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RUNNING THE RISK: EXAMINING DERMATOLOGIC CONCERNS AND SKIN NEOPLASMS IN RUNNERS

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Abstract:

This review summarizes the most prevalent dermatologic conditions encountered by runners and provides evidence-based recommendations for prevention and management. Due to high levels of ultraviolet radiation exposure, friction forces, specific environment of the activity and used garment runners are at the risk of various dermatologic complications, including skin neoplasms. Sun protection measures, such as applying sunscreen with sufficient SPF, wearing photoprotective clothing, and avoiding peak sun hours, are crucial for mitigating this risk. Friction-related injuries like blisters, calluses, and jogger's nipples are common among runners and can be prevented through proper footwear, moisture management, and lubrication. Educational interventions promoting safety practices are necessary to raise awareness and encourage behavioural change among runners.

Keywords: runners, dermatoses, melanoma, skin neoplasms, athletes, ultraviolet radiation

Introduction:

Running, a popular form of exercise, can expose the skin to various dermatologic challenges.[1] Notably, over 20% of marathoners experience skin-related problems.[2] The location of these lesions often centres around the feet, particularly for trail runners who encounter more rugged terrain.[3]

Several factors contribute to the unique dermatologic risks faced by runners. Runners can be categorized into three primary exposure groups: traumatic, environmental, and infectious.[4] Some studies also differentiate an inflammatory group of dermatologic conditions specific to athletes.[1] While experienced runners often possess knowledge of managing common conditions, novice runners may require assistance to prevent dermatological complications that could disrupt their rigorous training regimens.[1]

The specific demands of running place the skin under significant stress.[5] According to WHO, skin neoplasms are the most prevalent malignant tumors globally, with concerning increases in incidence rates.[6] While often linked to leisure sun exposure, athletes who train outdoors extensively are also at risk.[7] Runners, specifically, accumulate substantial UVR exposure due to frequent outdoor training sessions and often-uncovered skin. The degree of this exposure varies depending on factors like altitude, latitude, season, weather conditions, time of day, and sun protection measures employed.[8,9]

Sweat production alters the hydration of the stratum corneum, the skin's outermost layer, potentially reducing its ability to reflect and scatter UVR. This, combined with elevated skin temperature common during moderate exercise like jogging, can contribute to sunburn development.[10,11]

High-intensity exercise like running can lead to increased oxidative stress on the skin, while low-intensity exercise does not appear to carry this risk. When oxidative stress occurs, the skin's first line of defence weakens, potentially increasing susceptibility to sun damage. However, with consistent training, the skin's antioxidant defence system appears to become more active.[10]

Fortunately, the implementation of appropriate sun protection measures can significantly reduce the risk of UVR-induced skin problems. These measures include applying broad-spectrum sunscreen with sufficient SPF, utilizing photoprotective clothing, and avoiding peak sun hours and high-UVR environments.[10]

While strenuous endurance exercise like running can lead to a temporary state of moderate immunosuppression, potentially promoting the development of certain conditions, this area requires further research.[12] New diagnostic tools based on artificial intelligence are emerging to aid in identifying suspicious lesions.[13]

There is a scarcity of review articles specifically addressing dermatologic conditions in runners, with a particular focus on neoplasms. This review aims to bridge this gap by summarizing the most common dermatologic issues encountered by runners and providing evidence-based recommendations for prevention and management.

Skin neoplasm affecting runners

Marathon runners demonstrate an elevated risk for developing both malignant melanoma (MM) and non-melanoma (NMSC) skin cancers.[5,14] Awareness among runners about these lesions is not good enough and even worse in case of NMSC.[7] Marathon runners exhibit a significantly higher prevalence of atypical melanocytic nevi and solar lentigines compared to control groups.[5] Notably, the quantity of these lesions is recognized as the most robust independent predictor of increased MM risk.[15]

Ultraviolet radiation (UVR) exposure represents the primary preventable risk factor for the development of both NMSC and MM.[16] Running is connected with extremely high levels of UVR exposure.[4] According to the study of Serrano et al. daily UVR exposure of runners exceeded the exposure limit by approximately 3 times.[17] In the population of Valencia, runners did not transcend the limit of exposure, what is probably caused by unfavourable thermal conditions during sun peak hours.[9] Runners reported greater cumulative lifetime sun exposure compared to surfers, despite spending less time exercising during peak sunlight hours.[13] Erythema solare (sunburn) serves as a well-established biological marker for acute, high-dose UVR exposure and is recognized as a significant risk factor for the development of cutaneous neoplasms, encompassing MM.[5,18]

Around 1/3 of runners report at least one sunburn evidence of heavy sunburn before adulthood.[19] In a study of Miller et al. a high proportion (79.2%) of distance runners surveyed reported experiencing at least one blistering sunburn during their childhood.[13] Sunburns during training are more common for runners younger than 45 years old and surprisingly for runners with higher level of education, even though they report higher skin neoplasm awareness.[7,20] Sunburns are more common in runners with Fitzpatrick I and II skin types.[20] All of the surveyed runners report at least one sunburn during their lifetime. Individuals reporting a history of ten or more lifetime sunburns exhibited a higher prevalence of lentigines on the left shoulder compared to those with fewer reported sunburns.[14] What is more, runners who used staying in a shade as a protective measure are also more likely to get sunburned.[20]

Participants with Fitzpatrick I, II and III skin type have similar UVR protection score. The results of the studies suggest that athletes with the fairest skin tend to protect more from UVR than their darker colleagues.[7,19] The same correlation was found for runners with personal history of skin neoplasm. Surprisingly, there was no correlation shown in case of a positive family history of skin neoplasm. The age also plays a role in UVR protections behaviours as older athletes are more likely to use protection measures.[19,20] There was observed a correlation between lower educational level of the runner and higher skin neoplasm awareness score.[19] Women runners score higher at the score than their male collegues.[19]

While Ambros-Rudolph et al. reported no cases of MM among 210 marathon runners examined, Miller et al. identified a prevalence of 4.3% MM in their study population. These contrasting findings highlight the potential influence of methodological variations and population characteristics on the reported frequency of MM in athletes. [5,13] Significantly more male runners are diagnosed with actinic keratosis (which is a precancerous condition) and keratinocyte carcinomas comparing to female ones.[13]

Protective measures

Limiting exposure to sunlight, wearing protective clothing, headgear, sunglasses, applying of sunscreen on uncovered body parts are the most common protection strategies to avoid excessive exposure to sunlight. [19,21,22] Engaging in outdoor activities like running exposes significant areas of skin to UVR due to the typical attire of shorts and t-shirts. [5] An examination of distance runners revealed a higher prevalence of lentigines and nevi, particularly on sun-exposed areas like the shoulders compared to covered sites. Notably, runners wearing T-shirts exhibited a significantly lower number of shoulder lentigines compared to those with exposed shoulders. [14] What is more, runners reporting higher training intensity exhibited a statistically significant association with a greater number of nevi on the left shoulder.[14,23]

The usage of UVR protective measures among runners differ, depending on the examined population. Runners reported a greater adherence to facial sun protection measures (sunscreen, hat, sunglasses) compared to full-body protection strategies (sunscreen on all exposed areas, long sleeves). [24,25] Thirty percent (30%) of the participating distance runners reported consistently wearing sunglasses during training runs. [7] In the study of Purim and Leite 45% of the runners report frequent sunglasses use. [8,24] Spanish population of runners use sunglasses even more frequently. [20,25] The least popular protection measure are long-sleeved shirts. Their usage is reported by 4-10% of runners.[7,24,25]

The usage of head gear varies the most between studies. According to Durate et al., 17% of the runners consistently wear a hat. [7] Another study shows that the percentage reaches 33%. [25] In case of Spanish population of mountain runners the incidence reached 52%. [20] In Brazilian population of runners, the percentage was higher and reached 86%.[8] In another study the rate reached 82%.[13]

In the study of Miller et al. 4.7% of participating runners reported not having undergone a skin neoplasm screening in their life. [13] According to another study the percentage was much higher and as 60% of the participants have never had their nevi checked.[14]

Sunscreen use

Sunscreen use among runners exhibited substantial heterogeneity, especially for different body regions. According to Duarte et al., only 12% of runners apply a sunscreen. [7] In another study, 56.2% of runners reported regular sunscreen use, with an additional 41.9% reporting occasional use.[5] In the study of Tenforde et al., frequent use of sunscreen on all exposed skin was reported by 18% of the runners, and on the face by 42%. [24] While most Brazilian runners prioritize facial sun protection (72%), awareness extends beyond common areas, with over 40% applying sunscreen to ears, lips, and the nape of the neck. Interestingly, torso and limb coverage remains relatively low (17% and 26%, respectively), highlighting potential knowledge gaps regarding comprehensive sun protection.[8] Alarmingly, 28% of Brazilian runners reported neglecting sunscreen entirely during training sessions.[8] Around 70% of runners use sunscreen with sun protection factor over 30.[7] In Brazilian population of runners less athletes use such a sunscreens, around 53%.[8] However, 62% of Spanish runners apply sunscreen with 15 or higher sun protection factor.[20]

Males spent significantly longer activity sessions with sun exposure compared to females.[13] However, women are more likely to apply sunscreen before training comparing to male runners (32% versus 7%). [7,24] What is more, women are more likely to use sunscreen at least 30 minutes before training and men tend to do it immediately before going for a run.[7] Age also plays role in that aspect as older runners more frequently report sunscreen use before their trainings. [24] Other factors influencing the sunscreen usage are running fewer miles per week, lower BMI, history of skin neoplasm. [24] These findings underscore the need for targeted interventions to promote sun protection behaviours among runners.

Less than 5% of runners reapply sunscreen during training. Educational initiatives promoting sunscreen reapplication are crucial for long-distance runners, given the extended exposure times during training.[7]

Self-reported barriers to sunscreen use among collegiate athletes encompass a lack of perceived risk for skin neoplasm, minimal concern regarding wrinkles or sunburns, a preference for tanned skin, challenges with application consistency (forgetting or inconvenience), and cost considerations. Among the factors influencing

sunscreen use, fear of skin neoplasm emerged as the most prominent motivator, with 39.2% of participants citing it. Comfort level (28.7%) and fear of skin aging (15.8%) were also reported as influences on sunscreen use.[24]

As aforementioned, sweat enhances the susceptibility of skin to UVR, but it also can wash away sunscreen and increase the risk for UVR in this way.[4]

There is significant variability in sun exposure habits and levels of UVR exposure across different populations of runners. Studies have demonstrated that the average daily dose of sunlight, measured in units like minimal erythema dose (MED), can vary considerably between groups. Even in case of that one discipline, variation is likely due to a combination of factors, including geographic location, cultural practices related to sun exposure, and individual behaviours regarding sun protection. [21,22] Additionally, some cultural groups prioritize sun protection measures like sunscreen and sun-protective clothing. These contrasting approaches to sun exposure highlight the need to consider population-specific factors when construction educational materials for athletes.

Non-neoplastic dermatoses of runners

Blisters, or friction bullae, represent a prevalent skin injury among runners, with a reported prevalence ranging from 0.2% to 39%.[26,27] Purim and Leite observed an even higher prevalence of 50% in Brazilian road runners. [8] Notably, a 12-year study of the Twin Cities Marathon found an average blister rate of approximately 20%.[2]

The development of blisters is attributed to excessive or prolonged rubbing against weight-bearing surfaces with a thick stratum corneum (the outermost layer of the skin). This friction disrupts the adhesion between epidermal layers (within the epidermis) or between the epidermis and dermis, leading to a collection of fluid or blood beneath the disrupted area. Hot and humid environments, common within running shoes, further promote blister formation. Blisters can even occur under calluses.[1]

Blister treatment is frequently mishandled. [28] While most blisters are a minor inconvenience, deeper blisters can involve bleeding and hemorrhage. Leaving intact blisters whenever possible is recommended. [1] The most effective treatment involves early puncture to release trapped fluid while preserving the overlying skin, which acts as a natural dressing. [4,29,30] Some healthcare professionals advise applying adhesive tape to secure this natural barrier. Moleskin pads and hydrocolloid dressings offer additional options to reduce discomfort, protect the area from infection, and prevent further injury.[4]

Preventive measures focus on minimizing friction through moisture-wicking socks, petroleum jelly, and properly fitted shoes. Hardening the skin with tannic acid soaks, double-layering socks with powder, and using protective hand and foot gear are additional strategies, though less commonly employed.[1,30] Low-friction socks made of acrylic or polyester are recommended for their sweat-wicking properties.[4] Shoes should fit snugly to minimize slippage within the shoe.[1]

Calluses, a prevalent finding among runners with a reported prevalence of 34.2%, [3,8] develop as a localized area of thickened skin in response to chronic frictional forces. These lesions can arise on any skin surface in contact with an athlete's clothing or equipment and may even develop over areas previously affected by blisters.[1] Callus formation serves as a protective mechanism of the skin in response to repetitive stress.[29,30]

In many cases, the therapeutic need for callus removal is debatable.[29] When the causative activity ceases, the skin typically returns to its normal state even in the absence of treatment. However, it is crucial to differentiate calluses from warts, which can be distinguished by the presence of "black seeds" representing pericapillary haemorrhages.[26]

Punctate hyperkeratosis, also known as corns or clavi, are hyperkeratotic lesions that typically develop at pressure points near underlying bones.[1,29] Deeper and often more painful than calluses, corns most commonly present on the toes or plantar aspects of the foot, particularly over the distal metatarsal heads. Skeletal foot deformities and ill-fitting shoes are well-established contributing factors in corn development. [29] Topical keratolytic medications and pressure-distributing pads can be beneficial in managing corns by reducing hyperkeratosis and alleviating localized pressure.[1]

Abrasions, affecting an estimated 42.1% of the population of runners, [8] are a prevalent injury resulting from the scraping, impact or pressure on the skin's surface epithelium. [31] Friction and blunt force trauma are the most common mechanisms behind these injuries, which can occur during different type of situations during trainings. Fortunately, abrasions rarely necessitate physician intervention. Proper wound care, including gentle cleansing with mild soap and water, is crucial to prevent infection. Notably, aggressive scrubbing should be avoided, as it can worsen inflammation and delay healing. In some instances, particularly for larger or deeper abrasions, the application of a hydrocolloid or semiocclusive hydrogel dressing may be beneficial. The use of

appropriate protective gear, such as sliding pads, long sleeves, and knee or elbow pads, plays a vital role in preventing abrasions.[31]

Jogger's toe

Repetitive microtrauma from distance running can lead to a common condition known as "runner's toe." This condition is characterized by a shearing force applied to the nail plate of the most prominent toe (typically the hallux or second toe) during repetitive thrusting within the toe box, especially accentuated during downhill running. The affected toenail often exhibits thickening, ridging, and discoloration.[1,28,30]

Preventative measures can help mitigate runner's toe. Cautious trimming of the toenails to a short length in a straight, tangential plane has shown promise.[1,29] Additionally, proper shoe fitting and tight lacing are crucial to minimize excessive movement within the shoe. Some runners utilize protective measures such as sponge toe covers.[1,30] Regular nail plate care, including the application of an emollient cream, can enhance nail flexibility and potentially reduce the risk of splitting under pressure. By maintaining healthy and flexible nails, runners are better equipped to withstand the rigors of distance running.[1]

Subungual hematomas, a frequent occurrence in runners [1,3,27] , are characterized by blood accumulation beneath the toenail plate, leading to pain. These typically arise from a sudden, blunt external force to the toe.[30] Drainage of the accumulated blood can provide relief, with two common methods being hot wire puncture or incision of the nail plate.[30] An alternative, less invasive approach involves inserting a needle or pin into the hyponychium (the soft tissue beneath the free edge of the nail plate).[1]

Differential diagnosis of subungual hematomas is crucial, as clinicians may encounter confusion with sports-related nail dystrophies, subungual melanocytic nevi, and, in rare cases, melanoma.[1,28,30] When uncertainty surrounds the diagnosis, a biopsy becomes necessary.[1]

Jogger's nipple, a form of irritant dermatitis affecting 2-16.3% of runners[8,26,32], arises from friction between the runner's nipples or areolae and their clothing. This friction can lead to the development of painful erythematous erosions with crusting. Tight-fitting shirts made from coarse, slow-drying cotton fabrics are particularly problematic. Women who forego sports bras and overweight male runners are also at increased risk. Affected runners may get unrobed during runs or are found to develop bloody stains on their garments around the nipples.[1,4,28,29]

Treatment options for jogger's nipple include topical antibiotics and application of petroleum jelly. Preventive measures focus on reducing friction. Applying adhesive dressings or petroleum jelly directly to the nipples before running can be effective.[28,30]

Talon noir

It's a term originated in French which refers to discoloration of the area of the heel. It consists of several small petechiae caused by focal rupture and haemorrhage. Blood from dermal capillaries gets deposited in the thick stratum corneum of the heel. These often confuse physicians and make them suspect a pigmented neoplasm.[1,29,30] The lesions are often not painful, but while they are accompanied by hyperkeratosis, there can appear a discomfort caused by callus formation. Physicians do not recommend any specific therapy, just proper lubrication of the area and waiting for the condition to resolve.[30]

Runner's rump is another cutaneous condition characterized by discoloration due to ecchymosis. This condition manifests in the superior gluteal cleft, primarily affecting long-distance runners. The ecchymoses develop as a result of continuous contact between the buttocks during each running stride. Fortunately, runner's rump is purely cosmetic and typically resolves on its own after a period of reduced running activity.[29]

Athlete's nodules

Another prevalent finding among runners is a benign dermal condition known as either pilar sheath papilloma or collagenoma. These lesions typically present as soft, flesh-coloured nodules with a keratinised surface, and most commonly appear on the peroneal aspect of the ankle or the dorsum of the foot. The development of these nodules is thought to be stimulated by chronic, repetitive trauma to the affected area. It is important to differentiate pilar sheath papillomas from dermatofibromas, which can appear clinically similar.[4]

Tinea pedis, commonly known as athlete's foot, afflicts approximately 18.4% of runners. [8] This fungal infection flourishes in warm, moist environments, making runners who wear non-breathable footwear particularly susceptible. Sweating and maceration create ideal conditions for dermatophytes to thrive. Other contributing factors include occlusive footwear, skin trauma, and sharing communal showers. [26] Among

runners, *Trichophyton rubrum* and *Trichophyton mentagrophytes* are the most commonly identified dermatophyte species causing tinea pedis.

Preventative measures can significantly reduce the risk of tinea pedis in runners. These strategies include wearing moisture-wicking synthetic socks and changing them regularly throughout the day, maintaining dry feet by thoroughly drying them after showering or running, utilizing well-ventilated shoes, and incorporating the use of topical antifungal powders.[26]

Contact dermatitis is a prevalent concern among runners, with the rash developing in areas corresponding to direct contact with the irritant. [27,32] Potential culprits include components of running shoes such as rubber, leather, adhesives, and dyes. The humid environment within running shoes can further exacerbate the reaction. [32] Moreover, topical medications commonly used by athletes, such as analgesic sprays, topical salicylates, and anti-inflammatory creams or gels, have also been reported to cause acute contact dermatitis. This highlights the diverse range of potential triggers runners may encounter, necessitating a thorough investigation for accurate diagnosis and treatment.[31,32]

Urticaria

Running can be a trigger for cholinergic urticaria, a form of hives characterized by small wheals (2–5 mm) surrounded by erythema. Exercise-induced increases in core body temperature activate this response, though solar radiation, passive warming, and emotional stress can also be causative factors. While the wheals typically resolve within 24 hours and respond well to corticosteroids, cholinergic urticaria can pose a significant challenge for athletes due to the potential disruption to training and competition.[4,28]

Exercise-induced anaphylaxis (EIA) presents a unique challenge for runners, manifesting not only as a characteristic dermatologic condition, but also potentially progressing to respiratory or vascular collapse. [28] While not all cases reach this severity, pre-exercise meals have been identified as a predisposing factor for lesion development. Cutaneous and systemic symptoms are both observed in athletes with EIA. Pruritus, a constant finding, is often accompanied by variable occurrences of angioneurotic edema, urticaria, respiratory difficulties, gastrointestinal complaints (nausea, diarrhea, or cramps), and even vascular collapse. Notably, preventative strategies have shown some efficacy. Nearly half of EIA sufferers report a reduction in episodes by avoiding exercise in extreme weather conditions (hot, humid, or cold). Similarly, approximately one-third find that refraining from pre-exercise meals helps diminish the frequency of attacks.[4]

Conclusions:

Running exposes the skin to various dermatologic challenges, particularly for frequent runners who accumulate significant ultraviolet radiation (UVR) exposure. This review highlights the concerning prevalence of skin cancers, including melanoma and non-melanoma skin cancers, among runners. Fortunately, a variety of preventive measures can significantly reduce this risk. There appears to be a gap between knowledge and practice and it shows a serious need for educational interventions promoting sun-safe practices among runners, including scheduling workouts avoiding peak sun hours, utilizing photoprotective clothing, and incorporating regular application of water-resistant sunscreen. Beyond UVR exposure, runners are susceptible to other dermatologic conditions, mainly friction-related injuries. Through proper footwear selection, moisture management, and implementing targeted interventions, the incidence of these conditions can be minimized. In conclusion, runners can significantly enhance their skin health and optimize their training experiences by adopting a comprehensive approach to dermatologic risk reduction and management.

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Author's contribution

Conceptualization: AP, AN; Methodology: NW, AF; Formal analysis: AF, KS; Check: AN, JD, ZC; Investigation: AP, MD; Writing - rough preparation: AP, NW; Writing - review and editing: AN, JD, AM; Supervision: MP, AM

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