

# Keratinocyte carcinomas: A 5-year retrospective review of prevalence among urban versus rural patients

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## Abstract

**Background:** A history of significant sun exposure in patients is a crucial factor for the development of keratinocyte carcinomas (KCs) in one's lifetime. Because of this, patients living in rural areas with outdoor-based activities could be assumed to develop more KCs.

**Objectives:** To determine whether patients living in rural areas develop more KCs relative to patients living in urban areas.

**Methods:** We conducted a retrospective review of the patient database at a private dermatology

practice over a five-year period to determine the number of KCs diagnosed and number of patients diagnosed with KCs. Patients were determined to reside in rural or urban based on ZIP codes.

**Results:** 11,646 KCs were diagnosed in 5,821 patients over a 5-year period. There was significantly higher BCCs in both rural and urban populations compared to SCCs ( $p < 0.001$ ). However, there was no significant difference between basal cell carcinoma or squamous cell carcinoma based on urban or rural status.

**Conclusions:** No difference was found in the overall number of KCs diagnosed in patients residing in rural versus urban areas. Despite this, dermatologists should recognize the risk of KC development in both rural and urban settings in order to equitably distribute dermatologic surgery skillsets.

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**Categories:** Dermatology, Public Health

**Keywords:** recreational activities, skin cancer, squamous cell carcinomas, keratinocyte carcinomas, basal cell carcinomas

## Introduction

Skin cancer is the most common cancer in the United States, with millions of diagnoses made each year. In many cases, individual patients are diagnosed with more than one skin cancer. Basal cell carcinomas (BCCs) and squamous cell carcinomas (SCCs) are the two most common types of skin cancer, constituting a larger group of malignancies termed keratinocyte carcinomas (KCs) due to their origin. The increasing incidence of these skin cancers continues to put a strain on the healthcare system; in 2019 alone, 525 BCCs and 262 SCCs per 100,000 persons were diagnosed in the United States [1], and treatment of these non-melanoma skin cancers cost the health care system a staggering \$4.8 billion in 2011 [2]. Understanding the factors that contribute to the development of KCs is vital so that resources can be appropriately allocated to ensure that patients receive proper and timely treatment, and to decrease burden on the patient as well as the healthcare system. Many studies have been conducted to determine what factors contribute to the risk of development of KCs, including genetic variations [3], past medical history (ie. transplant history [4,5]), and importantly, sun exposure. UVA and UVB rays from sunlight cause extensive damage to the skin and increase the risk of acquiring both non-melanoma skin cancers like KCs and melanomas [6]. Because of this, patients living in rural areas with outdoor-based activities could be assumed to develop more KCs. The purpose of this study was to objectively determine if there is a difference in the number of KCs that patients develop as well as a difference in the number of BCCs versus SCCs that patients develop based on urban

versus rural ZIP Code status.

## Materials And Methods

A single-institution, retrospective review at a private practice dermatology clinic in Lubbock, Texas was performed to identify all KCs diagnosed during the 5-year period from January 1st, 2017 to December 31st, 2021. 11,646 total KCs were diagnosed in 5,821 patients. Exclusion criteria included patients for which geographic data could not be determined. All insurances including Medicare, and Medicaid were accepted during the study period. The ZIP codes identified for each of these KCs were then used to determine urban or rural locality. In order to make this determination of urban versus rural locality, ProximityOne, a nationally available database, determined ZIP Codes as being urban or rural, or some proportion thereof using 2010 U.S. consensus data [7]. In cases where the geographic determination was a proportion, the patient ZIP Codes were proportioned equivalently. Data on patients and their KCs was collected using specialized search parameters in a proprietary electronic medical record (EMR) that was created by the practice owner. KCs were classified as either BCC or SCC, and the corresponding patient was determined to reside in an urban or rural area based on the nationally available zip code data. Average number of BCC and SCC were compared using independent sample t-tests with Welch-Satterthwaite correction (continuous variables) in R.

## Results

During the 5-year period reviewed, 11,646 KCs were diagnosed in 5,821 patients. Of these 11,646 KCs, 6,932 were BCCs and 4,714 were SCCs. At least one KC was diagnosed in each of the 5,821 patients identified, with an average of 2.00 KCs diagnosed per patient. An average of 1.19 BCCs and 0.81 SCCs were diagnosed per patient, which was statistically significant ( $t = 13.555, p = 0.001$ ). The geographic breakdown of patients with at least 1 KC over the 5-year period is shown in Tables I and II. Notably, there was no significant difference between BCC or SCC based on urban or rural status ( $t = -0.736, p = 0.462$  and  $t = 0.783, p = 0.433$ , respectively).

Urban keratinocyte carcinoma statistics		P-value/t-value
Total number of urban patients	4287	
Total number of urban KCs	8578	
Urban BCC rate (per patient)	1.18	0.001/11.116
Urban SCC rate (per patient)	0.82	
Overall urban KC rate (per patient)	2.00	

**TABLE 1: Breakdown of keratinocyte carcinomas by urban locality.**

Rural keratinocyte carcinoma statistics		P-value/t-value
Total number of patients	1522	
Total number of rural KCs	3053	
Rural BCC rate (per patient)	1.22	0.001/7.758
Rural SCC rate (per patient)	0.79	
Overall rural KC rate (per patient)	2.01	

**TABLE 2: Breakdown of keratinocyte carcinomas by rural locality.**

## Discussion

As the number of KC diagnoses continues to increase in the United States, it is worthwhile knowing which groups of patients may be at risk for developing more KCs. As mentioned earlier, important factors for the development of KCs include genetics, a history of transplantation and/or immunosuppression, and sun exposure. Given the known association between excess cumulative UV exposure and the development of skin cancers, the question arises as to whether geographic variation contributes to these numbers. Certain cancers, specifically melanomas, vary intra-regionally based on urban and rural status of patients as well as

patient's recreational activities [8-11]. Thus far, however, no studies have been done to examine possible intraregional differences (ie. rural versus urban geographic distribution) that may contribute to the risk of developing KCs, specifically BCCs and SCCs, among patients. Based on what we know about the effects of sun exposure, as well as what we commonly expect to see vocationally in rural versus urban settings, we hypothesized that patients who live in rural settings will develop more KCs than urban patients, as these cancers are typically associated with outdoor occupations and activities. This study sought to answer this question by determining if there was a difference in the number or type of KCs per patient based on urban versus rural status once a patient has had a KC.

Despite our hypothesis, we found that 2.00 KCs per patient were diagnosed during this 5-year review, regardless of where they lived. Of interest, BCCs represented 59.5% and SCCs represented 40.5% of these KCs. Although BCC is still diagnosed more commonly than SCC [12], in our data set, the differences were not as significant as previously reported. This data also shows that once a patient has had a KC, almost all of them all develop a second KC within five years. When comparing KC rates based on geographic distribution, the number of KCs among urban patients was not significantly different from the number of KCs seen among rural patients. Also, the percentage of BCCs versus SCCs did not differ significantly between urban and rural patients. Furthermore, this study demonstrated that urban patients, once they have had a KC, are at a similar risk as rural patients for developing another KC, and most of them will develop a second KC within 5 years.

There are several possible reasons to explain the findings of our study, which differed from our initial hypothesis that rural patients develop more KCs than urban patient. The first factor to consider is the occupation of the patients seen at our private dermatology practice. Although we assumed that rural patients tend to have occupations such as farming, ranching and other agricultural jobs that increase their sun exposure, it is possible that some of the "urban" patients may have similar amounts of sun exposure through occupations such as construction, homebuilding, etc. or through activities such as running, rowing, biking, etc. The Lubbock, Texas metropolitan statistical area has an estimated population of 322,257 [13] and covers a relatively large geographic area encompassing 6,961 square kilometers [14]. Texas Tech Health University Sciences Center and the affiliated University Medical Center provides care for patients in more than 100 counties in West Texas and Eastern New Mexico and is the only level 1 trauma center in a 300-mile radius. There are approximately 3.41 practicing dermatologists per 100,000 population (11 dermatologists in Lubbock proper) which is lower than the recommend 4 dermatologists per 100,000 population to adequately meet demand [15]. Many patients who were designated as living in "urban" areas live on larger plots of land within or just outside of the city and engage in outdoor activities. Additionally, sun exposure, especially during childhood, is a significant risk factor for development of BCCs, specifically, in adult patients [16]. Childhood sun exposure is not a factor accounted for in the study. It is also important to note that patients deemed urban may have spent little or much time in a rural setting prior to this study, and vice versa. Other confounding factors not accounted for in this study include age, immunosuppression status, and the impact of the pandemic during which patients may have had limited access to healthcare or avoided seeking medical care in general.

No significant difference was found among patients with KCs based on their ZIP code-determined status, which may be partially explained by the fact that Lubbock has a relatively high number of practicing dermatologists compared to other towns in the West Texas and Panhandle areas. Patients in the surrounding counties are accustomed to traveling far distances to seek out medical care, which may contribute to the reason no difference was found between KCs in urban vs rural areas. Additionally, this study did not capture patients living in rural areas who are unable to travel for medical care, many of whom may have skin cancers that go untreated. Nonetheless, this data is important for corroborating and justifying that rural patients require just as much dermatologic care as urban patients. Despite this necessity, the distribution of the Mohs micrographic surgeon workforce remains unbalanced. Feng et al. found that Mohs surgeons are highly concentrated in urban areas, and only 0.4% of Mohs surgeon practice in rural areas [17], creating a potential barrier for rural patients in situations when Mohs micrographic surgery (MMS) is indicated. Lubbock, Texas, is unique in that most of the practicing dermatologists perform Mohs surgery, thereby eliminating a potential barrier seen in other urban areas.

A limitation of this study is that it is a single-institution, retrospective 5-year review at a private practice with two board certified (dermatology and micrographic dermatologic surgery) dermatologists and three dermatology mid-levels. The Lubbock metropolitan area is unique in that it is isolated from other urban areas in the state of Texas by many miles, so the results may not be applicable elsewhere. Of the nonmelanoma skin cancers (NMSC), only KCs (BCCs and SCCs), for which we could determine urban or rural status, are included in this review. Age, occupation and immunosuppression data among urban and rural patients was not included, all of which could serve as confounding variables in this study. Also, the ZIP Code status was determined for each KC based on the patient's address at the time of their last visit to the clinic.

## Conclusions

In this retrospective review, among patients with a history of KCs, there was no significant difference in the number of KCs based on geographic categorization of residence (rural versus urban). This may be due to

various reasons, including the effect of occupation on sun exposure as well as previous history of where patients lived, and the high percentage of practicing dermatologists who perform MMS in our region, among others. Larger scale, multi-center studies may help to elucidate whether this intra-variability (or lack thereof) remains true in different geographic regions. This study should encourage dermatologists to recognize the risk of KC development in both rural and urban settings, hopefully leading to equitable distribution of dermatologic surgery skillsets throughout the country.

## Additional Information

### Disclosures

**Human subjects:** All authors have confirmed that this study did not involve human participants or tissue.

**Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue.

**Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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