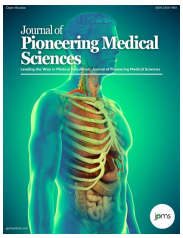

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Saudi Arabia's Incidence of Skin Cancer and its Risk Factors: A Scoping Review

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Abstract **Objectives:** Skin cancer accounts for 2.2% of newly diagnosed cancer cases in Saudi Arabia, according to the Saudi Cancer Registry 2020. While studies indicate skin cancers primarily occur in the extremities, head, neck and mucosal regions, comprehensive data on prevalence, mortality, morbidity, treatment modalities and overall burden in Saudi Arabia are lacking. This scoping review aimed to analyze existing literature on skin cancer within the Saudi population, assess its prevalence and potential risk factors and identify knowledge gaps. We systematically searched PubMed, Web of Science, SCOPUS and Science Direct databases, utilizing the Rayyan QCRI tool for data organization and synthesis. The review included 15 studies encompassing 2,596 patients, of whom 1,378 (56.2%) were male. Our analysis revealed basal cell carcinoma (BCC), squamous cell carcinoma (SCC) and malignant melanoma as the most common types. BCC and SCC predominantly affected the head and neck, while melanoma more often impacted the extremities. Surgical intervention was the primary treatment approach. Key risk factors identified included occupational pesticide exposure, UV radiation susceptibility and genetic predisposition. This review highlights the need for a comprehensive nationwide screening program to evaluate the prevalence of skin-related issues in Saudi Arabia and address the identified knowledge gaps in skin cancer epidemiology and management.

Key Words Skin cancers; non-melanoma skin cancer, Malignant melanoma, Saudi Arabia, Scoping review

INTRODUCTION

The skin is vulnerable to various pathological abnormalities, including endocrine, neo-plastic, traumatic, degenerative and inflammatory illnesses, similar to other body organs [1]. Studies on the epidemiology of disease are crucial for comprehending the effects of human illness. Making decisions on allocating funding for medical treatment and studies requires knowing the incidence and prevalence of particular diseases [2]. For instance, a proper di-agnosis is necessary for treating skin problems. In undeserved areas, non-dermatologists, like general practitioners, diagnose and treat skin disorders. This emphasizes the significance of offering a thorough analysis of the skin disorders in each area and applying greater priority to training non-dermatologists about some common skin disorders they might encounter [3-5].

Skin cancer is the most common type of cancer among humans, particularly affecting white populations, with over one million new cases reported each year [5,6]. The three most prev-alent types are non-melanocytic skin cancers (NMSCs), basal cell carcinomas (BCCs), squamous cell carcinomas (SCCs) and cutaneous malignant melanomas (CMs), also known as malignant melanoma of the skin or melanoma [5,7].

Skin cancer incidence markedly increases with age due to long latency periods related to environmental etiologies such as ultraviolet (UV) radiation exposure [8]. NMSCs are far more frequent than melanomas, which are much easier to treat and have better long-term progno-ses. The two main types, squamous and basal cell carcinomas, originate from epidermal keratinocytes. Their management is much simpler because they tend to stay localized to their primary disease site, making them less deadly than melanoma [9].

The face, arms and other body regions with the highest UV exposure are where most fatal keratinocyte cancers occur [7,8]. The prevalence of skin cancer varies geographically

and racially, with Australia having the highest rate [10]. In the Kingdom of Saudi Arabia (KSA), the latest Saudi Cancer Registry revealed that skin cancer accounted for 2.2% of all newly diagnosed cases in 2020 [11].

Studies across different regions of Saudi Arabia have revealed varying prevalence rates and demographic patterns of skin cancer. In the Al-Taif region, skin cancer was predominantly found in individuals over 60 years old, with a male-to-female ratio of 2.25:1 [12]. The Al-Baha region reported an average age of 70-80 years for skin cancer patients, with a male-to-female ratio of 1.6:1 [13]. In Jeddah, the average age was 46 years, with a male-to-female ratio of 2.1:1 [14].

The most common types of skin cancer in Saudi Arabia are basal cell carcinoma (BCC) and squamous cell carcinoma (SCC), with varying prevalence rates across different regions [15]. Other types, such as mycosis fungoides (MF), malignant melanoma (MM) and dermatofi-brosarcoma protuberans (DFSP) have also been reported [16].

Key risk factors for skin cancer in Saudi Arabia include ultraviolet (UV) radiation exposure, age, male sex, genetic susceptibility and fair complexion [17]. The head and neck, particu-larly the face, are the most common sites for both BCC and SCC, likely due to direct sun exposure [18].

Despite the increasing incidence of skin cancer in Saudi Arabia, there remains a knowledge gap concerning comprehensive data on prevalence, risk factors and the health burden asso-ciated with skin cancer across the country. Existing studies provide insights into specific re-gions [12-14]; however, a unifying analysis that encompasses incidence rates, mortality, morbidity, treatment modalities and risk factors on a national scale is lacking. This scoping review aims to address this knowledge gap by providing an extensive overview of the inci-dence and risk factors of skin cancer across diverse regions in Saudi Arabia. We seek to compile and evaluate the available evidence to present a holistic perspective on skin cancer, enabling informed decisions for public health strategies and resource allocation in combating this pressing health issue.

METHODS

Study Design

The “PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)” guidelines were followed in conducting this work [19]. September 2023 marked the start of this study.

Search Strategy

A comprehensive search was done using “PubMed, SCOPUS, Web of Science and Science Direct” to find the relevant literature. We only searched in English while considering each database's particular requirements. The relevant research was found by converting the fol-lowing keywords into PubMed Mesh terms; "Skin cancer," "Melanoma," "Non-melanoma," "Saudi Arabia," and "KSA." The essential keywords were matched by the Boolean operators "OR" and "AND." The search yielded a selection of publications that included full-text studies in English, accessible documents and trials involving human subjects.

Selection Criteria

The following inclusion criteria were considered (a) study designs that investigated the in-cidence and risk factors of skin cancer in Saudi Arabia; (b) there were no restrictions re-garding age; (c) metastatic skin manifestations were not included; (d) only human subjects; (e) English language; and (f) free accessible articles.

Data Collection

The results from the search method were verified using Rayyan (QCRI) [20]. The researchers reviewed the relevance of the titles and abstracts by editing each search outcome with inclu-sion/exclusion criteria. The editors gave each study that matched the criteria for inclusion a closer look. The authors discussed techniques for settling disagreements, including (a) two reviewers independently screened titles and abstracts and subsequently full texts, against the predefined inclusion and exclusion criteria to minimize bias and ensure thoroughness; (b) for any discrepancies that arose during the screening or data extraction phases, we conducted consensus meetings. During these meetings, both reviewers discussed each point of disa-greement in detail; (c) in cases where consensus could not be reached through discussion, a third reviewer with expertise in the subject matter was consulted to provide an independent judgment to help resolve the disagreement; and (d) all disagreements and resolutions were documented meticulously. This comprehensive record allowed us to transparently track the decision-making process and ensure all aspects of our review were transparent and repro-ducible.

A preexisting data extraction form was utilized to input the approved study information. The authors retrieved the study's authors, study year, city, participants, gender, forms of skin cancer and primary results. The risk of bias evaluation was done on a separate page.

Data Presentation

Summary tables were generated based on information extracted from pertinent studies to offer a qualitative overview of the findings and various study components. Once the data for this review were compiled, the optimal approach for leveraging the information from the selected articles was determined.

Quality Assessment and Bias Minimization

The quality of the studies included in the review was evaluated using the ROBINS-I tool to assess the risk of bias in non-randomized treatment trials [21]. The seven elements evaluated were confounding, deciding which participants to include in the research, the classification of interventions, variations from intended interventions, missing data,

evaluation of final results and selection of the reported outcome. By employing the following strategies, we aimed to ensure a comprehensive and unbiased selection of studies that accurately represents the cur-rent state of knowledge: (1) establishing specific inclusion/exclusion criteria based on rele-vant characteristics such as study design, population and geographical location, (2) running a thorough literature search across multiple databases (e.g., PubMed, Scopus, Web of Science) to identify all potentially relevant studies published, (3) applying a study selection process that involved multiple independent reviewers who assessed the literature against the prede-fined criteria and any disagreements between reviewers were resolved through discussion or by consulting a third reviewer to ensure consensus, (4) evaluating the methodological rigor of the included studies where relevant and (5) documenting each stage of the selection process, including the number of studies screened, included and excluded, along with the reasons for exclusion.

RESULTS

Search Outcome

The search turned up a total of 732 study articles; 113 identical copies were eliminated. A screening of 619 studies' titles and abstracts resulted in 533 studies being disregarded. Nothing was found despite the search for 86 articles. In the end, 86 studies passed the full-text screening; 45 were disqualified due to incorrect research outcomes, 21 were disqualified due to the incorrect population type and five publications were letters to the editors. This systematic review contained 15 appropriate study articles. Figure 1 presents a summary of the study selection process.

Characteristics of the Included Studies

Table 1 presents the sociodemographic details of the included study articles. Our results included fifteen studies with 2596 patients, including 1378 (56.2%) males. The included studies were all retrospective [12,14,22-33].

Table 2 presents the clinical characteristics. BCC was the most common skin cancer among the Saudi population, followed by SCC and malignant melanoma. The most

Table 1: The sociodemographic details of the included study articles

Study First author*	Country	Participants	Mean age (years)	Males (%)
Almalki [22]	Jeddah	119	63.3±16.3	62 (52.1)
Alshedoukhy [23]	Riyadh	98	58	42 (40.8)
Schellini [24]	Riyadh	129	71	76 (58.9)
Algarni [25]	Aseer	560	63.4±21.3	333 (59.4%)
Alsalman [26]	Riyadh	279	59±19.5	173 (62)
Al-Maghrabi [13]	Madinah	202	60.1±15	139 (68.8)
Arab [28]	Riyadh	111	NM	54 (48.6)
Algharbi [29]	Hail	120	NM	64 (53.3)
Mufti [30]	Jeddah	139	49	70 (50.6)
Al Dawsari [31]	Dahran	204	68	133 (65)
Mufti [14]	Jeddah	106	46.6	72 (67.9)
Alwunais [32]	Dammam	27	25-88	16 (59.2)
Al-Qahtani [33]	Riyadh	300	59.8	184 (61.3)
Hafez [34]	Abha	98	52.8±25.1	53 (54.1)
Al-Aboud [12]	Taif	104	NM	70 (67.3)

*All studies are retrospective. NM: Not mentioned

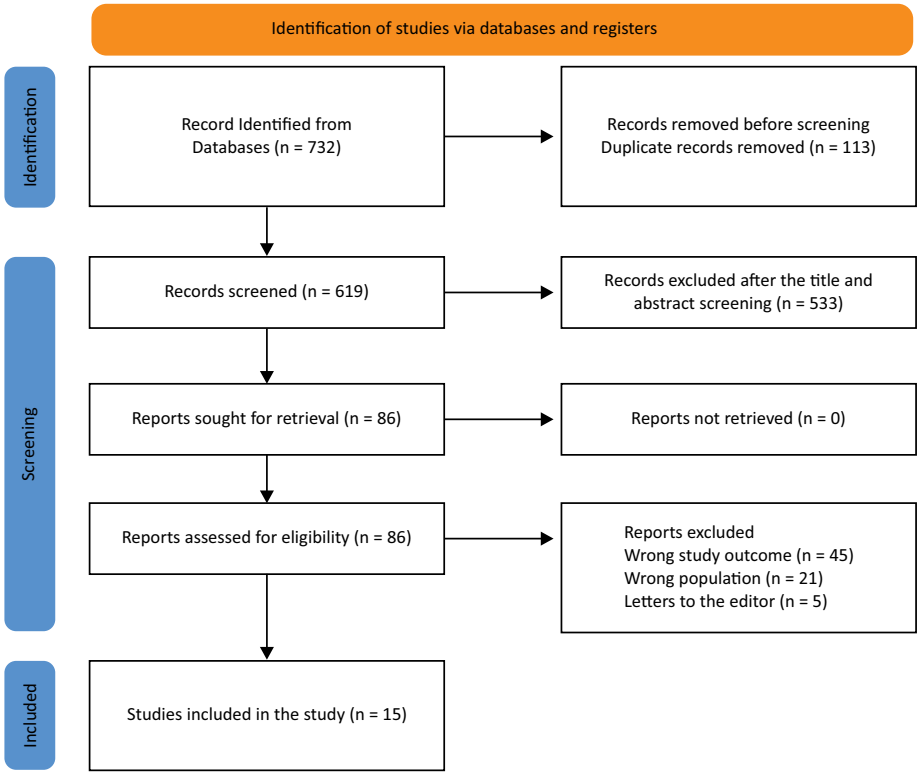

Figure 1: The "PRISMA" flowchart summarizes the study selection process

Table 2: Clinical aspects and results of the studies that were included

Studies	Type of skin cancer	Main outcomes	ROBIN-I
Almalki *et al.* [22]	BCC, SCC and malignant melanoma.	BCC was the most prevalent type of skin cancer, followed by SCC and malignant melanoma. The head and neck site was the most frequent anatomical site. Surgery was the most popular type of treatment technique. About 49.6% of the patients in the study were cured, 20.2% were in remission, 12.6% experienced relapses and 17.6% passed away.	Moderate
Alshedoukhy *et al.* [23]	Melanoma	The extremities, particularly the feet, were the most often affected areas, followed by the head, neck and mucosal regions. In the mouth, mucosal melanomas were most common. The most popular treatment method was surgical resection. Older patients received palliative care	Moderate
Schellini *et al.* [24]	BCC	BCC was predominantly classified as a mixed lesion in 41.1% of cases and exhibited a histological nodular pattern in 50.4% of instances. Factors associated with a poorer prognosis included tumor localization in the medial aspect of the eyelid, size exceeding 5 mm, histological subtypes such as ulcerative or morphea forms, compromised margins and the presence of recurrent lesions	High
Algarni *et al.* [25]	SCC, BCC, melanoma	The lifetime risk of cancer by age 75 was 9.9%. Analysis of surgical pathology reports from "Aseer Central Hospital" between 2011 and 2021 revealed that individuals aged 61-80 had the highest incidence, with SCC and BCC being the most commonly diagnosed types. Notably, men constituted 59.4% of cases, the majority of patients were Saudi nationals (94.3%) and the head and neck region was the most affected area, highlighting significant variations in cancer type by age and body location	High
Alsalman *et al.* [26]	Non-melanoma	BCC and SCC occurrence rates were 50.2% and 44.8%, respectively. The most typical place was the head and neck (79.6%). Xeroderma pigmentosum and previously treated solid tumors were the main contributing factors in patients under 50	High
Al-Maghrabi *et al.* [13]	SCC and BCC	33 (16.3%) cases of SCC and 124 (61.4%) cases of BCC were reported. The 60-69 year age group has the highest age distribution. The head and neck (92.7% and 66.7%) were the most frequently implicated sites in BCC and SCC, respectively	High
Arab *et al.* [28]	SCC, BCC and MSC	A total of 76 (68.5%) cases, or the majority of cases, were BCC. MSC was identified in 18 individuals (16.2%). SCC was identified in 17 patients who underwent further testing (15.3%)	Moderate
Albasri and Walaa [27]	BCC, MF, SCC and DFSP	The most frequent neoplasm was BCC (36%), followed by cutaneous lymphomas (mostly mycosis fungoides, 25%), SCC and dermatofibrosarcoma protuberance, which was 11%	Moderate
Mufti [30]	Melanoma	Acral 68.7% was the predominant distribution pattern. Other potential risk factors include occupational pesticide exposure, varying susceptibility to UV radiation and genetic predisposition	High
Algharbi and Laila [29]	SCC, BSC and MSC	In terms of cutaneous malignancies, BCC (36%) and SCC (23%) were the most prevalent, with both tumors most frequently occurring in the head and neck. The lower extremities were the most often affected area by malignant melanoma, which was the fourth most prevalent skin cancer (7%) overall	Moderate
Mufti [14]	SCC, BSC, MSC, MF and DFSP	BCC accounted for 28.3% of cases, squamous cell carcinoma (SCC) for 24.5%, mycosis fungoides for 18%, malignant melanoma for 10.3% and dermatofibrosarcoma protuberans for 5.7%	Moderate
Alwunais [32]	SCC, BSC, MSC, MF and DFSP	BCC and SCC were the two skin lesions with the highest cancer incidence. Malignant skin tumors are uncommon in dermatology practice. For BCC and SCC, respectively, the head and neck were the most typical sites	Moderate
Al-Qahtani *et al.* [33]	BSC, SCC, MF and MSC	All skin cancer types examined, with the exception of mycosis fungoides (MF), were more commonly observed in men than in women, with a ratio of 1.56 to 1. The most frequently occurring malignancies were basal cell carcinoma (BCC) and squamous cell carcinoma (SCC), followed by mycosis fungoides (MF) and melanoma (MM)	High
Hafez *et al.* [34]	CTCL, SCC, BSC, MSC	Cutaneous T-cell lymphoma (CTCL) (38.8%) was the most prevalent type of malignant skin lesion, followed by Kaposi's sarcoma (9.2%), SCC (22.4%), BCC (19.4%) and malignant melanoma (7.1%). For CTCL, the trunk was the most popular region-meanwhile, the head and neck were for SCC and BCC and the lower limbs were for MM and KS	Moderate
Al-Aboud *et al.* [12]	SCC, BSC and MSC	The most common type of cancer was BCC (51%), which was followed by SCC (26%) and malignant melanoma (12.5%)	Moderate

BCC: Basal cell carcinoma; SCC: Squamous cell carcinomas; MSCs: Melanocytic skin cancers; MF: Mycosis fungoides; DFSP: Dermatofibrosarcoma protuberance

common regions of BCC and SCC were head and neck, while the extremities were more frequent in melanoma. Surgical resection was the most popular approach to treat skin cancer. The re-ported potential risk factors included occupational pesticide exposure, varying susceptibility to UV radiation and genetic predisposition.

DISCUSSION

In this scoping review, we analyzed the epidemiology and risk factors associated with skin cancer patterns in several locations within Saudi Arabia, drawing on data from fifteen Studies involving 2,596 participants. Our findings indicate that BCC is the most prevalent skin cancer among the Saudi population, followed by SCC and malignant melanoma.

While prior research in the United States shows BCC accounts for approximately 30% of new cases [7,35], it's essential to contextualize this statistic within the Saudi landscape. The unique environmental, genetic and cultural factors may influence differences in incidence rates. Current data suggest that, while BCC generally has a low mortality

rate, its high morbidity can significantly burden healthcare systems globally [36]. This reflects the necessity for localized public health strategies that address the particularities of skin cancer in Saudi Arabia.

Similarly, while SCC also constitutes 15-20% of non-melanocytic skin cancers and has a higher potential for metastasis [7], the variation in incidence across different regions and demographics in Saudi Arabia warrants further exploration. For instance, trends in SCC prevalence have been noted in certain areas (Table 2). Yet, direct comparisons with other populations should be approached with caution due to potential variations in risk factors and healthcare access.

Our data indicate the head and neck as common sites for both BCC and SCC, with melanoma more frequently located on the extremities. The finding that surgical resection remains the most prevalent treatment option aligns with global practices [9]; however, it is vital to recognize that therapeutic approaches must be tailored to individual patient circumstances, such as tumor location, size and patient health status [37]. Exploration of adjunct treatment modalities-like cryotherapy, topical chemotherapy agents and radiation-highlights advances in management but implies that optimal care often requires a multi-disciplinary approach [38].

Furthermore, the incidence of malignant melanoma has shown a concerning upward trend, thought to be influenced by environmental factors such as increased UV radiation, along with genetic and lifestyle factors [39]. The multifactorial nature of melanoma risk highlights the complexity of its pathogenesis. Substantial evidence suggests that exposure to UV radiation is the primary driver of non-melanocytic skin cancers. However, other contributing factors, such as occupational exposures, genetic predispositions and skin type, should not be overlooked [40].

The significant rise in skin cancer incidence in recent decades suggests that shifting ecological and lifestyle factors may play a critical role, alongside improved detection rates [41]. Increased awareness and surveillance are crucial, but they must be complemented by effective preventive strategies that reflect local environmental conditions and population demographics [42].

Contemporary studies emphasize molecular heterogeneity and varying risk factors among different skin cancer subtypes, which add substantial value to understanding the disease mechanisms [43]. As research continues to evolve, it is essential to maintain a discerning outlook on the implications of these findings for prevention and treatment strategies [44].

Despite the valuable insights gained from this scoping review, several limitations must be acknowledged. First, the generalizability of the findings may be constrained due to the di-verse environmental, genetic and cultural contexts across different regions of Saudi Arabia, which may not apply uniformly to all populations within the country. Additionally, the variability in study design, methodologies and sample sizes among the included studies could introduce biases and affect the reliability of the results. The review predominantly included observational and cross-sectional studies, limiting the ability to establish causality between identified risk factors and skin cancer incidence. Furthermore, potential publication bias may also compromise the robustness of the findings, as studies with significant results are more likely to be published. Several studies did not sufficiently control confounding factors, such as sun exposure history and lifestyle choices, which can obfuscate the true relationships between risk factors and skin cancer. Lastly, the fast-evolving nature of skin cancer research, particularly concerning molecular mechanisms and genetic factors, means some recent and pertinent findings may not be reflected in this review. These limitations highlight the necessity for further research employing standardized methodologies and robust study designs to enhance our understanding of the complexities of skin cancer in Saudi Arabia.

CONCLUSIONS

This scoping review indicates that basal cell carcinoma (BCC) is the most common type of skin cancer among the Saudi population, followed by squamous cell carcinoma (SCC) and malignant melanoma (MM). While melanoma more frequently affects extremities, BCC and SCC predominantly occur on the head and neck, with surgical resection being the most frequent treatment modality. Additionally, we identified potential risk factors such as occupational pesticide exposure, varying susceptibilities to UV radiation and genetic predisposition.

To address these issues, we recommend implementing enhanced public awareness campaigns focused on skin cancer prevention and early detection, alongside strengthening the training of healthcare providers to improve the identification and management of skin cancers. Establishing regular skin cancer screening programs, particularly for high-risk populations, will further facilitate early intervention. Moreover, developing regulations for the safe use of pesticides in occupational settings is crucial.

For future research, we suggest several specific areas of investigation: longitudinal studies to assess the long-term trends in skin cancer incidence and associated risk factors; molecular studies to explore the genetic and epigenetic underpinnings of skin cancer in the Saudi pop-ulation; and research that evaluates the effectiveness of preventive measures, including public awareness campaigns and screening programs. By addressing these areas, further studies can significantly enhance our understanding of skin cancer dynamics in Saudi Arabia and con-tribute to more effective public health strategies.

Conflicts of Interest

The authors declare no conflicts of interest.

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