Trends in keratinocyte cancers in England, 2013–2022: basal cell carcinoma incidence, cutaneous squamous cell carcinoma incidence, and non-melanoma skin cancer mortality

Running head: Keratinocyte cancer trends in England 2013-2022

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Data availability: The raw data that support the findings of this study are available upon successful application and establishment of a paid Data Sharing Agreement with the Data Access Request Service (NHS England Digital).

Ethics statement: Data for this study were collected and analysed under the National Disease Registries Directions 2021, made in accordance with sections 254(1) and 254(6) of the 2012 Health and Social Care Act. Further ethical approval for this study was not required as per the definition of research according to the UK Policy Framework for Health and Social Care Research.

Patient consent: Not applicable.

What is already known about this topic?

- Keratinocyte cancers (KCs) are the most common malignancies in White populations, and the incidence of basal cell carcinoma (BCC) and cutaneous squamous cell carcinoma (CSCC) is increasing worldwide.
- KCs are substantially underreported, and robust long-term data on patient demographics, incidence, and mortality trends remain limited.

What does this study add?

- Age standardised incidence rates of CSCC continue to increase whereas recorded BCC incidence has stabilised since 2015.

- Mortality from non-melanoma skin cancer is rising in England, particularly in males.
- These findings highlight the growing burden of CSCC and reinforce the importance of effective skin cancer prevention strategies and treatment.

Abstract

Background: Basal cell carcinoma (BCC) and cutaneous squamous cell carcinoma (CSCC), collectively termed keratinocyte cancers (KCs), are the most common cancers in White populations, and their incidence is increasing globally. KCs are substantially underreported, and high-quality long-term data on patient demographics, incidence, and mortality trends remain limited.

Objectives: To describe the characteristics of patients with KCs and to assess incidence and mortality trends in England between 2013 and 2022.

Methods: We analysed all new KCs diagnosed in England from 2013 to 2022 using data from the National Disease Registration Service. Tumours were counted using per patient per annum (PPPA) methodology, whereby each individual could contribute one BCC and one CSCC per year. Age-standardised incidence rates (EASRs) and age-standardised mortality rates (ASMRs) were calculated using the 2013 European Standard Population, while age-specific incidence rates (ASIRs) were calculated using Office for National Statistics mid-year population estimates for the corresponding age group. Joinpoint regression was used to calculate annual percentage change (APC) and assess trends in EASRs, ASIRs, and ASMRs by gender and age per 100,000 person-years (PYs).

Results: Compared with the first-all-time registration method, the PPPA approach identified 67% more BCCs and 42% more CSCCs over the study period. In 2022, PPPA EASRs were 295 PYs for BCC and 102 PYs for CSCC. BCC EASRs increased initially before stabilising from 2015 (APC −0.2% (95% CI −0.8-0.3)). In contrast, CSCC EASRs increased rapidly from 2013 to 2015 (from 79 to 89; APC 6.1%) and continued to increase between 2015 and 2019 (from 89 to 97; APC 2.3%). NMSC ASMR increased significantly from 2013 (APC 4.0% (95% CI. 2.5-5.7)), with rates rising approximately twice as fast in males (APC 4.4% (95% CI 2.4-7.1)) compared to females (APC 2.2 (95% CI 0.3-4.6)). For CSCC, ASIRs plateaued in middle age groups from 2015 onwards but continued to increase in younger (<60 years) and older (≥80 years) individuals.

Conclusions: These findings highlight the importance of accurate tumour counting methods for healthcare planning. CSCC incidence continues to rise alongside increasing NMSC mortality, underscoring the need for strengthened prevention strategies, early diagnosis, and timely access to quality healthcare.

Introduction

Nonmelanoma skin cancer (NMSC) encompasses basal cell carcinoma (BCC), cutaneous squamous cell carcinoma (CSCC), and less common malignancies such as Merkel cell carcinoma (MCC). BCC and CSCC are collectively termed keratinocyte cancers (KCs) and represent the vast majority of NMSC diagnoses.

BCC and CSCC are the first and second most common cancers in White populations worldwide.[1,2] By contrast with the global stabilising of age-standardised incidence rates (ASRs) of melanoma, particularly among younger adults, ASRs for KCs continue to rise.[1,3,4] This increasing burden has substantial implications for healthcare systems, as KCs account for a high volume of urgent referrals and procedural interventions.[2,5] In addition to healthcare costs, these cancers may be associated with significant cosmetic and functional morbidity.[2] Furthermore, if current trends observed in England, the United States, Australia, and Europe persist, crude mortality from NMSC, driven largely by CSCC, will soon exceed that of melanoma.[6,7]

Several important gaps remain in the epidemiology of KCs. First, many cancer registries have not routinely recorded KCs or have limited registration to a single BCC and single CSCC per patient, leading to systematic under-ascertainment, which limits the accuracy of incidence estimates.[8-11] Second, contemporary national datasets with long-term follow-up incorporating validated first per patient per annum (PPPA) methodology remain scarce.[9-11] Finally, there is limited high-quality, population-level evidence describing temporal trends in incidence and mortality.[8,12-14] Such data are essential for healthcare planning and resource allocation, as well as for informing targeted prevention strategies. Accordingly, using validated longitudinal PPPA data, this study aimed to characterise trends in the incidence and mortality of KCs in England.

Patients and Methods

Study design and cohort selection

This retrospective cohort study used cancer registry data from National Health Service (NHS) England's National Disease Registration Service (NDRS). Reporting of cancer pathology data to

the NDRS is mandatory for all NHS pathology laboratories and recommended for private laboratories. Pathology reports are integrated with additional data sources, including the Patient Administration System (PAS) and the Cancer Outcomes and Services Dataset (COSD) provided by multidisciplinary team meetings, to generate comprehensive cancer registration records. These records can be linked to external datasets, including Office for National Statistics (ONS) mortality data and Hospital Episode Statistics (HES). NDRS data are considered the gold standard for population-level cancer surveillance in England. Data were extracted from the NDRS 'Get Data Out' (GDO) and 'Cancer incidence and mortality' programmes for KCs diagnosed from 1 January 2013 to 31 December 2022. These study periods were selected based on established data completeness and quality assurance within the registry.

BCCs and CSCCs were identified using International Classification of Diseases, Tenth Revision (ICD-10) site codes and International Classification of Diseases for Oncology, Third Edition (ICD-O-3) morphology and behaviour codes (Table S1). In England, prior to 2013, only the first BCC or CSCC per patient was recorded due to complexities in accurately registering multiple pathology reports.[9] In 2013, a revised PPPA methodology was introduced, whereby each patient may contribute one BCC and one CSCC per year, enabling more robust estimation of overall tumour burden.[9] Tumours were categorised as either 'first-ever' or 'subsequent' diagnoses with a look-back period to 1 January 1995, consistent with previously published methodology.[9] Unless otherwise specified, all incidence counts and rates are reported using the PPPA definition. Mortality data were reported using World Health Organisation (WHO) ICD-10 codes only and so can only be reported as NMSC overall. NMSC-specific mortality was defined as deaths for which the underlying cause of death recorded on the death certificate was ICD-10 C44.

Patient demographics included age at diagnosis, gender, self-reported ethnicity, tumour body site, geographic region, and deprivation quintile. Definitions of these variables are detailed in Table S2. Tumour site was categorised as head and neck (scalp and neck, ear, eyelid, lip, and face), limbs (upper and lower limbs), trunk, or unknown, and was analysed stratified by age and gender. The study adhered to the REporting of studies Conducted using Observational Routinely-collected health Data (RECORD) guidelines (Appendix 1).

Statistical analyses

All analyses were prespecified, and the study protocol was published online. (https://www.nottingham.ac.uk/research/groups/cebd/resources/protocol-registration.aspx). Patient demographics were summarised descriptively, with subgroup analyses performed where appropriate.

European age-standardised incidence rates (EASRs) were calculated using the European Standard Population 2013, and 95% confidence intervals (CIs) were calculated using Byar's approximation method.[15] EASRs could not be calculated by deprivation quintile, as KC counts were not available stratified simultaneously by deprivation and five-year age bands, therefore only crude incidence rates are reported. Regional variation in incidence was assessed using EASRs in 2022. Age-specific incidence rates (ASIRs) were calculated using ONS mid-year population estimates for the corresponding age group.[16] Temporal trends in incidence and disease-specific mortality were assessed using Joinpoint regression (Joinpoint Regression Program version 5.2.0.0, National Cancer Institute). Joinpoint regression identifies time points at which significant changes in trend occur, allowing rates to be modelled as a series of connected linear segments with differing slopes. Models were used to estimate annual percentage change (APC) in EASRs, ASIRs and age-standardised mortality rates (ASMRs), with stratified analyses by age and gender. The number of joinpoints was determined using the software's model selection criteria, with a maximum of four joinpoints permitted. Primary analyses of temporal trends were restricted to the pre-pandemic period (2013–2019) due to known disruption to cancer diagnosis during COVID-19. Data from 2020 onwards are presented to illustrate the impact of the pandemic and subsequent recovery but are interpreted with caution, and were not the focus of this study, as this has been described previously.[17,18] Five-year age bands with small counts were combined into broader, clinically relevant and similarly sized groups for statistical analyses.

Comparisons of proportions were performed using the χ^2 test. A two-sided P value <0.05 was considered statistically significant. All analyses were conducted using R version 4.3.2 (R Foundation for Statistical Computing, Vienna, Austria).

Survival time was calculated from the date of first-ever registered CSCC diagnosis among patients diagnosed in England between 2013 and 2020. Patients were censored at death, loss to follow-up (including emigration or absence of updated NHS records) or the study end date (17 May 2026) to enable estimation of 5-year net survival. In contrast, mortality analyses were based on annual population-level deaths registered in England between 2013-2022 because complete national mortality data were only available for these calendar years at the time of analysis. Age-standardised net survival (NS) at 1-, 3-, and 5-years was estimated using the Pohar Perme estimator, comparing observed survival among patients with CSCC to expected survival derived from life tables matched by single year of age, gender, deprivation, and geographic region. Due to the low frequency of death, NS estimates for BCC were not calculated however, population-based studies consistently report values exceeding 100%.[19,20]

Results

Demographics of patients with keratinocyte cancer

Patients with BCC and CSCC (PPPA) were more commonly male, with a male:female ratio of 1.3:1 and 2:1, respectively (Table 1). Subsequent tumours were more frequent in males than females for both BCC (62.1% vs 37.9%, χ^2 $p < 0.0001$) and CSCC (73.4% vs 26.6%, χ^2 $p < 0.0001$).

Median age at diagnosis (PPPA) was approximately 74 years (IQR 64–82) for BCC and 80 years (IQR 72–86) for CSCC. The median age at diagnosis of first-ever KC was 72 years (IQR 62–80) for BCC and 80 years (IQR 72–86) for CSCC. Fewer than 1% of patients with known ethnicity self-reported as non-White for KC.

In 2022, PPPA EASRs for BCC were highest in Southwest England (355 per 100,000 person-years (PYs)), and lowest in London (203 PYs) (Figure 1a). Similarly, for CSCC, EASRs were highest in Southwest England (136 PYs) and lowest in London (69 PYs) (Figure 1b).

Incidence of keratinocyte cancers

Using the PPPA method, BCC counts increased from 129,117 in 2013 to 158,226 in 2022 representing an increase of 23% (Table S3). By comparison, cSCC PPPA counts increased from 33,597 in 2013 to 51,376 in 2022, equivalent to a 53% increase. Compared with the first-all-time registration method, the PPPA approach identified 67% more BCCs and 42% more CSCCs over the study period.

In 2022, PPPA EASRs were 295 PYs (95% CI 294–297) for BCC and 102 PYs (95% CI 101–103) for CSCC. For BCC, EASRs increased from 277 PYs in 2013 by an average of 6.1% (95% CI 4.4–7.4) per year to 309 PYs in 2015, after which trends stabilised, with a non-significant change of −0.2% (95% CI −0.8-0.3) per year between 2015 and 2019 (Figure 2a). Similar patterns were observed in both genders. When including post-pandemic data, EASRs remained stable overall between 2013 and 2022 (APC -0.9%, 95% CI -2.9-1.3) (Figure S1a).

For CSCC, EASRs increased from 79 PYs in 2013 by an average of 6.1% (95% CI 5.8–6.4) per year to 89 PYs in 2015, after which trends decelerated but continued to increase at 2.3% (95% CI 2.1–2.4) per year between 2015 and 2019 (Figure 2b). Similar patterns were observed in both genders. When including post-pandemic data, EASRs increased between 2013 and 2022 (APC 2.4%, 95% CI 1.6–3.2) (Figure S1b).

Incidence of keratinocyte cancers by age groups

ASIRs for BCC (PPPA) increased across most age groups in both genders between 2013 and 2015, after which rates largely stabilised (Figure 2c, 2d). When post-pandemic data were included, this overall pattern of stability persisted across most age groups (Figure S1c, S1d).

For CSCC, ASIRs rose across all age groups in both genders between 2013 and 2015. Thereafter, trends diverged, rates plateaued in middle age groups, while continuing to increase in younger (<60 years) and older (≥80 years) individuals. This pattern was broadly consistent between males and females (Figure 2e, 2f). When post-pandemic data were included, early increases were again observed across most groups, followed by stabilisation in several age bands, with continued rises to 2022 primarily in younger and older individuals (Figure S1e, S1f).

Body site of keratinocyte cancers in England

The most common site for first-ever registered BCC and CSCC was the face (39.3% and 27.7%, respectively) (Table 1). For both tumour types, there was a clear age-related shift in anatomical distribution. Older patients were more likely to develop first-ever tumours on the head and neck, whereas younger patients more commonly presented with lesions on the trunk; these differences were statistically significant for both genders (all χ^2 $p < 0.0001$). Detailed site-specific distributions by age and gender, are presented in Table S4.

Incidence of keratinocyte cancers in England by deprivation

A lower proportion of patients in the most deprived quintile developed BCC and CSCC (PPPA) compared with the least deprived (BCC: 10.8% vs 28.5%; CSCC: 11.0% vs 27.6%) (Table 1). Crude incidence rates (CIRs) for BCC (PPPA) increased across all deprivation quintiles between 2013 and 2015, followed by stabilisation in quintiles 1 (most deprived), 2, and 4 and deceleration in quintiles 3 and 5 (least deprived) (Figure S2). For CSCC, CIRs increased across all quintiles between 2013 and 2015 and continued to rise thereafter, but at a slower rate from 2015 to 2019.

NMSC specific mortality in England

NMSC ASMR increased significantly from 2013 (APC 4.0% (95% CI. 2.5-5.7)) (Figure 3). Over the past decade the NMSC ASMR increased at double the rate in males (APC 4.4% (95% CI 2.4-7.1) compared to females (APC 2.2 (95% CI 0.3-4.6)). For CSCC, 1-, 3-, and 5-year NS remained stable between 2013 and 2020, with estimates of approximately 98%, 94%, and 90%, respectively (Table S5).

Discussion

This study represents, to our knowledge, the largest and most comprehensive national cohort of KCs reported to date, with almost two million tumours recorded in England between 2013 and 2022.

The use of PPPA methodology identified 60% more tumours than traditional first-ever registration, underscoring the substantial underestimation of KC burden in registries that do not employ this approach.[8,10,11] These findings highlight the importance of standardised, validated and accurate tumour counting methods to inform healthcare planning and policy. Crude tumour counts increased markedly over the study period, reflecting a growing healthcare burden that is likely to intensify with population ageing. This reinforces the need for effective primary prevention strategies.

Although EASRs (PPPA) for BCC initially increased in England, they have remained relatively stable since 2015. Similarly, longitudinal studies from across Europe have reported a deceleration in BCC EASRs over the past three decades.[21,22] Although changes in counting methods can influence temporal incidence trends, this is unlikely to explain the early increase observed in our study because the validated PPPA methodology was implemented nationally from 2013 and applied consistently throughout the study period using an automated registration process. Several factors may have contributed to the apparent stabilisation in BCC incidence, including increasing ethnic diversity, with the proportion of the population in England self-identifying as White decreasing from 90.9% in 2001 to 81.7% in 2021, and improvements in sun-protective behaviours.[23] However, these factors would also be expected to influence trends in CSCC and melanoma, yet the incidence of CSCC and melanoma in patients aged >50 years continued to increase during the same period, suggesting they are unlikely to be the principal explanation for the observed BCC plateau.[23-26] A more plausible explanation is incomplete case ascertainment resulting from an increasing proportion of BCCs being managed outside established cancer registration pathways. For example, greater use of first-line medical therapies without histological confirmation, particularly in very elderly or frail patients, would reduce the number of tumours available for registration.[27-30] Furthermore, if increasing demand exceeded NHS capacity after 2015, a growing proportion of BCCs may have been treated in the private sector or managed empirically without histological confirmation. Although many private pathology laboratories submit data to the NDRS, reporting is not mandatory and the proportion of laboratories that do not contribute data is unknown. Consequently, this hypothesis cannot currently be tested directly, limiting interpretation of the observed incidence trends. In addition, prioritisation of more aggressive tumours during the COVID-19 pandemic may have further reduced BCC ascertainment. Although some degree of under-ascertainment of BCC incidence is likely unavoidable, its magnitude may vary considerably between healthcare systems and could be substantial in the UK. Importantly, if the true incidence of BCC continues to increase while an increasing proportion of cases are managed outside registry capture, it could be inferred from registry-data that BCC is no longer an increasing public health burden. Such misinterpretation could adversely influence healthcare planning by reducing the perceived need for continued

investment in prevention, diagnostic services, and treatment capacity. Ideally, future studies should seek to evaluate temporal changes in BCC management pathways, quantify the proportion of patients managed in the private sector, and assess the completeness of cancer registration across different treatment settings.

In contrast to BCC, EASRs (PPPA) for CSCC increased continually in England over the study period. This is consistent with data from across Europe over the past three decades, which project further increases in CSCC EASRs up to 2044, particularly among patients aged ≥60 years.[31] International data have demonstrated an increasing ratio of CSCC to melanoma incidence over time, which may reflect increased cumulative UVR exposure, and differences in tumour aetiology, including immunosuppression and differential exposure to established CSCC risk factors such as photosensitising medications.[32,33] These findings underscore the importance of analysing CSCC separately, rather than collectively as KC or NMSC.

Temporal trends in ASIRs (PPPA) also differed between tumour types. ASIRs for CSCC continued to increase in younger (<60 years) and older (≥80 years) age groups. This may reflect the increasing prevalence and duration of immunosuppression, as well as demographic changes such as greater longevity and a rising proportion of individuals living with immunosenescence. Population-based analyses of ASIRs in CSCC remains limited, and further data are needed to better characterise temporal trends, particularly in the context of expanding immunosuppression, including among solid organ transplant recipients in whom risk is substantially increased.[34,35]

Consistent with previous studies, EASRs were highest in southern and coastal regions of England, likely reflecting geographic variation in UVR exposure with latitude, higher relative affluence facilitating increased foreign travel, greater engagement in outdoor activities, and a higher proportion of White ethnicity (87% in the South East vs 54% in London in 2021).[9,23,36]

KCs were more common in males, who were also more likely to develop subsequent tumours, consistent with national data from Sweden.[37] This may partly reflect gender differences in occupational and recreational UVR exposure.[38] In addition, although solid organ transplant recipients represent a small proportion of the overall population, they are more commonly male and remain an important high-risk subgroup with substantially increased CSCC incidence.[39] These findings underscore the need for targeted prevention and surveillance strategies in high-risk groups. Emerging national initiatives, such as targeted skin cancer screening programmes in Australia, highlight the potential for risk-stratified approaches, for which these data provide important supporting evidence.[40]

In keeping with previous studies, the head and neck were the most common sites for first-ever KC in elderley patients, consistent with cumulative UVR exposure.[9,41] By contrast, younger patients were more likely to develop KCs on the trunk, supporting a role for intermittent UVR exposure through sunbathing or sunbeds.[42] Temporal analyses of anatomical site distributions were not performed because approximately 15% of first-ever registered tumours had an unknown anatomical site, and changes in the completeness of site recording over time could therefore have biased any observed temporal trends. Interpretation of anatomical site distributions by age and gender should also be cautious despite restricting analyses to first-ever tumours to minimise bias from missing data. Moreover, site-specific analyses stratified by age and gender were not possible for BCC in patients aged <25 years and for CSCC in those aged <45 years due to low counts, however these groups represent a small and likely clinically heterogeneous population.

Similar to previous studies, KCs were more common in less deprived populations.[9,14,43] This may be explained by higher health literacy and improved access to healthcare, better health in older age enabling engagement in outdoor occupational and recreational activities, and greater UVR exposure through travel abroad. CIR trends increased throughout the study period for all deprivation quintiles for CSCC, whereas for BCC increases were confined to the less deprived quintiles. However, interpretation of deprivation-specific incidence trends was limited by the inability to calculate EASRs. Consequently, differences in population age structure may have influenced observed patterns, particularly given widening life expectancy inequalities between deprivation quintiles in England over the study period.[44] This lack of age-standardisation may therefore partly explain the higher apparent annual percentage change in less deprived groups.

ASMRs for NMSC increased significantly in both genders from 2013 onwards. Although some variation in ASMRs across countries has been reported, most emerging data show melanoma ASMRs decreasing while NMSC ASMRs continue to rise.[6,31] This may in part reflect the impact of systemic therapies, which have transformed outcomes for patients with advanced melanoma, highlighting the importance of therapeutic development for CSCC.[45,46] The rate of increase in ASMR was approximately twice as high in males as in females which may be attributable to differences in health-seeking behaviour, a predominance of male solid organ transplant recipients who experience increased CSCC-related mortality, and a greater predilection for tumours arising at high-risk anatomical sites such as the ears and scalp.[34,47] However, these findings should be interpreted with caution. The mortality analyses were based on deaths with an underlying cause of death coded as WHO ICD-10 C44, which does not distinguish between discrete skin cancer subtypes that are not melanomas, limiting tumour-specific interpretation. Although most NMSC-related deaths are attributable to CSCC, NMSC-related deaths include several rare but highly aggressive skin cancers such as MCC whose incidence has increased in recent years and which have substantially higher mortality rates.[7,48] Consequently, it remains unclear to what extent the reported mortality trend reflects deaths from CSCC versus other, more lethal skin cancer subtypes. Furthermore, mortality estimates are reliant on accurate certification of cause of death. In addition, due to data quality issues ASMR data for 2016–2017 were excluded, nevertheless,

the remaining years of data were considered sufficient for robust trend analysis. Finally, changes in mortality from competing causes over time may have influenced NMSC mortality trends, although the use of age-standardised cause-specific mortality rates is likely to reduce this effect. Notably, despite increasing NMSC-specific mortality at a population level, age-standardised net survival for CSCC remained stable over the study period. This suggests that the observed rise in mortality is likely driven by increasing incidence and population ageing, rather than deterioration in individual-level survival outcomes, although interpretation of longer-term survival trends is limited by insufficient follow-up for more recent diagnosis cohorts.

The main strengths of this study are the size, quality, and granularity of the dataset, however, several limitations should be acknowledged. As with all observational studies, causality cannot be inferred. KCs may be underreported, as patients presenting with multiple KCs have only one registered per annum. Key variables such as tumour stage were not available. Although NDRS data are quality assured and routinely audited, misclassification remains possible; there were higher levels of missing data for some variables, including self-reported ethnicity. The combination of incomplete ethnicity data and the low proportion of patients with known ethnicity who self-reported as non-White precluded stratified analyses by ethnicity. Given the established differences in KC incidence across ethnic groups, efforts to improve the completeness, accuracy and standardisation of ethnicity recording within cancer registries are warranted, alongside the use of clinically meaningful ethnicity classifications.[49] Further population-based studies in more ethnically diverse populations are needed to better characterise the epidemiology of KC across different ethnic groups. Regional variation in data completeness may have influenced comparisons in incidence by geographic region. Finally, findings from England may not be generalisable to other populations.

In conclusion, this study advances our understanding of the epidemiology of KCs and highlights the importance of accurate case ascertainment within national cancer registries to ensure that disease burden is appropriately captured. Given population ageing globally, the burden of KCs is expected to increase substantially. CSCC incidence continues to rise in younger as well as older age groups, and alongside increasing NMSC mortality, represents an ongoing public health challenge that warrants prioritisation. These findings provide important insights to inform targeted prevention strategies, including education and risk-based screening, to mitigate this growing burden.

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Figure legends

Figure 1 - Regional European age-standardised incidence rates (per 100,000 person-years) in England in 2022 using the keratinocyte cancer per patient per annum technique for (a) basal cell carcinoma (BCC) and (b) cutaneous squamous cell carcinoma (CSCC). ASR, European age-standardised incidence rates.

Figure 2 – European age-standardised incidence rates per 100,000 person years (PY) from 2013 to 2019 in England by gender using the keratinocyte cancer (KC) per patient per annum (PPPA) technique for (a) basal cell carcinoma (BCC) and (b) cutaneous squamous cell carcinoma

(CSCC). Age-specific incidence rates (per 100,000 PY) from 2013 to 2019 in England using the KC PPPA technique for (c) males with BCC (d) females with BCC, (e) males with CSCC, (f) females with CSCC. APC, annual percentage change. Asterisks (*) denote statistical significance at $P < 0.05$.

Figure 3 – European age-standardised mortality rates for non-melanoma skin cancer in England between 2013 and 2022 by gender. NMSC, non-melanoma skin cancer; APC, annual percentage change. Asterisks (*) denote statistical significance at $P < 0.05$.

Table 1 – Patient demographics of first-ever, subsequent and all registered per patient per annum basal cell carcinomas and cutaneous squamous cell carcinomas, England 2013-22

Patient demographics	**First-ever BCC, n = 883,070**	**Subsequent BCC, n = 588,370**	**All BCC, n = 1,471,440**	**First-ever CSCC, n = 303,725**	**Subsequent CSCC, n = 126548**	**All CSCC, n = 430,273**
Gender						
Male	474594 (53.7)	365294 (62.1)	839888 (57.1)	191859 (63.2)	92879 (73.4)	284738 (66.2)
Females	408476 (46.3)	223076 (37.9)	631552 (42.9)	111866 (36.8)	33669 (26.6)	145535 (33.8)
Age (years)						
Median (IQR)	72 (62-80)	77 (69-84)	74 (64-82)	80 (72-86)	80 (74-87)	80 (72-86)
0-39	20903 (2.4)	4490 (0.8)	25393 (1.7)	1111 (0.4)	147 (0.1)	1258 (0.3)
40-49	52801 (6.0)	15122 (2.6)	67923 (4.6)	3966 (1.3)	625 (0.5)	4591(1.1)
50-59	112408 (12.7)	42148 (7.2)	154556 (10.5)	14557 (4.8)	3152 (2.5)	17709 (4.1)
60-69	193006 (21.9)	96625 (16.4)	289631 (19.7)	39539 (13.0)	10137 (8.0)	49676 (11.5)
70-79	277722 (31.4)	206306 (35.1)	484028 (32.9)	97705 (32.2)	34419 (27.2)	132124 (30.7)
80-89	188480 (21.3)	184427 (31.3)	372907 (25.3)	112709 (37.1)	57300 (45.3)	170009 (39.5)

90+	37750 (4.3)	39252 (6.7)	77002 (5.2)	34138 (11.2)	20768 (16.4)	54906 (12.8)
Ethnicity						
White	703085 (79.6)	542418 (92.2)	1245503 (84.6)	278737 (91.8)	123346 (97.5)	402083 (93.4)
Asian	1047 (0.1)	315 (0.05)	1362 (0.09)	537 (0.2)	124 (0.1)	661 (0.2)
Black	539 (0.1)	275 (0.05)	814 (0.06)	305 (0.1)	72 (0.06)	377 (0.09)
Chinese	194 (0.02)	49 (0.08)	243 (0.02)	72 (0.02)	20 (0.02)	92 (0.02)
Mixed	836 (0.09)	414 (0.07)	1250 (0.08)	323 (0.1)	124 (0.1)	447 (0.1)
Other	4130 (0.5)	1914 (0.3)	6044 (0.4)	1445 (0.5)	450 (0.4)	1895 (0.4)
Unknown	173239 (19.6)	42985 (7.3)	216224 (14.7)	22306 (7.3)	2412 (1.9)	24718 (5.7)
Deprivation quintile						
1 (most deprived)	98336 (11.1)	60270 (10.2)	158606 (10.8)	34132 (11.2)	13284 (10.5)	47416 (11.0)
2	135821 (15.4)	85674 (14.6)	221495 (15.1)	47461 (15.6)	19324 (15.3)	66785 (15.5)
3	185056 (21.0)	121734 (20.7)	306790 (20.8)	64557 (21.3)	27100 (21.4)	91657 (21.3)
4	217496 (24.6)	147640 (25.1)	365136 (24.8)	74683 (24.6)	31120 (24.6)	105803 (24.6)
5 (least deprived)	246361 (27.9)	173052 (29.4)	419413 (28.5)	82892 (27.3)	35720 (28.2)	118612 (27.6)
Body site*						
Scalp and neck	68860 (7.8)	35002 (6.0)	/	54496 (18.0)	13574 (11.1)	/
Ear	38879 (4.4)	18344 (3.1)	/	27827 (9.2)	4990 (4.1)	/
Eyelid	45179 (5.1)	16830 (2.9)	/	3713 (1.2)	529 (0.4)	/
Lip	15351 (1.7)	5757 (1.0)	/	6450 (2.1)	801 (0.7)	/
Face	347307 (39.3)	158015 (27.1)	/	83879 (27.7)	13548 (11.0)	/
Lower limb	55805 (6.3)	33444 (5.7)	/	35018 (11.6)	6545 (5.3)	/

Upper limb	60719 (6.9)	28440 (4.9)	/	46946 (15.5)	8077 (6.6)	/
Trunk	130880 (14.8)	57229 (9.8)	/	20805 (6.9)	3014 (2.5)	/
Unknown	119143 (13.5)	230819 (39.5)	/	23480 (7.8)	71546 (58.3)	/

Data are n (%) unless otherwise specified. BCC, basal cell carcinoma; CSCC, cutaneous squamous cell carcinoma; IQR, interquartile range.

*First-ever BCC site data is only available for age ≥25 years (n = 882,123), subsequent BCC site data is only available for ≥40 years (n = 583,880), there is no data available for all BCC by site. First-ever CSCC site data is available for ≥40 years (n = 302,614), subsequent CSCC site data is only available for ≥60 years (n = 122,624), there is no available data for all CSCC.

Figure 1

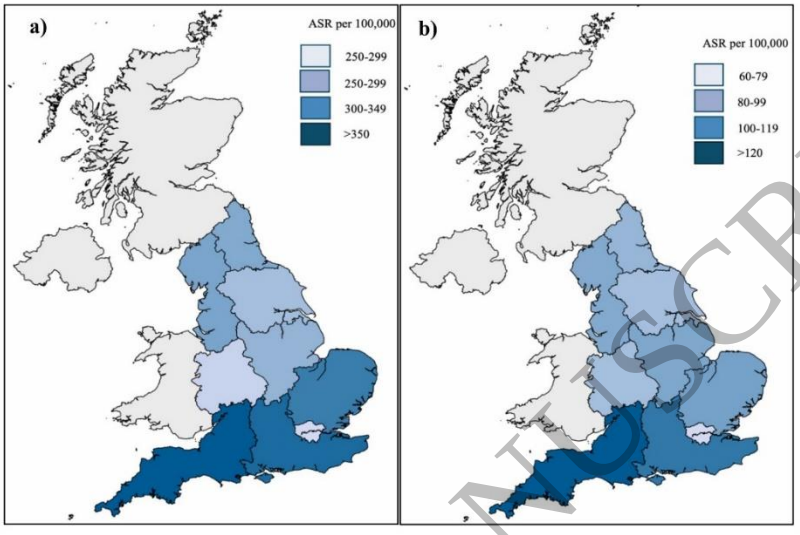

Figure 1
162x229 mm (x DPI)

Figure 2

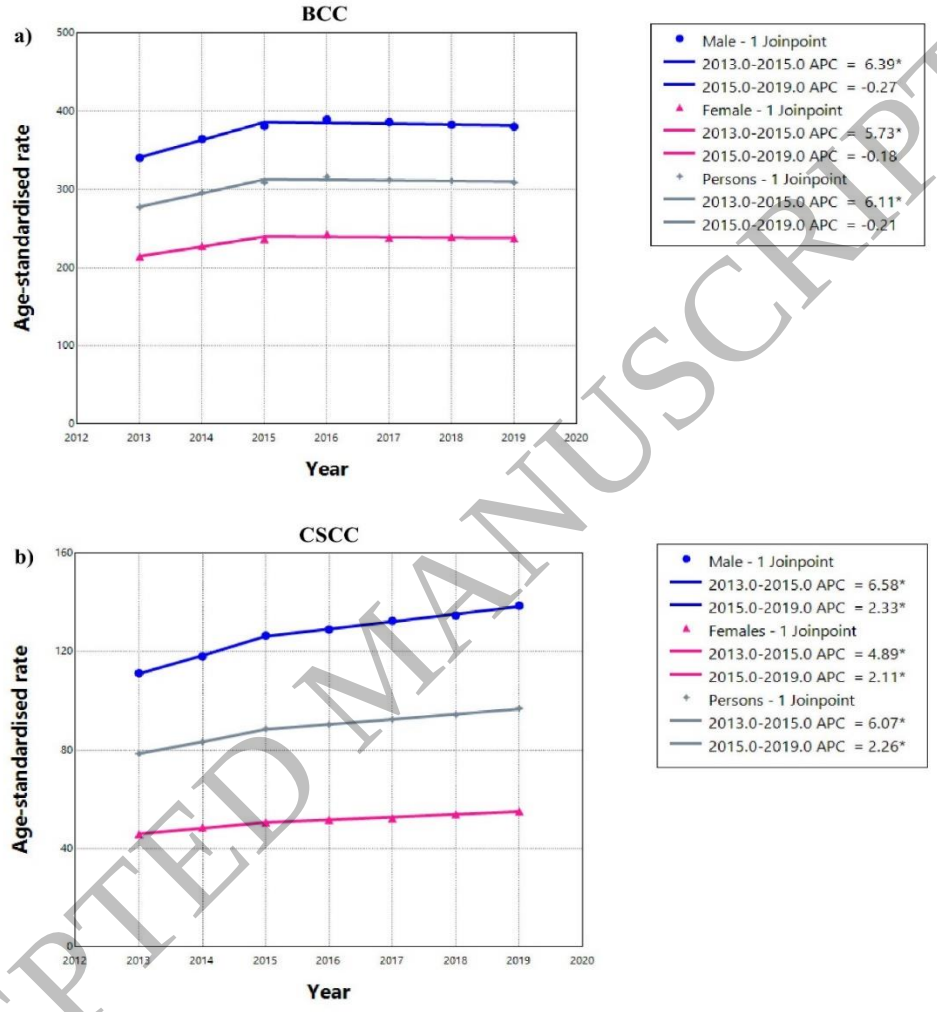

Figure 2A
162x229 mm (x DPI)

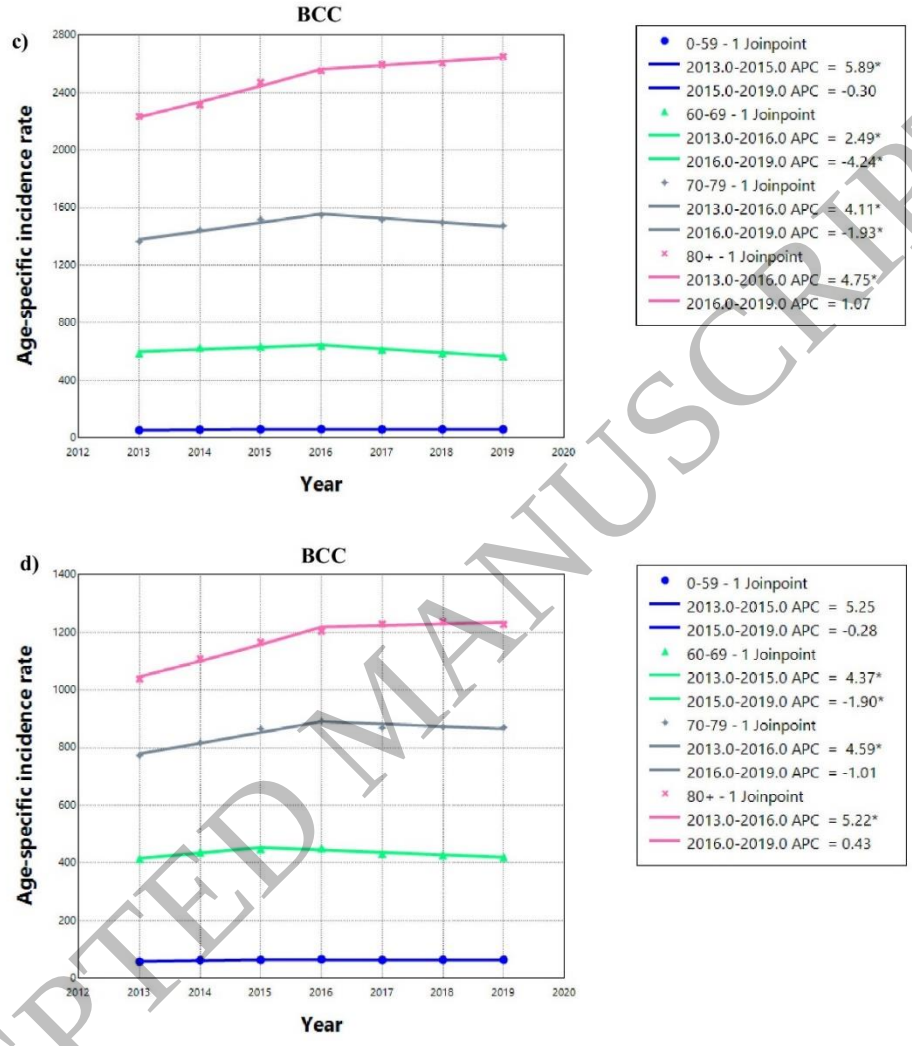

Figure 2B
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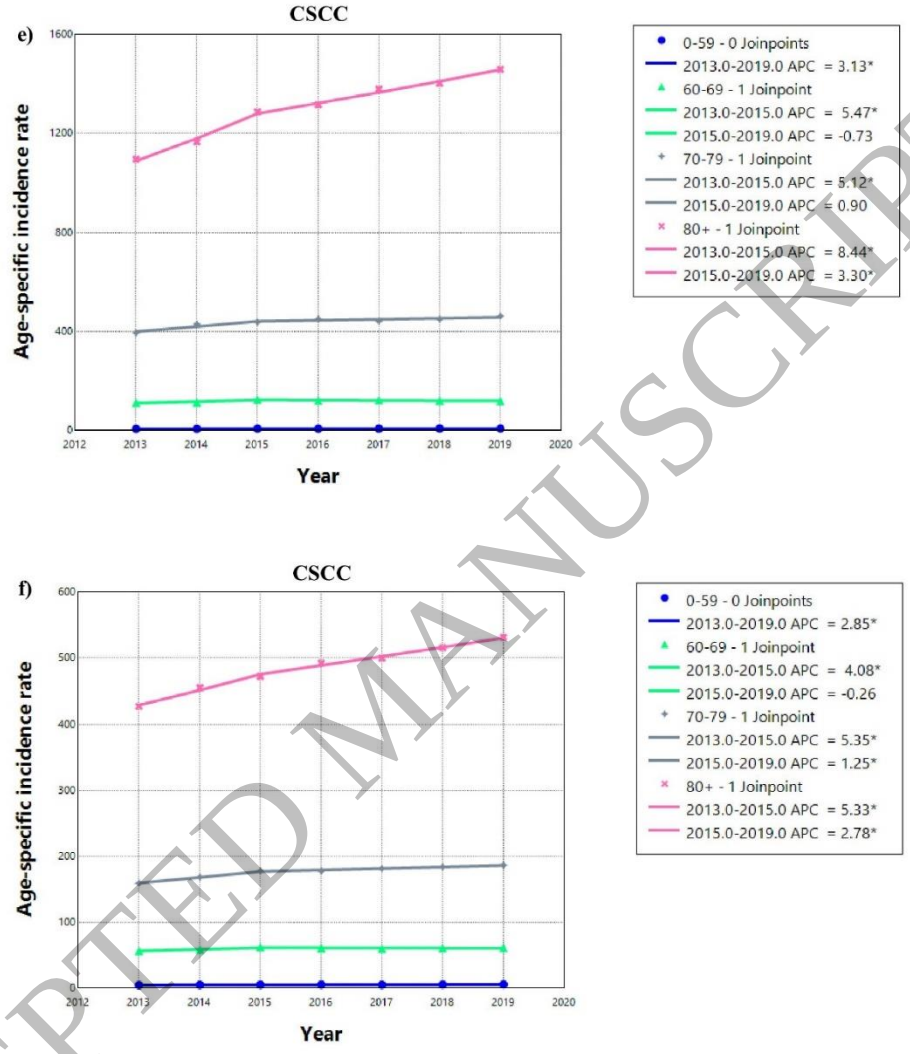

Figure 2C
162x229 mm (x DPI)

Figure 3

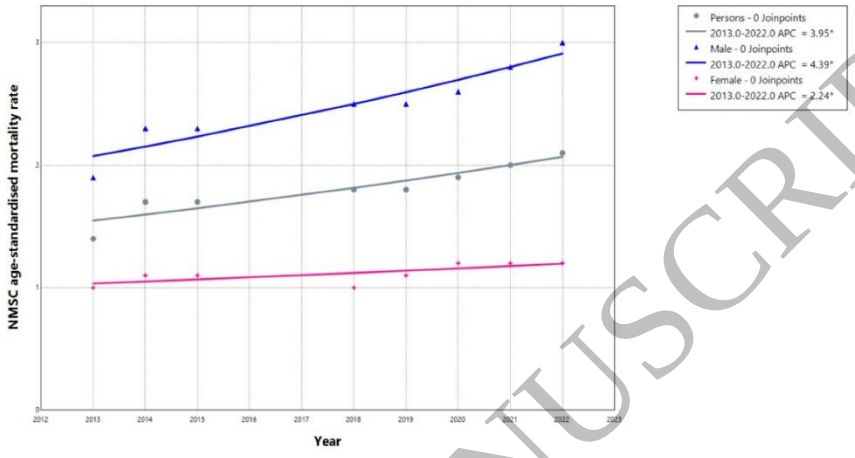

Figure 3
162x229 mm (x DPI)