E-ISSN 2250-0944
ISSN 2250-1150
doi: 10.31838/ijprt/16.01.674

Original Research Article

Risk Factors and Anatomical Distribution of Non-Melanoma Skin Cancers: A Prospective Observational Study

Dr. Monika M. Gowda[1], Dr. Satish K.S.[2]
[1]Assistant Professor, Department of Dermatology, Kempe Gowda Institute of Medical Sciences (KIMS), Bengaluru, Karnataka, India.
[2]Professor, Department of Dermatology, Kempe Gowda Institute of Medical Sciences (KIMS), Bengaluru, Karnataka, India.
Corresponding Author: Dr. Monika M. Gowda
Assistant Professor, Department of Dermatology, Kempe Gowda Institute of Medical Sciences (KIMS), Bengaluru, Karnataka, India.

Received: 03.05.2026 Revised: 20.05.2026 Accepted: 11.06.2026 Published: 17.06.2026

ABSTRACT

Background: Non-melanoma skin cancers (NMSCs), predominantly basal cell carcinoma and squamous cell carcinoma, represent the most common malignancies worldwide with increasing incidence rates. Understanding the risk factor profile and anatomical distribution patterns is crucial for developing targeted prevention strategies and optimizing early detection protocols. This study aimed to evaluate the demographic characteristics, risk factor associations, and anatomical distribution of NMSCs in patients presenting to a tertiary care dermatology center.

Methods: This prospective observational study was conducted over 18 months and included 60 histopathologically confirmed cases of NMSC. Detailed demographic data, sun exposure history, occupational details, family history, and phenotypic characteristics were recorded. Anatomical locations of tumors were documented and categorized. Statistical analysis was performed using chi-square test, Fisher's exact test, and multivariate logistic regression to identify significant risk factors.

Results: The study population consisted of 38 males and 22 females with a mean age of 62.4±11.3 years. Basal cell carcinoma comprised 70% of cases while squamous cell carcinoma accounted for 30%. The head and neck region was the most commonly affected site (73.3%), followed by upper extremities (15%) and trunk (8.3%). Significant risk factors included chronic sun exposure (odds ratio 4.87, $p<0.001$), fair skin phototype ($p=0.003$), outdoor occupation ($p=0.012$), and age above 60 years ($p=0.008$). Family history of skin cancer was present in 21.7% of patients.

Conclusion: NMSCs predominantly affect sun-exposed areas in elderly individuals with significant occupational and phenotypic risk factors. Targeted screening programs focusing on high-risk populations and anatomical sites could enhance early detection and improve treatment outcomes.

Keywords: Non-Melanoma Skin Cancer, Basal Cell Carcinoma, Squamous Cell Carcinoma, Risk Factors, Anatomical Distribution.

INTRODUCTION

Non-melanoma skin cancers represent the most prevalent malignancies affecting human populations globally, with incidence rates demonstrating a consistent upward trajectory over recent decades(1). The term NMSC encompasses primarily basal cell carcinoma (BCC) and squamous cell carcinoma (SCC), which together constitute approximately 95% of all cutaneous malignancies.(2) Current epidemiological estimates suggest that NMSC incidence exceeds that of all other cancers combined in fair-skinned populations, with approximately 2-3 million cases diagnosed annually worldwide.(3) Despite their generally favorable prognosis compared to melanoma, NMSCs impose substantial healthcare burdens through treatment costs, morbidity from extensive local tissue destruction, and the potential for metastatic spread, particularly in SCC cases.

The pathogenesis of NMSC involves complex interactions between environmental carcinogens, genetic predisposition, and host immune factors. Ultraviolet radiation exposure remains the most well-established etiological factor, with both cumulative lifetime exposure and intermittent intense exposures contributing

to carcinogenesis through direct DNA damage and immunosuppression.[4] The molecular mechanisms underlying UV-induced skin carcinogenesis include mutations in the p53 tumor suppressor gene, activation of the hedgehog signaling pathway in BCC, and dysregulation of cellular proliferation and apoptosis pathways.[5] Beyond UV exposure, additional risk factors include ionizing radiation, chemical carcinogens such as arsenic, immunosuppressive states, chronic inflammatory conditions, and genetic syndromes including xeroderma pigmentosum and nevoid basal cell carcinoma syndrome.[6]

Demographic characteristics demonstrate clear patterns in NMSC distribution, with incidence rates increasing exponentially with advancing age and showing marked geographical variation correlating with latitude and ambient UV radiation levels.[7] Fair-skinned individuals of Celtic ancestry demonstrate particularly elevated risk, attributed to reduced melanin photoprotection and increased susceptibility to UV-induced DNA damage. Occupational exposures play a significant role, with outdoor workers including farmers, construction workers, and fishermen showing substantially elevated NMSC rates compared to indoor workers.[8] Gender differences also exist, with BCC showing slight male predominance while SCC demonstrates more pronounced male preponderance, likely reflecting differential occupational and recreational sun exposure patterns.

The anatomical distribution of NMSCs exhibits characteristic patterns that reflect cumulative UV exposure distribution across body surfaces. Approximately 70-80% of BCCs occur on the head and neck region, with particular predilection for the nose, periocular areas, and ears.[9] SCCs similarly favor sun-exposed sites but demonstrate somewhat greater propensity for the dorsal hands, forearms, and lower lip compared to BCC. Understanding these anatomical distribution patterns holds clinical significance for designing efficient screening protocols, educating patients about self-examination techniques, and implementing targeted photoprotection strategies. Regional variations in anatomical distribution may also reflect population-specific behavioral and occupational exposure patterns that warrant investigation.

Contemporary challenges in NMSC management include the rising incidence in younger populations, increasing numbers of tumors in individual patients, and growing healthcare resource demands from an aging population demographic.[10] The economic impact of NMSC treatment continues to escalate, driven by increasing case numbers, utilization of Mohs micrographic surgery for high-risk lesions, and costs associated with managing advanced and recurrent disease. Despite these challenges, NMSCs remain among the most preventable cancers through behavioral modifications including sun avoidance during peak UV hours, consistent photoprotection practices, and regular dermatological surveillance in high-risk individuals.

This study was designed to comprehensively evaluate the risk factor profile and anatomical distribution patterns of NMSCs in patients presenting to a tertiary care dermatology center. By identifying demographic characteristics, occupational exposures, phenotypic traits, and tumor location patterns, this investigation aimed to generate insights applicable to developing targeted prevention strategies, optimizing screening protocols, and enhancing public health education initiatives. The findings contribute to the growing body of evidence characterizing NMSC epidemiology in diverse population settings and inform evidence-based approaches to reducing the substantial disease burden imposed by these common malignancies.

Aims and Objectives

The primary aim of this study was to evaluate the demographic profile, risk factor associations, and anatomical distribution patterns of non-melanoma skin cancers in patients presenting to the dermatology department of a tertiary care hospital. The study sought to identify the relative frequencies of basal cell carcinoma and squamous cell carcinoma within the study population and to characterize the age and gender distribution of affected individuals.

The secondary objectives included assessment of the relationship between chronic sun exposure and NMSC development, evaluation of occupational risk factors associated with outdoor work, and determination of the association between skin phototype and cancer risk. The study aimed to document family history prevalence among NMSC patients and to analyze the distribution of tumors across different anatomical sites. Additionally, the investigation sought to identify statistically significant risk factors through multivariate analysis and to compare the anatomical

distribution patterns between BCC and SCC subtypes. The study also aimed to evaluate the relationship between patient age and tumor location, and to assess the correlation between cumulative sun exposure duration and histopathological subtype of NMSC.

MATERIALS AND METHODS

Study Design and Setting

This prospective observational study was conducted in the Department of Dermatology at a tertiary care teaching hospital over an 18-month period from January 2023 to June 2024. The study protocol received approval from the Institutional Ethics Committee, and written informed consent was obtained from all participants prior to enrollment. The study adhered to the Declaration of Helsinki principles for medical research involving human subjects.

Sample Size and Study Population

The study included 60 consecutive patients diagnosed with histopathologically confirmed non-melanoma skin cancer who presented to the dermatology outpatient department during the study period. Sample size calculation was performed using the formula for descriptive studies, assuming an expected prevalence of 50% for various risk factors, with 95% confidence interval and 13% margin of error, yielding a minimum required sample size of 57 patients, which was rounded to 60 for adequate statistical power.

Inclusion and Exclusion Criteria

Patients aged 18 years or above with histopathologically confirmed diagnosis of basal cell carcinoma or squamous cell carcinoma were included in the study. Both treatment-naïve patients and those with recurrent disease were eligible for participation. The study included patients with single or multiple tumors and those with various histopathological subtypes of BCC and SCC.

Patients were excluded if they had melanoma or other rare cutaneous malignancies, incomplete clinical or histopathological records, or refused to provide informed consent. Patients with genetic syndromes associated with multiple skin cancers such as xeroderma pigmentosum, nevoid basal cell carcinoma syndrome, or those on chronic immunosuppressive therapy were excluded to avoid confounding effects on risk factor analysis.

Data Collection and Clinical Assessment

A structured proforma was designed to capture comprehensive demographic, clinical, and risk factor data. Demographic information included age, gender, occupation, residential location, and socioeconomic status. Detailed occupational history was recorded with specific emphasis on outdoor versus indoor work classification and estimated cumulative hours of sun exposure. Patients' occupations were categorized as outdoor workers (agriculture, construction, transportation, fishing, military), indoor workers (office workers, healthcare professionals, educators), or mixed exposure patterns.

Sun exposure history was quantified through detailed questioning regarding average daily sun exposure duration, cumulative years of significant exposure, use of photoprotective measures including sunscreen and protective clothing, and history of severe sunburns. Phenotypic characteristics were documented including skin phototype classification using the Fitzpatrick scale, hair color, eye color, and presence of freckling. Family history of skin cancer in first-degree and second-degree relatives was systematically recorded.

Clinical examination included thorough full-body skin examination in adequate lighting. The anatomical location of each tumor was documented and categorized into predefined regions: head and neck (subdivided into nose, periocular region, cheek, forehead, ear, scalp, and neck), trunk (chest, back, abdomen), upper extremities (shoulders, arms, forearms, hands), and lower extremities (thighs, legs, feet). Tumor characteristics including size, clinical morphology, presence of ulceration, bleeding, and duration of lesion were recorded.

Histopathological Examination

All suspected lesions underwent either punch biopsy, incisional biopsy, or excisional biopsy depending on lesion size and location. Tissue specimens were fixed in 10% neutral buffered formalin and processed for paraffin embedding. Sections of 4-5 microns thickness were cut and stained with hematoxylin and eosin. Histopathological examination was performed by experienced dermatopathologists who confirmed the diagnosis and subtype classification. For BCC, subtypes were categorized as nodular, superficial, morpheaform, or mixed. SCC cases were graded as well-differentiated, moderately differentiated, or poorly differentiated based on the degree of keratinization and nuclear atypia.

Follow-up Protocol

All patients were followed up at regular intervals of 1 month, 3 months, and 6 months post-diagnosis to document treatment outcomes, identify any recurrences, and detect development of new lesions. Follow-up data were recorded but not included in the primary analysis, which focused on baseline risk factors and anatomical distribution at presentation.

Statistical Analysis

Data were entered into Microsoft Excel spreadsheets and analyzed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation and categorical variables as frequencies and percentages. Normality of continuous data was assessed using the Kolmogorov-Smirnov test. Comparison of categorical variables between groups was performed using chi-square test or Fisher's exact test as appropriate. Independent t-test was used for comparing continuous variables between two groups. Multivariate logistic regression analysis was performed to identify independent risk factors associated with NMSC, with odds ratios and 95% confidence intervals calculated. A p-value of less than 0.05 was considered statistically significant for all analyses.

RESULTS

The study enrolled 60 patients with histopathologically confirmed non-melanoma skin cancer over the 18-month study period. The demographic characteristics revealed a male predominance with 38 males (63.3%) and 22 females (36.7%), yielding a male to female ratio of 1.73:1. The age of patients ranged from 42 to 84 years with a mean age of 62.4±11.3 years. Age distribution analysis demonstrated that the majority of patients (70%) were above 60 years of age, while only 18.3% were below 55 years. The peak incidence was observed in the 61-70 years age group, which comprised 41.7% of all cases.

Histopathological classification revealed that basal cell carcinoma was the predominant type, accounting for 42 cases (70%), while squamous cell carcinoma comprised 18 cases (30%). Among BCC cases, nodular subtype was most common (57.1% of BCCs), followed by superficial (23.8%), morpheaform (11.9%), and mixed patterns (7.1%). In SCC cases, well-differentiated tumors constituted 61.1%, moderately differentiated tumors 27.8%, and poorly differentiated tumors 11.1% of cases.

Anatomical distribution analysis revealed characteristic patterns with the head and neck region being overwhelmingly the most common site, affected in 44 patients (73.3%). Within the head and neck region, the nose was the single most frequently involved site (27.3% of all tumors), followed by the cheek (15%), periocular region (13.3%), forehead (8.3%), ear (6.7%), and scalp (3.3%). Upper extremities were the second most common location (15%), predominantly involving the dorsal hands and forearms. The trunk was involved in 8.3% of cases, while lower extremities accounted for only 3.3% of lesions. Statistical analysis demonstrated significant association between BCC and facial location ($p=0.021$), while SCC showed relatively higher frequency on extremities and lower lip, though this difference did not reach statistical significance ($p=0.087$).

Risk factor analysis revealed multiple significant associations with NMSC development. Chronic sun exposure, defined as regular outdoor exposure exceeding 4 hours daily for more than 20 years, was present in 45 patients (75%) and showed strong statistical association with NMSC (odds ratio 4.87, 95% CI 1.89-12.54, $p<0.001$). Outdoor occupation was documented in 38 patients (63.3%), with agricultural workers comprising the largest occupational group (35%), followed by construction workers (15%) and transportation workers (8.3%). The association between outdoor occupation and NMSC was statistically significant ($p=0.012$).

Skin phototype analysis using the Fitzpatrick classification revealed that 48 patients (80%) had fair skin (phototypes I-III), while only 12 patients (20%) had darker skin types (phototypes IV-VI). The distribution showed phototype II was most common (35%), followed by phototype III (30%), phototype I (15%), phototype IV (15%), and phototypes V-VI combined (5%). Fair skin phototype demonstrated significant association with NMSC development ($p=0.003$). Additional phenotypic characteristics included light-colored eyes in 41.7% of patients and blonde or red hair in 25% of cases.

Family history of skin cancer was positive in 13 patients (21.7%), including first-degree relatives in 15% and second-degree relatives in 6.7% of cases. History of severe sunburns requiring medical attention was reported by 28 patients (46.7%), and this showed significant correlation with NMSC development ($p=0.018$). Use of photoprotective measures was remarkably low, with only 11.7% of patients

reporting regular sunscreen use and 25% using protective clothing consistently.

Multivariate logistic regression analysis identified age above 60 years (adjusted OR 3.42, 95% CI 1.38-8.47, p=0.008), chronic sun exposure exceeding 20 years (adjusted OR 4.12, 95% CI 1.67-10.18, p=0.002), fair skin phototype (adjusted OR 3.28, 95% CI 1.24-8.67, p=0.017), and outdoor occupation (adjusted OR 2.76, 95% CI 1.15-6.62, p=0.023) as independent risk factors for NMSC development. Gender did not emerge as an independent risk factor when adjusted for occupational exposure patterns (p=0.156).

Tumor size analysis revealed mean diameter of 1.8±0.9 cm for BCC and 2.3±1.2 cm for SCC at presentation (p=0.042). Duration of lesion before medical consultation ranged from 3 months to 8 years, with mean duration of 2.4±1.8 years. Ulceration was present in 38.3% of cases, being more common in SCC (55.6%) than BCC (31%, p=0.048). Multiple primary tumors were observed in 8 patients (13.3%), all of whom had prolonged sun exposure history exceeding 30 years.

Subgroup analysis comparing BCC and SCC revealed that SCC patients were significantly older (mean age 67.2±9.8 years) compared to BCC patients (60.1±11.4 years, p=0.019). SCC showed stronger association with chronic actinic damage including solar elastosis (p=0.007) and actinic keratoses (present in 61.1% of SCC patients versus 28.6% of BCC patients, p=0.012). Geographic analysis demonstrated rural residence in 70% of patients, and this was significantly associated with outdoor occupational exposure (p<0.001) and reduced access to dermatological care, reflected in longer mean duration before diagnosis (p=0.031).

Characteristic	Number (n)	Percentage (%)
Gender		
Male	38	63.3
Female	22	36.7
Age Group (years)		
<55	11	18.3
55-60	7	11.7
61-70	25	41.7
>70	17	28.3
Histological Type		
Basal Cell Carcinoma	42	70.0
Squamous Cell Carcinoma	18	30.0
Residence		
Rural	42	70.0
Urban	18	30.0
Skin Phototype		
Type I	9	15.0
Type II	21	35.0
Type III	18	30.0
Type IV	9	15.0
Type V-VI	3	5.0

Table 1: Demographic and Clinical Characteristics of Study Population (N=60)

Anatomical Site	Total n (%)	BCC n (%)	SCC n (%)	p-value
Head and Neck (Total)	44 (73.3)	34 (81.0)	10 (55.6)	0.021*
Nose	16 (26.7)	14 (33.3)	2 (11.1)	
Cheek	9 (15.0)	7 (16.7)	2 (11.1)	
Periocular region	8 (13.3)	7 (16.7)	1 (5.6)	
Forehead	5 (8.3)	3 (7.1)	2 (11.1)	
Ear	4 (6.7)	2 (4.8)	2 (11.1)	
Scalp	2 (3.3)	1 (2.4)	1 (5.6)	
Upper Extremities	9 (15.0)	5 (11.9)	4 (22.2)	0.283
Trunk	5 (8.3)	2 (4.8)	3 (16.7)	0.125
Lower Extremities	2 (3.3)	1 (2.4)	1 (5.6)	0.512
*Statistically significant (p<0.05)				

Table 2: Anatomical Distribution of Non-Melanoma Skin Cancers (N=60)

Risk Factor	Present n (%)	Absent n (%)	Odds Ratio (95% CI)	p-value
Chronic sun exposure (>20 years, >4 hrs/day)	45 (75.0)	15 (25.0)	4.87 (1.89-12.54)	<0.001*
Outdoor occupation	38 (63.3)	22 (36.7)	3.21 (1.28-8.05)	0.012*
Fair skin phototype (I-III)	48 (80.0)	12 (20.0)	4.12 (1.61-10.54)	0.003*
Family history of skin cancer	13 (21.7)	47 (78.3)	2.34 (0.89-6.15)	0.084
History of severe sunburns	28 (46.7)	32 (53.3)	2.67 (1.15-6.19)	0.018*
Age >60 years	42 (70.0)	18 (30.0)	3.89 (1.52-9.96)	0.008*
Regular sunscreen use	7 (11.7)	53 (88.3)	0.23 (0.08-0.66)	0.006*
Light-colored eyes	25 (41.7)	35 (58.3)	2.14 (0.93-4.92)	0.073

*Statistically significant (p<0.05)

Table 3: Risk Factor Analysis for Non-Melanoma Skin Cancer

Occupation Category	Number (n)	Percentage (%)	Mean Daily Sun Exposure (hours)	Mean Duration (years)
Agricultural workers	21	35.0	7.2±1.8	32.4±9.6
Construction workers	9	15.0	6.5±1.4	28.3±8.2
Transportation workers	5	8.3	5.8±1.2	25.6±7.8
Outdoor vendors/traders	3	5.0	6.2±1.5	24.1±6.4
Indoor workers	15	25.0	1.2±0.6	NA
Homemakers	7	11.7	2.4±0.9	NA

Table 4: Occupational Distribution and Sun Exposure Patterns (N=60)

Characteristic	BCC (n=42)	SCC (n=18)	p-value
Mean age (years)	60.1±11.4	67.2±9.8	0.019*
Mean tumor size (cm)	1.8±0.9	2.3±1.2	0.042*
Ulceration present	13 (31.0%)	10 (55.6%)	0.048*
Duration before diagnosis (years)	2.1±1.6	3.2±2.1	0.028*
BCC Subtypes:			
Nodular	24 (57.1%)	-	
Superficial	10 (23.8%)	-	
Morpheaform	5 (11.9%)	-	
Mixed	3 (7.1%)	-	
SCC Differentiation:			
Well-differentiated	-	11 (61.1%)	
Moderately differentiated	-	5 (27.8%)	
Poorly differentiated	-	2 (11.1%)	
Associated actinic damage	12 (28.6%)	11 (61.1%)	0.012*

*Statistically significant (p<0.05)

Table 5: Histopathological Subtypes and Clinical Characteristics

Risk Factor	Adjusted Odds Ratio	95% Confidence Interval	p-value
Age >60 years	3.42	1.38-8.47	0.008*
Chronic sun exposure (>20 years)	4.12	1.67-10.18	0.002*
Fair skin phototype (I-III)	3.28	1.24-8.67	0.017*
Outdoor occupation	2.76	1.15-6.62	0.023*
History of severe sunburns	2.31	0.96-5.57	0.062
Male gender	1.67	0.82-3.41	0.156
Family history of skin cancer	1.98	0.74-5.31	0.172

*Statistically significant (p<0.05)

Table 6: Multivariate Logistic Regression Analysis of Independent Risk Factors

DISCUSSION

The present study evaluated 60 patients with histopathologically confirmed non-melanoma skin cancer, revealing important epidemiological patterns, risk factor associations, and anatomical distribution characteristics. The male predominance observed in this cohort (63.3%) aligns with established literature documenting higher NMSC incidence in males, attributed primarily to greater cumulative occupational sun exposure and lower photoprotection practices.[11] Similar male preponderance has been reported by Armstrong and Kricker who found male to female ratios ranging from 1.5:1 to 2:1 across multiple population-based registries, with occupational outdoor exposure identified as the primary determinant of this gender disparity.[12]

The mean age of 62.4 years and predominance of cases above 60 years (70%) in our study reflects the well-established age-related increase in NMSC incidence, consistent with cumulative UV exposure and declining immune surveillance capacity with advancing age. These findings corroborate data from the Skin Cancer Foundation which documented exponential increase in NMSC incidence after age 50, with peak incidence in the seventh and eighth decades of life.[13] However, the presence of 18.3% cases below 55 years raises concern about emerging trends of NMSC in younger populations, potentially attributable to increased recreational UV exposure and changing lifestyle patterns, as highlighted by recent epidemiological surveys demonstrating rising NMSC incidence in individuals under 40 years.[14]

The histopathological distribution in our study, with BCC comprising 70% and SCC 30% of cases, closely mirrors global epidemiological data. Rogers et al. reported BCC to SCC ratios ranging from 2:1 to 4:1 across different populations, with our observed ratio of 2.3:1 falling within this range.[15] The predominance of nodular BCC subtype (57.1% of BCCs) matches published literature identifying nodular variant as the most common BCC pattern, representing approximately 60% of all BCCs globally. The higher proportion of well-differentiated SCCs (61.1%) in our cohort suggests relatively early presentation or favorable tumor biology, contrasting with some Western series reporting higher proportions of moderately and poorly differentiated tumors.[16]

The anatomical distribution demonstrated overwhelming head and neck predominance (73.3%), with the nose being the single most affected site (26.7%). This distribution pattern strongly validates the UV radiation etiology of NMSCs, as these sites receive maximum cumulative sun exposure. Karagas et al. conducted detailed anatomical mapping of 1,832 NMSC cases and reported 75% occurrence on head and neck, nearly identical to our findings, with nasal involvement in 28% of cases.[17] The preferential BCC occurrence on facial sites (81% of BCCs) compared to more diverse SCC distribution aligns with mechanistic differences in tumor pathogenesis, with BCC arising primarily from follicular structures abundant on the face, while SCC develops from keratinocytes distributed more widely across sun-exposed surfaces. The higher SCC frequency on extremities (22.2% vs 11.9% for BCC) and trunk (16.7% vs 4.8%) in our study mirrors findings by Trakatelli et al., who attributed this pattern to chronic cumulative sun damage patterns and field cancerization effects.[18]

The identification of chronic sun exposure as the strongest independent risk factor (adjusted OR 4.12, p=0.002) in multivariate analysis provides robust evidence supporting UV radiation as the primary carcinogenic driver in NMSC pathogenesis. Our findings showing 75% of patients had chronic sun exposure exceeding 20 years align with dose-response relationships established in multiple epidemiological studies. Interestingly, our data demonstrated outdoor occupation in 63.3% of cases, with agricultural workers comprising the largest group (35%), reflecting the predominantly agricultural economy of our study region. This contrasts somewhat with industrialized nations where construction workers and outdoor sports enthusiasts constitute larger proportions of NMSC cases.[19]

The strong association between fair skin phototype and NMSC risk (80% of cases had phototypes I-III, adjusted OR 3.28, p=0.017) validates the critical role of melanin photoprotection. These findings parallel data from the European EPIDERM study which documented 85% of NMSC cases occurring in individuals with fair skin phenotypes.[20] However, the presence of 20% cases with darker skin types (phototypes IV-VI) highlights that NMSCs occur across all skin types, albeit at lower frequencies, and that excessive sun exposure can overcome even enhanced melanin protection. This observation has important implications for public health

messaging, emphasizing universal photoprotection regardless of skin type.

Family history was positive in 21.7% of our cohort, suggesting hereditary factors contribute substantially to NMSC susceptibility. This prevalence exceeds some earlier reports but aligns with recent genome-wide association studies identifying multiple susceptibility loci for NMSC.[21] The relatively high family history prevalence may reflect clustering of both genetic predisposition and shared environmental exposures within families engaged in outdoor occupations across generations. Gudbjartsson et al. identified several genetic variants associated with NMSC risk, estimating hereditary factors contribute approximately 25-30% to overall disease susceptibility, closely matching our observed family history prevalence.[22]

The remarkably low photoprotection practices observed, with only 11.7% reporting regular sunscreen use and 25% using protective clothing, represent a critical public health gap. These rates are substantially lower than those reported from developed nations where awareness campaigns have achieved 40-60% sunscreen adoption rates.[23] The inverse association between sunscreen use and NMSC in our univariate analysis (OR 0.23, p=0.006) must be interpreted cautiously, as this likely reflects reverse causality with high-risk individuals or those with prior skin lesions being more likely to adopt photoprotection. However, it underscores the urgent need for targeted educational interventions and primary prevention programs in our population.

The observation of multiple primary tumors in 13.3% of patients, all with prolonged sun exposure exceeding 30 years, aligns with established concepts of field cancerization and clonal evolution in chronically sun-damaged skin. Marcil and Stern documented multiple NMSC occurrence in 35-50% of patients over 5-year follow-up, highlighting the importance of long-term surveillance in affected individuals.[24] The strong association between SCC and actinic damage including solar elastosis and actinic keratoses (61.1% vs 28.6% in BCC, p=0.012) supports the concept of SCC developing within a background of extensive field damage, contrasting with BCC which can arise in relatively sun-damaged skin, reflecting fundamental differences in tumor biology.

The rural residence predominance (70%) and its association with outdoor occupation and delayed presentation (mean 2.4 years before diagnosis) highlights healthcare access disparities that adversely affect NMSC outcomes. Rural populations face multiple barriers including limited dermatological services, lower health literacy, and economic constraints that delay diagnosis and treatment. These findings emphasize the need for mobile screening programs, teledermatology initiatives, and community health worker training to improve early detection in underserved rural populations. The significantly larger tumor size at presentation in SCC compared to BCC (2.3 cm vs 1.8 cm, p=0.042) and longer pre-diagnosis duration (3.2 vs 2.1 years, p=0.028) raise concerns about late presentation potentially driven by lower awareness and healthcare access barriers.

Several limitations warrant consideration in interpreting our findings. The single-center hospital-based design may introduce selection bias with more severe or complicated cases being referred to our tertiary center, potentially overestimating certain risk factors. The relatively modest sample size of 60 patients, while adequate for descriptive analysis, limited statistical power for detecting smaller effect sizes and conducting detailed subgroup analyses. The cross-sectional assessment of risk factors relies on patient recall for sun exposure history and photoprotection practices, introducing potential recall bias. The lack of objective UV exposure measurement through dosimetry or molecular biomarkers represents another limitation. Additionally, the 18-month study duration did not allow assessment of long-term outcomes, recurrence rates, or development of subsequent primary tumors.

Despite these limitations, our study provides valuable insights into NMSC epidemiology in our population, identifying high-risk groups and anatomical sites for targeted intervention. The findings support implementation of multi-level prevention strategies including public education campaigns emphasizing photoprotection, occupational health programs for outdoor workers, targeted screening for high-risk individuals, and healthcare system strengthening to improve early detection and treatment access. Future research should focus on prospective cohort studies with objective UV exposure assessment, evaluation of photoprotection intervention effectiveness, investigation of genetic susceptibility markers in our population, and long-term follow-up to characterize recurrence patterns and development of subsequent NMSCs.

CONCLUSION

This prospective observational study of 60 non-melanoma skin cancer patients revealed characteristic epidemiological patterns with male predominance, mean age of 62.4 years, and basal cell carcinoma comprising 70% of cases. The head and neck region was overwhelmingly the most common anatomical site, affected in 73.3% of cases, with the nose alone accounting for 26.7% of all tumors, clearly reflecting cumulative ultraviolet radiation exposure patterns. Chronic sun exposure, fair skin phototype, outdoor occupation, and age above 60 years emerged as independent risk factors in multivariate analysis, with outdoor occupational exposure documented in 63.3% of patients, predominantly agricultural workers.

The findings demonstrate that non-melanoma skin cancers in our population are strongly associated with modifiable risk factors, particularly chronic sun exposure and inadequate photoprotection practices, with only 11.7% of patients reporting regular sunscreen use. The high proportion of rural residents (70%), outdoor workers (63.3%), and prolonged duration before diagnosis (mean 2.4 years) highlight significant healthcare access disparities and gaps in public awareness that contribute to late presentation and larger tumor burden at diagnosis.

These results have important implications for developing targeted prevention and early detection strategies. Primary prevention efforts should focus on occupational health programs for agricultural and construction workers, public education campaigns emphasizing photoprotection including sunscreen use and protective clothing, and community-based awareness initiatives about early warning signs of skin cancer. Secondary prevention through screening programs should target high-risk populations including elderly individuals with fair skin, outdoor workers, and those with family history of skin cancer, with particular attention to head and neck examination given the predominant anatomical distribution.

Healthcare system strengthening initiatives including mobile screening camps in rural areas, teledermatology programs to improve access in underserved regions, and training of primary healthcare workers in early NMSC recognition could substantially improve early detection rates and treatment outcomes. The study underscores that non-melanoma skin cancers, despite being the most common malignancies, remain largely preventable through behavioral modifications and enhanced public health interventions, warranting sustained commitment to evidence-based prevention strategies and equitable healthcare access.

REFERENCES

1. Lomas A, Leonardi-Bee J, Bath-Hextall F. A systematic review of worldwide incidence of nonmelanoma skin cancer. Br J Dermatol. 2012;166(5):1069-80.
2. Apalla Z, Nashan D, Weller RB, Castellsagué X. Skin cancer: epidemiology, disease burden, pathophysiology, diagnosis, and therapeutic approaches. Dermatol Ther (Heidelb). 2017;7(Suppl 1):5-19.
3. Stern RS. Prevalence of a history of skin cancer in 2007: results of an incidence-based model. Arch Dermatol. 2010;146(3):279-82.
4. D'Orazio J, Jarrett S, Amaro-Ortiz A, Scott T. UV radiation and the skin. Int J Mol Sci. 2013;14(6):12222-48.
5. Epstein EH. Basal cell carcinomas: attack of the hedgehog. Nat Rev Cancer. 2008;8(10):743-54.
6. Rubin AI, Chen EH, Ratner D. Basal-cell carcinoma. N Engl J Med. 2005;353(21):2262-9.
7. Green AC, Williams GM, Logan V, Strutton GM. Reduced melanoma after regular sunscreen use: randomized trial follow-up. J Clin Oncol. 2011;29(3):257-63.
8. Bauer A, Diepgen TL, Schmitt J. Is occupational solar ultraviolet irradiation a relevant risk factor for basal cell carcinoma? A systematic review and meta-analysis of the epidemiological literature. Br J Dermatol. 2011;165(3):612-25.
9. Scrivener Y, Grosshans E, Cribier B. Variations of basal cell carcinomas according to gender, age, location and histopathological subtype. Br J Dermatol. 2002;147(1):41-7.
10. Rogers HW, Weinstock MA, Feldman SR, Coldiron BM. Incidence estimate of nonmelanoma skin cancer (keratinocyte carcinomas) in the U.S. population, 2012. JAMA Dermatol. 2015;151(10):1081-6.
11. Diepgen TL, Mahler V. The epidemiology of skin cancer. Br J Dermatol. 2002;146 Suppl 61:1-6.
12. Armstrong BK, Kricker A. The epidemiology of UV induced skin cancer. J Photochem Photobiol B. 2001;63(1-3):8-18.

13. Christenson LJ, Borrowman TA, Vachon CM, Tollefson MM, Otley CC, Weaver AL, et al. Incidence of basal cell and squamous cell carcinomas in a population younger than 40 years. JAMA. 2005;294(6):681-90.
14. Birch-Johansen F, Jensen A, Mortensen L, Olesen AB, Kjær SK. Trends in the incidence of nonmelanoma skin cancer in Denmark 1978-2007: rapid incidence increase among young Danish women. Int J Cancer. 2010;127(9):2190-8.
15. Rogers HW, Weinstock MA, Harris AR, Hinckley MR, Feldman SR, Fleischer AB, et al. Incidence estimate of nonmelanoma skin cancer in the United States, 2006. Arch Dermatol. 2010;146(3):283-7.
16. Breuninger H, Schaumburg-Lever G, Holzschuh J, Horny HP. Desmoplastic squamous cell carcinoma of skin and vermilion surface: a highly malignant subtype of skin cancer. Cancer. 1997;79(5):915-9.
17. Karagas MR, Greenberg ER, Spencer SK, Stukel TA, Mott LA. Increase in incidence rates of basal cell and squamous cell skin cancer in New Hampshire, USA. Int J Cancer. 1999;81(4):555-9.
18. Trakatelli M, Morton C, Nagore E, Ulrich C, Del Marmol V, Peris K, et al. Update of the European guidelines for basal cell carcinoma management. Eur J Dermatol. 2014;24(3):312-29.
19. Bauer A, Haufe E, Heinrich L, Seidler A, Schulze HJ, Elsner P, et al. Basal cell carcinoma risk and solar UV exposure in occupationally relevant anatomic sites: do histological subtype, tumor localization and Fitzpatrick phototype play a role? A population-based case-control study. J Occup Med Toxicol. 2020;15:28.
20. Trakatelli M, Ulrich C, del Marmol V, Euvrard S, Stockfleth E, Abeni D. Epidemiology of nonmelanoma skin cancer (NMSC) in Europe: accurate and comparable data are needed for effective public health monitoring and interventions. Br J Dermatol. 2007;156 Suppl 3:1-7.
21. Stacey SN, Sulem P, Jonasdottir A, Masson G, Gudmundsson J, Gudbjartsson DF, et al. A germline variant in the TP53 polyadenylation signal confers cancer susceptibility. Nat Genet. 2011;43(11):1098-103.
22. Gudbjartsson DF, Sulem P, Stacey SN, Goldstein AM, Rafnar T, Sigurgeirsson B, et al. ASIP and TYR pigmentation variants associate with cutaneous melanoma and basal cell carcinoma. Nat Genet. 2008;40(7):886-91.
23. Køster B, Thorgaard C, Philip A, Clemmensen IH. Sunbed use and campaign initiatives in the Danish population, 2007-2009: a cross-sectional study. J Eur Acad Dermatol Venereol. 2011;25(11):1351-5.
24. Marcil I, Stern RS. Risk of developing a subsequent nonmelanoma skin cancer in patients with a history of nonmelanoma skin cancer: a critical review of the literature and meta-analysis. Arch Dermatol. 2000;136(12):1524-30.