Non-melanoma skin cancer in Australia: the 2002 national survey and trends since 1985

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ABSTRACT

Objectives: To measure the incidence of treated non-melanoma skin cancer (NMSC) in Australia in 2002 and investigate trends since 1985 by histological type, sex, age group, latitude and skin type.

Design: Face-to-face survey between 1 January and 31 December 2002 using stratified sampling of households to identify people treated for skin cancer in the previous 12 months. Self-reported diagnoses were confirmed with treatment providers. Data from similar surveys conducted in 1985, 1990 and 1995 were used to assess trends.

Setting: Whole of Australia (population 19.6 million).

Participants: Of 57 215 people interviewed, 4098 said they had been treated for skin cancer in the past year and 3198 gave permission for their diagnoses to be confirmed with their doctor.

Results: 817 people were confirmed as having at least one skin cancer treated in the past year. The age-standardised rate per 100 000 population for NMSC was 1170, for basal cell carcinoma (BCC) 884, and for squamous cell carcinoma (SCC) 387. The estimated number of NMSC cases in Australia for 2002 was 374 000. Cumulative risks to age 70 years of having at least one NMSC were 70% for men and 58% for women. Rates of BCC and SCC have increased since 1985, and the increases greatest for people aged 60 years and older; rates for those younger than 60 years have stabilised.

Conclusions: The incidence of treated NMSC in Australia in 2002 was more than five times the incidence of all other cancers combined. Although the overall NMSC rates have risen since 1985, the stabilisation of rates for people younger than 60 years who were exposed to skin cancer prevention programs in their youth highlights the importance of maintaining and strengthening these programs.

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Australia has the highest incidence of skin cancer in the world,[1,2] and non-melanoma skin cancer (NMSC) is the most commonly diagnosed cancer in Australia.[3] It is Australia's most expensive cancer, with more than $264 million (9% of the total costs for cancer) spent on diagnosis and treatment in 2000–01.[4]

Despite its frequency and cost implications, NMSC is not usually recorded by cancer registries in Australia. Incidence has been measured in defined communities at different locations across Australia,[5-9] and nationally using a series of household surveys conducted in 1985, 1990 and 1995.[2,10,11] These surveys showed increases in the incidence of both basal cell carcinoma (BCC) and squamous cell carcinoma (SCC) between 1985 and 1995, but the increases were not consistent across age groups.

This report presents the results of the fourth national survey, conducted in 2002, and an analysis of trends since 1985.

METHODS

The methods used were as in previous surveys.[2,10-12] Face-to-face interviews were conducted by a market research company throughout 2002 to identify people who had been treated for skin cancer. Respondents who had been treated in the previous 12 months were asked for permission to confirm their diagnosis with the treatment provider.

During February, all respondents were asked about the reaction of their skin when it was repeatedly exposed, without any protection, to bright sunlight in summer. Three skin type categories were used: "Skin tans deeply", "Skin tans moderately" and "Skin does not tan". For the remainder of the year, only people reporting treatment for skin cancer in the past 12 months were asked the skin reaction question.

Age- and sex-specific rates were calculated by latitude, skin type, country of birth, and income and education levels. People with both BCC and SCC were counted for one occurrence of each cancer in the rates for each histological type and once only for the NMSC rates. Rates were adjusted for diagnoses we could not confirm by assuming that the skin cancer rate in respondents whose diagnoses could not be confirmed was the same as in those whose diagnoses could be confirmed. The adjustment factor used was the inverse of the overall response rate. To enable international comparisons and comparisons with previous surveys, the rates were standardised to the world standard population.[1] For the analysis by latitude, Australia was divided into three zones at state borders that approximate the 29° S and 37° S parallels.

The body site distributions of BCC and SCC were compared using relative tumour density (RTD), calculated as the ratio of the proportion of tumours at a particular site to the proportion of total skin surface area of that site. The RTD adjusts the distribution of tumours at a site for its proportion of the total body surface area.[13]

Trends in rates were investigated by age, sex, latitude, and the sun sensitivity of the skin using data available from all four surveys. The number of cases was modelled as a Poisson random variable. Rate ratios (RRs) relative to rates in 1985 were estimated by age group, sex, latitude and skin type. The significance of trends in rates across the surveys was assessed from the significance of a continuous linear term for survey year in the model.

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1 Number of lesions and relative tumour density (RTD) at different body sites

	Basal cell carcinoma						Squamous cell carcinoma					
	Men		Women		Total		Men		Women		Total	
	n	RTD	*n*	RTD	*n*	RTD	*n*	RTD	*n*	RTD	*n*	RTD
Head and neck	281	5.84	196	5.75	477	5.81	120	5.55	52	3.72	172	4.82
Trunk	166	0.96	84	0.69	250	0.89	25	0.32	7	0.17	32	0.26
Upper limbs	61	0.60	62	0.87	123	0.70	60	1.3	63	1.94	123	1.55
Lower limbs	36	0.15	40	0.25	76	0.20	38	0.4	39	0.62	77	0.49

Approval for this study was obtained from the Human Research Ethics Committee of The Cancer Council Victoria.

RESULTS

2002 survey

Between 1 January and 31 December 2002, 57 215 people were interviewed across Australia and 10 378 (18%) reported having ever been treated for skin cancer. Of these 4098 (7% of interviewees) were treated in the previous 12 months and follow-up with the doctor was possible for 3139 (77%) of these. Responses from the doctor were received for 2502 (80% of requests), giving a response rate of 61% for access to confirmation of diagnosis for those reporting treatment within the previous 12 months. The factor of 1.64 (1/0.61) was used to adjust rates to allow for the non-response.

Clinical and demographic factors

The skin cancer diagnosis was confirmed clinically for 817 (33%) people; BCC for 612 people and SCC for 286. There were 30 people younger than 40 years with confirmed BCC, and one with SCC. Forty-six people had in-situ or invasive melanoma. All melanoma, 84% of SCC and 81% of BCC diagnoses were confirmed by histological examination. Multiple lesions within the 12-month period occurred in 27% of those with clinically confirmed diagnoses, and the proportion of people with multiple lesions was similar for males and females and for each histological type. Multiple BCCs were diagnosed in 27% with confirmed BCC and multiple SCCs in 25% with confirmed SCC.

The distribution of cancers by body site (Box 1) differed for BCC and SCC. Most lesions occurred on the head and neck and for each tumour type this site also had the greatest RTD. For BCC the trunk had the next highest number and RTD, while for SCC this was the upper limbs.

Incidence rates

Box 2 shows that incidence rises more steeply with age for SCC than for BCC. SCC rates were too low to measure accurately for people younger than 40 years, but the BCC rates were substantial for this age group. Rates of BCC were higher for women than men younger than 55 years, but above this age men had the higher rates. Rates of SCC were higher for men in all age groups 40 years or over. Based on these rates, we estimated that about 374 000 people, or about 1.8% of the total population of 19 662 800 people, were treated for NMSC in Australia during 2002. This compares with 88 398 cases of all other cancers combined.[14] The risk of being treated for any NMSC (either BCC or SCC) before the age of 70 years in Australia was 69% for men and 58% for women.

People who reported that their skin tanned deeply had lower rates for both types of NMSC than people whose skin did not tan. Rates increased steadily with a decreasing tendency of the skin to tan. The increase from lowest to highest rates was about 2–2.5 times for BCC and 3.5–3.6 times for SCC.

There was no regular trend in either BCC or SCC rates with level of education or other measures of socioeconomic status (data not shown).

Geography

A regular trend was observed from lowest rates in the south to highest rates in the north of Australia (Box 3).

Australian-born respondents accounted for around 70% of people surveyed, but more than 90% of all BCC and SCC cases (Box 3). For each skin cancer type, rates were lower for people born outside Australia.

2 Age-standardised rates per 100 000 (95% CI) by tumour type from the 2002 survey

	Basal cell carcinoma			Squamous cell carcinoma			Non-melanoma skin cancer		
	Men	Women	Total	Men	Women	Total	Men	Women	Total
Age (years)									
< 40	157	244	203	0	13	7	157	257	210
40–49	1074	1316	1208	537	322	419	1432	1580	1513
50–59	2595	2067	2309	1455	734	1065	3656	2768	3175
60–69	4876	2510	3644	2097	1400	1734	6292	3717	4951
⩾ 70	7051	3880	5308	3979	2146	2972	9519	5490	7305
Age-standardised rate (world standard)	1041	745	884	499	291	387	1375	991	1170
(95% CI)	(936–1158)	(662–839)	(816–957)	(430–580)	(242–349)	(344–434)	(1254–1507)	(895–1098)	(1092–1253)
Age-standardised rate (Australian standard)	1541	1070	1288	772	442	593	2051	1436	1719
(95% CI)	(1385–1713)	(950–1205)	(1190–1394)	(665–897)	(368–531)	(528–666)	(1871–2249)	(1296–1590)	(1606–1841)
Estimated number of cases Australia-wide	144 000	112 000	256 000	71 000	47 000	118 000	215 000	159 000	374 000
Risk to age 70 (2002)	59%	48%	54%	34%	22%	28%	69%	58%	64%

Trends between 1985 and 2002

In each survey, the age-standardised rates were higher for BCC than for SCC (Box 4), and, within each cancer type, the rates were higher for men than for women. There were overall rate increases between 1985 and 2002. These increases varied by age (Box 5). There was no significant increase in BCC rates in any age group under 60 years, but the rates increased in those aged 60 years and older. For SCC, there was no significant increase at ages younger than 50 years, but rates in those aged 50 years and older increased. The older age groups accounted for most skin cancers diagnosed. All further trend analyses were carried out after dichotomising age into two groups with a cut-point at 60 years.

Trends by latitude

The latitudinal gradient, with higher rates in the north, was evident in each survey and for each cancer and the trends by latitude were consistent with the overall rate trends for the two age groups. All latitudes showed strong increasing trends in the rate of BCC for those aged 60 years and older, but not for the younger age group (Box 5). SCC rates also increased significantly for the older age group at all latitudes, with no trend in the younger age group.

Trends by skin type

In each survey, BCC and SCC rates were highest for non-tanners and lowest for deep tanners, but the time trends by skin type differed from the overall trends (Box 5). For BCC, an increasing trend was seen for deep tanners in both age groups, but not for non-tanners or moderate tanners. For SCC, the rates increased across the surveys for all skin types for people aged 60 years and older. In people younger than 60 years, an increase was seen only in the non-tanner group.

3 Confirmed cases and age-standardised rates per 100 000 (95% CI) by tumour type, latitude, region of birth and skin type from the 2002 survey

	Basal cell carcinoma			Squamous cell carcinoma		
	Men	Women	Total	Men	Women	Total
Latitude						
North region (< 29°S)	2145 (1778–2588)	1259 (1004–1579)	1662 (1439–1921)	1240 (961–1601)	429 (285–645)	794 (639–985)
Central (29°S–37°S)	1088 (935–1265)	843 (718–990)	959 (859–1071)	473 (380–588)	400 (318–503)	432 (368–506)
South (> 37°S)	646 (505–827)	462 (349–614)	547 (454–659)	306 (217–433)	171 (109–267)	232 (177–306)
Skin type						
Tans deeply	685 (529–889)	484 (340–688)	585 (475–721)	268 (178–403)	132 (71–245)	215 (153–303)
Tans moderately	935 (796–1098)	558 (458–679)	722 (637–818)	406 (321–514)	252 (189–335)	319 (266–382)
Does not tan	1406 (1092–1811)	1217 (993–1491)	1271 (1085–1489)	965 (339–629)	462 (715–1301)	611 (493–758)
Region of birth						
Australia	1367 (1218–1535)	913 (803–1038)	1113 (1021–1213)	704 (600–826)	412 (340–498)	541 (479–611)
All other than Australia	614 (469–803)	462 (337–632)	541 (441–663)	207 (134–322)	95 (50–183)	152 (106–219)
United Kingdom	758 (527–1091)	648 (434–966)	703 (537–920)	Insufficient data *		
Southern Europe	470 (152–1457)	350 (88–1401)	385 (160–925)	Insufficient data *		

*There were too few cases of squamous cell carcinoma in overseas-born participants to estimate separate rates for countries other than Australia, thus a rate for all other countries combined has been reported. ◆

DISCUSSION

In 2002, almost 2% of the whole population, 4% of those ⩾ 40 years and 8% of those ⩾ 70 years were treated for NMSC.

The highest age-standardised rates reported for NMSC outside Australia were almost an order of magnitude lower (men in Ireland 146.3; women in Graubünden, Switzerland, 102.7).[1]

Sun exposure (particularly during childhood), fair skin and poor tanning ability are established risk factors for skin cancer.[15-17] The strong inverse association with latitude, the higher rates for Australian-born people and for people whose skin does not tan, all highlight the role of sun exposure in skin cancer risk.

Despite overall increases in the age-standardised rates of both BCC and SCC between 1985 and 2002, it is encouraging that the BCC rates for people younger than 60 years showed no substantial increase. The major determinant of lifetime potential for skin cancer is sun exposure in childhood and adolescence,[18] although adult sun exposure also plays a role.[19-21] Skin cancer prevention programs stressing moderation of sun exposure began about 35 years ago and were prominent in Australia from about 1980.[22,23] Adults older than 60 years in 2002 were then 20 years old in 1962, and educational programs would not have affected their adolescent exposure. The stabilisation of BCC rates at ages less than 60 years is consistent with educational programs from the 1960s reducing childhood and teenage sun exposures, with or without changes in adult exposures. For SCC, a similar benefit in younger people may exist, but the numbers of cases surveyed in this age group were small. The trends in NMSC rates as younger people age into the high skin cancer risk age groups will also provide clearer evidence of the long-term effect of sun protection programs on skin cancer outcomes.

The relative increases in SCC rates between 1985 and 2002 were greater than those seen for BCC. Studies in other countries over similar periods have not found this difference[24-28] and several have reported declining SCC rates.[25,27] Cumulative sun exposure, such as might be acquired by fair skinned populations living in areas close to the equator, is associated with an increased risk of SCC. The fairer skinned populations in those studies lived further from the equator than Australia, while the studies reporting declining SCC rates were either predominantly Asian or had a substantial Hispanic population, which may account for some of the discrepancies.

There was no evidence that higher rates in the lower latitudes were approaching a plateau, as the magnitudes of the rate ratios were

similar for each latitudinal zone. The caveat here is that the rates by latitude are based on the region of current residence, rather than where the respondent lived during childhood.

There is no simple method for monitoring the incidence of NMSC. For other cancers, Australia-wide population-based registries collate pathological and demographic data. To apply this technique to all NMSC is logistically impossible and would not account for skin cancers treated without pathological confirmation. The survey method we used was developed to overcome this lack of cancer registry data and to provide a reasonable estimate of the incidence of treated NMSC.

4 Age-standardised rates per 100 000 (95% CI) by tumour type

	1985	1990	1995	2002
Basal cell carcinoma				
Men	735 (623–847)	849 (767–931)	955 (879–1034)	1041 (936–1158)
Women	593 (491–694)	605 (537–674)	629 (568–696)	745 (662–839)
All people	657 (585–729)	726 (673–780)	788 (739–840)	884 (816–957)
Squamous cell carcinoma				
Men	209 (149–268)	338 (287–389)	419 (372–473)	499 (430–580)
Women	122 (75–169)	164 (139–199)	228 (193–268)	291 (242–349)
All people	166 (128–204)	250 (220–281)	321 (292–354)	387 (344–434)

In the 2002 survey, about a quarter of people with confirmed NMSC had more than one skin cancer treated in the 12-month period. Multiple primary NMSCs are common, and up to 40% of patients could develop a second NMSC within 2 years.[29-32] We counted people treated for confirmed skin cancers during a 12-month period, irrespective of whether they had skin cancer diagnosed in previous years. This differs from cancer registry reports of cancer incidence, which are based on the first ever occurrence of a primary cancer at a particular site.

Our survey method has several drawbacks. It relies on self-reported treatment for skin cancer and verification of those reports by the treatment provider. Most respondents reported no skin cancer, and we could not verify the accuracy of these negative reports. Diagnoses could not be verified if permission

5 Trends in non-melanoma skin cancer frequency by sex, age, area of residence, and skin type

	Basal cell carcinoma						Squamous cell carcinoma					
	Rate ratio relative to 1985				Rates per 100 000		Rate ratio relative to 1985				Rates per 100 000	
	1990 (*n* = 456)	1995 (*n* = 589)	2002 (*n* = 612)	*P* for trend	1985	2002	1990 (*n* = 1660)	1995 (*n* = 258)	2002 (*n* = 2860)	*P* for trend	1985	2002
All people	1.02	1.18	1.25	< 0.0005	657	884	1.41	1.90	2.12	< 0.0005	166	387
Male	1.03	1.23	1.22	0.014	735	1041	1.52	2.02	2.08	< 0.0005	209	499
Female	1.01	1.14	1.33	0.002	593	745	1.23	1.81	2.3	< 0.0005	122	291
Age < 40 years	1.15	1.19	1.06	0.937	174	203	—	—	—	—	0	7
Age 40–49 years	1.05	0.88	1.10	0.722	966	1208	0.91	0.75	1.53	0.105	258	419
Age 50–59 years	0.83	0.96	0.93	0.871	1916	2309	1.51	1.79	2.08	0.021	399	1065
Age 60–69 years	1.02	1.22	1.66	< 0.0005	2571	3644	1.31	1.80	2.31	< 0.0005	886	1734
Age ⩾ 70 years	1.11	1.51	1.45	< 0.0005	3279	5308	1.73	2.77	2.72	< 0.0005	1004	2972
Age < 60 years												
All < 60 (age adjusted)	0.97	0.98	1.02	0.752	572	878	1.29	1.43	1.86	0.005	105	324
North region	1.13	1.09	1.32	0.177	932	1665	1.27	1.32	1.69	0.176	224	561
Central region	0.89	0.92	0.84	0.332	665	812	1.24	1.17	1.49	0.204	129	302
South region	1.10	0.96	1.10	0.871	215	378	—	—	—	—	0	171
Non-tanners	0.85	0.88	1.00	0.675	1231	1445	1.91	2.13	3.1	0.017	159	587
Moderate tanners	1.07	0.98	0.94	0.494	507	680	1.53	1.53	1.66	0.283	88	235
Deep tanners	0.93	0.81	1.82	0.020	221	513	0.54	0.68	0.93	0.743	98	121
Age ⩾ 60 years												
All ⩾ 60 (age adjusted)	1.07	1.37	1.51	< 0.0005	2853	4519	1.48	2.18	2.37	< 0.0005	933	2385
North region	1.29	1.74	1.84	0.002	3613	7631	1.39	2.03	2.43	0.002	1506	5335
Central region	1.12	1.23	1.44	0.003	3139	5255	1.73	2.30	2.34	< 0.0005	997	1836
South region	0.73	1.38	1.47	0.003	1853	3432	0.84	2.21	2.6	0.001	463	162
Non-tanners	1.63	1.76	1.80	0.054	2691	5648	1.60	1.81	2.08	0.024	1480	3617
Moderate tanners	0.96	1.11	0.95	0.818	3471	3863	1.68	2.27	2.2	0.009	792	2076
Deep tanners	0.82	0.76	1.51	0.019	1975	3302	2.46	2.93	4.17	0.004	329	1529

to contact the doctor was not given, or if the doctor did not respond to our enquiries. A high proportion of the doctors replied to our requests for confirmation, but only 33% of the self-reported skin cancers were confirmed. The main reasons for this were that many people reporting skin cancer had been diagnosed more than 12 months ago, or had had benign lesions other than skin cancer treated.

We have assumed that the skin cancer rate for respondents whose information we could not access was the same as for those we could, but cannot check the validity of this assumption. The methods were the same as in earlier surveys, and the proportion of unconfirmed reports was similar in all surveys (varying between 32% and 39%) and should not affect the trends.

A strength of our survey is that lesions treated with destructive techniques or topical agents such as imiquimod, but not histologically confirmed, would be counted. Standard cancer registry methods that depend on histological confirmation would not include these skin cancers.

This survey has documented the highest rates of a cancer in a whole population that have ever been recorded, and the high and increasing skin cancer rates highlight the importance of continuing to monitor their incidence. The stabilisation of NMSC rates, particularly for BCC, in people exposed to skin cancer prevention programs in their youth suggests that these programs have played a role, but the overall increases in NMSC rates seen since 1985 highlight the importance of maintaining and strengthening these initiatives for fair-skinned people.

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COMPETING INTERESTS

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