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Epidemiology of lentigo maligna and lentigo maligna melanoma in England between 2013 and 2023

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Abstract

Background **Lentigo maligna (LM) is a melanoma *in situ* usually found on the sun-exposed skin of older adults. Data on the risk of progression to lentigo maligna melanoma (LMM) are limited. Outcomes without surgical treatment are unknown.**

Objectives **To describe the characteristics of patients with LM and LMM; to identify the incidence of LM and LMM in England from 2013 to 2023; and to calculate the survival of this cohort and estimate the risk of progression of LM to LMM, as well as its modifying factors.**

Methods **Pseudonymized data for LM and LMM in England between 2013 and 2023 were provided by the National Disease Registration Service. Joinpoint regression was used to calculate incidence rates for LM and LMM. Kaplan–Meier curves were used for melanoma-specific and all-cause survival. The cumulative incidence of LMM after LM was calculated using a latency period of 6 months or 1 year, for identical or plausibly matching sites. Cox regression was used to explore the influence of covariates on survival and progression.**

Results **Age-standardized incidence rates of LM [4.91–5.03 per 100 000 person-years (PY), annual percentage change (APC) 0.25, 95% confidence interval (CI) −2.68 to 3.35] and LMM (1.84–1.97 per 100 000 PY, APC 0.59, 95% CI −2.31 to 3.76) remained stable from 2013 to 2019, decreased in 2020 and increased in 2023 to higher than prepandemic levels. Patients with LM and LMM were more likely to die from other cancers or cardiovascular disease than from melanoma. Female sex (hazard ratio 0.56, 95% CI 0.49–0.66; $P < 0.001$) was protective, while increasing age conferred a higher risk of dying from melanoma. The risk of progression of LM to LMM was 1.0% (95% CI 0.8–1.1) at 10 years and increased with age and for tumours located on the head and neck.**

Conclusions **The incidence rates of LM and LMM in the future will clarify if the post-COVID-19 pandemic increases are due to delayed presentations or a true rise in cases. The excellent net and overall survival of patients with LM, together with the low risk of progression to LMM, favour patient-centred discussions in the management of LM in older, frailer adults. The risk of progression without treatment requires further evidence.**

Lay summary

Lentigo maligna (LM) often appears as a brown or black area on sun-exposed skin in older adults. Unlike melanoma (a type of skin cancer), LM is limited to the skin surface and does not spread or lower life expectancy. However, over a long time, some LM may transform into a type of melanoma known as lentigo maligna melanoma (LMM).

In this study, our aims were to find out the number of new people diagnosed with LM and LMM in England from 2013 to 2023. We also wanted to compare their survival, and estimate how often LM changes to LMM. We used official National Disease Registration Service data from England to calculate the statistics. The change of LM to LMM was estimated by identifying people who developed an LMM in the same place as a previous LM, regardless of treatment, at least 6 months or 1 year apart. The number of new cases of LM and LMM remained stable from 2013 to 2019, fell in 2020 (during the COVID-19 pandemic) and increased

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from 2021 to 2023. People with LM and LMM were more likely to die from other cancers or heart disease than from melanoma. Being a woman offered some protection from dying of melanoma. However, being older increased the risk. The risk of LM changing to LMM was 1 in 100 over 10 years. This risk increased with age and for LM located in the head and neck area.

Our findings support the importance of patient-centred discussions when deciding the best treatment, if any, for LM in older adults.

What is already known about this topic?

- Incidence rates of lentigo maligna (LM) have been rising across several countries; however, recent data from England show a plateauing trend.
- Survival after LM is excellent, but data on the risk of progression to lentigo maligna melanoma (LMM) are lacking.

What does this study add?

- Incidence rates of LM and LMM in England did not change significantly between 2013 and 2019, decreased in 2020 and rose to higher than prepandemic levels in 2023.
- Patients with LM and LMM are more likely to die from other cancers or cardiovascular disease than melanoma.
- The risk of progression to LMM was approximately 1% at 10 years, and increased for tumours on the head and neck, highlighting the clinical equipoise in surgical treatment of LM in older, frailer adults.

Lentigo maligna (LM) is a type of melanoma *in situ* mostly found on the head and neck of older adults.[1] Since 1892, when Sir Jonathan Hutchinson described it as a 'senile freckle', to the early 1900s, when Dubreuilh characterized it as *lentigo malin des vieillards* (French for 'malignant lentigo of older adults'), the association of LM with cumulative exposure to ultraviolet (UV) radiation (UVR) is now better understood.[2–4] The median age at first diagnosis is between 66 and 72 years, and men are more commonly affected.[5]

The incidence of LM is rising, with the zenith in Australia [12.2 per 100 000 person-years (PY), 2006 crude data], and increases in the USA (1970–2007, age-standardized, 2000 US Census), the Netherlands (1998–2013, age-standardized, European Standard Population), Denmark (1997–2011, age-standardized, World Standard Population), the Czech Republic (2002–2017, age-standardized, 2000 US Census) and Spain (2000–2007, crude).[6–11] We recently showed that crude incidence rates plateaued in England (2013–2019).[1]

Histologically, LM is characterized by solar elastosis, flattened rete ridges and the extension of atypical melanocytes alongside adnexal structures.[12] Evidence on the natural history of LM is limited as lesions are often biopsied or removed upon diagnosis. Estimates on progression to invasive lentigo maligna melanoma (LMM) vary, from 2–50% over a lifetime to 3.5% per year following treatment.[7,13–15] A retrospective study using patient questionnaires reported a mean time of progression of 28.3 years [95% confidence interval (CI) 20.0–40.5 years] and recent data from the USA indicate a cumulative incidence of LMM after LM of 0.94% at 10 years.[15,16] Recent data on the risk of progression are lacking.

Patients with LM have excellent 5-year net survival (103.7%, 95% CI 101.2–106.3), but outcomes without treatment remain poorly understood.[17,18] At present, the gold standard management is surgical excision with 5–10-mm margins. Margins are often indistinct, rendering surgery challenging at cosmetically sensitive sites. Recurrence rates at 5 years range between 5% and 20%.[19–21] Reflectance confocal microscopy has shown that over half of patients with LM had subclinical disease beyond the 5-mm dermoscopic margin.[22] Topical imiquimod is a noninvasive alternative, but it may not clear all disease.[23–25] Radiotherapy is less commonly used in the UK and although it was found to be noninferior to imiquimod in one underpowered study, it is less cost-effective.[26] The limitations of surgery and insidious nature of LM result in clinical equipoise on management when excision margins are incomplete and in older or frailer adults, in whom a specific patient-decision aid is available to facilitate shared decision-making.[27]

The aims of this study were to describe the patient characteristics of those with LM ± LMM, to identify the incidence of LM ± LMM in England between 2013 and 2023, to calculate the survival of this cohort and to estimate the risk of progression of LM to LMM.

Materials and methods

Data sources

Data were provided upon application to the Data Access Request Service of the National Disease Registration Service (NDRS), after establishing a paid data-sharing agreement between NHS England and the sponsor, Norfolk and Norwich University Hospital NHS Trust. The NDRS collects and rigorously checks the validity of these datasets, which are automatically populated by integrated feeds, such as medical discharge letters, death certificates and skin cancer multidisciplinary team discussions. Pseudonymized data on LM [International Classification of Diseases, 10th Revision (ICD-10) code D03, morphology 8742/2] and LMM (ICD-10 code C43, morphology 8742/3) in England, between 2013 and 2023, were reviewed retrospectively for patient demographics and lesion characteristics.

Statistical analyses

Joinpoint (version 5.4.0; https://surveillance.cancer.gov/joinpoint/) was used for incidence trend analysis of LM and LMM by sex and age group, with average annual percentage changes (APC) restricted to 0-1 joinpoints given the number of years included in the analysis (2013–2019). Descriptive statistics were used from 2020 onwards, due to marked reductions in incidence in 2020, probably reflecting the effects of the COVID-19 pandemic. Crude incidence rate ratios (IRRs) are reported with 95% CIs using the Poisson method. Age-standardized incidence rates were derived from the 2013 European Standard Population (EASI).

Patient data on vital status were available from January 2013 to June 2025. SPSS Statistics suite version 31.0.0.0 (IBM, Armonk, NY, USA) was used for Kaplan–Meier survival analysis and Cox regression with Schoenfeld residuals to assess the effects of covariates on survival of patients with LM or LMM, with standard errors transformed to Wald 95% CIs.

Progression was defined as a diagnosis of LMM at a plausibly matching site (e.g. 'other face' and 'lip') at least 6 months (> 182 days) after a diagnosis of LM. This latency window served to exclude possible duplicate registrations, or upstaging, which can occur after an incompletely biopsied LM is found to be an LMM on subsequent wide local excision. Sensitivity analyses were performed for a latency period of 1 year (> 365 days) and for identical sites (e.g. 'left upper limb' and 'left upper limb'). The risk of progression (reported as cumulative incidence of LMM after LM) was modelled using the 'cmprsk' package in R studio (version 4.5.1; R Foundation for Statistical Computing, Vienna, Austria), accounting for death as a competing factor. Cox regression was used to identify associations between patient- or tumour-specific factors and the risk of progression, with direct acyclic graphs using the 'dagitty' R package. Age was modelled as a continuous variable using restricted cubic splines (4 knots) due to nonlinearity with outcomes (Wald tests $P < 0.01$ for mortality and progression).

Results

Patient demographics

In total, 29 367 LM and 11 543 LMM tumours were recorded between 2013 to 2023 in England among 39 100 patients. The commonest site for LM (77.1%) and LMM (75.6%) was the head and neck, with a similar median age distribution for LM [74 years; interquartile range (IQR) 66–81] and LMM (76 years; IQR 68–83) (Tables 1, 2). Most of the cohort identified as White ($n = 38\,864/39\,226$; 99.1%), with the largest proportion of lesions recorded in South East England ($n = 8459/40\,155$; 21.1%) and the smallest in London ($n = 2390/40\,155$; 6.0%). Median Index of Multiple Deprivation decile (2019 data; 1 = most deprived, 10 = least deprived) was 7 (IQR 5–9) ('unknown' cases excluded; see Table 1). Diagnosis of LMM was through urgent general practitioner referrals in 53.9% of cases ($n = 6225/11\,543$), not known for 40.6% of cases ($n = 4682/11\,543$), with the remainder diagnosed as inpatients, outpatients or emergency presentations. Staging data for LMM (90.4% completeness), based on five staging systems (Union for International Cancer Control TNM 6th, 7th and 8th Editions; American Joint Committee on Cancer 7th and 8th Editions), showed that most tumours were stage I ($n = 9044/11\,543$; 78.4%) followed by stage II ($n = 1160/11\,543$; 10.0%). Breslow thickness was recorded for 94.7% ($n = 10\,931/11\,543$) of LMMs (median 0.60 mm; IQR 0.36–1.11).

Table 1 Demographic information for 39 100 patients with lentigo maligna (LM) and/or lentigo maligna melanoma (LMM) in England (40 910 cases) recorded in the National Disease Registration Service database between 2013 and 2023

Demographic	*n* (%)[a]
Age (years)	
LM, median (IQR)	74 (66–81)
LMM, median (IQR)	76 (68–83)
Background[b]	
White	38 864 (95.0)
Any other/mixed	266 (0.7)
Black	49 (0.1)
Asian	47 (0.1)
Unknown	1684 (4.1)
Region	
South East	8459 (20.7)
South West	7199 (17.6)
Midlands	6308 (15.4)
North East & Yorkshire	6237 (15.2)
East of England	4974 (12.2)
North West	4588 (11.2)
London	2390 (5.8)
Unknown	755 (1.8)
IMD decile, median (IQR)	7 (5–9)
1 – most deprived	1583 (3.9)
2	1856 (4.5)
3	2366 (5.8)
4	3289 (8.0)
5	4069 (9.9)
6	4582 (11.2)
7	5127 (12.5)
8	5233 (12.8)
9	5631 (13.8)
10 – least deprived	6419 (15.7)
Unknown	755 (1.8)
Living environment	
Urban	27 577 (67.4)
Rural near a city	6771 (16.6)
Rural far from a city	4426 (10.8)
Unknown	2136 (5.2)

IMD, Index of Multiple Deprivation; IQR, interquartile range. [a]Data are presented as *n* (%) unless otherwise stated. [b]Breakdown is as per (and from) the 2021 English Census. The 'Any other/mixed' group includes White and Asian, White and Black African, White and Black Caribbean, and others derived from free text (the most common being Arab, Sikh, Hispanic or Latin American and Kurdish).

Incidence

The age-standardized incidence (EASI) rates of LM increased between 2013 and 2016 (APC 3.65, 95% CI 0.58–7.09) and fell during 2016–2019 (APC −3.04, 95% CI −6.10 to −0.15), from 4.91 to 5.03

Table 2 Tumour characteristics for 40 910 cases of lentigo maligna (LM)/lentigo maligna melanoma (LMM) in England, recorded in the National Disease Registration Service database between 2013 and 2023

Characteristic	*n* (%)
Lesion type	
LM	29 367 (71.8)
LMM	11 543 (28.2)
Lesion body site	
LM	
Head and neck	22 273 (75.8)
Limbs	4171 (14.2)
Trunk	2207 (7.5)
Unknown	716 (2.4)
LMM	
Head and neck	8519 (73.8)
Limbs	1799 (15.6)
Trunk	937 (8.1)
Unknown	288 (2.5)
Laterality	
LM	
Left	11 622 (39.6)
Right	11 284 (38.4)
Midline/bilateral	717 (2.4)
Unknown	5744 (19.6)
LMM	
Left	4547 (39.4)
Right	4385 (38.0)
Midline/bilateral	220 (1.9)
Unknown	2391 (20.7)
LMM stage	
I	9044 (78.4)
II	1160 (10.0)
III	171 (1.5)
IV	59 (0.5)
Unknown	1109 (9.6)
LMM referral pathway	
GP/urgent suspected cancer	6225 (53.9)
Other outpatient	467 (4.0)
Emergency	124 (1.1)
Inpatient	45 (0.4)
Unknown	4682 (40.6)

GP, general practitioner.

per 100 000 PY (2013–2019), with similar trends by sex (Figure 1). EASI rates for LMM did not change significantly between 2013 and 2019 (from 1.84 to 1.97 per 100 000 PY; APC 0.59, 95% CI −2.31 to 3.76), without differences by sex (Figure 1). Crude incidence rates increased for LMM in men between 2013 and 2019 (APC 2.24%, 95% CI −0.46 to 5.15) and otherwise mirrored EASI rates (Figure S1; see Supporting Information). Compared with 2013–2019, incidence rates reduced by 34.3% (LM) and 24.3% (LMM) in 2020, with the largest reduction in those aged 70–79 years with LM (40.2%) and the smallest in those aged < 60 years with LMM (4.0%). Crude IRRs post-COVID-19 pandemic compared with 2019 revealed annual increases for LM and LMM, with peaks seen in 2023 (IRR_{LM} 1.21, 95% CI 1.15–1.27; IRR_{LMM} 1.29, 95% CI 1.19–1.40) (Figure 1). LM and LMM were more common in men across all age groups and became increasingly common in older men (reaching a ratio of 2.1 : 1 for LM and 1.9 : 1 for LMM in those aged ≥ 80 years), except for people aged < 60 years, where similar numbers of LM were seen in both sexes (Table S1, Figure S2; see Supporting Information). Binary logistic regression for anatomical site differences between the sexes showed a higher likelihood of LM or LMM in the head-and-neck area in men [odds ratio (OR) 1.77, 95% CI 1.69–1.85; $P < 0.001$]. Age-specific incidence rates mirrored EASI trends for LM and LMM (Figure S2).

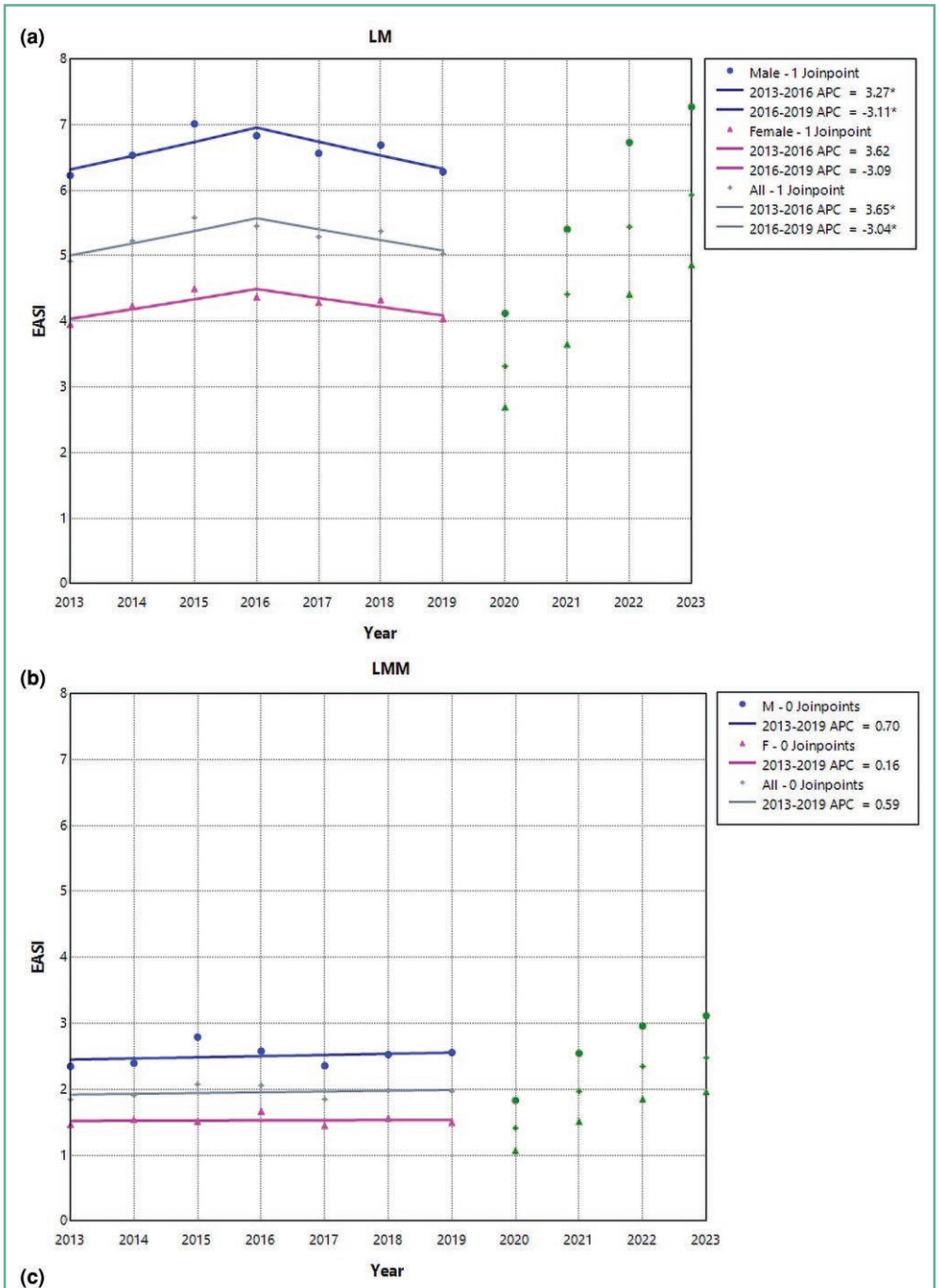
Survival

Melanoma-specific survival for LM and LMM was 98.2% (95% CI 97.8–98.6) and 91.7% (95% CI 90.7–92.7), respectively, at 12 years (Figure 2). All-cause survival was 61.6% (95% CI 60.4–62.8) for LM and 50.7% (95% CI 48.7–52.6) for LMM at 9.5 years (Figure 2). A breakdown of causes of death by ICD-10 code is available in Table S2 (see Supporting Information). Patients with LM were seven times more likely to die from a different cancer [$\chi^2(1, n = 6903) = 1459.1$; $P < 0.001$] and almost six times more likely to die from cardiovascular disease [$\chi^2(1, n = 6903) = 939.5$; $P < 0.001$] than from melanoma. Those with LMM were also more likely to die from other cancers [$\chi^2(1, n = 3615) = 86.4$; $P < 0.001$] or cardiovascular disease [$\chi^2(1, n = 3615) = 33.6$, $P < 0.001$] compared with melanoma.

For Cox regression there was minimal collinearity between independent variables (highest variance inflation factor 1.13 and highest tolerance 0.89). The proportional hazards assumption was assessed using Schoenfeld residuals, showing no evidence of time-dependent effects. Patients with LMM were more likely to die from melanoma than those with LM [hazard ratio (HR) 5.21, 95% CI 4.75–6.05; $P < 0.001$]. Older age was associated with increased risk of death from melanoma (Table S3, Figure S3; see Supporting Information), while female sex was associated with lower risk (HR 0.56, 95% CI 0.49–0.66; $P < 0.001$). Tumour laterality, geographical region and anatomical site were not associated with altered risk of death from melanoma or any cause (Table S3). A lower level of deprivation was associated with lower all-cause mortality but not with melanoma-specific mortality. Binary logistic regression by sex in patients with LMM did not identify any differences in Breslow thickness, while women were less deprived than men (Table S4; see Supporting Information). LMM was more common on the limbs than on the head and neck in women compared with men (OR 2.45, 95% CI 2.19–2.74; $P < 0.001$) (Table S4).

Upstaging and progression

Upstaging to LMM occurred in 2.2% ($n = 658/29\,367$) of all patients with LM within 6 months. Accounting for this latency period, the subsequent 10-year risk of progression of LM to LMM was 1.0% (95% CI 0.8–1.1), rising to 1.2% (95% CI 1.0–1.4) for LM on the head and neck [Figure 3; Figure S3 (see Supporting Information)]. Manually censoring patients who died before progression (as a separate, confirmatory way of the model for competing risk of death) resulted in similar findings (10-year risk 1.0%, 95% CI



(c)

IRR to 2019	2020	2021	2022	2023
LM	0.67 (0.63 – 0.71) *	0.89 (0.85 – 0.95) *	1.11 (1.05 – 1.17) *	1.21 (1.15 – 1.27) *
LMM	0.73 (0.66 – 0.80) *	1.02 (0.94 – 1.11)	1.22 (1.13 – 1.33) *	1.29 (1.19 – 1.40) *

Figure 1 Age-standardized incidence (European Age Standardized Incidence; EASI) rates for (a) lentigo maligna (LM) and (b) lentigo maligna melanoma (LMM) by sex in England between 2013 and 2023, and (c) crude incidence rate ratios (IRRs) from 2019 onwards, with 95% confidence intervals for average annual percentage change (APC). F, female; M, male. *$P < 0.05$.

0.8–1.2). Sensitivity analyses resulted in a minimum 10-year risk of progression of 0.6% (95% CI 0.5–0.7), when accounting for a 1-year latency period (to rule out upstaging or duplicate registrations), and progression by identical sites only (Figure S4; see Supporting Information).

Collinearity between covariates in the final Cox regression model was minimal (highest variance inflation factor 1.25 and lowest tolerance 0.80) (Table S5; see Supporting Information). The proportional hazards assumption was assessed using Schoenfeld residuals, showing no evidence of time-dependent effects. Increasing age was associated with a higher risk of progression (Table S5). Anatomical location on the head and neck area was also associated with a higher risk of progression; tumour location on the trunk (HR 0.27, 95% CI 0.11–0.66; $P = 0.009$) and limbs or

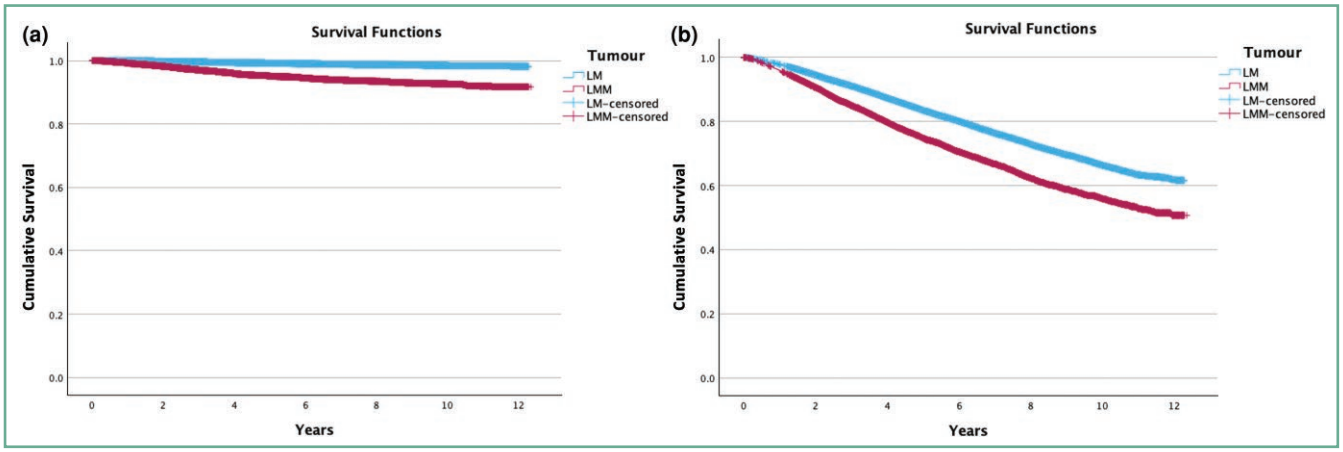


Figure 2 (a) Melanoma-specific and (b) overall Kaplan–Meier survival curves for patients with lentigo maligna (LM; turquoise) and lentigo maligna melanoma (LMM; crimson), with error bars representing the standard error.

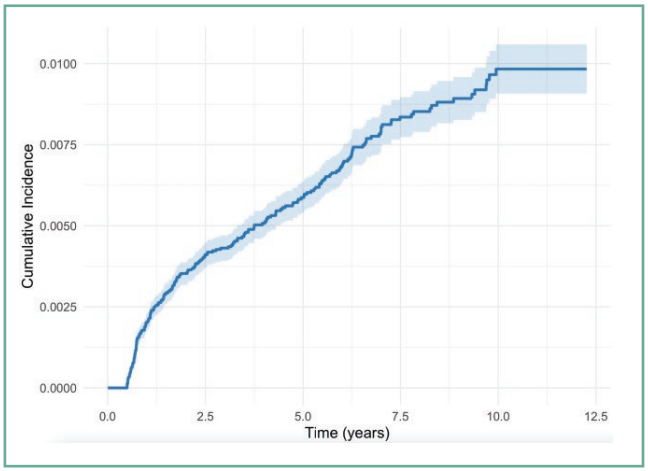


Figure 3 Cumulative incidence of lentigo maligna melanoma at least 6 months after a lentigo maligna diagnosis at a plausibly matching site, with death as a competing factor. The shaded area represents the 95% confidence interval.

other anatomical site (HR 0.20, 95% CI 0.10–0.43; $P < 0.001$) was protective. Upon sensitivity analysis, sex, tumour laterality and geographical region did not influence the progression of LM to LMM (Table S5). There was no statistical difference in Breslow thickness between the progressed LMMs (median 0.6; IQR 0.3–1.1) and those not preceded by an LM diagnosis (median 0.5; IQR 0.3–0.9) (Mann–Whitney *U* test $P = 0.13$).

Discussion

This is the largest study, to date, on LM and LMM in Europe, comprising 40 910 tumours in 39 100 patients between 2013 and 2023 in England. Contrary to data from Europe and the USA, incidence rates for LM and LMM in England plateaued between 2013 and 2019. An early increase in the incidence of LM and LMM between 2013 and 2015 may have been secondary to improved awareness of and access to systematic registrations that began by the NDRS in 2013. Incidence rates fell in 2020, mirroring the effect of the COVID-19 pandemic on public services. Subsequent increases until 2023 may reflect the ongoing diagnostic backlog, as seen with early-stage melanoma in England as a result of patient anxiety in seeking medical attention during the pandemic and disrupted service provision.[28] We have previously shown that the rising incidence rates of all *in situ* melanomas in England decelerated from 2001–2015 (APC 7.51%, 95% CI 6.96–8.68) to 2015–2019 (APC 1.90%, 95% CI −3.02 to 4.53), possibly due to stabilization of diagnostic drifts.[29] In addition, most of the increases in melanoma incidence are accounted for by tumours in the trunk and limbs (associated with intermittent UVR exposure), whereas LM most commonly affects the head and neck (associated with chronic and cumulative UVR exposure).[30,31] Stabilization of LM incidence rates (as measured by histology samples) may be due to a number of reasons, such as: (i) a true plateau; (ii) increased awareness from clinicians and patients on its indolent course; (iii) difficulty accessing services due to longer National Health Service (NHS) waiting lists; (iv) fewer face-to-face consultations (and therefore a lower likelihood of diagnosing coincidental malignancies); and (v) older age group affected (approximately 72 years old) compared with other *in situ* melanomas (61–63 years old) resulting in fewer biopsies, excisions or multidisciplinary discussions, and thereby fewer registrations of LM.

The incidence of LM increases with age and affects men more than women, which may be due to biological, behavioural or anatomical differences.[32] As expected, the highest male-to-female incidence ratios for LM (2.1 : 1) and LMM (1.9 : 1) were seen in the group aged ≥ 80 years. Taken together with the analysis on anatomical location of LM and LMM by sex (head-and-neck tumours were more common in men; OR 1.77, 95% CI 1.68–1.85), these findings suggest that hair is probably a protective factor. This may explain, in part, why LM is seen equally in men and women aged < 60 years. Other possibilities include a lower threshold to seek care and higher rates of self-examination in women.[33,34] The highest increases in incidence rates post-COVID-19 were seen for people aged > 60 years (LM) or > 70 years (LMM). Possible diagnostic delays and the higher burden of disease in older adults may add pressure to healthcare systems and result in poorer outcomes for LMM in those with thicker tumours and at an age when immunotherapy or targeted therapies may not be suitable or tolerated.[35]

Openly available English data (2013–2015) show an LM net survival over 100% (suggesting better survival than an age-, sex-, region- and deprivation-matched cohort without LM) compared with 89.3% for invasive melanoma.[36] This may be due to the

comparative fitness of those with LM investigated with histological diagnosis (and thus the exclusion of frailer adults), as well as healthcare access, education, awareness, advocacy and an outdoors lifestyle resulting in greater cumulative UV exposure. Cumulative UV exposure might confer advantages on cardiovascular status through a nitric oxide-mediated reduction of blood pressure, although more research is needed.[1,37] Patients with LMM, most of whom had early stage disease [78.4% stage I (n = 9044/11 543) and 10.0% stage II (n = 1160/11 543)], had a relatively higher net survival compared with published data on other invasive melanomas, including superficial spreading melanomas of similar stage.[38,39] The survival advantage seen in women is likely due to anatomical (e.g. male pattern baldness), behavioural, hormonal and genetic factors.[29,40] Women are diagnosed earlier than men across all equivalent Breslow thicknesses, probably suggesting causal origins for these differences.[41] Unlike previous studies, no difference in survival was found comparing head-and-neck tumours with other sites, although tumours of the head and neck were more likely to progress.[42] While the higher vasculature and lymphatic density of the head and neck – together with the difficulty of wider margin surgery – may facilitate tumour spread, insidious changes in LM may be more readily noticeable by patients for tumours on evident sites, such as their face, and therefore earlier detection may be offsetting a poorer prognosis.

The risk of progression of LM to LMM (1% at 10 years) was in keeping with conservative estimates in the literature.[13,16] Increasing age was a poor prognostic factor, probably due to reduced immunosurveillance that would normally thwart tumour growth.[43] In this study, 2.2% of patients with LM were upstaged within 6 months of diagnosis, while two small studies, and recent national results from the Netherlands, found that 10–16% of LM were upstaged on subsequent excision.[44–46] Therefore, the latency period in this study may not fully exclude upstaging.

The results of this study may not fully translate to a more diverse population, as 99.1% of patients identified as White. While LM and LMM mostly affect people with lighter skin types, those with richly pigmented skin types experience diagnostic delays and present with thicker LMM and a lower net 5-year survival.[47,48] Data for 257 'other' or 'unspecified' invasive or *in situ* melanomas were not available, some of which may have been unclassified LM or LMM. Although NHS laboratories submit their data by law to the NDRS, the same does not apply for private clinics and, therefore, this cohort of the population (up to 14% of British people are insured privately for health) may not be adequately represented in the dataset.[49] Data on surgical excision margins were not analysed due to incompleteness (7.2%). The 1-year latency period for progression can also introduce immortal bias, which was addressed by comparative sensitivity analyses using a 6-month window, yielding similar results.

In conclusion, this dataset on LM and LMM from England between 2013 and 2023 is the largest in Europe and shows that the previously plateauing incidence rates of LM and LMM began to rise after the COVID-19 pandemic. Patients with LM or LMM are more likely to die from other cancers or cardiovascular diseases than from melanoma. Older age is associated with lower survival, while female sex is associated with improved survival. The risk of progression to LMM is 1% in 10 years and increases with older age and head-and-neck tumours. Studies of longer duration are required to accurately identify true risk with and without treatment. Our estimates may be helpful in treatment discussions of LM in adults with a limited life expectancy.

Author contributions

Dimitrios Karponis (Conceptualization, Data curation, Methodology [equal], Formal analysis, Funding acquisition, Investigation, Validation, Writing—original draft, Writing—review & editing [lead]), Vasiliki A. Nikolaou (Conceptualization, Investigation, Methodology, Writing—review & editing [supporting], Supervision [equal]), Alexander J. Stratigos (Conceptualization, Investigation, Methodology, Writing—review & editing [supporting], Supervision [equal]), Khaylen Mistry (Formal analysis, Investigation, Writing—review & editing [supporting]), Nick J. Levell (Conceptualization, Methodology, Supervision [equal], Data curation, Formal analysis, Funding acquisition, Investigation, Writing—original draft, Writing—review & editing [supporting]), and Zoe Venables (Conceptualization, Methodology [equal], Data curation, Formal analysis, Funding acquisition, Investigation, Writing—original draft, Writing—review & editing [supporting], Supervision [lead])

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Conflicts of interest

Z.C.V. is a project collaborator with Merck (unpaid), Regeneron and SkinAnalytics, with fees paid to an institutional research account, and is also a section editor for the *BJD*. K.M. is the Deputy Editor of *CED*. The other authors declare no conflicts of interest.

Data availability

The secure dataset analysed to produce this manuscript is available upon successful application and establishment of a paid Data Sharing Agreement with the Data Access Request Service (NHS England Digital).

Ethics statement

Ethical approval was granted by the Health Research Authority and Health and Care Research Wales through the Integrated Research Application System (IRAS ID: 323941).

Patient consent

Not applicable.

Supporting Information

Additional Supporting Information may be found in the online version of this article at the publisher's website.

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