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Spatial disparities in melanoma incidence and prognosis with consideration to stage at diagnosis, gender and marital status

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ABSTRACT

Screening strategies need to consider differences in late-stage disease detection linked to socio-demographic and geographic factors. We specifically addressed disparity in melanoma stage at diagnosis linked to residential municipality, gender and marital status within the middle- and old-age population of southern and western Sweden. Population-based registers were used to identify the melanoma cases diagnosed in 2004–2013 ($n = 7{,}417$). Disease mapping for each population group based on gender and marital status showed marked spatial disparities in melanoma incidences and the overall patterns differed by stage at diagnosis. The incidence of early-stage melanoma was markedly higher in the western region, whereas the incidence of late-stage melanoma was markedly higher in the southern region except for married women. Excess mortality among cases was observed to be higher in the southern than in the western region, with significant regional differences for the married male cases and the unmarried female cases.

1. Introduction

Malignant melanoma has shown increasing incidence rates in many western countries over the past 50 years (Erdmann et al., 2013). Socioeconomic inequalities in malignant melanoma have been described in relation to incidence, morbidity, mortality and survival; high socioeconomic status (SES) is associated with an increased incidence, whereas low SES is linked to late detection and an adverse prognosis (Jiang et al., 2015). In previous studies, SES based on area-level data, yielding e.g. a deprivation score, has commonly been assessed to all individuals living in a specific area (Jiang et al., 2015). Less commonly, individual-level data on SES have been available. Study reports on melanoma that have evaluated effects of both individual-level variables and living area (i.e., a "contextual" effect) are exceptional (Eriksson et al., 2013; Strömberg et al., 2016).

Several socio-demographic variables have been observed to be associated with melanoma incidence and prognosis. SES based on educational level, income or occupation has been studied extensively (Jiang et al., 2015). There is convincing evidence for gender differences in melanoma detection; men are generally diagnosed later with more advanced tumors (Balch et al., 2001; Eriksson et al., 2014). There is growing evidence that marital status may be associated with cancer survival (Aizer et al., 2013).

Abbreviations: CMM, cutaneous malignant melanoma; SES, socioeconomic status; SIR, standardized incidence ratio; SSHCR, Southern Swedish Health Care Region; WSHCR, Western Swedish Health Care Region.

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For melanoma, marital/cohabitation status has been linked to tumor thickness at detection and, among men, to survival (McLaughlin et al., 2011; Youl et al., 2011; Eriksson et al., 2014).

In Sweden the incidence of melanoma is increasing by ca. 5% annually and the total number of cases has increased by nearly 75% during the last decade. With the aim to provide data to support design of skin cancer prevention programs, we assessed melanoma-related health disparities in relation to residential municipality, using register data for nearly 10,000 cases in southern and western Sweden along with population data. In a previous analysis we found that the residential municipalities with an elevated incidence of melanoma generally appeared to be different from the residential municipalities with an elevated risk for late-stage melanomas specifically (Strömberg et al., 2016). In other words, we found that the spatial patterns of melanoma incidence per stage at diagnosis differed markedly. In the present paper we analyze spatial disparities in melanoma incidence per stage at diagnosis with population stratification on gender and marital status, and address the consequences of such disparities on excess mortality among the cases.

2. Materials and methods

2.1. Study area

The study area comprised the Southern and Western Swedish Health Care Regions, SSHCR and WSHCR (Fig. 1).

2.2. Case data

Based on unique Swedish identity numbers, data from the southern and the western parts of the population-based national Cancer Register, the Swedish Melanoma Register and Statistics Sweden's registers were linked. We have identified all cases aged ≥15 years with a first, primary invasive cutaneous malignant melanoma (CMM) diagnosed between January 1, 2004, and December 31, 2013, who resided in the study area at the time of diagnosis ($n = 10{,}621$) (Strömberg et al., 2016). There may be a few of those cases who have a previous melanoma diagnosis, as we did not have information on cancer diagnoses registered for residents outside the study area. Eligible for the present analysis were all cases aged 50 years or older, considered to be a relevant age-span for studying "exposure" by marital status with links to late detection of melanoma. Data on diagnosis, sex, age and residential municipality were obtained from the Cancer Register, whereas data on marital status were obtained from Statistics Sweden. Marital status at the end of diagnosis year was thereby obtained. Marital status was classified as married or unmarried (i.e., not living as married, comprising never married and divorced persons, and widow/widower). Information providing assessment of melanoma stage at diagnosis, according to the 2002 American Joint Committee on Cancer system (Balch et al., 2001), was obtained from the Swedish Melanoma Register. Generally speaking, a melanoma ≤1 mm thick, or ≤2 mm if not ulcerated (i.e., the covering layer of skin over the tumor is not broken) is classified as *stage I*; a melanoma with greater thickness but with no sign that it has spread to lymph nodes or other parts of the body is classified as *stage II*; a melanoma that has spread into lymph nodes is classified as *stage III*; and a melanoma that has spread elsewhere in the body is classified as *stage IV*. The present analysis included 7417 cases with data on stage at diagnosis.

Information on vital status was obtained from Statistics Sweden and the follow-up data were assessed by survival times (all-cause of death as the end point); censoring of survival times at date of emigration or December 31, 2014.

2.3. Population data

The study population consisted of all inhabitants ≥50 years of age within the study area (0.67 million in 2013). Statistics Sweden provided the population data needed for incidence calculations, i.e., population size by municipality, sex, 5-year age groups and marital status.

2.4. Ethical approval

The study was approved by the Regional Ethical Review Board, Lund, Sweden.

2.5. Statistical methods

Disease maps depicting how the incidence of first, primary invasive CMM in relation to stage at diagnosis, gender and marital status varied across the 101 residential municipalities were produced by hierarchical Bayes estimation based on the standardized incidence ratios (SIRs). More precisely, for melanomas detected at stage I, stage II and stage III-IV, respectively, the expected number of such cases in each residential area was calculated from the sex, age (15–19, 20–24,..., 85–89, 90+) and marital status specific incidences in the total study population. The relative risk parameters λ_i for each area $i = 1, 2,..., 101$ were estimated by the smoothed SIRs obtained from the Besag–York–Mollié (BYM) model (Besag et al., 1991). We thereby assume that the observed number of cases in area i, Oi ∼ Poisson(λi Ei), with prior λi ∼ Gamma(α, β). The BYM model specifies hyperprior distributions for α and β, with a spatial correlation pattern (Besag et al., 1991); the posterior has no closed analytical form and estimation is accomplished by using the WinBUGS software for Bayesian analysis. The Rapid Inquiry Facility program was used for the disease-mapping (Beale et al., 2008). Along with a disease map, the corresponding statistical certainty map was produced based on the posterior probabilities: Each residential area with $\Pr(\lambda_i > 1|\text{data}) > 0.80$ was colored *red*, each area with $\Pr(\lambda_i > 1|\text{data}) < 0.20$ was colored *green* and the remaining areas were colored *yellow*. The choice of 0.80 for identifying an elevated incidence area (or 0.20 for identifying a lowered incidence area) has been shown to provide a cut-off with reasonable sensitivity and high specificity (Richardson et al., 2004). The statistical certainty maps were used to identify geographic disparities in melanoma incidences with consideration to stage at diagnosis, gender and marital status.

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