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The Impact of Physical Activity on Skin Health and Condition: Physiological Mechanisms and Dermatological Effects

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Abstract

Introduction and purpose:

The skin, the largest organ of the human body, plays a crucial role as a protective barrier. Its condition deteriorates with age and under the influence of external factors such as UV radiation, stress, or diet. This review examines the impact of physical activity on skin health, focusing on mechanisms that enhance its function and appearance.

Materials and Methods

A literature review was conducted using medical databases, including PubMed and Google Scholar. Articles were retrieved in English using keywords such as “physical activity,” “skin health,” “effects of exercise on skin,” “anti-aging effects of physical activity,” and “antioxidant properties of exercise” in various configurations.

Description of the state of knowledge:

Regular physical activity positively affects skin health by improving microcirculation, stimulating collagen synthesis, hydrating the stratum corneum, and reducing oxidative stress and inflammation. Exercise also supports the skin barrier function and may alleviate the course of dermatological conditions such as psoriasis or atopic dermatitis. Additionally, physical activity improves sleep quality and mental well-being, which indirectly benefits skin health. The potential of facial exercises to enhance aesthetics is also noted, though their effectiveness requires further research. Despite numerous benefits, some forms of activity, such as swimming, may negatively affect the skin barrier due to exposure to irritating chemical substances.

Conclusion:

In summary, physical activity has a multidimensional impact on skin health, supporting its protective functions, appearance, and anti-aging properties. However, further research is needed to better understand the mechanisms and efficacy of specific types of exercise.

Key words: “physical activity”, “skin health”, “effects of exercise on skin”, “anti-aging effects of physical activity”, “antioxidant properties of exercise”

INTRODUCTION AND OBJECTIVE

The skin, the largest organ of the human body, serves as a protective barrier separating the body from the external environment. It safeguards the body from pathogens and harmful chemical and physical stimuli [1, 2]. The primary function of the skin lies in its barrier role, mainly fulfilled by the stratum corneum [1]. With age, skin functionality deteriorates, manifesting not only in the form of wrinkles but also through reduced skin elasticity and decreased water content in the epidermis [3, 4].

In addition to natural aging-related changes, numerous external factors contribute to the decline in skin function. The most significant of these include lifestyle factors such as sun exposure, smoking, and diet [5, 6, 7]. Proper habits, such as regular skin hydration, hygiene practices, stress reduction, and improving the quantity and quality of sleep, can significantly enhance skin condition [8, 9, 10].

Beyond these factors, physical activity is gaining recognition as a means to improve skin functionality and aesthetics [11]. It is well known that regular exercise has positive effects on overall health, including mental health [12, 13, 14]. However, the impact of exercise on the skin has not yet been thoroughly explored. This review aims to highlight the connections between lifestyle and skin functionality, discuss the mechanisms identified to date, and evaluate the potential effects of physical activity on skin condition.

DESCRIPTION OF THE STATE OF KNOWLEDGE

For many years, it has been well established that regular physical activity promotes health and is beneficial in preventing and managing numerous diseases, such as heart disease, hypertension, diabetes, and osteoporosis. Physical activity is also beneficial for mental health, helping to prevent cognitive decline and alleviate symptoms of depression and anxiety. Regular exercise contributes to maintaining a healthy weight and overall well-being [12–16]. Increasing research highlights the positive impact of physical activity on skin health through various mechanisms, including improved blood flow to the skin, promotion of skin hydration, positive effects on the hormonal system, and increased collagen production in the dermal layer. A study involving 25 healthy Japanese women aged 30–35 showed that regular, moderate physical activity positively influences the mechanical properties of the skin [17].

With age, a decrease in blood flow to the skin and impaired endothelium-dependent vasodilation are observed. However, this process can be reversed through regular physical activity. Numerous studies have shown that regular physical activity not only increases skin blood flow—enhancing its ability to transport and eliminate heat—but also improves vasodilation by significantly enhancing endothelial function. This improvement is mediated through increased bioavailability of nitric oxide (NO), reduced oxidative stress, and anti-inflammatory effects, such as the suppression of TNFα [9, 18, 19, 20, 21].

Physical exercise can also positively affect skin hydration levels**.** In a study conducted on volunteers aged 30–64 without skin diseases, an 8-week regimen of "moderate" or "intense" physical activity demonstrated a trend toward higher hydration in the stratum corneum. However, no significant changes were observed in transepidermal water loss (TEWL) [22]. Another study showed that groups with moderate and high levels of activity had better skin hydration compared to the low-activity group [23]. These studies, however, did not provide information on which specific type of exercise is most effective in improving skin structure and hydration. Moreover, the mechanism by which exercise promotes skin hydration remains unclear, necessitating further research. Researchers believe that the decline in skin functions, such as hydration and barrier function, is caused by increased production of reactive oxygen species (ROS) due to age-related mitochondrial dysfunction. One study demonstrated that endurance exercise stimulates the release of interleukin-15, which prevents mitochondrial dysfunction and promotes mitochondrial biosynthesis. This, in turn, may correlate with better skin hydration in physically active individuals [9, 23, 24, 25, 26]. Proper skin hydration improves its natural barrier function, facilitating protection against internal and external irritants, thereby preventing the development of common skin conditions such as atopic dermatitis, contact dermatitis, psoriasis, and acne [9, 27, 28].

Physical activity can also alleviate symptoms in individuals with skin conditions. A study involving 303 overweight or obese patients with moderate-to-severe chronic plaque psoriasis, who did not show improvement after four weeks of continuous systemic treatment, found that a 20-week dietary intervention combined with increased physical activity reduced the severity of psoriasis [29]. Numerous other studies have demonstrated an inverse relationship between physical activity levels and the risk of psoriasis. Another study using mouse models confirmed that moderate-intensity aerobic exercise improves atopic dermatitis. Although the mechanism is not entirely clear, the improvement may result from the effect of exercise on immune system modulation, as the exercising group showed significant reductions in serum levels of IgE, MCP-

1, and MDC. [30] In another mouse study, IL-15 and exercise treatment reduced circulating levels of inflammatory cytokines IL-6 and MCP-1. The anti-inflammatory effect of exercise, confirmed in multiple studies, could provide valuable insights for the treatment of skin diseases [26, 31, 32].

Regular physical activity may also improve the quality of life of dermatological patients due to its positive impact on body weight, a significant etiological factor in many skin conditions such as hidradenitis suppurativa and psoriasis. Studies have shown that exercise can influence psoriasis both by reducing adipose tissue, which releases inflammatory cytokines, and directly through its own unclear mechanisms. Obesity has been shown to increase levels of key cytokines, such as TNF-alpha, which are crucial in psoriasis development, and stimulate Th17 cells to produce IL-17 [33].

In one study, researchers also noted the positive impact of exercise on collagen synthesis. After 12 weeks of endurance training in sedentary elderly adults, an increase in collagen content, the number of mtDNA copies in the skin, and a reduction in the thickness of the stratum corneum were observed. An increase in the thickness of the spinous layer and collagen content in the skin was also observed in mice receiving daily intravenous injections of recombinant murine IL-15 (rmIL-15), which mimicked the physiological rise of endogenous IL-15 seen after acute exercise. This was associated with the effect of IL-15 on mitochondrial biosynthesis. [9,26]

Collagen synthesis, and thereby the maintenance of proper skin elasticity and thickness, is influenced by the hormonal system. Estrogens and growth hormones have been shown to play a significant role in collagen synthesis, with deficiencies in these hormones linked to skin quality deterioration. [9,34] In one study, postmenopausal women were found to have a significant decrease in collagen content in the skin compared to premenopausal women, a phenomenon associated with postmenopausal hypoestrogenism. [35] Increasing evidence suggests that resistance exercises induce significant hormonal changes. Studies indicate that levels of anabolic hormones, such as testosterone and growth hormone (GH), rise within 15–30 minutes after resistance exercise, provided the stimulus is adequate. Training protocols characterized by high volume, moderate to high intensity, short rest intervals, and involvement of large muscle mass typically result in the greatest short-term hormonal increases (e.g., testosterone, GH, and cortisol). In comparison, protocols with low volume, high intensity, and longer rest intervals elicit smaller hormonal changes. [36]

Furthermore, the magnitude of GH release is greater in young women than in young men and decreases by 4-7 times in older individuals compared to younger ones. [37] The precise mechanism of GH release in response to physical activity is not yet fully understood but is thought to be related to intense resistance training directly stimulating the anterior pituitary. This process may be aided by increased circulation of catecholamines, lactate, nitric oxide, and changes in acid-base balance. Additionally, an increase in GH levels post-resistance training has been observed in the context of elevated estrogen levels in women. It has also been reported that resistance training significantly enhances aromatase enzyme activity, leading to increased estrogen biosynthesis from androgens. This explains why exercise-induced testosterone elevation contributes to increased estrogen levels in women. [38]

Regular exercise is also believed to reduce stress. Physical activity has a positive impact on the central nervous system (CNS), improving mood, cognitive abilities, and correlating with increased expression of neurotrophic factors and synaptic plasticity markers while reducing inflammatory factors. Published studies show that the energy challenge posed by physical exercise can affect the CNS by improving cellular bioenergetics, stimulating processes responsible for removing damaged organelles and molecules, and mitigating inflammatory processes. [39,40] Evidence from animal studies indicates that a sedentary lifestyle is associated with stress vulnerability, while a physically active lifestyle is linked to stress resilience. [41]

The skin actively responds to psychological stress through immune cells, hormones, and neurotransmitters, significantly impacting the skin barrier function, impairing wound healing, and promoting the release of pro-inflammatory cytokines, thereby exacerbating existing skin conditions such as psoriasis, atopic dermatitis, acne, or urticaria. [42] Stress-induced skin responses primarily involve cytokine secretion (e.g., interleukin-6, interleukin-1, interferon-γ) and activation of the skin's corticotropin-releasing hormone (CRH)-proopiomelanocortin (POMC)-adrenocorticotropic hormone (ACTH)-corticosteroid axis, leading to acute/chronic corticosteroid secretion in the skin. Thus, reducing stress through physical activity can positively affect skin health. [43]

Skin condition is also heavily influenced by sleep quality and duration, as sleep is essential for maintaining proper skin surface pH, transepidermal water loss (TEWL), blood flow, and skin temperature. Many hormones and pro-inflammatory cytokines exhibit circadian rhythms. [44] During sleep, cortisol, norepinephrine, and adrenaline secretion decrease, while the levels of growth-promoting hormones such as growth hormone, melatonin, and prolactin increase. Pro-

inflammatory cytokines like interleukin (IL)-1, IL-2, IL-6, and tumor necrosis factor (TNF)-α rise at night, whereas anti-inflammatory cytokines like IL-4 and IL-10 increase upon waking. Sleep deprivation can thus disrupt hormone release and inflammatory marker levels. [45,46,47]

Many studies have demonstrated that longer daily activity is associated with better sleep quality, which directly affects skin condition. A study involving 60 healthy women assessing the impact of chronic poor sleep quality on skin health and aging showed that good sleepers had significantly lower intrinsic skin aging scores (SCINEXA™). Poor sleepers exhibited significantly higher TEWL levels and 30% slower skin barrier recovery compared to good sleepers. Good sleepers also reported better perceptions of their appearance and physical attractiveness. [48]

Moreover, research on women with significant sleep restriction noted a substantial reduction in skin hydration and elasticity after just one day of sleep deprivation. [49] Poor subjective sleep quality was also associated with objectively worse acne conditions [50], while elevated inflammatory markers (matrix metallopeptidase-9, Toll-like receptor-2, cyclic adenosine monophosphate) suggested that poor sleep may exacerbate rosacea through localized skin inflammation. [44,51]

It is widely known that physical activity positively affects sleep quality, particularly its depth, latency, and efficiency. Increasingly, studies show that physically active individuals sleep better and longer than those with a sedentary lifestyle, making improved sleep through exercise an excellent support for addressing dermatological issues. [52,53,54]

Facial exercises focusing on improving facial appearance are gaining popularity. One study involving middle-aged women observed cosmetic changes in facial appearance after daily facial exercises for 20 weeks. [55] However, the evidence so far is insufficient to establish whether facial exercises are effective in facial rejuvenation due to a lack of randomization or subjective assessments by study participants, necessitating further research for definitive conclusions. [56,57]

While physical exercise offers numerous health benefits, it can sometimes negatively impact the skin. Athlete's skin is exposed to repetitive injuries, heat, humidity, and various allergens and chemicals, which can lead to irritation or contact dermatitis. [58] Swimming sports may also harm the epidermal barrier due to the presence of chlorine and other irritating chemicals in pools. A study comparing swimmers and football players demonstrated that differences in

TEWL levels before and immediately after training sessions were higher in swimmers, confirming that the training environment (i.e., pools) is associated with increased TEWL immediately post-exercise. [59]

Additionally, humid environments promote bacterial and fungal growth, increasing the risk of skin infections like athlete's foot. However, proper skincare can minimize the risk of adverse skin complications related to physical activity. [60,61]

SUMMARY

Physical activity plays a crucial role in maintaining overall health, and its impact on skin condition is gaining increasing attention in scientific literature. Studies confirm that regular exercise improves skin function by enhancing blood flow and oxygenation of tissues, which supports regenerative processes. Physical activity may also reduce skin inflammation and help maintain microbiome balance, which is significant in preventing and managing dermatological conditions such as acne, psoriasis, and eczema.

Additionally, exercise influences the regulation of stress hormones, such as cortisol, which in excess can negatively affect skin health. It has also been proven that physical activity promotes collagen production, improving skin elasticity and firmness, and potentially delaying the aging process. However, it is essential to tailor the type and intensity of exercise to individual needs to avoid adverse effects, such as excessive sweating, which can lead to skin irritation.

In conclusion, physical activity has a multifaceted impact on skin health, emphasizing its importance as a natural method to support skin function and appearance. Research findings encourage further exploration of this area, particularly in the context of specific skin conditions and optimizing physical activity to maximize its dermatological benefits.

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