



The Epidemiology of Malignant Melanoma, Squamous Cell Carcinoma, and Basal Cell Carcinoma in the United Kingdom from 2004-2014: A Population-Based Cohort Analysis using the Clinical Practice Research Datalink

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3 *To the editor:*
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6 Skin cancers, including malignant melanoma and keratinocyte skin cancers, are the
7 most common malignancy in the United Kingdom (UK), and global incidence is increasing
8 rapidly¹. While malignant melanoma (MM) accounts for most skin cancer deaths, keratinocyte
9 skin cancers, squamous cell carcinoma (SCC) and basal cell carcinoma (BCC), comprise up to
10 95% of skin cancer cases in the UK^{2,3}. Studies on trends in MM incidence and survival have
11 been conducted using Scottish, Northern Irish, and English and Welsh data⁴. Data for
12 keratinocyte skin cancers has historically been unreliable and under-reported due to the United
13 Kingdom and Ireland Association of Cancer Registries rule to only report the first SCC or BCC
14 per patient when a substantial proportion of patients develop multiple tumours. For the few
15 studies on SCC and/or BCC, trends are geographically limited in scope to a particular region or,
16 when considering the whole of the UK, report trends from a limited time period^{5,6}. In 2013,
17 changes in England's national cancer registry resulted in nationalized and automated SCC and
18 BCC registration. While this has improved reporting of keratinocyte skin cancer incidence in
19 England and will allow tracking and analysis of future trends, knowledge of epidemiologic trends
20 in SCC and BCC before this time, and reporting for the rest of the UK, remain inconsistent.
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30 The primary care Clinical Practice Research Datalink (CPRD) provides the opportunity to
31 characterize the trends of both MM and keratinocyte skin cancers as well as their primary care
32 burden prior to 2013. Here we describe epidemiologic trends of MM, SCC and BCC over a ten-
33 year period (2004-2014) using CPRD GOLD data (Independent Scientific Advisory Committee
34 protocol number 16_136). CPRD collects de-identified patient data from a network of GP
35 practices across the UK. Primary care data are linked to a range of other health related data to
36 provide a longitudinal, representative UK population health dataset. The data encompass 50
37 million patients, including 14 million currently registered patients. Additional methods and results
38 are available upon direct request.
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45 In our cohort there were 12057, 17614, and 80854 patients in the whole of the UK living
46 with MM, SCC, or BCC respectively. The prevalence of MM was 0.3%, SCC was 0.4% and BCC
47 was highest at 1.8%. Over the 10-year study period there was a 36% increase in the age-
48 adjusted incidence MM, a 34% increase in SCC, and a 21% increase of BCC. Sex-stratified
49 incidence per 100,000 PY age-adjusted (standard error) for 2004 then 2014 was: for MM, 15.8
50 (0.9) to 26.4 (1.0) for men and 22.4 (1.1) to 25.5 (1.0) for women; for SCC, 48.2 (1.4) to 66.0
51 (1.6) for men and 25.4 (1.2) to 32.6 (1.2) for women; and for BCC, 161.2 (2.6) to 201.1 (2.7) for
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3 men and 124.0 (2.5) to 143.8 (2.5) for women. A logistic regression model, with mixed random-
4 effects parameters for patient ID and practice, demonstrated, for the keratinocyte skin cancers,
5 older patient age, male patient sex, and more recent year of diagnosis was associated with an
6 incident case. In comparison to England, patients in Wales were more likely, and those in
7 Scotland or Northern Ireland were less likely, to be diagnosed with a new BCC, whereas the
8 opposite was true for SCC. For MM, younger patient age, female patient sex, and more recent
9 year of diagnosis were associated with an incident case; patients in Wales were less likely to
10 have a new MM diagnosis compared to those in England. Amongst patients for whom Office of
11 National Statistics death registration data were available, all-cause mortality rates were 3.63
12 deaths/1,000 person-years for MM, highest for SCC with 7.02 deaths/1,000 person-years, and
13 3.04 deaths/1,000 person-years for BCC. Across all cancers, all-cause mortality was associated
14 with older patient age and male patient sex, as well as socioeconomic index.
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25 Currently, there are few UK reports comparing the prevalence of all skin cancers prior to
26 2014. This study therefore provides novel data, which are likely to be representative of the UK
27 as a whole, and provide a comparison for MM, SCC and BCC. Using the newly available data
28 on keratinocyte skin cancers in England's cancer registry, Venables *et al*⁷ describe that in 2013-
29 2015 the SCC incidence was 77.3 per 100,000 person-years in men and 34.1 per 100,000
30 person year in women. Our data supplements this work to suggest a true ongoing trend of
31 increased cases of not only SCC, but also BCC and MM in England as well as the entire UK. A
32 limitation of our study is that there is likely an underestimation of true tumour incidence; we
33 attempted to attenuate this by including multiple primaries, defined as the reappearance of a
34 skin cancer medcode after a three-year lapse. We describe incidence of MM and keratinocyte
35 skin cancers, as well as outline the potential role of patient age, sex, and higher socioeconomic
36 index on outcomes. Furthermore, our work suggests that current trends in incidence in other
37 countries which do not include keratinocyte skin cancers in central cancer registries may also be
38 assessed by similar general practice records, including the Veterans Health Project in the
39 United States and the Electronic Medical Record Administrative Linked Database (EMRALD)
40 and Canadian Primary Care Sentinel Surveillance Network (CPCSSN) in Canada.
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Table 1. Stratified incidence and mortality model for basal cell carcinoma (BCC), squamous cell carcinoma (SCC), and malignant melanoma (MM) in the UK (2004-2014) using the European Standard Population in 5-year age categories.

Sex, Region, and Age- Stratified Incidence, 2004-2014		BCC										SCC										MM									
		M					F					M					F					M					F				
		0-19	20-39	40-59	60-79	80+	0-19	20-49	50-69	70-89	90+	0-19	20-49	50-69	70-89	90+	0-19	20-49	50-69	70-89	90+	0-19	20-49	50-69	70-89	90+	0-19	20-49	50-69	70-89	90+
Per 100,000 PY (Standard Error)	England	0.2 (0.06)	10.4 (0.4)	90.2 (1.2)	452.9 (3.3)	1001.2 (10.8)	0.3 (0.07)	14.1 (0.5)	99.6 (1.3)	332.9 (2.8)	588.4 (6.3)	0.1 (0.05)	1.3 (0.1)	17.1 (0.5)	127.1 (1.8)	467.5 (7.4)	0.1 (0.05)	2.0 (0.2)	12.1 (0.4)	64.7 (1.2)	221.8 (3.8)	1.6 (0.2)	7.4 (0.4)	20.0 (0.6)	47.7 (1.1)	79.7 (3.1)	1.8 (0.2)	16.3 (0.5)	27.5 (0.7)	40.1 (1.0)	48.1 (1.8)
	Wales	0.0 (0.0)	1.0 (0.4)	22.6 (1.8)	158.4 (5.5)	615.7 (24.8)	0.2 (0.2)	2.5 (0.6)	15.0 (1.4)	74.4 (3.7)	273.4 (12.4)	0.5 (0.3)	12.9 (1.4)	125.2 (4.1)	626.7 (11.0)	1316.4 (36.3)	0.4 (0.3)	14.8 (1.5)	127.2 (4.2)	423.5 (8.7)	717.9 (201)	2.1 (0.5)	6.2 (1.0)	19.3 (1.6)	50.9 (3.1)	88.1 (9.4)	1.7 (0.5)	16.7 (1.6)	24.6 (1.9)	37.6 (2.6)	45.6 (5.0)
	Scotland	0.2 (0.2)	8.2 (1.1)	72.4 (3.0)	358.9 (8.8)	909.3 (34.7)	0.3 (0.2)	10.0 (1.2)	71.1 (3.0)	252.8 (7.0)	538.0 (19.4)	0.0 (0.0)	1.4 (0.4)	15.6 (1.4)	120.1 (5.1)	460.6 (24.7)	0.0 (0.0)	1.6 (0.5)	8.2 (1.0)	56.4 (3.3)	216.0 (12.3)	1.1 (0.4)	5.9 (0.9)	16.6 (1.4)	41.9 (3.0)	83.4 (10.5)	1.9 (0.6)	14.4 (1.4)	20.9 (1.6)	31.8 (2.5)	52.9 (6.1)
	Northern Ireland	1.3 (0.8)	9.0 (1.9)	94.6 (6.1)	481.7 (18.0)	1121.9 (66.7)	0.5 (0.5)	9.9 (2.0)	83.5 (5.7)	316.9 (13.8)	654.4 (36.4)	0.0 (0.0)	2.4 (1.0)	30.1 (3.4)	206.1 (11.7)	757.3 (54.8)	0.0 (0.0)	4.9 (1.4)	18.9 (2.7)	99.7 (7.7)	405.2 (28.7)	2.7 (1.1)	10.2 (2.0)	16.4 (2.5)	57.5 (6.2)	87.2 (18.6)	1.9 (0.9)	24.6 (3.2)	33.5 (3.6)	40.6 (4.9)	66.9 (11.6)
Mortality Model† Coefficient (95% CI)	Age (Year-on- Year)	1.137 (1.133, 1.140)										1.068 (1.065, 1.072)										1.079 (1.074, 1.084)									
	Gender (Female)	0.667 (0.636, 0.699)										0.859 (0.799, 0.924)										0.629 (0.561, 0.704)									
	Index of Multiple Deprivation (Increasing Deprivation Twentiles)	1.040 (1.035, 1.045)										1.045 (1.037, 1.053)										1.033 (1.021, 1.044)									

† Values in the mortality model are represented as odds ratios.