Socioeconomic Patterning in the Incidence and Survival of Children and Young People Diagnosed with Malignant Melanoma in Northern England

Richard J.Q. McNally[1], Nermine O. Basta[1], Steven Errington[1], Peter W. James[1], Paul D. Norman[2] and Alan W. Craft[3]

Previous studies have found marked increases in melanoma incidence. The increase among young people in northern England was especially apparent among females. However, overall 5-year survival has greatly improved. The present study aimed to determine whether socioeconomic factors may be involved in both etiology and survival. All 224 cases of malignant melanoma diagnosed in patients aged 10–24 years during 1968–2003 were extracted from a specialist population-based regional registry. Negative binomial regression was used to examine the relationship between incidence and area-based measures of socioeconomic deprivation and small-area population density. Cox regression was used to analyze the relationship between survival and deprivation and population density. There was significantly decreased risk associated with living in areas of higher unemployment (relative risk per 1% increase in unemployment = 0.93; 95% confidence interval (CI) 0.90–0.96, $P<0.001$). Survival was better in less deprived areas (hazard ratio (HR) per tertile of household overcrowding = 1.52; 95% CI 1.05–2.20; $P=0.026$), but this effect was reduced in the period 1986–2003 (HR = 0.61; 95% CI 0.40–0.92; $P=0.018$). This study found that increased risk of melanoma was linked with some aspects of greater affluence. In contrast, worse survival was associated with living in a more deprived area.

Journal of Investigative Dermatology (2014) **134,** 2703–2708; doi:10.1038/jid.2014.246; published online 10 July 2014

INTRODUCTION

During the 1970s, malignant melanoma was very rare in children, teenagers, and young adults, with around 2% of all melanomas occurring in those aged less than 20 years and only 0.2% occurring in children aged 0–10 years (Bader *et al.*, 1985). Since then and up to the early 21st century there has been a marked increase in the incidence of melanoma in children and young people residing in developed countries (Downing *et al.*, 2006; Purdue *et al.*, 2008). A previous analysis from northern England has shown that a marked rise in incidence was confined to females (Magnanti *et al.*, 2008). It is well known that both genetic susceptibility and exposure to UVR are key factors in etiology (Cockburn *et al.*, 2001; Wachsmuth *et al.*, 2001; Shahbazi *et al.*, 2002; El Ghissassi *et al.*, 2009). The finding of a seasonal association between time of birth and risk of subsequently developing melanoma suggests that early life exposures may be implicated (Basta *et al.*, 2011). Some studies from the United States of America have found that higher incidence of melanoma is associated with greater socioeconomic affluence (Clegg *et al.*, 2009; Hausauer *et al.*, 2011; Singh *et al.*, 2011). In the United Kingdom, the putative association between risk of melanoma and socioeconomic deprivation has only been studied at the Government Office Region level. The observed patterns were not clear at this large level of aggregation (Wallingford *et al.*, 2013). The possible roles that socioeconomic factors may have in the survival of patients diagnosed with malignant melanoma have not been investigated in the United Kingdom. In general, survival from most adult cancers has been found to be lower in areas of greater deprivation (Coleman *et al.*, 2004).

In light of the previous findings, this study aimed to test whether spatial variation in incidence and survival of cases of melanoma relate to area-level population density and area-level socioeconomic deprivation and provide context for the interpretation of lifestyle factors (e.g., for incidence, exposure to UVR). The following *a priori* hypotheses were examined: a main factor determining spatial variation of incidence of melanoma is modulated by differences in (i) less and more densely populated areas of residence and (ii) less and more socioeconomically deprived areas of residence; and a main factor determining spatial variation in survival from melanoma is modulated by differences in (iii) less and more densely populated areas of residence and (iv) less and more socio-economically deprived areas of residence. We have analyzed

[1]Institute of Health and Society, Newcastle University, Newcastle upon Tyne, UK; [2]School of Geography, University of Leeds, Leeds, UK and [3]Northern Institute of Cancer Research, Newcastle University, Newcastle upon Tyne, UK

Correspondence: Dr Richard JQ McNally, Institute of Health and Society, Newcastle University, Sir James Spence Institute, Royal Victoria Infirmary, Queen Victoria Road, Newcastle upon Tyne NE1 4LP, UK. E-mail: Richard.McNally@ncl.ac.uk

Abbreviations: CI, confidence interval; CL, confidence limit; HR, hazard ratio; NRYPMDR, Northern Region Young Persons' Malignant Disease Registry

Received 27 February 2014; revised 24 April 2014; accepted 8 May 2014; accepted article preview online 13 June 2014; published online 10 July 2014

data from the population-based Northern Region Young Persons' Malignant Disease Registry (NRYPMDR). The study describes socioeconomic patterning in the incidence of and survival from malignant melanoma in children and young people (aged 10–24 years), diagnosed while resident in Northern England.

RESULTS

Incidence

The study analyzed 224 cases of malignant melanoma diagnosed in those aged 10–24 years. There were 82 (37%) cases aged 10–19 years (30 males, 52 females), of whom 14 (17%) were aged 10–14 years, and 142 (63%) cases aged 20–24 years (36 males, 106 females). The overall age-standardized rate was 9.32 per million persons per year (95% confidence interval (CI) 8.10–10.54) for all cases aged 10–24 years. Case numbers, crude rates, and age-standardized rates by age group, gender, and period are presented in Table 1. Poisson regression analysis found that there was a significant increase in incidence of 4.8% per year (95% CI 3.4–6.2%) over the duration of the study (Figure 1). Furthermore, joinpoint regression revealed no evidence of discontinuities in the trend.

Age and gender both significantly improved the model fit for melanoma incidence ($P<0.001$ for both variables), with higher rates in females and higher rates for older ages. Period also significantly improved the model fit ($P<0.001$), with incidence increasing over time. The effect of gender was the same for all age groups, as an age by gender interaction was not significant ($P=0.338$) (Table 2, models 1–5). The composite Townsend score (Townsend *et al.*, 1988), as well as all individual components, significantly improved the model fit (Townsend: $P<0.001$; household overcrowding: $P<0.001$; non-home ownership: $P<0.001$; unemployment: $P<0.001$; non-car ownership: $P<0.001$) (Table 2, models 6–10). Population density and interactions between unemployment by age, unemployment by gender, and unemployment by period did not further improve the model (Table 2, models 11–14). The best-fitting model contained gender, age, period, and household unemployment together with spatial effects representing increased incidence for North Tyneside and for Redcar and Cleveland (Table 2, model 16). Table 3 presents relative risks for the final model (model 16), which showed that there was a statistically significant decreased risk associated with higher levels of unemployment (relative risk for 1% increase in the level of unemployment = 0.93; 95% CI 0.90–0.96; $P<0.001$). Figure 2 shows incidence rates, together with 95% CIs, by tertile of unemployment.

Table 1. Rates of malignant melanoma in Northern England by age, gender, and period during 1968–2003

	N	Population (000's)	Crude rate/ million	ASR (95% CI)
Age				
Ages 10–19	82	15,711.1	5.22	5.26 (4.12–6.40)
Ages 20–24	142	7,689.9	18.47	18.47 (15.27–21.28)
Gender				
Males	66	11,845.5	5.51	5.51 (4.18–6.84)
Females	158	11,555.6	13.18	13.18 (11.12–15.24)
Period				
1968–1976	29	6,350.9	4.57	4.67 (3.02–6.60)
1977–1985	39	6,482.3	6.02	5.89 (4.04–7.73)
1986–1994	65	5,529.5	11.76	10.75 (8.12–13.38)
1995–2003	91	5,038.3	18.06	17.90 (14.22–21.57)
Total	224	23,401.0	9.32	9.32 (8.10–10.54)

Abbreviations: ASR, age-standardized rate; CI, confidence interval; *N*, number of cases.

Survival

Age and gender did not improve the model fit for melanoma survival ($P=0.576$ and 0.075, respectively; Table 4, models 1 and 2). The composite Townsend score, as well as two individual components, significantly improved the model fit (Townsend: $P=0.026$; unemployment: $P=0.032$; household overcrowding: $P=0.006$; Table 4, models 4, 5, and 8). Population density, non-home ownership and non-car ownership did not further improve the model (Table 4, models 3, 6, and 7). The best-fitting model contained household overcrowding with linear variation in tertiles and an interaction with period (Table 4, model 20). Living in an area with greater levels of household overcrowding was associated with worse survival (hazard ratio (HR) per tertile of household overcrowding = 1.52; 95% CI 1.05–2.20; $P=0.026$), but this effect was reduced for the time period 1986–2003 (HR = 0.61; 95% CI 0.40–0.92; $P=0.018$; Figure 3).

DISCUSSION

This study presents small-area analysis of socioeconomic patterning in the incidence of and survival from malignant melanoma. It has been feasible because of the availability of highly accurate and complete cancer registration data from the NRYPMDR (a specialist regional population-based registry), together with matching census population and socioeconomic data. There were two significant findings: (a) decreased risk of melanoma was associated with residing in areas of greater unemployment; and (b) worse survival from

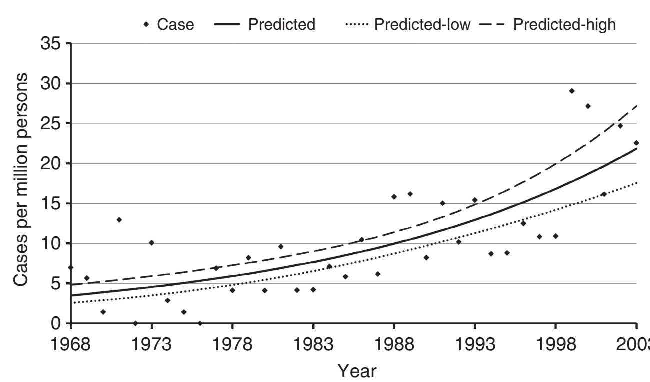

Figure 1. Trends over time for crude incidence (per million population) of malignant melanoma in the age group 10–24 years. Predicted-low, lower 95% confidence limit (CL); predicted-high, upper 95% CL.