International Journal of Innovative Technologies in Social Science

e-ISSN: 2544-9435

Scholarly Publisher
RS Global Sp. z O.O.
ISNI: 0000 0004 8495 2390

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ARTICLE TITLE	VIRAL WARTS IN ATHLETES: A COMMON DERMATOLOGICAL CHALLENGE WITH EVOLVING DIAGNOSTIC AND THERAPEUTIC APPROACHES
ARTICLE INFO	Magdalena Domisiewicz, Magdalena Mendak, Agata Białek, Monika Klimczak, Aleksandra Woskowska, Anna Hanslik. (2025) Viral Warts in Athletes: A Common Dermatological Challenge with Evolving Diagnostic and Therapeutic Approaches. *International Journal of Innovative Technologies in Social Science*. 3(47). doi: 10.31435/ijitss.3(47).2025.3543
DOI	https://doi.org/10.31435/ijitss.3(47).2025.3543
RECEIVED	01 July 2025
ACCEPTED	12 August 2025
PUBLISHED	14 August 2025
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VIRAL WARTS IN ATHLETES: A COMMON DERMATOLOGICAL CHALLENGE WITH EVOLVING DIAGNOSTIC AND THERAPEUTIC APPROACHES

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ABSTRACT

Aim of the Study: This review aims to analyze the prevalence, risk factors, diagnostic strategies and treatment modalities of viral warts in athletes, a population predisposed to cutaneous HPV infections. The paper focuses on dermoscopic features, therapeutic approaches, and return-to-play recommendations, aiming to provide clinicians with practical guidance for managing HPV-related skin lesions in physically active individuals.
Study methods: A narrative review was conducted based on a selection of 22 peer-reviewed articles obtained from PubMed and Scopus, including randomized controlled trials, clinical guidelines, dermoscopic case series, and epidemiological studies. Additional reference materials included dermatological textbooks and online resources for healthcare professionals. Emphasis was placed on athlete-specific data, non-invasive diagnostic methods and evidence-based management strategies.
Results: Athletes are especially vulnerable to HPV due to frequent skin trauma, occlusion, moisture exposure, and shared environments. Verruca vulgaris, verruca plantaris, and verruca plana are the most common manifestations. Dermoscopy improves diagnostic accuracy by identifying patterns such as red or black dots, papilliform projections, and disrupted skin lines. Treatments vary by wart type and severity; while cryotherapy and salicylic acid remain first-line, newer therapies such as immunomodulators and photodynamic therapy show promising outcomes. Preventive measures, such as protective gloves and lesion coverage, are critical to control transmission in athletic settings.
Conclusions: Cutaneous warts significantly impact athletes' health, performance, and participation. Effective management relies on early diagnosis, targeted treatment, and education on preventive practices. A multidisciplinary approach involving dermatologists, sports physicians, and trainers is essential to reduce transmission risk and ensure safe return to sport.

KEYWORDS
Verruca Vulgaris, Viral Warts, Common Warts, Viral Skin Diseases, Contact Disease, Dermoscopy

CITATION

Magdalena Domisiewicz, Magdalena Mendak, Agata Białek, Monika Klimczak, Aleksandra Woskowska, Anna Hanslik. (2025) Viral Warts in Athletes: A Common Dermatological Challenge with Evolving Diagnostic and Therapeutic Approaches. *International Journal of Innovative Technologies in Social Science*. 3(47). doi: 10.31435/ijitss.3(47).2025.3543

Introduction.

Verruca vulgaris is a viral nongenital skin condition caused by human papillomavirus (HPV) keratinocytes infection. Viral warts are benign proliferative lesions that affect all age and social groups. It is estimated that 7–12% of the general population may be affected by verruca vulgaris, yet there have been identified social groups with significantly higher prevalence like, for example athletes. Human papillomavirus is a double-stranded DNA virus and currently there have been more than 200 types of HPV identified. HPV's carcinogenic potential is in spotlight for years now, therefore this study focuses on low-carcinogenic-risk types. Humanpaillomavirus' life cycle is closely related with the proliferation and differentiation of epithelium. Cutaneous HPV infection frequently present as warts such as flat warts (verruca plana - if located on hands and face), common warts (verruca vulgaris), planta warts (verruca plantaris - if appeared on soles of feet), and condyloma acuminatum (AC; anogenital warts - if occurs on anus, genitalia, or perianal area). The vast majority of cutaneous HPV manifestations are benign proliferative lesions and only scarcely develop into skin cancers such as squamous cell carcinoma (SCC). The HPV infection is primarily transmitted by skin-to-skin contact although factors such as certain drugs, toxins and smoking are responsible for higher predisposition to the transmission [1]. Autoinoculation is common. HPV's incubation period varies from weeks to years which should lead to emphasis of importance of regular cleaning and disinfection in common spaces, especially those used by athletes.

Since both professional and recreational athletes are at higher risk of HPV infection, it is crucial to take appropriate measures for contamination prevention, quick and preferably non-invasive diagnosis, correct treatment and long-time management of cutaneous HPV infection [2].

The aim of this review is to evaluate the risk factors specific for athletes, HPV dermoscopic features and management strategies of viral warts. It focuses on recent advancements in diagnostic techniques, particularly dermoscopy, and emerging treatment modalities, with the goal of improving clinical outcomes and minimizing the risk of HPV transmission by rising the awareness amongst both: medical professionals and athletes about viral warts' clinical presentation and protection methods that need to be taken in order to cut the route of infection.

Study methods

A narrative review was conducted based on peer-reviewed articles sourced via PubMed and Scopus. A total of 22 key studies were included, ranging from epidemiological surveys to randomized controlled trials, dermoscopic analyses and available clinical guidelines. Articles focused mainly on athletes, the dermatological features of warts, treatment efficacy, and technological advancements in diagnosis - notably dermoscopy since it is easily available, fast and non-invasive diagnostic method with clearly defined characteristic features. The study was expanded by dermatological guidelines and current knowledge available in both books and internet portals dedicated for medical professionals, such as DermNet.

1. Verrucae - clinical variants

1.1. Verrucae vulgares

Common warts typically occur as multiple lesions and may appear on any area of the body. They are more frequently observed in children, particularly those with atopic dermatitis or impaired immunity. Distal, cyanotic areas of the skin are more susceptible to infection.

1.1A. Clinical Presentation

In the early stages, warts present as small papules with smooth surfaces, usually no larger than a pinhead. They can generally be distinguished from the surrounding skin due to disruption of the normal skin line pattern. As they grow, they become darker and develop a rough surface.

This reflects elongation of rete ridges and dermal papillae (papillomatosis), accompanied by hyperkeratosis and the appearance of small, pinpoint hemorrhages in the stratum corneum. In most cases, the primary wart is significantly larger than the subsequent lesions. The clinical appearance of warts is also influenced by their anatomical location - table 1.

Table 1. Clinical appearance of warts according to anatomical location

Location	**Clinical image**
Fingers and dorsal hands	Lesions typically manifest as keratotic papules.
Interdigital spaces	Warts often adopt a papillomatous morphology.
Palms	Warts on the palms are usually smooth, well-demarcated from the surrounding skin, and subjected to less mechanical pressure than plantar warts.
Periungual area	Warts are frequently found around the nails, commonly affecting the lateral nail fold, although they may also develop distally. In such cases, they may lead to onycholysis and significant pain. Warts on the fingers often serve as a source of autoinoculation to other body sites, including via hand-to-mouth transmission.
Nail bed	Warts in this location are extremely rare and may appear as painful pigmented macules or nodules. Diagnosis is often indirect—when multiple warts are present elsewhere on the body, a subungual lesion is likely to be a wart as well. These lesions may result in bone damage. Differential diagnoses should include psoriasis, Bowen's disease, keratoacanthoma, glomus tumor (angiomyoneuroma), and subungual exostosis.
Eyelids	Warts in this area are typically long, thin, and filiform, and may be difficult to distinguish from soft fibromas.
Chin area	Both flat and filiform warts may occur here and are often numerous due to autoinoculation during shaving. A similar pattern is observed on the lower extremities of women who shave their legs.
Vermilion border of the lips	Warts in this region are whitish in color and may present as elongated lesions.
Anogenital Region	On the penis and the external surface of the labia majora, warts tend to have a broad base and appear flat, sometimes exhibiting pigmentation. In cases where atypical keratinocytes are observed, the lesion is classified as bowenoid papulosis.

1.1B. Histopathology

The histological appearance of common warts is typically distinctive. There is acanthosis of the epidermis, which envelops the dermal core of the lesion. This thickening is accompanied by elongation of rete ridges and dermal papillae, resulting in papillomatosis.

Dilated capillaries within the dermal papillae often lead to blood extravasation into the stratum corneum, which may be visible both clinically and histologically.

In the upper epidermal layers, keratinocytes demonstrate ballooning degeneration and contain basophilic intranuclear inclusions—cells with these features are known as koilocytes. The stratum corneum often displays parakeratosis and hemorrhagic foci.

Viral particles, due to their small size, are detectable only by electron microscopy. They are readily visible in early lesions but may be sparse or absent in long-standing warts.

1.2. Plantar Warts (Verrucae Plantares)

In recent years, the incidence of plantar warts has been increasing, and they are now considered as common as verrucae vulgaris. They are among the most contagious wart types and are frequently encountered in environments where barefoot walking is common—such as swimming pools, gymnasiums, dormitories, and correctional facilities. Warmth and moisture promote maceration of the stratum corneum, facilitating viral transmission as infected keratinocytes detach and adhere to the softened skin of uninfected individuals, often entering through microabrasions.

1.2A. Clinical Presentation

Plantar warts may occur as both: solitary or multiple lesions. They are most commonly located over the metatarsal heads. A single lesion can be extremely painful if situated in a weight-bearing area. Due to mechanical pressure during ambulation, the lesion becomes compressed into the dermis, often leading to the sensation of a “a stone in the shoe”. Once the hyperkeratotic surface is pared down, dilated capillaries and punctate hemorrhages (resembling “black dots”) may be seen. When located outside of pressure zones, warts tend to be less painful and exhibit a more exophytic growth pattern.

The mosaic wart is a subtype of plantar warts and is characterized by coalescence of multiple individual lesions into a large, flat, tile-like configuration. Although typically painless, this form is clinically significant due to its refractory nature and resistance to conventional therapies.

The giant plantar wart is a rare variant of plantar warts. Located particularly on the heel, may invade deeper tissues and is associated with extensive local spread.

1.2B. Histopathology

In the histopathological image of plantar warts, numerous viral inclusions are typically observed, with the changes primarily affecting the granular layer of the epidermis. Usually, analysis of biopsy material or curettage samples does not allow for the full assessment of endophytic growth, and characteristically, the papillary dermis lacks the changes observed in common warts.

1.2C. Clinical Course and Prognosis

Plantar warts, especially mosaic warts, may be highly resistant to all forms of treatment and may persist in adults for decades. Even when they appear to be completely resolved, there remains a significant risk of recurrence. In children, spontaneous resolution is more frequently observed.

1.3. Flat Warts (Verrucae Planae)

Flat warts most commonly affect children and adolescents. They can spread through direct skin contact. In adults, they are often transmitted during shaving or cosmetic procedures, and frequently appear on women’s legs.

1.3A. Clinical Presentation

The primary lesion is a small papule with a flat surface, often pigmented, usually located on the face. They may also appear on the hands, arms, and trunk. The coloration often matches tanned or brown skin tones but may appear red in the presence of inflammation. In individuals with darker skin, they may be more pigmented.

1.3B. Histopathology

Histopathological findings are subtle. Flat papules may show vacuolar degeneration within the granular layer, mild acanthosis without elongation of dermal papillae, and a minimal inflammatory infiltrate in the dermis.

1.3C. Clinical Course and Prognosis

Flat warts frequently resolve spontaneously. An extensive inflammatory reaction is a good prognostic sign, indicating that the host immune system has recognized the wart as foreign and initiated an effective immune response. Some lesions may persist for years and then exhibit slight inflammation before resolving completely within a few days [3].

2. Athletes 'specific risk factors for HPV infection

Viral warts, caused by human papillomavirus (HPV), are common among athletes due to close skin contact, moisture, and shared surfaces. Papadopoulou et al. observed a high prevalence in beach volleyball players and swimmers. Contributing factors include physical skin trauma that facilitates HPV infection, shared equipment that might be the source of contamination and public locker room use [4-7].

M.C Roach and J.H. Chretien conducted a survey on members of the university track team and of the crew team. The questions focused on the exercise's type, used equipment and protective gloves. In this study more rowers (25%) than runners (10%) acquired HPV cutaneous infection. The research highlighted that the regularly damaged and macerated skin may be an important prevalence factor due to the much higher warts' development in crew team members. Although both athletes' groups did similar activities such as weight lifting, the runners used weight lifter's gloves more often than the crew team, which is considered to be an important protection for verruca vulgaris, especially amongst athletes [8].

3. Diagnostic Methods

3.1. Clinical Evaluation

Viral warts are mainly diagnosed by a visual examination. The general presentation consists of a scaly nodules with visible black dots at the centre of the lesion. The most common locations are the hands and feet, although any part of the body might be affected. Warts are typically painless but can become painful or itchy if there is sufficient local trauma or abrasion to the region. Common sites include the hands, feet, and knees. However, atypical forms require advanced diagnostics.

3.2. Dermoscopy

In atypical skin lesions the dermoscopic examination might be crucial in establishing the correct diagnosis. Dermoscopy significantly improves diagnostic accuracy by identifying characteristic vascular and surface patterns of viral warts such as followed:

A. Common warts are characterized by papilliform structures with central red or black dots or loops [9].
B. Plantar warts are defined by disrupted dermatoglyphics and hemorrhagic spots [10].
C. Flat warts are marked by fine red dots and a smooth, yellowish surface [11].
D. Genital warts present patterns like mosaic, knoblike, or fingerlike architecture [12].

Table 2. Dermoscopic image in *Verruca vulgaris*

Type of wart	Location	Dermoscopy Features
Common warts *(Verruca vulgaris)*	Palms, fingers	Papilliform structures with central red or black dots or loops, thromboses capillaries
Plantar warts *(Verruca plantaris)*	Soles	disrupted dermatoglyphics and hemorrhagic spots, hemorrhagic dots or brown/black clots
Flat warts *(Verruca plana)*	Face, neck, back of hands	Smith, yellowish surface, red dots, often grouped
Genital warts *(Candyloma acuminatum)*	Genitalia, perineal area	Mosaic pattern, fingerlike or knoblike structures, whitish projections

In a conducted by H. Dong et al. case-series study [13] amongst 132 patients with a total of 220 suspected condyloma acumulatum (CA) lesions proved that the dermoscopic-based diagnosis characterized with more accuracy than that of a isolated visual examination. Furthermore Y. Zhang's study [15] disclosed that dermatoscopy is superior to visual observation in case of smaller warts with a significantly higher rate of accurate diagnosis ($p < 0.01$). Presented studies highlight the high sensitivity, rapidity and noninvasiveness of dermoscopy. However, it is also important to mention the method's limitations such as the accessibility still mainly in dermatology departments and offices. Also due to most of the dermatoscopes' construction, it is very difficult to examine some locations, such as the urethral orifice or annus [3].

3.3. Fluorescent immunoassay

Group specific antigens might be detected in matured cells that contain large amounts of the HPV, therefore the available tests show low sensitivity and specificity.

3.4. DNA hybridization

Currently the most common method for identifying HPV types is viral DNA hybridization conducted via Southern Blot technique. Currently available commercial kit is called HC-II and is based on hybrid capture (HC) with a chemiluminescent detection system. However it does not allow for the identification of individual HPV type but only detects the presence of oncogenic genital HPV types. In compare to the polymerase chain reaction (PCR), the HC is similarly sensitive but less specific in detecting the oncogenic types of the HPV. The fluorescent in situ hybridization (FISH) is another method that might be used for viruses' identification.

3.5. Polymerase chain reaction (PCR)

The PCR method is widely available an exceptionally sensitive although there is a high risk of false positive results due to the possibility of a sample contamination [3].

4. Therapeutic strategies

The contemporary therapeutic approach to HPV infections focuses primarily on enhancing the local immune response rather than on the physical destruction of infected tissues. Nevertheless, the optimal treatment strategy depends on the location and number of warts. Given the viral etiology and high likelihood of spontaneous resolution, therapeutic interventions should avoid excessive aggressiveness, scarring, or significant pain. Surgical removal is recommended only if there is a risk of progression to squamous cell carcinoma.

Both surgical and pharmacological methods can remove visible warts, which is the key to eliminate the risk of contamination other athletes, that share common spaces or have physical contact with already infected patients. The Chinese guidelines published in 201746 indicated that lesions located in vagina and cervix require cytological examination prior to the treatment of CA [2].

The conventional treatments of common, plantar and flat warts, such as salicylic acid and cryotherapy are widely used, although it is important to mention that patients receiving cryotherapy may experience treatment-related pain and it's side effects, such as tissue scaring and hypo/hyperpigmentation [15,16]. Thermotherapy is also advised, principally for patients with multiple warts but the treatment often needs to be repeated to achieve satisfying results. The side effects include burning sensation, blisters and hyperpigmentation. Local injections of 5-Fluorouracyl or bleomycin are also efficient in recurrent viral warts. Emerging therapies involve: intralesional furosemide and digoxin, achieving 92.5% clearance [17], oral zinc sulfate, effective for recalcitrant warts and novel approaches like photodynamic therapy and immunotherapy [18-21].

Due to the long-lasting treatment, it is advised to cover the HPV caused lesions if possible while in shared spaces and to avoid the direct skin to skin contact to minimize the risk of HPV spread amongst athletes. However the verrucal warts are not a strict contraindication for sport training.

4.1. Cryotherapy

Cryosurgery with liquid nitrogen is a widely used method for wart treatment. The most effective outcomes are achieved using a spray technique. The contact method carries a risk of HPV transmission, while the "tip-stick" technique (cotton swab application) often fails to reach sufficient freezing depth. The main effect of cryotherapy is subepidermal blister formation, which detaches and removes infected epidermal tissue. However, HPV itself is not eradicated by freezing. In most cases, healing occurs without scarring. Cryotherapy should be performed at weekly or biweekly intervals [3].

4.2. Surgical excision

Warts may be removed under local anesthesia via curettage or electrosurgery. The primary indication is the presence of isolated exophytic lesions. Plantar warts can be curetted, but often leave a painful, deep scar. Surgical excision is frequently associated with considerable pain and a high recurrence rate.

4.3. Laser therapy

Carbon dioxide (CO_2) laser and dye laser treatment is a reasonable alternative, particularly for periungual warts and large or multiple anogenital warts. However, laser smoke is infectious and poses a risk to both medical personnel and patients; it must be evacuated with a specialized filtration system [3].

4.4. Keratolytic agents

Various keratolytic preparations can soften the hyperkeratotic surface of warts, after which the thickened tissue can be removed mechanically (e.g., with a scalpel or abrasive agents). The standard agent is salicylic acid, available in collodion form or medicated plasters, and sometimes combined with lactic acid or 5-fluorouracil (5-FU). This method is most commonly used for plantar and periungual warts. Treatment requires persistence, as resolution may take several months. Topical tretinoin gel may be applied until slight irritation is achieved [3].

4.5. Cytotoxic agents

For many years, the standard treatment for genital warts in outpatient settings involved weekly application of alcoholic podophyllin solution (20–25%) in benzoin. Podophyllin is no longer recommended due to variability in composition and efficacy. Instead, its active component, podophyllotoxin (1%), is now commonly used and can be applied by patients at home on a daily basis. Topical 5-FU is also used [3].

4.6. Immunotherapy

Immunomodulation against HPV can be achieved using interferon, which may be administered intralesionally, subcutaneously, or topically in gel form. However, distinguishing between local and systemic effects of interferon injections is often challenging. Due to limited evidence of superiority over other treatments and high costs, interferons have not been widely adopted. Imiquimod is an approved topical immunomodulator for the treatment of condylomata acuminata. It activates Toll-like receptor 7 (TLR7), triggering a cytokine cascade that promotes T-lymphocyte and monocyte chemotaxis to the site of application. Patients apply the cream three times per week for a maximum of 16 weeks. This treatment also affects infected cells in surrounding clinically normal skin and is currently the most effective available option, associated with the lowest recurrence rate [3].

5. Additional recommendations

It is advised that athletes wear protective gloves while using gym equipment, such as weights, rowing machines or the boat oars. This recommendation is even more important for water sports enthusiasts since they are way more exposed to skin maceration that leads to inoculation of the HPV [9].

Due to lack of screening guidelines for polish sports medicine teams, it is possible that majority of skin infections are under diagnosed unless the athlete seeks medical help on their own. According to the National Collegiate Athletic Association (NCAA) the systematic head-to-toe visual examination should be performed regularly. One of the most HPV exposed athletes - the wrestlers, undergo an examination after undressing completely, with only briefs on. They are asked to stand with feet spread to shoulder width and arms abducted to 90O with thumbs pointed to the ceiling in a well-lit area, so that all potential skin lesions are exposed [1].

6. Return to the play suggested guidelines

According to the NCAA „lesions must be „adequately covered" or curetted. Facial lesions can be covered with a mask", according to the National Federation of State High School Associations „lesions should be covered if prone to bleeding". In Poland there are still no recommendations for either disqualification or return to competition for cutaneous infection. We are not in position to bring up the discussion if this is the right approach since in the USA from 1988 to 2004 approximately 20% of sports-related conditions involved dermatoses, leading to lost of practice and competition time resulting in affecting individual and team success. Therefore it cannot be missed, that HPV infected patient is a reservoir and with lack of proper treatment and no coverage of the wart, the transmission route will not be cut resulting in inoculation of the virus by inanimate objects and shared spaces.

7. Conclusions

Viral warts pose a substantial dermatological burden in athletes, impacting performance, participation, and transmission risk. With advances in diagnostics like dermoscopy and novel therapeutic options, clinicians are better equipped to manage HPV-induced lesions. Preventive strategies and vaccination programs should be integrated into sports health protocols to curb incidence and recurrence. Multidisciplinary collaboration, athlete education, and evidence-based clinical decisions will improve outcomes for this often-overlooked issue.

Disclosures

Author's contribution:

Conceptualization - Magdalena Domisiewicz;
Methodology - Anna Hanslik;
Software - Monika Klimczak;
Analysis - Agata Białek;
Investigation - Aleksandra Woskowska, Magdalena Mendak;
Resources - Anna Hanslik;
Data curation - Magdalena Mendak, Anna Hanslik;
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Preparation - Magdalena Domisiewicz;
Visualization - Aleksandra Woskowska, Monika Klimczak;
Supervision - Anna Hanslik;
Project administration - not applicable.

All authors have read and agreed with the published version of the manuscript.

Funding Statement: This Research received no external funding.

Institutional Review Board Statement: Not applicable

Informed Consent Statement: Not applicable.

Data Availability Statement: The authors confirm that the data supporting the findings of this study are available within the article's bibliography

Conflicts of Interests: Authors declare no conflict of interests.

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