Abstract
Desert dermatology describes the cutaneous changes and the diseases affecting those living in the desert. Diurnal variation in temperature is high and is characteristic of the deserts. The lack of water affects daily activities and impacts dermatological conditions. Adaptation to the desert is, therefore, important to survival. Infections are the most common conditions seen among this population, and among them, fungal infections are the most common. The high incidence of these infections would be accounted for by the poor hygienic conditions due to lack of bathing facilities due to scarcity of water and the consequent sweat retention and overgrowth of cutaneous infective organisms. Pigmentary disorders, photodermatoses, leishmaniasis, and skin tumors are found to be more prevalent in this region. Desert sweat dermatitis was another specific condition found to have an increased incidence. The environment of the desert provides for a wide variety of dermatoses that can result in these regions with few of these dermatoses found in much higher incidence than in other regions.

Key Words: Climate, desert dermatoses, environment, infections, water

Introduction
Deserts are two types: The hot and cold deserts. The hot desert, though, is what the term connotes in common usage and this is the connotation that will be the subject of this discussion. Desert dermatology is a comparatively new concept. It aims to describe the cutaneous changes and the diseases affecting those living in the desert.

Deserts occupy about \(47 \times 10^2\) km\(^2\) of the Earth’s surface. They are characterized by low humidity, dry weather and high temperatures, especially during the summer, and low temperatures during winter. Diurnal variation in temperature is high and is characteristic of the deserts. Sandstorms are common. The lack of water affects daily activities and impacts dermatological conditions seen in these areas. Adaptation to the desert is important to survival. The Thar Desert in India is predominantly located in Rajasthan and is geologically and strategically important as it separates India from its western neighbor.

Living Conditions
Those living in the deserts, especially nomads such as Kalbelias, Gadaria Lohar, Gujar, Raika Merdh, Dewasi, and others, have limited facilities compared with those who live in the cities. They have no source of continuous water supplies; they must depend on wells and limited storage capacity. They usually live in tents made from camel skins/cloth and have no electricity, no kitchens, and no bathrooms. The whole family lives in the same area, all in one tent that is sometimes divided by a partition. They are always on the move; consequently, they do not have houses. Instead, they have tents, which are easy to dismantle and construct. Nomads depend mainly on camels that can live in the desert, usually called “desert ships.” Dogs, goats, and some other animals can also survive in these conditions. Sources of food are limited, and nomads depend on their cattle and gathering. There are very few types of edible plants. Clothing is usually helpful in providing protection from the sun and comfort in both cold and hot weather. They use elaborate clothing and various kinds of stone ornaments which not only have protective action but also lend color to the monochrome of the desert [Figure 1].

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The Thar Desert in Western Rajasthan is the most arid part of the state where the annual rainfall varies from 100 to 400 mm, quite often erratic, so much so, that the entire rainfall of the year may fall on a single day and the rest of the year may be dry. As an illustration, a certain area (Osian) has been used to depict the environmental aspects of desert life. The average humidity is low [Figure 2]. Average summer temperatures are always high [Figure 3], and the diurnal range exceeds even 20°C. Winters are of short duration, not exceeding 2 months - December and January.

In addition to the desert nomads, soldiers are also affected by the desert environment as they also have to adapt in similar living conditions in terms of surviving in tentage and being on constant move, combined with water scarcity, and less than ideal sanitation facilities.

Prevalent Dermatoses

Desert dermatoses have not been reviewed comprehensively in India. Patients seen in a hospital in Jodhpur, Rajasthan, with a catchment area of the whole of Western Rajasthan including the Thar Desert area were analyzed to find trends and provide much-needed data for program managers for the allocation of resources for health care in this region. A total of 17,155 patients were analyzed over a year and a half to arrive at the data described below.\[^{2,3}\]

Infective conditions comprised 21.6%, and noninfective conditions formed 78.4% of all patients seen. Among infective conditions, fungal infections were the most common infections (8.3%), followed by viral (4.8%), bacterial (4.6%), and scabies (1.7%). Viral warts comprised ~ 66% of viral infections. Leprosy formed 0.4% of patients. The high incidence of fungal and bacterial infections would be accounted for by the poor hygienic conditions due to lack of bathing facilities due to scarcity of water and the consequent sweat retention and overgrowth of cutaneous infective organisms.

Among noninfective conditions, eczemas were the most common and comprised 28.3% of all cases and 36.1% of all noninfective conditions. Discoid eczemas were the most common single type of eczema seen (24.6% of all eczemas, due to dry weather coinciding with its known predisposition). Acne and rosacea comprised 10.9% of all and 13.9% of noninfective dermatoses which was somewhat higher than other studies in India\[^{4-8}\] and abroad.\[^{9}\] The increased awareness and comparatively younger population of soldiers who also formed part of the patient population may have been responsible for this variation. Pigmentary disorders comprised 11.1% of all dermatoses and 14.2% of all noninfective disorders. This is similar to some studies\[^{4,5}\] but more than others.\[^{7,8}\] In one of these studies,\[^{4}\] it was second in frequency among noninfective conditions, photodermatoses accounted for 11.4% of all skin conditions seen in this study. The sunny weather which persists for most parts of the year in this area may be an important factor in the development of photodermatoses. Such a high incidence of photodermatoses has not been seen in any of the quoted studies in India and indicates that photodermatoses are the highest in the desert areas and measures toward photodermatoses are important in preventive desert dermatology. Psoriasis accounted for 5.3% of the patients. This is higher than that quoted from most studies in India, again, due to the dry
environmental conditions prevalent throughout the year and wintry cold nights. Lichen planus constituted 2.1% of the total cases and 2.7% of noninfective dermatoses. In addition to the classical presentation, actinic, mucosal, and hypertrophic lichen planus were the most common variants seen. Actinic lichen planus can again be explained by the sunnier climates of the desert. Drug reactions formed 0.4% of the dermatoses. The predominately rural population and lesser availability and use of medications may be responsible for the reduced incidence of drug reactions. Neoplastic disorders, probably related in some way to increased sun exposure, comprised 5.1% of patients.

Sexually Transmitted Infections
Another study of 209 sexually transmitted infection cases was concurrently carried out over a retrospective period of 9 years in this population when the author was posted to Jodhpur, Rajasthan. It was carried out among patients belonging to the community of the armed forces serving in this area. It is well known that long periods of separation from families may be an important factor responsible for visits to commercial sex workers and frequency of sexually transmitted diseases (STDs) in this cohort. Chancroid was the most common STD in our patients accounting for 28.2% of cases. Condylomata acuminata was the second in frequency accounting for 16.8% of cases. The incidence of nongonococcal urethritis was 13.9%, which was third in frequency. This was more in comparison to other studies in India from the armed forces as well as elsewhere.[10-17] Syphilis was the next most common condition seen, accounting for 10.5% of patients over the study period. Most cases were of early syphilis, accounting for 8.4% of cases while late syphilis accounted for 2.1% of cases. Gonorrhea was the next common STD accounting for 8.6% of cases. It accounted for 38.3% of all genital discharges. Genital herpes was found to have an incidence of 8.1%. Genital molluscum contagiosum accounted for 1.4% of cases. Other conditions which are sexually transmitted such as infective balanitis, scabies, and pediculosis accounted for 5.7% of cases. The proportion of viral STDs had been on the increase during the period of the study. This is the harbinger of a trend which is being seen all over the world including India, where conditions such as genital herpes are being seen more often, in the recent past.[16-18]

The overall rate of HIV seropositivity in this group of patients was 7.2%. The rate showed an increasing trend over the period from 12% in 1995 to 19.2% in 1996 and thereafter fluctuated to a high of 20% in 2001. Thereafter, no case of HIV seropositivity among STD cases was detected. It is probable that after the initial spurt of increase in HIV infection among STD cases, education and control measures in the form of condom promotion and other activities have been helpful in the control of this condition in the service community of this area as evidenced by the total overall trend toward reduction in STD incidence as well.

Common Conditions
Infections
The close relationship of humans and animals in the desert is essential but can contribute to diseases and infestations.

Bacterial infections
Bacterial infections are exceedingly common and are related to the poor hygiene conditions. Folliculitis, furunculosis, and deeper infections are common, more so in the nomads and soldiers. Occlusive clothing is associated with sweat retention, which further predisposes to bacterial infections.

Scabies
Scabies is an intensely pruritic, nonseasonal, contagious skin disease caused by the species-specific, Sarcoptes scabiei. The camel mite, Sarcoptes scabiei var. cameli, infects the Arabian as well as the Indian camel.[19] Canine scabies, Sarcoptes scabiei var. canis, is common, but feline scabies, Notoedres cati, is less common.

Pediculosis
Lice are species-specific parasites that spread by direct contact. Cattle, horses, and goats can be affected. Transmission to humans is less likely but can occur by direct contact.

Warts
Humans can acquire wart infection from cattle, and they are common in the butcher community.

Herpes
Herpes, both simplex and zoster, is more common in the desert environment, especially among troops as they are faced with the stresses of having to live away from their families and face the vagaries of weather as well as the prospect of exercises/military operations.

Fungal diseases
Fungal infections in dogs and cats are important sources of zoonotic infections in humans. As in humans, dermatophytosis affects the hair and the skin of animals.[20] Here again, occlusive clothing plays a part in leading to humid milieu, most suited to the growth of candida/dermatophytes. Women, especially in occlusive clothing, face the prospect of chronic vulvovaginal candidiasis.

Mycetoma
This condition is known as Madura foot in the endemic areas of India. It occurs worldwide but with an uneven distribution. It is common in the thorny semi-deserts of
Central and South America, Africa, and India, and it has been reported from Saudi Arabia. The environmental and living conditions help produce a favorable condition for this disease. It is common in barefooted herdsmen and farmers, where thorns pierce the skin and introduce the organisms. This results in a localized, chronic infection with various fungi or actinomycetes, resulting in severe damage to skin, subcutaneous tissues and bones of the feet, hands, and other parts of the body.

Leishmaniasis
Zoonotic cutaneous leishmaniasis is endemic in many arid countries extending from North Africa to Afghanistan as well as some parts of Rajasthan. Cases have been documented from patients living in the desert for long periods. The cause of the disease is Leishmania major, which infects desert rodents (e.g., Psammomys and Rhombomys). Chenopod desert plants provide the rodents with the food and water they need for survival in this harsh environment. The disease is maintained in colonies of those rodents, and it is transmitted by the sand fly, Phlebotomus papatasi. The inhabitants, nomads passing through endemic areas, as well as soldiers participating in maneuvers in those areas are at high risk of acquiring the infection.

Control of the disease involves destruction of burrows of the animal reservoirs around villages and army camps. This is often carried out by plowing the area within a few kilometer radius. The use of repellents and pesticide-impregnated bed nets is also helpful in protecting people at risk.

Other Skin Changes Seen in Nomads
Skin tumors
Nomads are usually dark-skinned (Type III–VI); this partially protects them from the carcinogenic effect of the sun. They protect their skin by wearing long-sleeved clothes, and they cover their heads with “safas” (turban) and even faces are covered in women. Because of the nature of the sunny desert all year round, they are prone to develop skin tumors such as basal cell carcinoma, squamous cell carcinoma, and melanoma. A study of 125 cases of cutaneous melanoma from the desert areas in Iran has shown that acral lentiginous melanoma (ALM) represented 28.8% and nodular melanoma occurred in 20% of cases. Limbs were the site of occurrence in 44% of tumors, whereas 36% of tumors occurred in the head and neck region. There was a significant correlation between age and ALM ($P = 0.007$) and also between gender and melanoma types ($P = 0.024$).

Dry skin
The dryness of the desert and its low humidity with frequent sandstorms makes the skin dry and leathery. Conditions such as psoriasis, ichthyoses, and atopic dermatitis are more common consequently.

Atopic dermatitis
A study was undertaken to assess the burden and clinical peculiarities of atopic dermatitis among civilians, troops, and families posted in and around Jodhpur, Rajasthan. Cases of atopic dermatitis among patients reporting to a service hospital in Jodhpur, Rajasthan, were assessed to elucidate its frequency among troops and families in Western Rajasthan as well as analyze reasons for its high frequency and characterize its clinical peculiarities compared to the rest of the country. Data were analyzed for a period of 2 years. Out of a total of 25,400 patients who attended the skin outpatient department during a period of 2 years, a total of 7112 (28%) cases of various types of eczemas were diagnosed. Atopic dermatitis diagnosed as per standard (UK Working Party) criteria was seen in 1010 (14.2%) cases of eczemas. However, clinically, the condition was seen in a form more severe as compared to that in the rest of the country and similar to that seen in the west. Extensor distribution of lesions was seen very frequently among older children and adults as well. Unusual morphological forms were seen in addition to the usual pattern of lesions. A strong association with autosomal dominant ichthyosis was found as expected. Following this, a study of this condition in the community revealed that it was present in 11.8% of children in the community and among 7% of adults and 6% of the elderly. It was found in a greater proportion of individuals posted in from other parts of the country (9%) than among troops native to this part of the state (2%). In the majority of patients native to other parts of the country, the condition was first diagnosed at this station. An association with other elements of the atopic diathesis in the patient or his family was seen in only 12% cases. It therefore appears that environmental factors seem to be important in manifestations of atopic dermatitis in this group of patients.

Desert sweat dermatitis
Three hundred and twenty-seven patients presenting to the Dermatology Department of a hospital in this area who had an unusual scaly dermatosis involving the area covered by the trunk undergarment were assessed clinically and by patch testing in a prospective manner. Lesions were present exclusively in the hot dry summers [Figure 4]. A number of patients were soldiers. Males outnumbered females 4:1, and all were between 16 and 40 years of age. All patients spent a considerable amount of time outdoors in work involving significant physical activity. The use of a reasonably tight porous undergarment over the trunk was universal. Patch test to patients’ own sweat showed an irritant reaction in all patients.

A chronic cumulative irritant contact dermatitis to sweat solutes in individuals who consume less fluid, sweat but whose sweat dries up rapidly under a garment due to low
humidity appear significant in causation of this unusual pattern of dermatosis. The type of garment involved which allows this condition to develop is itself of porous material, allowing the fluid component of the sweat to evaporate easily, leaving the sweat solutes which are in a higher concentration in these patients, to cause the irritant reaction. The reason for reporting this typical finding was that it is not consistent with the described forms of miliaria. The term “sweat dermatitis” has been used for this observed unique dermatologic condition, which has been observed once before in a report from Bikaner, Rajasthan, India,[25] but has not been assessed to be able to hypothesize the cause as has been done in the quoted study.

**Solar elastotic degeneration**

Solar elastotic degeneration is common among desert dwellers. These individuals spend long hours under the open sun, and this leads to early appearance of wrinkles and features of skin aging [Figure 5].

**Pigmentary changes**

Photomelanosis is another common problem seen in the Thar Desert region of Rajasthan, India. Photomelanotic pigment of exposed areas acts as partial protection against extensive ultraviolet radiation damage.

**Fissured heels and dystrophic toenails**

Although the sand dunes are hot during the day, nomads walk almost barefoot. This results in hyperkeratotic thick feet. Fissured heels are frequently seen. Repeated trauma to toenails results in their abnormality, ending in dystrophy.

**Desert dust and its related disorders**

Dust storms may originate in many of the world’s drylands and have an effect not only on human health in the drylands and deserts themselves but also in downwind environments, including some major urban centers in the near vicinity. In the Thar, inhabitants of cities such as Jaipur and Jodhpur may be involved. In some parts of the world, dust storms occur frequently throughout the year. They can transport particulate material, pollutants, and potential allergens over thousands of km from the source. The frequency of dust storms is changing in response to land use and climatic changes, and in such locations, the health implications may become more severe. Various pollutants (heavy metals, pesticides, etc.) and biological components (spores, fungi, bacteria, etc.) are involved. Particulate loadings can far exceed healthy levels. Among the human health effects of dust storms are skin irritation, in addition to respiratory disorders (including asthma, tracheitis, pneumonia, allergic rhinitis, and silicosis), cardiovascular disorders (including stroke), conjunctivitis, meningococcal meningitis, valley fever, diseases associated with toxic algal blooms and mortality, and injuries related to transport accidents.[26]

**Desert Skin Care**

How can one combat environmental pollutants, the affect of solar radiation, and the noteworthy drying effects of the arid desert winds? How can one be sure that one is using the correct products on the skin – so one can be healthy inside and out? Here are tips to assist in this process:[1]

- One must be very aware of what is in skin care products. The use of products that are all simple in content as much as possible is necessary. One must avoid products containing a large number of ingredients. All natural products may not be good for the skin
- To find products with antioxidants. These two vitamins can protect the skin from premature aging caused by the sun, pollution, and other environmental factors. They also provide advanced

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**Figure 4:** Desert sweat dermatitis involving entire back of a soldier serving in the desert

**Figure 5:** Extensive rhytides due to actinic skin damage
nutrition to the skin to keep it appearing smooth and firm. Sunscreens used must protect from ultraviolet-B as well as ultraviolet-A. Physical sunscreens such as calamine and zinc oxide are more effective in this situation, especially as the former helps keep the skin cool.

- If possible, one must use products that are paraben free. Parabens are synthetic chemical preservatives that are widely used in personal care products such as shampoos, conditioners, hairstyling products, makeup, facial masks, skin lotions and creams, and deodorants. They also are typically ingredients in baby lotions, shampoos, and other personal care products for infants and children. In addition, parabens are in many foods and pharmaceutical products. Researchers are beginning to find parabens in benign and malignant human breast tumors. While some studies have challenged their toxicity in many products and question their long-term affect on humans, using products that are paraben free can eliminate the risk of exposure to this harmful chemical.

- One must drink plenty of water! Really, plenty of water – extra water. Water hydrates skin and hair as well as flushes toxins out of the body.

**Conclusion**

Although the concept of desert dermatology is new and considered to be in the realms of future research, we are already in the midst of reassessing the common conditions that medical officers are faced with in these areas. In rural areas (Osian), sun-related disorders such as polymorphic light eruptions are common as are miliaria and fungal and bacterial infections due to the poor hygiene of the population due to scarcity of water. Dry discoid eczemas are also common, again due to the low humidity. However, in the urban areas, melasma and acne are the most common disorders. Psoriasis is also common, understandably, due to the low humidity.

Data gleaned from conduct of more studies in the rural areas and their correlation with conditions faced within urban areas will further help elicit these conditions and their relationship to the desert ecology.

**Declaration of patient consent**

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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**Conflicts of interest**

There are no conflicts of interest.

**What is new?**

This symposium article condenses all that has been gleaned by previous publications and the experiences of the author during his tenure in Jodhpur, Rajasthan when he was involved in the skin care of military personnel in the Thar desert region. A comprehensive outline of infections, pigmenitary disorders, photodermatoses, skin tumors and others along with their correlation with the climate of the desert have been described herein.

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