | **161.86** | **17.6%** |
| Mortality | 624.78 | 89.8% | 45.44 | 37.0% | 71.74 | 69.6% | 741.96 | 80.5% |
| Morbidity | 6.46 | 0.9% | 8.73 | 7.1% | 2.79 | 2.7% | 17.98 | 2.0% |
| **Total indirect costs** | **631.24** | **90.7%** | **54.17** | **44.1%** | **74.53** | **72.3%** | **759.94** | **82.4%** |
| **Total costs** | **695.96** | **100%** | **122.81** | **100.0%** | **103.03** | **100.0%** | **921.80** | **100%** |

*Note:* MM, malignant melanoma; BCC, basal cell carcinoma; SCC, squamous cell carcinoma.

**Annual Direct and Indirect Costs of Skin Cancers in Canada**
No APC Scenario
**2031** (in $millions, 2004 constant dollars, undiscounted)

| Type of Cost | MM | % | BCC | % | SCC | % | Total | % |
|---|---|---|---|---|---|---|---|---|
| Primary care | 2.80 | 0.5% | 46.76 | 53.3% | 13.53 | 18.2% | 63.09 | 8.0% |
| Hospital-based day surgery | 29.84 | 4.8% | 1.69 | 1.9% | 4.63 | 6.2% | 36.16 | 4.6% |
| Hospital inpatient care | 19.67 | 3.2% | 1.10 | 1.3% | 3.32 | 4.5% | 24.10 | 3.1% |
| **Total direct costs** | **52.32** | **8.4%** | **49.55** | **56.5%** | **21.47** | **28.9%** | **123.35** | **15.7%** |
| Mortality | 563.94 | 90.7% | 32.03 | 36.5% | 50.57 | 68.2% | 646.53 | 82.5% |
| Morbidity | 5.62 | 0.9% | 6.19 | 7.1% | 2.14 | 2.9% | 13.95 | 1.8% |
| **Total indirect costs** | **569.56** | **91.6%** | **38.22** | **43.5%** | **52.71** | **71.1%** | **660.49** | **84.3%** |
| **Total costs** | **621.88** | **100%** | **87.77** | **100%** | **74.18** | **100.0%** | **783.83** | **100%** |

*Note:* MM, malignant melanoma; BCC, basal cell carcinoma; SCC, squamous cell carcinoma.

**Annual Direct and Indirect Costs of Skin Cancers in Canada**
Medium APC Scenario
**2031** (in $millions, 2004 constant dollars, undiscounted)

| Type of Cost | MM | % | BCC | % | SCC | % | Total | % |
|---|---|---|---|---|---|---|---|---|
| Primary care | 3.89 | 0.5% | 82.75 | 52.4% | 22.37 | 17.0% | 109.01 | 10.3% |
| Hospital-based day surgery | 43.65 | 5.7% | 3.02 | 1.9% | 7.60 | 5.8% | 54.27 | 5.1% |
| Hospital inpatient care | 29.57 | 3.8% | 1.95 | 1.2% | 5.54 | 4.2% | 37.07 | 3.5% |
| **Total direct costs** | **77.11** | **10.0%** | **87.72** | **55.6%** | **35.52** | **26.9%** | **200.35** | **18.9%** |
| Mortality | 685.63 | 89.0% | 58.85 | 37.3% | 92.92 | 70.5% | 837.39 | 79.0% |
| Morbidity | 7.31 | 0.9% | 11.27 | 7.1% | 3.43 | 2.6% | 22.01 | 2.1% |
| **Total indirect costs** | **692.93** | **90.0%** | **70.12** | **44.4%** | **96.35** | **73.1%** | **859.40** | **81.1%** |
| **Total costs** | **770.04** | **100%** | **157.84** | **100.0%** | **131.87** | **100.0%** | **1,059.75** | **100%** |

*Note:* MM, malignant melanoma; BCC, basal cell carcinoma; SCC, squamous cell carcinoma.

## Using Discount Rates

Discount rates are most commonly applied to both costs and effects in economic evaluations in order to take into account time preference. In short, a dollar spent now (or an effect produced now) is of higher value than the equivalent phenomenon in the future. The further into the future, the lower the value of the dollar or the effect. This is particularly problematic for interventions focusing on future disease prevention, as is the current situation. The most important benefits (prevention of skin cancers) occur decades after prevention programs assist in modifying unhealthy behaviours. As noted by Crott, discounting "clearly favours events that occur close to the moment of intervention and penalise ... those events happening much later in life."[370] Thus a number of research groups have suggested that different discount rates be applied to costs and effects when assessing prevention programs.[371,372,373]

In their authoritative guide to economic evaluations in health care, Drummond and co-authors recommend that costs and consequences be first presented in their undiscounted form (essentially utilizing a 0% discount rate) with a sensitivity analysis including rates of 3% and 5%. A key reason for undertaking the sensitivity analysis would be to "alert decision makers to the importance of the choice of discount rate (pg. 73)".[374] The approach recommended by Drummond and colleagues has been used in this section.

In 2004, applying a discount rate of 3% reduced the total estimated economic burden from $532 million to $411 million. A 5% discount rate further reduced this value to $355 million.

**Economic Burden of Skin Cancer in Canada**
In 2004, Sensitivity Analysis

| | Discount Rate | | |
|---|---|---|---|
| | 0% | 3% | 5% |
| ***Including*** Non-Workforce Participation Costs | | | |
| Direct | $ 66.05 | $ 66.05 | $ 66.05 |
| Indirect | $ 465.70 | $ 344.60 | $ 288.64 |
| **Total** | **$ 531.75** | **$ 410.65** | **$ 354.69** |
| ***Excluding*** Non-Workforce Participation Costs | | | |
| Direct | $ 66.05 | $ 66.05 | $ 66.05 |
| Indirect | $ 215.80 | $ 160.09 | $ 134.28 |
| **Total** | **$ 281.86** | **$ 226.14** | **$ 200.34** |

The following table provides a summary of the economic burden of skin cancer in Canada in 2031 based on various assumptions regarding discount rates, projection scenarios and whether or not non-workforce participation costs are included (modifying the standard human capital

[370] Crott R. Economic analysis of HPV-vaccines: Not so simple? *Vaccine.* 2007; 25(45): 7717.
[371] Bos JM, Beutels P, Annemans L et al. Valuing prevention through economic evaluation: some considerations regarding the choice of discount model for health effects with focus on infectious diseases. *PharmacoEconomics.* 2004; 22(18): 1171-9.
[372] Brouwer WB, Niessen LW, Postma MJ et al. Need for differential discounting of costs and health effects in cost effectiveness analyses. *Bmj.* 2005; 331(7514): 446-8.
[373] Gravelle H, Brouwer W, Niessen L et al. Discounting in economic evaluations: stepping forward towards optimal decision rules. *Health Economics.* 2007; 16(3): 307-17.
[374] Drummond MF, O'Brien B, Stoddart GL and Torrance GW. Methods for the Economic Evaluation of Health Care Programmes. 2nd Edition. Oxford University Press, New York. 1997.

approach). The results are quite sensitive to these three variables, with the estimated economic burden ranging from a low of $295 million to a high of $1,060 million in 2031.

**Economic Burden of Skin Cancer in Canada**
In 2031, Sensitivity Analysis

| | Discount Rate 0% | 3% | 5% |
|---|---|---|---|
| **No APC Scenario** | | | |
| ***Including*** Non-Workforce Participation Costs | | | |
| Direct | $ 123.35 | $ 123.35 | $ 123.35 |
| Indirect | $ 660.49 | $ 515.08 | $ 443.65 |
| **Total** | **$ 783.83** | **$ 638.42** | **$ 567.00** |
| ***Excluding*** Non-Workforce Participation Costs | | | |
| Direct | $ 123.35 | $ 123.35 | $ 123.35 |
| Indirect | $ 253.98 | $ 198.51 | $ 171.44 |
| **Total** | **$ 377.33** | **$ 321.86** | **$ 294.79** |
| **Low APC Scenario** | | | |
| ***Including*** Non-Workforce Participation Costs | | | |
| Direct | $ 161.86 | $ 161.86 | $ 161.86 |
| Indirect | $ 759.94 | $ 602.55 | $ 523.73 |
| **Total** | **$ 921.80** | **$ 764.40** | **$ 685.59** |
| ***Excluding*** Non-Workforce Participation Costs | | | |
| Direct | $ 161.86 | $ 161.86 | $ 161.86 |
| Indirect | $ 271.47 | $ 216.29 | $ 188.82 |
| **Total** | **$ 433.33** | **$ 378.15** | **$ 350.68** |
| **Medium APC Scenario** | | | |
| ***Including*** Non-Workforce Participation Costs | | | |
| Direct | $ 200.35 | $ 200.35 | $ 200.35 |
| Indirect | $ 859.40 | $ 689.09 | $ 602.66 |
| **Total** | **$ 1,059.75** | **$ 889.44** | **$ 803.01** |
| ***Excluding*** Non-Workforce Participation Costs | | | |
| Direct | $ 200.35 | $ 200.35 | $ 200.35 |
| Indirect | $ 288.97 | $ 233.37 | $ 205.31 |
| **Total** | **$ 489.32** | **$ 433.72** | **$ 405.66** |

## Appendix G: Estimating the Effect of a Comprehensive Skin Cancer Prevention Program in Canada

### Model Assumptions

As outlined in Appendix C, the most comprehensive, long-term skin cancer prevention programs have occurred in Australia. Modelling the effectiveness and the cost-effectiveness of these Australian prevention programs has been completed by Carter and colleagues.[375,376,377] In their latest analysis of the *SunSmart* program, Shih and Carter make the following key assumptions: [378]

*For Melanoma*

- Assess the effectiveness of the *SunSmart* program in the state of Victoria based on the difference between the expected skin cancer incidence (using trend analysis in melanoma incidence from the period before prevention programs operated, i.e., 1982 to 1988 in Victoria) and the rate following the implementation of *SunSmart* (1988 to 2004).
- Assume that 50% of the reduction in melanoma incidence is directly attributable to *SunSmart*. Vary this assumption in the sensitivity analysis (from 30-70%).
- Assume a 5-year lag time before any observed reduction in melanoma incidence/mortality.

*For Non-Melanoma Skin Cancer*

- Assume a 5% reduction in SCC for individuals under the age of 50.
- Assume a reduction in BCC by age-group over a 10-year period, as follows:
    - 20-24 – 30%
    - 25-29 – 25%
    - 30-34 – 20%
    - 35-39 – 15%
    - 40-44 – 10%
    - 45-49 – 5%
- Assume a 15-year lag time before any reduction in NMSC incidence/mortality
- Sensitivity analysis includes assuming a decay rate of 0%, 10%, and 20% in the effectiveness of *SunSmart* after 10 years.

The researchers further based their work on known information about skin cancer prevention program spending (up to 2006) and potential impact on incidence (data available up to 2003).

To begin to adapt the Australian experience to the present project, additional detailed information from Australia was gathered and analyzed, as summarized in Appendix C.

---

[375] Carter R, Marks R, Hill D. Could a national skin cancer primary prevention campaign in Australia be worthwhile?: an economic perspective. *Health Promotion International*. 1999; 14(1): 73-82.

[376]Shih ST, Carter R, Sinclair C et al. Economic evaluation of a national SunSmart program. *Preventive Medicine (submitted; revision under review).*

[377] Cancer Council Australia, The Australian College of Dermatologists. *Skin cancer prevention: A blue chip investment in health*. 2009. Available at http://www.cancer.org.au/File/PolicyPublications/Skin_Cancer_Prevention-a_Blue_Chip_Investment.pdf. Accessed May 2009.

[378]Shih ST, Carter R, Sinclair C et al. Economic evaluation of skin cancer prevention in Australia. *Preventive Medicine.* 2009; Epublished ahead of print: 5 pp.

Based on the analysis in Appendix C and the work of Shih and Carter in Australia,[379] the following major assumptions pertain to the projection of skin cancer prevention impacts in Canada from a program that was posited to have launched in 2004:

*Melanoma*

- Assume a **9-year lag time** before any observed reduction in melanoma incidence/mortality. The analysis of the Victoria data suggests a major change in trend at approximately 1997, i.e., 9 years after the *SunSmart* program began in 1988.
- Adjust the **Low Annual Percent Change Scenario** from:
    - No annual percent change (APC) in males or females under the age of 50 (note that the other age groups had an APC for males/females at 50-64 years of 0.66%/0.84%; at 65-74 years, 1.40%/0.92%; and 75+ years, 1.85%/1.64%).

    To:

    - APC for males/females age less than 20: -4.98%/-13.85%; 20-29: -0.47%/-4.69%; 30-39: -1.04%/-5.31%; 40-49: -3.39%/-3.52% (the APC for the older age groups remains the same as above).
- Assume that the change in the model from 0% APC for the age groups up to 50 years to the observed decrease in APC identified in Victoria (by gender and age group) is entirely attributable to a prevention program. The Australian analysis assumed that 50% of the reduction in melanoma incidence is directly attributable to a comprehensive skin cancer prevention program and then varied this assumption in the sensitivity analysis (from 30-70%). That is, 50% of the difference between the historical increase in trend and the significant decline in trend following the implementation of *SunSmart* is attributable to the program. The current application of the model to the Canadian context assumes that the difference between 0% APC and the observed average APC of -4.13% starting in 1997 is entirely due to the *SunSmart* program. In essence, the Australian analysis assumed that 50% of the difference between the average 3.71% APC increase prior to 1997 and the -4.13% APC starting in 1997 was attributable to *SunSmart*.

*Non-melanoma Skin Cancer*

- Assume a 5% reduction over a 10-year period (0.5% annually) in SCC for individuals under the age of 50
- Assume a reduction in BCC by age-group over a 10-year period
    - 20-24 – 30%
    - 25-29 – 25%
    - 30-34 – 20%
    - 35-39 – 15%
    - 40-44 – 10%
    - 45-49 – 5%
- Assume a **15-year lag time** before any observed reduction in NMSC incidence/mortality

[379] Shih ST, Carter R, Sinclair C et al. Economic evaluation of a national SunSmart program. This report has been summarized in the article: Shih ST, Carter R, Sinclair C et al. Economic evaluation of skin cancer prevention in Australia. *Preventive Medicine.* 2009; Epublished ahead of print: 5 pp.

## Incidence and Mortality with Prevention Program

### Melanoma

For convenience, the Low APC scenario for diagnosis-based melanoma case projections from Appendix D is reproduced here in tabular form.

**Projected Annual Number of**
**Cutaneous Melanoma Cases in Canada**
**By Province, Gender and Year (2004 to 2031)**
**Diagnosis-Based Incidence Approach (Low Annual Percent Change Scenario)**

| | 2004 | | | 2011 | | | 2016 | | | 2021 | | | 2026 | | | 2031 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 397 | 336 | 733 | 494 | 399 | 892 | 577 | 450 | 1,027 | 662 | 498 | 1,160 | 750 | 549 | 1,299 | 836 | 602 | 1,438 |
| AB | 254 | 245 | 499 | 295 | 263 | 558 | 350 | 297 | 646 | 404 | 330 | 735 | 464 | 369 | 833 | 524 | 409 | 932 |
| SK | 58 | 66 | 124 | 73 | 72 | 146 | 81 | 76 | 157 | 88 | 80 | 168 | 97 | 85 | 182 | 105 | 91 | 196 |
| MB | 81 | 60 | 141 | 89 | 72 | 161 | 101 | 79 | 180 | 114 | 85 | 199 | 126 | 92 | 218 | 137 | 101 | 238 |
| ON | 1,081 | 978 | 2,058 | 1,366 | 1,104 | 2,470 | 1,606 | 1,250 | 2,856 | 1,847 | 1,393 | 3,240 | 2,107 | 1,544 | 3,651 | 2,362 | 1,702 | 4,063 |
| QC | 423 | 344 | 767 | 546 | 455 | 1,002 | 626 | 501 | 1,127 | 697 | 540 | 1,237 | 769 | 578 | 1,347 | 837 | 610 | 1,448 |
| NB | 62 | 56 | 118 | 78 | 72 | 150 | 90 | 79 | 169 | 101 | 85 | 186 | 112 | 91 | 203 | 121 | 97 | 217 |
| NF&L | 30 | 32 | 62 | 39 | 36 | 75 | 44 | 39 | 83 | 49 | 42 | 91 | 54 | 45 | 99 | 57 | 48 | 105 |
| PEI | 11 | 17 | 28 | 16 | 19 | 35 | 18 | 21 | 40 | 21 | 23 | 44 | 23 | 25 | 48 | 25 | 27 | 52 |
| NS | 104 | 109 | 213 | 129 | 118 | 246 | 148 | 130 | 278 | 166 | 141 | 307 | 184 | 153 | 337 | 199 | 163 | 362 |
| YK | 2 | 2 | 4 | 3 | 2 | 5 | 3 | 2 | 5 | 3 | 3 | 6 | 4 | 3 | 6 | 4 | 3 | 7 |
| NWT | 2 | 2 | 4 | 3 | 2 | 5 | 3 | 3 | 6 | 4 | 3 | 7 | 4 | 4 | 8 | 5 | 4 | 9 |
| NV | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 1 | 3 | 1 | 1 | 3 |
| **Canada** | **2,506** | **2,249** | **4,755** | **3,132** | **2,616** | **5,748** | **3,650** | **2,927** | **6,577** | **4,157** | **3,226** | **7,383** | **4,695** | **3,539** | **8,234** | **5,213** | **3,857** | **9,070** |

*Note: Calculated numbers are not rounded and thus may appear not to add appropriately.*

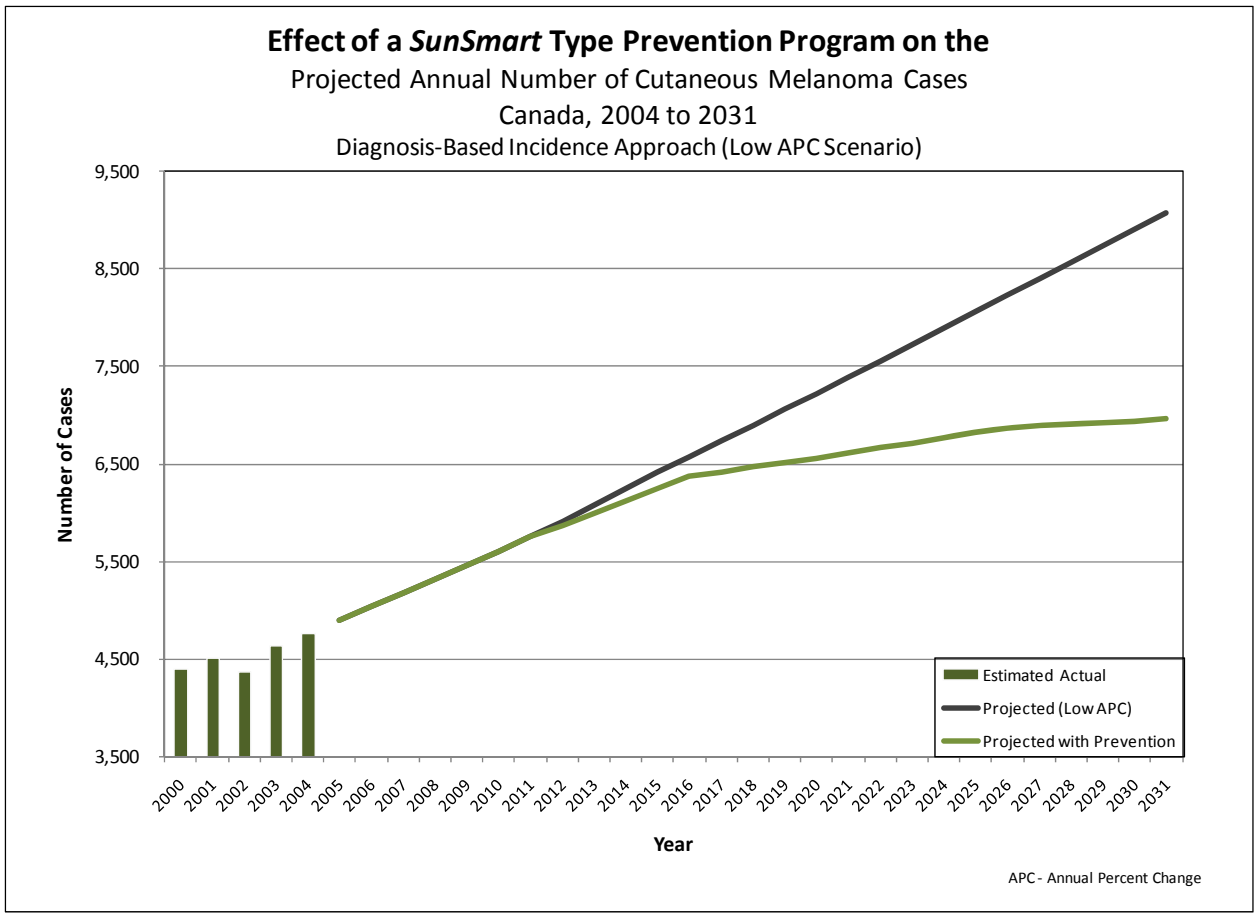
Applying the new assumptions to the Low APC scenario yields the following melanoma incidence results following prevention in various index years.

**Projected Annual Number of**
**Cutaneous Melanoma Cases in Canada**
**By Province, Gender and Year (2004 to 2031)**
**Diagnosis-Based Incidence Approach (Low Annual Percent Change Scenario) with Prevention**

| | 2004 | | | 2011 | | | 2016 | | | 2021 | | | 2026 | | | 2031 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 397 | 336 | 733 | 494 | 399 | 892 | 568 | 426 | 995 | 608 | 431 | 1,038 | 657 | 424 | 1,081 | 707 | 390 | 1,097 |
| AB | 254 | 245 | 499 | 295 | 263 | 558 | 343 | 278 | 622 | 368 | 280 | 648 | 404 | 277 | 681 | 441 | 260 | 701 |
| SK | 58 | 66 | 124 | 73 | 72 | 146 | 80 | 73 | 152 | 81 | 69 | 150 | 85 | 66 | 152 | 89 | 61 | 150 |
| MB | 81 | 60 | 141 | 89 | 72 | 161 | 100 | 75 | 175 | 104 | 75 | 179 | 110 | 74 | 183 | 115 | 69 | 184 |
| ON | 1,081 | 978 | 2,058 | 1,366 | 1,104 | 2,470 | 1,582 | 1,186 | 2,768 | 1,694 | 1,209 | 2,903 | 1,845 | 1,202 | 3,047 | 1,997 | 1,124 | 3,121 |
| QC | 423 | 344 | 767 | 546 | 455 | 1,002 | 615 | 476 | 1,092 | 637 | 472 | 1,109 | 673 | 454 | 1,127 | 705 | 407 | 1,112 |
| NB | 62 | 56 | 118 | 78 | 72 | 150 | 89 | 76 | 165 | 93 | 76 | 169 | 99 | 74 | 173 | 104 | 68 | 172 |
| NF&L | 30 | 32 | 62 | 39 | 36 | 75 | 44 | 37 | 81 | 45 | 37 | 82 | 47 | 36 | 83 | 49 | 33 | 82 |
| PEI | 11 | 17 | 28 | 16 | 19 | 35 | 18 | 20 | 39 | 19 | 21 | 40 | 20 | 20 | 41 | 21 | 19 | 40 |
| NS | 104 | 109 | 213 | 129 | 118 | 246 | 146 | 125 | 271 | 153 | 126 | 279 | 163 | 125 | 288 | 170 | 116 | 286 |
| YK | 2 | 2 | 4 | 3 | 2 | 5 | 3 | 2 | 5 | 3 | 2 | 5 | 3 | 2 | 5 | 3 | 2 | 5 |
| NWT | 2 | 2 | 4 | 3 | 2 | 5 | 3 | 3 | 6 | 3 | 3 | 6 | 4 | 3 | 6 | 4 | 2 | 6 |
| NV | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 |
| **Canada** | **2,506** | **2,249** | **4,755** | **3,132** | **2,616** | **5,748** | **3,592** | **2,779** | **6,371** | **3,810** | **2,800** | **6,610** | **4,112** | **2,759** | **6,871** | **4,407** | **2,552** | **6,959** |

*Note: Calculated numbers are not rounded and thus may appear not to add appropriately.*

In line with the assumption of a 9-year lag time, the first decrease related to a 2004 program launch appears after 2012; for example, in 2016, a total of 206 cases would be avoided. By 2031, the decrease would be 2,111 cases, as illustrated in the following chart. Over the 28 years of the prevention program, a cumulative total of 18,047 melanoma cases would be avoided.


Effect of a SunSmart Type Prevention Program on the
Projected Annual Number of Cutaneous Melanoma Cases
Canada, 2004 to 2031
Diagnosis-Based Incidence Approach (Low APC Scenario)
Number of Cases
9,500
8,500
7,500
6,500
5,500
4,500
3,500
Estimated Actual
Projected (Low APC)
Projected with Prevention
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
Year
APC - Annual Percent Change

The following two tables replicate the analysis for melanoma mortality, starting with the information calculated in Appendix D when no prevention program is in place, and then turning to the results of projections according to the assumptions adopted for the Canadian model.

**Projected Annual Number of**
**Deaths due to Cutaneous Melanoma in Canada**
**By Province, Gender and Year (2004 to 2031)**
**Low Annual Percent Change Scenario**

| | Average 2000-2004 | | | 2011 | | | 2016 | | | 2021 | | | 2026 | | | 2031 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 63 | 44 | 107 | 85 | 57 | 142 | 100 | 66 | 166 | 116 | 75 | 191 | 134 | 85 | 219 | 152 | 96 | 248 |
| AB | 36 | 22 | 58 | 50 | 29 | 79 | 60 | 34 | 94 | 70 | 39 | 109 | 81 | 45 | 126 | 93 | 52 | 144 |
| SK | 14 | 10 | 24 | 16 | 11 | 28 | 18 | 12 | 30 | 20 | 13 | 33 | 22 | 14 | 37 | 24 | 16 | 40 |
| MB | 18 | 11 | 29 | 22 | 13 | 35 | 25 | 14 | 40 | 29 | 16 | 44 | 32 | 17 | 50 | 36 | 19 | 55 |
| ON | 210 | 126 | 336 | 282 | 163 | 445 | 332 | 187 | 519 | 384 | 211 | 595 | 442 | 239 | 681 | 500 | 271 | 771 |
| QC | 81 | 52 | 133 | 106 | 65 | 171 | 123 | 73 | 196 | 140 | 80 | 220 | 157 | 89 | 246 | 174 | 98 | 271 |
| NB | 9 | 8 | 17 | 11 | 10 | 21 | 13 | 11 | 24 | 15 | 12 | 27 | 17 | 13 | 30 | 19 | 15 | 33 |
| NF&L | 6 | 5 | 11 | 8 | 6 | 14 | 9 | 7 | 16 | 10 | 8 | 18 | 11 | 9 | 20 | 12 | 10 | 22 |
| PEI | 2 | 1 | 3 | 3 | 2 | 4 | 3 | 2 | 5 | 3 | 2 | 5 | 4 | 2 | 6 | 4 | 3 | 7 |
| NS | 14 | 11 | 25 | 18 | 13 | 31 | 21 | 15 | 35 | 23 | 16 | 40 | 26 | 18 | 44 | 29 | 20 | 49 |
| YK | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| NWT | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 2 |
| NV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Canada** | **454** | **291** | **745** | **602** | **370** | **973** | **706** | **421** | **1,128** | **812** | **474** | **1,286** | **929** | **533** | **1,462** | **1,044** | **599** | **1,644** |

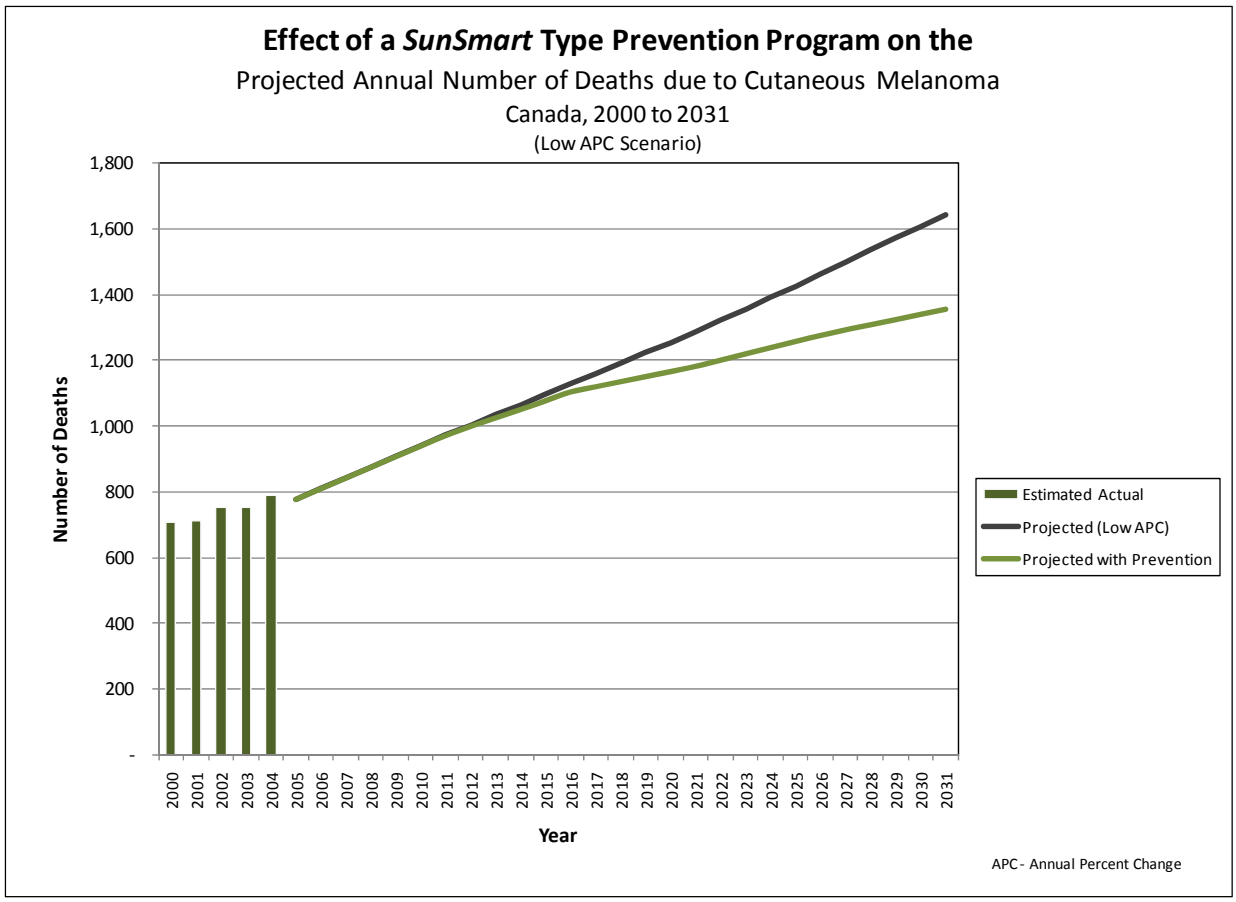
*Note: Calculated numbers are not rounded and thus may appear not to add appropriately.*

**Projected Annual Number of**
**Cutaneous Melanoma Deaths in Canada**
**By Province, Gender and Year (2004 to 2031)**
**With Prevention (Low Annual Percent Change Scenario)**

| | 2004 | | | 2011 | | | 2016 | | | 2021 | | | 2026 | | | 2031 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 63 | 44 | 107 | 85 | 57 | 142 | 99 | 64 | 163 | 108 | 68 | 176 | 120 | 72 | 192 | 131 | 74 | 205 |
| AB | 36 | 22 | 58 | 50 | 29 | 79 | 59 | 33 | 92 | 64 | 36 | 100 | 72 | 38 | 110 | 80 | 39 | 118 |
| SK | 14 | 10 | 24 | 16 | 11 | 28 | 18 | 12 | 30 | 19 | 12 | 31 | 20 | 12 | 32 | 21 | 12 | 33 |
| MB | 18 | 11 | 29 | 22 | 13 | 35 | 25 | 14 | 39 | 26 | 14 | 41 | 29 | 15 | 43 | 31 | 15 | 46 |
| ON | 210 | 126 | 336 | 282 | 163 | 445 | 327 | 181 | 508 | 354 | 192 | 546 | 390 | 201 | 592 | 429 | 203 | 632 |
| QC | 81 | 52 | 133 | 106 | 65 | 171 | 122 | 71 | 192 | 129 | 74 | 203 | 140 | 77 | 217 | 150 | 76 | 226 |
| NB | 9 | 8 | 17 | 11 | 10 | 21 | 13 | 11 | 24 | 14 | 11 | 25 | 15 | 12 | 27 | 16 | 12 | 28 |
| NF&L | 6 | 5 | 11 | 8 | 6 | 14 | 9 | 7 | 15 | 9 | 7 | 16 | 10 | 8 | 17 | 10 | 8 | 18 |
| PEI | 2 | 1 | 3 | 3 | 2 | 4 | 3 | 2 | 5 | 3 | 2 | 5 | 3 | 2 | 5 | 4 | 2 | 6 |
| NS | 14 | 11 | 25 | 18 | 13 | 31 | 20 | 14 | 35 | 22 | 15 | 37 | 24 | 16 | 39 | 25 | 16 | 41 |
| YK | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| NWT | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| NV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Canada** | **454** | **291** | **745** | **602** | **370** | **973** | **696** | **408** | **1,105** | **750** | **432** | **1,182** | **824** | **453** | **1,277** | **899** | **457** | **1,356** |

*Note: Calculated numbers are not rounded and thus may appear not to add appropriately.*

Again, the first decrease is seen after 2012. Thus, in 2016, there would be 23 fewer deaths compared to the projection with no prevention program in place. By 2031, the annual premature deaths avoided would climb to 288. The widening gap compared with projected deaths in the absence of prevention is illustrated in the following chart. Over the 28 years of the prevention program, 2,430 *cumulative* melanoma deaths would be avoided.


Effect of a SunSmart Type Prevention Program on the
Projected Annual Number of Deaths due to Cutaneous Melanoma
Canada, 2000 to 2031
(Low APC Scenario)
Number of Deaths
1,800
1,600
1,400
1,200
1,000
800
600
400
200
-
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2029
2030
2031
Year
Estimated Actual
Projected (Low APC)
Projected with Prevention
APC - Annual Percent Change

## Non-Melanoma Skin Cancer

A similar approach may be applied to the incidence rate of non-melanoma skin cancers in persons under 50 years of age, as shown in the following table for BCC.

**Projected Annual Number of**
**Basal Cell Carcinoma Cases in Canada**
**By Province, Gender and Year (2004 to 2031)**
**Diagnosis-Based Incidence Approach (Low Annual Percent Change Scenario) with Prevention**

| | 2004 | | | 2011 | | | 2016 | | | 2021 | | | 2026 | | | 2031 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 5,949 | 4,718 | 10,667 | 8,009 | 5,970 | 13,979 | 9,782 | 7,078 | 16,860 | 12,007 | 8,328 | 20,335 | 14,681 | 9,666 | 24,348 | 17,519 | 11,053 | 28,572 |
| AB | 2,723 | 2,419 | 5,141 | 3,791 | 3,147 | 6,938 | 4,742 | 3,778 | 8,519 | 5,901 | 4,486 | 10,386 | 7,282 | 5,234 | 12,516 | 8,743 | 6,022 | 14,765 |
| SK | 1,194 | 944 | 2,139 | 1,400 | 1,054 | 2,454 | 1,597 | 1,162 | 2,758 | 1,874 | 1,297 | 3,171 | 2,235 | 1,459 | 3,693 | 2,615 | 1,636 | 4,250 |
| MB | 1,064 | 991 | 2,054 | 1,324 | 1,151 | 2,476 | 1,563 | 1,306 | 2,868 | 1,875 | 1,489 | 3,363 | 2,246 | 1,682 | 3,929 | 2,629 | 1,880 | 4,508 |
| ON | 13,713 | 11,110 | 24,824 | 18,357 | 13,966 | 32,323 | 22,376 | 16,430 | 38,806 | 27,433 | 19,174 | 46,608 | 33,590 | 22,149 | 55,738 | 40,213 | 25,299 | 65,512 |
| QC | 5,656 | 4,913 | 10,569 | 7,524 | 6,031 | 13,555 | 9,060 | 6,936 | 15,996 | 10,927 | 7,906 | 18,833 | 13,073 | 8,859 | 21,932 | 15,194 | 9,787 | 24,980 |
| NB | 681 | 596 | 1,277 | 881 | 730 | 1,611 | 1,066 | 848 | 1,914 | 1,291 | 971 | 2,262 | 1,551 | 1,093 | 2,644 | 1,799 | 1,201 | 2,999 |
| NF&L | 417 | 373 | 790 | 542 | 468 | 1,009 | 654 | 549 | 1,202 | 785 | 636 | 1,420 | 933 | 720 | 1,653 | 1,068 | 799 | 1,867 |
| PEI | 172 | 214 | 386 | 222 | 256 | 478 | 265 | 297 | 563 | 324 | 342 | 666 | 383 | 390 | 773 | 444 | 433 | 877 |
| NS | 1,363 | 1,280 | 2,643 | 1,757 | 1,540 | 3,297 | 2,112 | 1,775 | 3,887 | 2,548 | 2,037 | 4,586 | 3,054 | 2,308 | 5,362 | 3,542 | 2,566 | 6,108 |
| YK/NWT/NV | 57 | 41 | 98 | 79 | 59 | 138 | 97 | 70 | 167 | 118 | 87 | 206 | 139 | 100 | 239 | 163 | 113 | 276 |
| **Canada** | **32,989** | **27,598** | **60,587** | **43,886** | **34,371** | **78,257** | **53,313** | **40,229** | **93,541** | **65,083** | **46,752** | **111,835** | **79,166** | **53,660** | **132,826** | **93,928** | **60,787** | **154,715** |

*Note: Calculated numbers are not rounded and thus may appear not to add appropriately.*

Because of longer lag times, the change in incidence rate and absolute number of cases shows up later in the modelling period. The cumulative impact over 28 years equates to 19,843 BCC cases avoided. The absolute impact on SCC incidence would be quite modest, yielding the results in the table below for the various index years. The cumulative impact over 28 years equates to only 641 avoided cases.

**Projected Annual Number of**
**Squamous Cell Carcinoma Cases in Canada**
**By Province, Gender and Year (2004 to 2031)**
**Diagnosis-Based Incidence Approach (Low Annual Percent Change Scenario) with Prevention**

| | 2004 | | | 2011 | | | 2016 | | | 2021 | | | 2026 | | | 2031 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 1,482 | 916 | 2,398 | 2,042 | 1,198 | 3,239 | 2,508 | 1,435 | 3,943 | 3,033 | 1,724 | 4,758 | 3,683 | 2,088 | 5,771 | 4,522 | 2,526 | 7,048 |
| AB | 876 | 538 | 1,413 | 1,248 | 730 | 1,978 | 1,592 | 895 | 2,487 | 1,970 | 1,095 | 3,065 | 2,425 | 1,347 | 3,772 | 2,999 | 1,672 | 4,671 |
| SK | 427 | 241 | 669 | 505 | 274 | 779 | 574 | 300 | 874 | 652 | 333 | 985 | 756 | 381 | 1,137 | 894 | 447 | 1,341 |
| MB | 245 | 160 | 404 | 306 | 187 | 493 | 361 | 209 | 570 | 424 | 239 | 663 | 502 | 280 | 782 | 601 | 334 | 936 |
| ON | 4,084 | 2,322 | 6,407 | 5,621 | 3,035 | 8,656 | 6,929 | 3,613 | 10,543 | 8,362 | 4,301 | 12,663 | 10,084 | 5,166 | 15,250 | 12,265 | 6,264 | 18,529 |
| QC | 1,639 | 1,030 | 2,669 | 2,247 | 1,329 | 3,576 | 2,762 | 1,566 | 4,328 | 3,316 | 1,832 | 5,148 | 3,967 | 2,157 | 6,124 | 4,716 | 2,549 | 7,265 |
| NB | 244 | 151 | 396 | 314 | 187 | 501 | 383 | 219 | 602 | 461 | 258 | 718 | 552 | 308 | 860 | 657 | 369 | 1,027 |
| NF&L | 121 | 76 | 197 | 157 | 99 | 256 | 194 | 119 | 313 | 233 | 143 | 377 | 280 | 173 | 454 | 331 | 209 | 540 |
| PEI | 52 | 47 | 100 | 67 | 56 | 124 | 81 | 67 | 147 | 100 | 79 | 179 | 116 | 95 | 210 | 138 | 114 | 252 |
| NS | 415 | 280 | 695 | 535 | 340 | 875 | 652 | 395 | 1,047 | 785 | 466 | 1,251 | 942 | 557 | 1,499 | 1,126 | 667 | 1,793 |
| YK/NWT/NV | 14 | 6 | 20 | 19 | 9 | 29 | 25 | 12 | 37 | 30 | 17 | 47 | 37 | 20 | 57 | 46 | 25 | 72 |
| **Canada** | **9,597** | **5,768** | **15,366** | **13,061** | **7,444** | **20,505** | **16,063** | **8,829** | **24,892** | **19,368** | **10,487** | **29,855** | **23,343** | **12,572** | **35,915** | **28,297** | **15,177** | **43,474** |

*Note: Calculated numbers are not rounded and thus may appear not to add appropriately.*

The impact of a prevention program for NMSC is delayed due to the longer lag time associated with the generally older age of NMSC incidence. However, though starting at a later point, the impact on absolute NMSC incidence eventually (by 2023) catches up to and then surpasses that seen for melanoma; by 2031, an estimated 3,113 NMSC cases are avoided annually, compared to 2,111 melanoma cases.

The following two tables replicate the analysis for NMSC mortality, starting with the information calculated in Appendix E when no prevention program is in place, and then turning to the results of projections according to the assumptions adopted for the Canadian model.

**Projected Annual Number of**
**Deaths Due to Non-Melanoma Skin Cancer in Canada**
**By Province, Gender and Year (2004 to 2031)**
**Low Annual Percent Change Scenario**

| | 2004 | | | 2011 | | | 2016 | | | 2021 | | | 2026 | | | 2031 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 21 | 12 | 33 | 29 | 15 | 44 | 35 | 18 | 53 | 44 | 21 | 65 | 55 | 25 | 80 | 70 | 31 | 101 |
| AB | 11 | 7 | 17 | 15 | 9 | 24 | 19 | 11 | 30 | 25 | 13 | 37 | 32 | 16 | 47 | 41 | 20 | 61 |
| SK | 4 | 3 | 7 | 5 | 3 | 8 | 5 | 4 | 9 | 6 | 4 | 10 | 7 | 4 | 11 | 9 | 5 | 14 |
| MB | 4 | 2 | 7 | 5 | 3 | 8 | 6 | 3 | 9 | 7 | 3 | 11 | 9 | 4 | 13 | 11 | 5 | 16 |
| ON | 55 | 30 | 85 | 75 | 40 | 115 | 92 | 47 | 139 | 113 | 55 | 168 | 142 | 66 | 208 | 180 | 81 | 261 |
| QC | 22 | 14 | 35 | 30 | 17 | 47 | 36 | 20 | 57 | 45 | 24 | 68 | 56 | 28 | 83 | 69 | 34 | 103 |
| NB | 3 | 2 | 6 | 4 | 3 | 7 | 5 | 3 | 8 | 6 | 4 | 10 | 8 | 4 | 12 | 10 | 5 | 15 |
| NF&L | 2 | 1 | 3 | 2 | 1 | 3 | 3 | 1 | 4 | 3 | 2 | 5 | 4 | 2 | 6 | 5 | 3 | 8 |
| PEI | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 1 | 3 |
| NS | 6 | 4 | 9 | 7 | 5 | 12 | 9 | 5 | 14 | 11 | 6 | 16 | 13 | 7 | 20 | 16 | 9 | 25 |
| YK/NWT/NV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 1 |
| **Canada** | **128** | **75** | **204** | **174** | **97** | **271** | **212** | **113** | **325** | **261** | **132** | **393** | **328** | **158** | **486** | **413** | **195** | **608** |

*Note: Calculated numbers are not rounded and thus may appear not to add appropriately.*

**Projected Annual Number of**
**Non-Melanoma Skin Cancer Deaths in Canada**
By Province, Gender and Year (2004 to 2031)
Diagnosis-Based Incidence Approach (Low Annual Percent Change Scenario) with Prevention

| | 2004 | | | 2011 | | | 2016 | | | 2021 | | | 2026 | | | 2031 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| BC | 21 | 12 | 33 | 29 | 15 | 44 | 35 | 18 | 53 | 44 | 21 | 65 | 54 | 26 | 79 | 67 | 32 | 99 |
| AB | 11 | 7 | 17 | 15 | 9 | 24 | 19 | 11 | 30 | 25 | 13 | 37 | 31 | 16 | 47 | 39 | 20 | 59 |
| SK | 4 | 3 | 7 | 5 | 3 | 8 | 5 | 4 | 9 | 6 | 4 | 10 | 7 | 4 | 11 | 8 | 5 | 13 |
| MB | 4 | 2 | 7 | 5 | 3 | 8 | 6 | 3 | 9 | 7 | 3 | 11 | 9 | 4 | 13 | 11 | 5 | 16 |
| ON | 55 | 30 | 85 | 75 | 40 | 115 | 92 | 47 | 139 | 113 | 55 | 168 | 138 | 67 | 205 | 171 | 82 | 254 |
| QC | 22 | 14 | 35 | 30 | 17 | 47 | 36 | 20 | 57 | 45 | 24 | 68 | 54 | 28 | 82 | 66 | 34 | 100 |
| NB | 3 | 2 | 6 | 4 | 3 | 7 | 5 | 3 | 8 | 6 | 4 | 10 | 8 | 4 | 12 | 10 | 6 | 15 |
| NF&L | 2 | 1 | 3 | 2 | 1 | 3 | 3 | 1 | 4 | 3 | 2 | 5 | 4 | 2 | 6 | 5 | 3 | 7 |
| PEI | 1 | 1 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 2 | 1 | 3 | 2 | 2 | 3 |
| NS | 6 | 4 | 9 | 7 | 5 | 12 | 9 | 5 | 14 | 11 | 6 | 16 | 13 | 7 | 20 | 16 | 9 | 25 |
| YK/NWT/NV | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 1 |
| **Canada** | **128** | **75** | **204** | **174** | **97** | **271** | **212** | **113** | **325** | **261** | **132** | **393** | **318** | **160** | **479** | **394** | **198** | **592** |

*Note: Calculated numbers are not rounded and thus may appear not to add appropriately.*

Again, the first decrease is seen after 2021. Thus, in 2026, there would be 7 fewer deaths compared to the projection with no prevention program in place. By 2031, the annual premature deaths avoided would increase to 16. Over the 28 years of the prevention program, 85 *cumulative* NMSC deaths would be avoided.

### Estimating Potential Future Cost Avoidance

Applying the reduced incidence and mortality numbers due to prevention to the full costing model developed for this project generates data for direct and indirect costs avoided. These are summarized in the following table and two charts.

The estimated costs of a *SunSmart* type skin cancer prevention program in Canada were estimated by converting the $0.28 AUS annual per capita expenditure in Victoria over the duration of *SunSmart* to an equivalent Canadian $ value ($0.271 CAN) and multiplying this per capita expenditure by the projected annual Canadian population (see Appendix C for details). Based on this assumption, the annual cost of a *SunSmart* type skin cancer prevention program in Canada would be $8.65 million in 2004, increasing to $10.65 million in 2031. The cumulative cost over the 28 year modelling period would be $269.8 million.

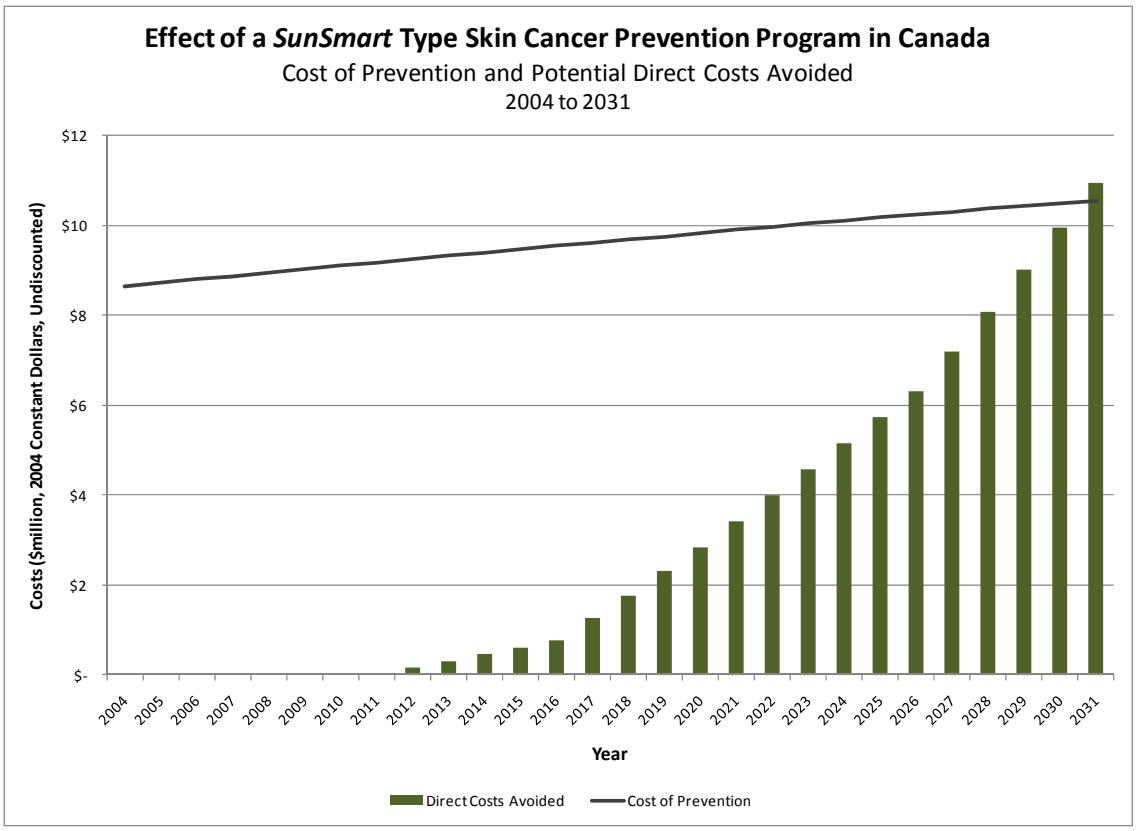
The following table provides a summary of the cases, deaths, and direct and indirect costs avoided due to the implementation of such a program. As noted in the model assumptions, no effect would be observed for melanoma until 9 years (2012) after the prevention program was initiated; this would increase to 15 years (to 2018) for NMSC. The direct and indirect costs avoided would also be delayed by 9 and 15 years respectively.

**Estimated Effect of a *SunSmart* Type Skin Cancer Prevention Program in Canada**
**2004 to 2031** (2004 Constant $, Undiscounted)

| | Calendar Year | | | | | | |
|---|---|---|---|---|---|---|---|
| | **2004** | **2011** | **2016** | **2021** | **2026** | **2031** | **28 Year Total** |
| **Cases Avoided** | | | | | | | |
| Melanoma | - | - | 206 | 773 | 1,364 | 2,111 | **18,047** |
| BCC | - | - | - | 545 | 1,626 | 2,996 | **19,843** |
| SCC | - | - | - | 15 | 43 | 117 | **641** |
| **Total** | **-** | **-** | **206** | **1,333** | **3,033** | **5,224** | **38,531** |
| **Deaths Avoided** | | | | | | | |
| Melanoma | - | - | 23 | 104 | 185 | 288 | **2,428** |
| PYLL Avoided | - | - | 952 | 3,369 | 5,805 | 8,485 | **76,872** |
| PYLL Avoided per Death | - | - | 40.5 | 32.4 | 31.3 | 29.4 | **31.7** |
| NMSC | - | - | - | - | 8 | 16 | **85** |
| PYLL Avoided | - | - | - | - | 287 | 450 | **2,839** |
| PYLL Avoided per Death | - | - | - | - | 37.4 | 28.8 | **33.3** |
| **Direct Costs Avoided ($millions)** | | | | | | | |
| Melanoma | | | $0.77 | $3.17 | $5.59 | $9.57 | **$75.91** |
| BCC | | | | $0.24 | $0.70 | $1.29 | **$8.55** |
| SCC | | | | $0.01 | $0.03 | $0.08 | **$0.41** |
| **Total** | | | **$0.77** | **$3.41** | **$6.32** | **$10.94** | **$84.88** |
| **Indirect Costs Avoided - Morbidity ($million)** | | | | | | | |
| Melanoma | | | $0.19 | $0.76 | $1.33 | $1.90 | **$17.06** |
| BCC | | | | $0.06 | $0.19 | $0.35 | **$2.29** |
| SCC | | | | | $0.01 | $0.02 | **$0.09** |
| **Sub-Total** | | | **$0.19** | **$0.82** | **$1.52** | **$2.26** | **$19.44** |
| **Indirect Costs Avoided - Mortality ($million)** | | | | | | | |
| Melanoma ($million) | | | $26.43 | $88.87 | $147.87 | $206.85 | **$1,936.41** |
| NMSC ($million) | | | | | $7.90 | $11.87 | **$75.08** |
| **Sub-Total** | | | **$26.43** | **$88.87** | **$155.77** | **$218.72** | **$2,011.49** |
| **Total Indirect Costs Avoided** | | | **$26.61** | **$89.69** | **$157.29** | **$220.98** | **$2,030.93** |
| **Direct Costs per Case Avoided** | | | | | | | |
| Melanoma | | | $3,715 | $4,100 | $4,100 | $4,534 | **$4,206** |
| BCC | | | | $431 | $431 | $431 | **$431** |
| SCC | | | | $662 | $646 | $644 | **$645** |
| **Indirect Costs Avoided - Mortality** | | | | | | | |
| $ per Melanoma Death | | | $1,124,667 | $855,341 | $798,439 | $717,853 | **$797,386** |
| $ per Melanoma PYLL | | | $27,772 | $26,376 | $25,473 | $24,378 | **$25,190** |
| $ per NMSC Death | | | | | $1,031,107 | $758,672 | **$881,089** |
| $ per NMSC PYLL | | | | | $27,534 | $26,370 | **$26,443** |

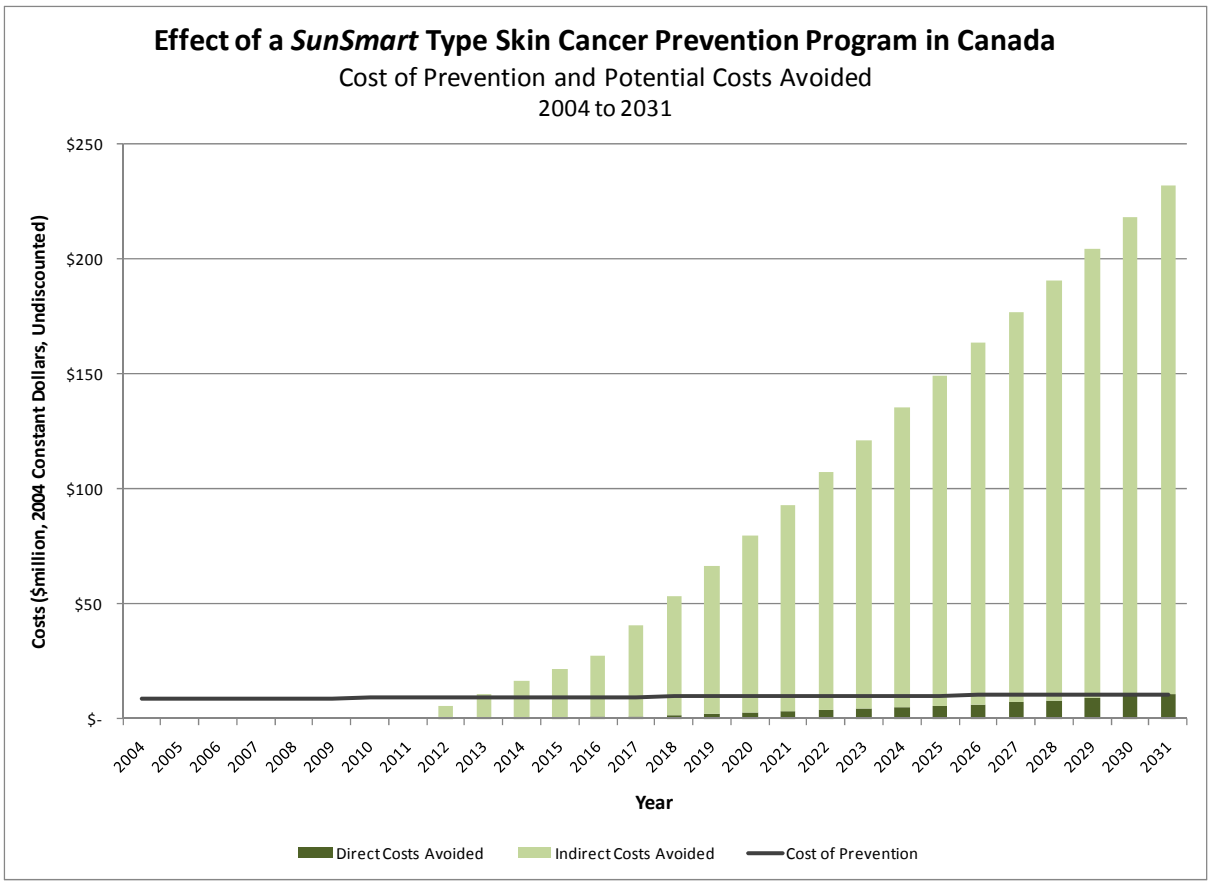
*PYLL = Potential Years of Life Lost*

Direct costs avoided during the 28 year period from 2004 to 2031 are estimated to be $85 million. On an annualized basis, avoided direct costs will surpass the cost of the program only by the end of the modelling period in 2031 (see following chart). The main reasons for the "delay" in an investment return that is, quite simply, that prevention takes time (that is, there is a lag time related to the biological effects of carcinogenesis, and in seeing the impact of such effects being reduced).




The effect on indirect costs avoided, however, shows a very different pattern (see following chart). The indirect mortality costs associated with any deaths among young individuals (each with multiple decades of life lost and the associated earning potential) create a disproportionately higher impact at an earlier point in the modelling. In the prevention model, for example, initial avoided melanoma deaths resulted in 40 potential years of life lost (PYLL) avoided, valued at $27,772 per year, for a total of $1.1 million per death. This total decreases over time as the longer-term prevention program leads to the reduction of deaths in older cohorts. By 2031, the PYLL avoided per death decreases to 29 PYLL avoided (note that this is still substantially higher than the average of about 20 PYLL per death estimated for all melanoma deaths in 2004), valued at $24,378 per year, for a total of $0.7 million per death.

Indeed, the annual costs for a comprehensive skin cancer prevention program launched in 2004 are exceeded by total costs avoided as early as 2013. Importantly, the same effect leads to *cumulative* prevention program costs of $270 million being exceeded by cumulative total costs avoided as early as 2020. The growing absolute number of skin cancers avoided year-over-year ultimately also plays a strong role in the generation of avoided total costs. Thus, in the last year of the modelling period, *the total costs avoided in that year alone almost match the cumulative prevention spending over 28 years* ($232 million versus $270 million). Total direct and indirect costs avoided during the 28 years modelling period are estimated to total $2.12 ***billion***, or 7.8 times the cost of prevention.




## Sensitivity Analysis

The sensitivity analysis detailed in Appendix F found that indirect costs are quite sensitive to the application of discount rates and whether or not lost "non-productive" time is given a value. As would be expected, the prevention modelling results are also highly sensitive to these two variables (see following table).

**Skin Cancer Prevention Program in Canada**
**Potential Costs Avoided** ($millions)
2004 to 2031, Sensitivity Analysis

| | Discount Rate 0% | 3% | 5% |
|---|---|---|---|
| ***Including*** Non-Workforce Participation Costs | | | |
| Direct | $ 84.9 | $ 84.9 | $ 84.9 |
| Indirect | $ 2,030.9 | $ 1,305.6 | $ 1,017.8 |
| **Total** | **$ 2,115.8** | **$ 1,390.5** | **$ 1,102.7** |
| ***Excluding*** Non-Workforce Participation Costs | | | |
| Direct | $ 84.9 | $ 84.9 | $ 84.9 |
| Indirect | $ 1,061.8 | $ 686.0 | $ 536.9 |
| **Total** | **$ 1,146.6** | **$ 770.9** | **$ 621.8** |

Over the 28-year period of the model (2004 to 2031), total costs avoided were estimated at $2.12 billion compared to the estimated cost of a prevention program of $270 million. If lost non-productive time is not given a monetary value (i.e. this would go against the recommendations for the modified human capital approach detailed in Appendix F) and a 5% discount rate is applied, then the total cumulative costs avoided over the 28-year time period would decrease to $622 million. While this is less than a third of the base case estimate, it is still 2.3 times the estimated cumulative cost of the prevention program.