



# Incidence and Trends of Basal Cell Carcinoma and Cutaneous Squamous Cell Carcinoma: A Population-Based Study in Olmsted County, Minnesota, 2000 to 2010

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## Abstract

**Objective:** To determine population-based incidence estimates of basal cell carcinoma (BCC) and cutaneous squamous cell carcinoma (cSCC).

**Patients and Methods:** We reviewed the medical records of a population-based cohort diagnosed with nonmelanoma skin cancer between January 2, 2000, and December 31, 2010. The age- and sex-adjusted incidence rates were calculated and compared with estimates from previous periods.

**Results:** The age-adjusted BCC incidence (cases per 100,000 person-years) was 360.0 (95% CI, 342.5-377.4) in men and 292.9 (95% CI, 278.6-307.1) in women. The age-adjusted cSCC incidence (cases per 100,000 person-years) was 207.5 (95% CI, 193.9-221.1) in men and 128.8 (95% CI, 119.4-138.2) in women. From years 1976 to 1984 to years 2000 to 2010, the age- and sex-adjusted incidence (cases per 100,000 person-years) of BCC increased from 222.0 (95% CI, 204.5-239.5) to 321.2 (95% CI, 310.3-332.2) and that of cSCC from 61.8 (95% CI, 52.3-71.4) to 162.5 (95% CI, 154.6-170.3). Over time, the anatomical distribution of BCC shifted from the head and neck to the torso and that of cSCC shifted from the head and neck to the extremities.

**Conclusion:** The incidences of BCC and cSCC are increasing, with a disproportionate increase in cSCC relative to BCC. There is also a disproportionate increase in the incidence of both tumors in women, as well as a shift of anatomical distributions.

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Nonmelanoma skin cancer (NMSC) has a higher prevalence in whites than all other cancers combined.<sup>1,2</sup> The absence of an NMSC registry<sup>1,3-6</sup> necessitates estimates of incidence rates that are discrepant. The World Health Organization<sup>7</sup> estimates that 2 to 3 million NMSCs occur annually worldwide; others<sup>6</sup> estimate that 5.4 million NMSCs occur annually in the United States alone. Recent estimates suggest that between 186,157 and 700,000 cutaneous squamous cell carcinomas (cSCCs) are diagnosed annually in the United States.<sup>2,8</sup> Studies<sup>3,8-17</sup> from around the world have described an increasing incidence of NMSC.

The last population-based incidence studies<sup>18,19</sup> in the United States used 1976

to 1984 data for basal cell carcinoma (BCC) and 1984 to 1992 data for cSCC. The primary aim of the present study was to determine the sex- and age-adjusted population-based incidence and trends of BCC and cSCC in Olmsted County, Minnesota, from 2000 through 2010.

## PATIENTS AND METHODS

### Study Setting

In 2010, Olmsted County had a population of 144,248.<sup>20</sup> Although the average socioeconomic status, proportion of college graduates, and proportion of non-Hispanic whites are higher than national averages, epidemiological studies<sup>21</sup> in Olmsted County

have historically been consistent with national data.

This study was approved by the Mayo Clinic and Olmsted Medical Center institutional review boards. A retrospective population-based cohort was identified through the Rochester Epidemiology Project,<sup>22</sup> a research infrastructure (R01-AG034676) that captures health care information for virtually all residents of Olmsted County from 1966 to the present, with 93% of Olmsted County residents seeing any health care provider within the previous 3 years.

### Study Criteria

Using the Rochester Epidemiology Project, all medical records were identified for Olmsted County residents who received an *International Classification of Diseases, Ninth Revision* code diagnosis of 173.00 to 173.99 from January 2, 2000, through December 31, 2010. An NMSC was considered incident if it was a patient's first BCC or cSCC and was diagnosed during the study period while the patient resided in Olmsted County. A patient could have an incident BCC or cSCC (or both) during the study period. Exclusion criteria included the following: (1) younger than 18 years; (2) cSCC in situ; (3) no BCC or invasive cSCC; (4) previous diagnosis of BCC or cSCC before January 2, 2000; (5) anogenital location; (6) not an Olmsted County resident at the time of incident tumor diagnosis; (7) genetic disorder predisposing to NMSC; (8) previous radiotherapy to the area of tumor formation; and (9) denial of medical record access for research purposes.

### Data Collection

Medical records were reviewed by an abstractor (J.G.M. or A.R.S.). The following data were collected: age at diagnosis, sex, race, and previous diagnosis of melanoma. The number of incident tumors, location, size, and histologic subtype were documented for BCC and cSCC, and acantholysis and perineural invasion were documented for cSCC only. For patients with multiple incident tumors, 1 tumor was randomly selected for data collection with a Web-based randomization program.<sup>23</sup> Dates were collected for local recurrence, nodal recurrence, distant metastasis, and most recent relevant clinical follow-up with a dermatologist or

primary care provider for skin examination. All data were entered into the Research Electronic Data Capture hosted at Mayo Clinic.

### Statistical Analyses

Data for BCC and cSCC were analyzed separately. The age- and sex-specific incidence rates (cases per 100,000 person-years) in Olmsted County were calculated, with the numerator being the number of persons who had an incident BCC or cSCC diagnosis and the denominator being the age- and sex-specific counts of the Olmsted County population (from decennial census data and linear interpolation for intercensal years). The rates were adjusted for age and sex according to 2010 US population data; a Poisson error distribution was assumed for 95% CIs. Generalized linear regression models were used to evaluate incidence rates in relation to sex and age (Poisson error distribution was assumed, with crude incidence counts for sex and age groups, offset by the natural logarithm of the number of people).

To facilitate the comparison of incidence estimates for the 2000 to 2010 period with those from earlier periods, previous incidence rates were recalculated after limiting the cases in the previous periods to patients aged 18 years or older and using the total US population structure in 2010 to obtain age- and sex-adjusted estimates. For BCC, incident cases from Rochester were available for the 1976 to 1984 period.<sup>18</sup> For cSCC, incident cases from Rochester were available for the 1976 to 1984 and 1984 to 1992 periods and are reported for the 1976 to 1984 and 1985 to 1992 periods.<sup>19</sup> In addition, BCC and cSCC incident cases from patients between the ages of 18 and 39 years were available for the 1976 to 1999 period for all of Olmsted County.<sup>24</sup> Denominators for each cohort were obtained from the decennial census for Rochester and Olmsted County, with linear interpolation between census years.

Associations between histologic subtype, tumor site, and sex were evaluated using chi-square tests. For the 2000 to 2010 cohort, the duration of follow-up was calculated from the date of the incident BCC or cSCC diagnosis to the date of recurrence or last relevant clinical follow-up. The cumulative

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