50 Use of Cosmetics in Sports

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INTRODUCTION

Our objective was to search the literature for cosmetic and pharmaceutical products that are frequently used or specially designed around the specific needs of sport activities and athletes. A narrative literature search was performed using the online databases Pubmed and Google Scholar. The authors choose to differentiate between pharmaceuticals and cosmetic products not by following the definition of an "active" or "inert" action on the skin but by restricting to products that may be sold directly to a consumer without a prescription from a health care professional. These products can be classified into five functional groups of cosmetic products with a potential biological effect to skin.

1. The use of aesthetic cosmetic products in sports is well established, especially in aesthetic sports such as gymnastics, ice skating, and synchronized swimming where an attractive appearance supports the self-confidence of the athlete. Not only the individual performance will benefit but also beauty and attractiveness can influence the scores given by the judges committee.
2. During a sport, the skin of an athlete is often exposed to harsh environmental conditions. In order to protect and to prevent damage to the skin, the cosmetic industry has developed special preventive and protective skin care products, meeting the requirements of the individual sportsperson.
3. Cosmeceuticals are cosmetic products that exert a pharmaceutical therapeutic benefit without having a biological effect on living tissue. Cosmeceuticals are effective in the treatment of sport-related dermatological disorders and can be a useful adjunct to prescription medications.
4. Stimulating products especially those with a hyperaemising or cooling capacity are frequently used by athletes in the preparation for sport or to stimulate the body in order to enhance physical performance.
5. After physical activity, adequate personal hygiene is important in maintaining the body healthy and vital. Intensive showering after each training session requires a cosmetic cleansing formulation that supports the natural skin balance with regard to pH value, moisture content, and cleansing capacity.

AESTHETIC SPORT COSMETICS

It is well known that sport and physical activity have a positive effect on medical health and subjective well-being. Sport has a positive effect on our attitude to our own body image and our feelings of strength and fitness. To participate in sports because of "body and appearance" is, through an interaction between age and gender, clearly more important in women than in men, as the women's body image is more closely linked to overall self-esteem than men's [1].

In modern society, the perception of health and beauty and the desire to maintain youthfulness are considered to be of great importance. As people wish to maintain a youthful look as long as possible, the demand for products designed to treat and reduce the cosmetic effects of aging continues to grow [2]. Attractiveness and beauty have gained importance since the media started to broadcast sporting competition and events on television. Millions of people are watching, the athletes perform, and in the prize-giving ceremonies, the media is highlighting and focusing on the athlete in person [3]. The appropriate use of cosmetics and the feeling of looking good and happiness positively support the self-confidence and self-esteem of an athlete. Happy and attractive personalities attract the interest of media and sponsors; the combination of being successful and media publicity can have a major impact on the career of an athlete. Today, sport equipment companies bring out their own cosmetic line, with colors in line with the clothing, supporting the appearance and attractiveness of the athlete on the track. These sport cosmetics are adapted to the needs of the individual athlete, with waterproof and sweat resistant makeup and deodorant fragrances.

DEPILATORY CREAMS

It is a common practice for professional and amateur road cyclist to remove leg hair for a number of reasons. The absence of hair increases the comfort and effectiveness of a massage, as the therapist can effleurage the skin without irritating the hair follicles. In the case of a crash, the absence of the leg hair reduces friction on the skin during a sliding fall reducing skin damage. "Road rash" and the affected area can be treated more efficiently. Also, professional swimmers remove hair off their legs not to prevent drag with the water from slowing them down as is commonly believed but to remove a dead layer of skin, providing a heightened "feel"

for the water. Depilatory hair removal is an economical and easy method, which can be performed at home. Chemical depilatories function by damaging the hair to the point where it breaks at the skin surface; they contain detergents to remove the protective sebum from the hair and adhesives that aid the depilatory in sticking to the hair shaft. Disulfide bond-breaking chemicals with a high degree of acidity such as sodium thioglycolate, or calcium thioglycolate, react with the keratin structure of the hair and break down and dissolve hair within the follicle. Depending on hair coarseness, the process takes from 5 to 15 min; during that time, the hair is dissolved into a glop, which can then be washed away. As the hair shaft and skin have a similar keratin composition, most chemical depilatories interact with the skin and hold a high irritancy potential if the manufacturer's recommendations are not carefully followed [4]. Adverse effects from the use of thioglycolates include burning, itching sensations, and allergic contact dermatitis [5].

PREVENTIVE AND PROTECTIVE SPORT COSMETICS

Sunscreens and UV Protection

Outdoor sports with sun exposure can cause both local and systemic immunosuppression depending on the area of exposure and the dosage of UV radiation. The immunosuppressive and carcinogenic effects of UV light on the skin are complex, involving a variety of cell types, including antigen-presenting cells, lymphocytes, and cytokines. UV radiation can cause dysregulation of antigen-presenting cells such as Langerhans cells and dermal dendritic cells, which, in turn, can activate regulatory T cells to suppress the immune system [6].

Epidemiological studies show that participating in outdoor sport activities and sun exposure during leisure time activities and outdoor sport in general can increase the risk of developing basal cell carcinoma (BCC) and cutaneous melanoma (CM) [7–9]. In cutaneous photobiology, radiant exposure is often expressed as multiples of "standard erythema dose" (SED); one SED corresponds to 100 J/m^2. In various dosimeter studies, the anatomical distribution of sunlight and UV exposure during physical activity was documented. Playing golf or tennis or participation in sailing was associated with relatively high UV exposure ranging from 3.5 up to 5.4 SED per hour [10]. In the Tour the Swiss cycling race, the daily average personal UV exposure of a professional cyclist was determined to be 20.3 SED [11]. Three triathletes participating at the 1999 Ironman Triathlon World Championships in Hawaii had a mean personal UV exposure of 20.8 SED [12]. The study conducted by Rigel et al. [13] showed that skiers with an average skin type and without sunscreen protection started to get sunburned only after 6 min at an altitude of 11,000 ft. [13]. Sweating induced by physical exercise in warm environmental conditions increases the stratum corneum hydration, which can significantly contribute to UV-related skin damage as it increases the photosensitivity of the skin, facilitating the risk of sunburns [14,15]. Although studies indicate that a single application of sunscreen efficiently reduces sunburn [16–18], it should be considered that despite the use of water-resistant sunscreen preparations, protection might be less effective because of water exposure, sweating, friction, and possible interaction of clothing with the sunscreen formulation. Sport sunscreens specially designed for outdoor sport activities should be very water resistant, have a higher sun protection factor (SPF), and block both UVA and UVB rays.

Since 2002, FDA regulations have required companies to eliminate the use of the words "Sunblock," "Sweat proof," and "Waterproof" when referring to sunscreens as these claims cannot be substantiated. Instead, the label on the front of the package can only read either "water resistant (40 minutes)" or "water resistant (80 minutes)." Also, sunscreens may no longer claim to provide "instant protection" nor can they claim to maintain efficacy for more than 2 h without reapplication [6].

Unfortunately, athletes frequently seem to know little about the risk of sun exposure and do not apply sunscreen, and those who initially apply it do not reapply it after perspiration or water exposure [19]. Therefore, the use of water-resistant sunscreen and the need to reapply it every 2 h, after swimming, or after heavy perspiration still needs to be promoted in the community of an outdoor sportsman [15].

Petroleum Jelly

Petroleum jelly, petrolatum, white petrolatum, soft paraffin, or better known as "Vaseline" (trademarked brand of petroleum jelly) is a semisolid mixture of saturated hydrocarbons, originally promoted as a topical ointment for its healing properties [20]. Petroleum jelly is recognized by the US FDA as an approved over-the-counter (OTC) drug and is widely used in cosmetic skin care as skin protectant.

In sporting activities, athletes use petroleum jelly as a topical agent in the prevention of blisters [21–23], chafing and abrasions [19,24,25], and otitis externa (swimmer's ear) [26] and as protecting ointment to cold environmental conditions [27,28].

Blisters affect athletes who sustain mechanical friction on the sole of the feet in an environment of increased temperature, dryness, or moisture. Horizontal shearing forces cause epidermal splits, leading the separated layers to be filled with tissue transudate or blood [29]. Prevention of blisters should primarily focus on measures reducing the mechanical aspect of friction by the use of well-fitting shoes (with appropriated space around the toes) and moisture-wicking socks. Several studies reported the topical application of petrolatum to decrease the risk of blisters and an acceleration of the healing process [21–23,29–32]. Besides these measures, running athletes can promote the hardening of the skin with 10% tannic acid soaks [21,22,24,31,33].

Chafing is a superficial inflammatory dermatitis appearing on skin surfaces subjected to increased moisture, friction, and maceration [30,34]. Jogger's nipples, a particular form of

chafing, is a common phenomenon in long distance runners as a result of repetitive friction between a runner's shirt and their nipples [19,24,25]. Prevention of chafing is best accomplished by wearing dry, synthetic moisture-wicking clothes. Talcum and alum powders are mildly helpful for drying, and the use of petroleum jelly, patches, or adhesive tape over the nipples is effective in reducing friction [29,30,34].

Cotton wool coated in petroleum jelly was reported to be the most effective method of ear protection and was found to be a comfortable and easy-to-use method in the prevention of otitis externa (swimmer's ear) [26,35]. Long distance swimmers and triathletes coat themselves in petroleum jelly as a protection against the stingers of jellyfish and as a thermal isolation in cold water when doing training or long ocean swims. Some controversial reports were found on the thermal insulation provided by petroleum jelly in cold environmental conditions. The in vivo study from Lehmuskallio et al. [27] showed that subjects with petroleum jelly applied thickly on half of the face cooled at least as quickly as the untreated half; however, white petrolatum often produced a subjectively warming skin sensation. The authors concluded that "protecting" emollients can provoke a false sensation of safety leading to an increased risk of frostbite by neglecting efficient protective measures [27].

Insect Repellents

Besides children and occupational groups such as farmers, the outdoor sport enthusiast is frequently a victim of insect stings and bites [36]. In a prospective study by Dannenberg et al. [37], the most frequent overuse injuries and medical problems in Cycle Across Maryland tour in 1994 were evaluated. Next to common overuse injuries such as knee pain, hand or wrist numbness, and dehydration, this study revealed that insect stings and bites had high incidence rate among cyclists [37]. Arthropods, notably insects and arachnids, are vectors of potentially serious ailments and remain a major cause of patient morbidity. Measures to curtail the impact of insect bites are important in the worldwide public health effort to protect people and to prevent the spread of disease [38]. The use of a skin-based insect repellent, combined with protective clothing, limiting outdoor time and chance in patterns of activity or behavior, are elementary in the prevention of bites. A variety of formulations of different insect repellents are available including pump sprays, aerosols, lotions, creams, grease sticks, and cloth-impregnating laundry emulsions [39]. Repellents containing DEET (N,N-diethylmetatoluamide) as an active ingredient are considered to be effective broad-spectrum, insect repellents and are recommended by most authorities. Formulations containing less than 35% DEET are recommended and provide adequate protection against mosquitoes, ticks, and other arthropods [40]. Permethrin-containing repellents are recommended for use only on clothing, shoes, bed nets, and camping gear. Permethrin is a highly effective insecticide–acaricide and repellent. Permethrin-treated clothing repels and kills ticks, mosquitoes, and other biting and nuisance arthropods [40,41]. Repellents that are applied according to label instructions may be used with sunscreen with no reduction in repellent activity; however, limited data show a one-third decrease in the SPF of sunscreens when DEET-containing insect repellents are used after a sunscreen is applied. Products that combine sunscreen and repellent are not recommended, because sunscreen may need to be reapplied more often and in larger amounts than needed for the repellent component to provide protection from biting insects. In general, the recommendation is to use separate products, applying sunscreen first and then applying the repellent [40,42,43].

Prevention of Jellyfish Stings

Jellyfish stings are a common occurrence among people swimming, wading, or diving in seawaters [44]. In the United States, 500,000 jellyfish stings are estimated to occur in the Chesapeake Bay and up to 200,000 stings in Florida waters annually [45]. Contact with the tentacles trailing from the jellyfish body can discharge microscopic barbed stingers that release venom into the skin, causing skin irritation and sometimes-severe manifestations [44–46]. In the randomized control trial of Boulware [44], the efficacy of a jellyfish sting inhibitor lotion (Safe Sea) was evaluated. In comparison to the placebo product, the Safe Sea topical barrier cream was effective in preventing >80% jellyfish stings. In the studies of Kimball et al. [47] and Tønseth et al. [46], the prophylactic and protective effects of a jellyfish sting inhibitor formulated in sunscreen lotion versus a conventional sunscreen was investigated. The authors concluded that the prophylactic treatment with jellyfish sting inhibitor did not eliminate but significantly reduced the frequency and severity of stings [46,47].

EFFICACY OF TOPICAL ANTIFUNGALS IN THE TREATMENT OF DERMATOMYCOSIS

Epidemiological studies show that tinea pedis, formerly known as athlete's foot, tinea corporis gladiatorum, and onychomycosis are common sport-related dermatoses affecting the athletes' skin [24]. Dermatomycosis are fungal infections that are widespread throughout the world, which are an important cause of morbidity [48–50]. Dermatophytosis is the most common, caused by different species of dermatophytes particularly *Trichophyton rubrum* and *Trichophyton mentagrophytes*, followed by *Candida* species and nondermatophytic molds [51]. The prevalence of dermatomycosis is increased in population with avid sport participation. Athletic activities with an increased incidence are wrestling, judo, swimming, gymnastic, cycling, horse riding, and in general sports with occlusive footwear. The athletes are mainly exposed to fungal contamination at places where sports are practiced barefooted such as public swimming or using showers and changing rooms [24,52]. The treatment of these conditions often consists of the use of topical or oral antifungal agents or a combination of these, depending on the site, extent of infection, and the causative organism [53–56].

There is good evidence for the effectiveness of topical antifungals in the treatment of dermatomycosis. In the systematic review and meta-analysis (k = 135) of Rotta et al. [56], the efficacy and safety of topical antifungals versus placebo in the treatment of tinea pedis and onychomycosis were evaluated. The authors concluded that azoles, allylamines, and other antifungals, such as butenafine and ciclopirox olamine, are all efficacious in the management of any dermatomycosis compared to placebo treatment. These results are in line with other published systematic reviews with meta-analysis conducted by Hart et al. [57] and Crawford and Hollis [58] investigating the management of tinea pedis.

STIMULATING AND PERFORMANCE-ENHANCING SPORT COSMETICS

Liquids with Cooling Properties

Our literature search revealed a study from Leite et al. [59], evaluating the therapeutic efficiency of a cooling liquid versus conventional cryotherapy. Liquid Ice is an all-natural liquid cooling solution including menthol and alcohol and is applied soaked in a wrap [59]. The manufacturer claims that the product was designed to cool efficiently and effectively though natural evaporative cooling. The two cryotherapy modalities compared included crushed ice in a room temperature wet towel and Liquid Ice. The crushed ice induced lower skin surface temperatures compared to the Liquid Ice application. The authors concluded that Liquid Ice is not useful as a clinical cryotherapy modality.

Cooling Liquids to Increase Physical Performance

Heat production by intense prolonged exercise induces a decrease in physical performance. Over the last decade, several studies have been conducted to investigate the effects of local cryotherapy on physical performance.

Duffield et al. [60] conducted a study on the effect of cooling the skin with an ice jacket before and between repeated sprint exercises in warm, humid conditions. There was no improvement in physical performance, although the perception of thermal load was reduced [60]. Under warm and humid environmental conditions, evaporation is the primary mechanism for muscle heat dissipation [61].

In our own study, we evaluated the effects of local upper arms cooling, upper body cooling, and combined cooling of the upper arms and upper body on the endurance capacity during cycling in warm (35°C) humid (40%) conditions. For cooling, we used *Energicer* bands and cotton vests saturated with a cooling liquid, based on alcohol and menthol and produced by the Swiss company Liquid Ice Cosmedicals. The manufacturer claims that the use of *Energicer* Bands regulates the body temperature, optimizes the heart rate, reduces the lactate buildup in the muscle, and increases the power during exercise.

In a randomized crossover study design, we conducted a standardized incremental bike ergometer test, where time to exhaustion was determined and used as the independent variable for endurance capacity. At the end of each incremental step, the following variables were measured: blood lactate, heart rate, body temperature, and perceived exhaustion (BORG scale). Mean time to exhaustion did not differ between the four conditions ($p > 0.05$). We observed no significant differences at blood lactate, heart rate, and body temperature during examination between the four conditions. However, all participants mentioned to feel more comfortable when wearing the cooling vest under the used environmental conditions. This effect might aggravate with the airflow when cycling under outdoor conditions, which may lead to psychological advantages for the athlete [62].

TOPICAL MUSCLE AND JOINT ANALGESICS

During recent years, the use of OTC topical muscle and joint analgesics has become increasingly common in sports. Topical analgesics are applied to the skin for temporary treatment and management of musculoskeletal injuries and disorders. Topical OTC analgesic products are available in a variety of formulations, including gels, ointments, creams, lotions, and patches in single-entity or combination formulations. In clinical use, topical analgesics can be divided into four basic groups: nonsteroidal anti-inflammatory drugs (NSAIDs), local anesthetics, capsaicin, counterirritants, and other agents. As this chapter is mainly focusing on cosmetic and cosmeceuticals, we will discuss only revulsive products such as capsaicin and nicotinates.

Revulsive products produce a reddening of the skin. This erythema is due to an increased perfusion of the microcirculation after a vasodilation of the arterial plexus at the different skin levels. Nicotinates act via an endothelium relaxant factor, while capsaicin uses a neurogenic cascade with the involvement of substance P.

Revulsive products (i.e., rubefacients and urticants) are known for several clinical and nonclinical applications. Clinically, they are used in the treatment of neuropathological (diabetic neuropathy, postherpetic neuralgia [PHN]) and/or musculoskeletal disorders (e.g., osteoarthritis, rheumatoid arthritis, muscle soreness, and back pain). Nonclinically, they are used in some sports as passive warming-up products and in the cosmetic industry as an ingredient in skin products [63].

Despite the widespread use of revulsive products in sport ointments, patches, wraps, gels, sprays, and balms, studies reporting on the nonclinical effectiveness of these products are scarce. Clarys et al. [64] reported only significant warming of the superficial skin after application of nicotinate containing revulsive products.

FDA is alerting the public that the use of certain (OTC) topical muscle and joint analgesic products has been reported to cause rare cases of serious skin injuries, ranging from first- to third-degree chemical burns, where the products were applied. Consumers using an OTC topical muscle and joint pain reliever who experience signs of skin injury where the product was applied, such as pain, swelling, or blistering of the skin, should stop using the product and seek medical attention immediately [65].

CLEANSING PRODUCTS

Skin cleansing is essential for maintaining healthy skin and hygiene. Its primary function is to remove dirt, soil, bacteria, and dead cells from skin. The athletes' skin is more exposed to intense sunlight, dirt, bacteria, and excessive sweat. Showering after each training session prevents dirt and bacteria from clogging the pores and is an important aspect of skin care. Frequently cleansing with commonly used soap-based shower and bath products induces skin dryness and leads to a weakening of the stratum corneum barrier. Over the last decades, the personal cleansing market has evolved greatly manufacturing mild cleansing formulations that remove oils and soil from skin, but without the dryness and irritation that accompanied typical soap-based products. Frequently cleansing with water alone does not prevent the skin from getting dry, as the contact to water only hydrates skin transiently, leaving the skin after evaporation as dry or drier than before [66].

For regular body cleansing, athletes should use mild emollient-rich body washes as they have been shown to be milder and more moisturizing than regular body washes [67].

Also, daily skin care using a moisturizing emollient-rich cream or lotion containing a lipid system is an effective treatment to rehydrate and restore dry skin.

CONCLUSION

The terminology "sport cosmetic" is used by the cosmetic industry to commercialize a wide range of cosmetic products. Some are specially developed for the use in sport and well adapted to needs of sporting people. Others are normal cosmetics using the co-notations associated with the term "sport" intending to provide a subjective feeling associated with being physically active. Some products are widely used without any prove of efficiency. There is a need for further studies concerning the efficacy of different mentioned sport cosmetics. Equally no data are available regarding possible side effects on the skin of repetitive and long-term use of these products.

REFERENCES

1. Seippel Ø. The meaning of sport: Fun, health, beauty or community? *Sport Soc* 2006;9(1):51–70.
2. Manela-Azulay M, Bagatin E. Cosmeceuticals vitamins. *Clin Dermatol* 2009;27(5):469–74.
3. Greiter F. Sport and cosmetics. *Sport Med* 1985;2:248–53.
4. Trüeb RM. Causes and management of hypertrichosis. *Am J Clin Dermatol* 2002;3:617–27.
5. Yamasaki R, Dekio S, Jidio J. Allergic contact dermatitis to ammonium thioglycolate [letter]. *Contact Dermatitis* 1984;11:255.
6. Jou PC, Feldman RJ, Tomecki TJ. UV protection and sunscreens: what to tell patients. *Cleve Clin J Med* 2012;79(6):427–36.
7. Garbe C, Buttner P, Weiss J et al. Risk factors for developing cutaneous melanoma and criteria for identifying persons at risk: Multicenter case-control study of the Central Malignant Melanoma Registry of the German Dermatological Society. *J Invest Dermatol* 1994;102:695–9.
8. Dozier S, Wagner RFJ, Black SA et al. Beachfront screening for skin cancer in Texas Gulf coast surfers. *South Med J* 1997;90:55–8.
9. Ambros-Rudolph C, Hofmann-Wellenhof R, Richtig E et al. Malignant melanoma in marathon runners. *Arch Dermatol* 2006;142:1471–4.
10. Herlihy E, Gies PH, Roy CR et al. Personal dosimetry of solar UV radiation for different outdoor activities. *Photochem Photobiol* 1994;60:288–94.
11. Moehrle M, Heinrich L, Schmid A, Garbe C. Extreme UV exposure of professional cyclists. *Dermatology* 2000; 201:44–5.
12. Moehrle M. Ultraviolet exposure in the ironman triathlon. *Med Sci Sports Exerc* 2001;33:1385–6.
13. Rigel DS, Rigel EG, Rigel AC. Effects of altitude and latitude on ambient UVB radiation. *J Am Acad Dermatol* 1999; 40:114–6.
14. Moehrle M, Koehle W, Dietz K et al. Reduction of minimal erythema dose by sweating. *Photodermatol Photoimmunol Photomed* 2000;16:260–2.
15. Moehrle M. Outdoor sport and skin cancer. *Clin Dermatol* 2008;26:12–5.
16. Agin PP, Levine DJ. Sunscreens retain their efficacy on human skin for up to 8 h after application. *J Photochem Photobiol B* 1992;15:371–4.
17. Eaglstein WH, Taplin D, Mertz P, Smiles KA. An all-day test for the evaluation of a topical sunscreen. *J Am Acad Dermatol* 1980;2:513–20.
18. Bodekaer M, Faurschou A, Philipsen PA, Wulf HC. Sun protection factor persistence during a day with physical activity and bathing. *Photodermatol Photoimmunol Photomed* 2008;24:296–300.
19. Adams BB. Dermatologic disorders of the athlete. *Sports Med* 2002;32(5):309–21.
20. "Petrolatum (White)" inchem.org. International Programme on Chemical Safety and the Commission of the European Communities, March 2002. Retrieved August 5, 2011.
21. Levine N. Friction blisters. *Phys Sportsmed* 1982;10:84–92.
22. Knapik JJ, Reynolds KL, Duplantis KL, Jones BH. Friction blisters: Pathophysiology, prevention and treatment. *Sports Med* 1995;20:136–47.
23. Cortese TA, Fukuyama K, Edstein WL. Treatment of friction blisters. *Arch Dermatol* 1968;97:717–21.
24. Adams BB. Sports dermatology. *Adolesc Med* 2001;12:305–22.
25. Adams BB. Skin and sports: Common skin conditions in athletes and tips on treatments. *Skin Aging* 2003;11:65–70.
26. Robinson AC. Evaluation for waterproof ear protectors in swimmers. *J Laryngol Otol* 1989;103(12):1154–7.
27. Lehmuskallio E, Rintamäki H, Anttonen H. Thermal effects of emollients on facial skin in the cold: Clinical report. *Acta Derm Venerol* 2000;80(3):203–7.
28. Hassi J, Lehmuskallio E, Juhani J, Rytkönen M. Frostbite and other problems of skin expose to cold. *Duodecim* 2005; 121(4):454–61.
29. Mailler-Savage EA, Adams BB. Skin manifestations of running. *J Am Acad Dermatol* 2006;55:290–301.
30. Mailler EA, Adams BB. The wear and tear of 26.2: Dermatological injuries reported on marathon day. *Br J Sports Med* 2004;38:498–501.
31. Bart B. Skin problems in athletics. *Minn Med* 1986;66:239–41.
32. Klein AW, Rish DC. Sports related skin problems. *Compr Ther* 1992;18:2–4.

33. Basler RSW. Skin lesions related to sports activity. *Prim Care* 1983;10:479–94.
34. Eiland G, Ridley D. Dermatologic problems in the athlete. *J Orthop Sports Phys Ther* 1996;23:388–402.
35. Chisholm EJ, Kuchai R, Mc Partlin D. An objective evaluation of the waterproofing qualities, ease of insertion and comfort of commonly available earplugs. *Clin Otolaryngol Allied Sci* 2004;29:128–32.
36. Frazier CA. Insect reactions related to sports. *Cutis* 1977; 19(4):439–44.
37. Dannenberg AL, Needle S, Mullady D, Kolodner KB. Predictors of injury among 1638 riders in a recreational long-distance bicycle tour: Cycle across Maryland. *Am J Sports Med* 1996;24:747–53.
38. Katz TM, Miller JH, Herbert A. Insect repellents: Historical perspectives and new developments. *J Am Acad Dermatol* 2008;58(5):865–71.
39. Brown M, Hebert AA. Insects repellents: An overview. *J Am Acad Dermatol* 1997;36:243–9.
40. Centers for Disease Control and Prevention. Protection against mosquitoes and other arthropods. Available at http://www.cdc.gov.
41. Stafford KC. Tick bite prevention and the use of insect repellents. Available at http://www.caes.state.ct.us/FactSheetFiles/Entomology/TickBitePrevention05.pdf.
42. Montemarano AD, Gupta RK, Burge JR, Klein K. Insect repellents and the efficacy of sunscreens. *Lancet* 1997; 349(9066):1670–1.
43. Murphy ME, Montemarano AD, Debboun M, Gupta R. The effect of sunscreen on the efficacy of insect repellent: A clinical trial. *J Am Acad Dermatol* 2000;43(2 Pt 1):219–22.
44. Boulware DR. A randomized, controlled field trial for the prevention of jellyfish stings with a topical sting inhibitor. *J Travel Med* 2006;13(3):166–71.
45. Burnett JW. Human injuries following jellyfish stings. *Md Med J* 1992;41:509–13.
46. Tønseth KA, Andersen TS, Pripp AH, Karlsen HE. Prophylactic treatment of jellyfish stings—a randomised trial. *Tidsskr Nor Laegeforen* 2012;132(12–13):1446–9.
47. Kimball AB, Arambula KZ, Stauffer AR, Levy V, Davis VW, Liu M, Rehmus WE, Lotan A, Auerbach PS. Efficacy of a jellyfish sting inhibitor in preventing jellyfish stings in normal volunteers. *Wilderness Environ Med* 2004;15:102–8.
48. Borgers M, Degreef H, Cauwenbergh G. Fungal infections of the skin: Infection process and antimycotic therapy. *Curr Drug Targets* 2005;6:849–62.
49. Charles AJ. Superficial cutaneous fungal infections in tropical countries. *Dermatol Ther* 2009;22:550–9.
50. Garber G. An overview of fungal infections. *Drugs* 2001;61 (Suppl. 1):1–12.
51. Singal A, Khanna D. Onychomycosis: Diagnosis and management. *Indian J Dermatol Venereol Leprol* 2011;77(6):659–72.
52. Bassiri-Jahromi S, Sadeghi G, Paskiaee FA. Evaluation of the association of superficial dermatophytosis and athletic activities with special reference to its prevention and control. *Int J Dermatol* 2010;49(10):1159–64.
53. Gupta AK, Cooper EA. Update in antifungal therapy of dermatophytosis. *Mycopathologia* 2008;166:353–67.
54. Meis JF, Verweij PE. Current management of fungal infections. *Drugs* 2001;1:13–25.
55. Severo LC, Londero AT. *Tratado de Infectologia*. São Paulo: Atheneu, 2002.
56. Rotta I, Sanchez A, Gonçalves PR, Otuki MF, Correr CJ. Efficacy and safety of topical antifungals in the treatment of dermatomycosis: A systematic review. *Br J Dermatol* 2012;166(5):927–33.
57. Hart R, Bell-Syer SE, Crawford F et al. Systematic review of topical treatments for fungal infections of the skin and nails of the feet. *BMJ* 1999;319:79–82.
58. Crawford F, Hollis S. Topical treatments for fungal infections of the skin and nails of the foot. *Cochrane Database Syst Rev* 2007;3:1–157.
59. Leite M, Ribeiro F. Liquid Ice™ fails to cool the skin surface as effectively as crushed ice in a wet towel. *Physiother Theory Pract* 2010;26(6):393–8.
60. Duffield R, Dawson B, Bishop D, Fitzsimons M, Lawrence S. Effect of wearing an ice jacket on repeat sprint performance in warm/humid conditions. *Br J Sports Med* 2003;37(2):164–9.
61. Nybo L. Exercise and heat stress: Cerebral challenges and consequences. *Exerc Sport Sci Rev* 2007;35(3):110–8.
62. Hohenauer E, Clijsen R, Cabri J, Clarys P. Effects of different local cooling applications on the endurance capacity during cycling. Book of Abstracts, 14th Annual Congress of the European College of Sport Science, Oslo/Norway, 2009, 321.
63. Caselli A, Hanane T, Jane B et al. Topic methyl nicotinate-induced skin vasodilatation in diabetic neuropathy. *J Diabetes Complications* 2003;17:205–10.
64. Clarys P, Barel AO, Taeymans J. Can ointments replace warming up? *Sportverletzungen Sportschaden* 1998;18(4):167–71.
65. Available at http://www.fda.gov/safety/MedWatch/SafetyInformation/SafetyAlertsforHumanMedicalProducts/ucm319353.htm.
66. Johnson AW. Overview: Fundamental skin care-protecting the barrier. *Dermatol Ther* 2004;17:1–5.
67. Abbas S, Weiss Goldberg J, Massaro M. Personal cleanser technology and clinical performance. *Dermatol Ther* 2004;17:35–42.

Q1: Please check if the section levels were correctly identified.
Q2: Please check if the edits made in the following are OK: "Horizontal shearing forces cause epidermal splits, leading the separated layers to be filled with tissue transudate or blood."
Q3: Note that 5 groups are provided here. Please check.
Q4: The use of et al. in the reference list is inconsistent. Please provide all the author names.
Q5: Please provide year.
Q6: Please provide year.