



## THE EFFECTS OF EXERCISE IN SKIN AGING PREVENTION AND TREATMENT

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### ABSTRACT

Aging is a definitive, inescapable process that certainly will happen in any part of the body, including the skin. Both intrinsic and extrinsic factors play a role in causing skin aging. Several skin aging prevention and treatment strategies have been implemented. Lifestyle changes, such as implementing a healthy diet and exercise, can be very helpful in preventing aging and skin aging. Exercise is known to improve mitochondrial function, circulation, produce antioxidants and anti-inflammatory factors, alter the circulating levels of cytokines and hormones, thus, exercise is considered to have anti-aging effects.

**Objectives:** To improve understanding of the effects of exercise to prevent and to treat skin aging.

**Methods:** This systematic review uses recent studies (within 10 years) obtained via the internet. The returned results were screened by all the three authors using the inclusion and exclusion criteria. Data regarding study characteristics (skin aging characteristics or characteristics related to skin aging), research objects or subjects, intervention method, duration, and the results, are extracted and summarized from each paper.

**Results:** 15 eligible, relevant in vivo, ex vivo or clinical studies were selected. All analyzed studies showed that exercise can help rejuvenate the skin, improve wound healing and protect skin against age-related skin disorder.

**Conclusions:** Physical exercise has some beneficial anti-aging effects and can be considered as one of main treatments and effective preventive therapies for skin aging in the future.

**Keywords:** *exercise, resistance training, physical activity, effect of exercise, skin aging, skin aging prevention*

## 1. Introduction

Aging is a definitive, inescapable process that will certainly be experienced by every human being and will happen in any part of the body, including the skin. Intrinsic factors, such as telomere shortening and mitochondrial dysfunction which leads to cellular senescence, and extrinsic or external factors, such as constant exposure to environmental pollutants and ultraviolet radiation (UVR), play a role in causing skin aging. Oxidative stress as a result of reactive oxygen species (ROS) accumulation is generally involved in both processes. (Gu et al., 2020; Lee et al., 2021; Ho and Dreesen, 2021; Nishikori et al., 2023)

Aging skin is characterized by a change in skin texture and skin structure, decreased regeneration and wound healing ability, compromised skin barrier, dry skin, dyschromia, and the development of wrinkles following a loss of skin elasticity. (Bay and Topal, 2022; Gu et al., 2020; Ho and Dreesen, 2021) The latter is usually associated with dermal thickness deterioration that results from extracellular matrix (ECM) degradation. (Nishikori et al., 2023)

Skin protection from UVR by using broad spectrum sunscreens with minimal sun protection value (SPF) 30, application of antioxidant products, skin renewal using retinoid or vitamin A derivatives or alpha hydroxy acids (AHAs) and skin regeneration using peptides are some of many anti-aging strategies that can be done to prevent or undo the signs of skin aging. However, there is one important thing yet often forgotten, that should be considered as an effective and cost-effective skin-aging prevention strategy. Lifestyle changes, such as quitting smoking, more water intake, healthy diet, and exercise, can be very helpful in preventing aging and skin aging. (Bay and Topal, 2022) Both aerobic and resistance exercise training are known to improve mitochondrial function and volume density, thus it can improve aging. (Nilsson and Tarnopolsky, 2019) Exercise can also increase blood flow, and by its ability to improve circulation, it also helps eliminate waste products and increases oxygen and nutrition supply to the skin to help nourish and regenerate the skin. (Bay and Topal, 2022; Hu et al., 2022) Moreover, moderate-intensity exercise can also help produce antioxidants and anti-inflammatory factors, thus, can help protect the skin against oxidative stress. (Hu et al., 2022)

Additionally, the beneficial anti-aging effect of physical exercise is also possibly acquired from its ability to influence hormones and cytokines levels, e.g. IL-15, which is produced by muscle cells during exercise. (Nishikori et al., 2023)

In this article review, we explored recent studies available about the correlation between exercise and skin aging. We aimed to improve the understanding of the effects of exercise and its possibility to be considered as one of main preventive therapies for anti-aging therapy in the future.

## 2. Aging of the Skin

### 2.1. Skin Aging Process

Skin aging occurs due to degradation of skin function because of the accumulation of cells and tissue changes against stress or disease. (Mohiuddin, A.K., 2019)

#### Molecular mechanisms of aging:

Cellular senescence is caused by telomere shortening as cells age and by the decreased proliferative of cell. Chronic inflammation and mitochondrial DNA single mutation contribute to ROS-mediated cellular senescence. (Karimi, N., 2023)

#### Change that Occurs in Skin Aging

In aging skin approximately 1% collagen content is decreased due to reduction in collagen production and increased collagen breakdown. The collagen degradation is caused by senescent fibroblasts in the dermis. (Karimi, N., 2023)

**Table 1.** Comparison of Intrinsic and Extrinsic Aging (Mohiuddin, A.K., 2019)

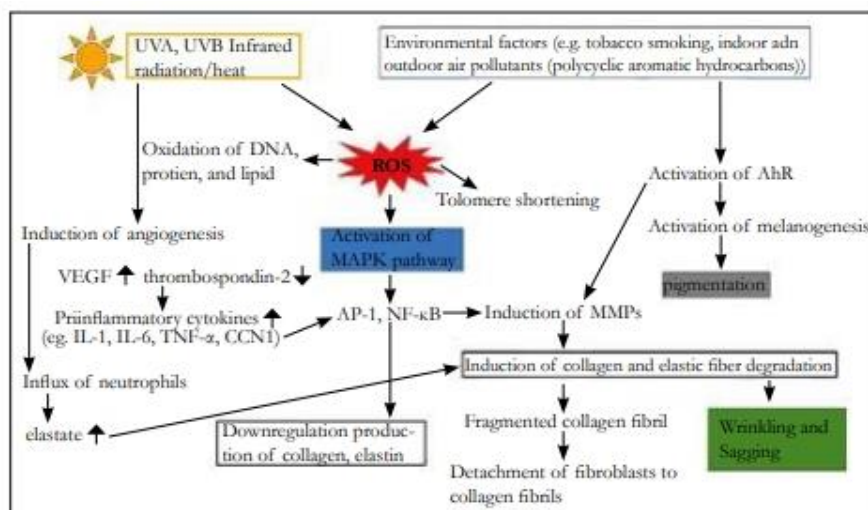
| Feature             | Intrinsic aging  | Photoaging   |
|---------------------|--|--|
| Clinical appearance | Fine wrinkles, some deepening of skin surface markings, some loss of elasticity, redundant skin; Skin is smooth, unblemished, but shows saggy appearance   | Nodular, leathery surface sallow complexion, yellowish mottled pigmentation, coarse wrinkles, severe loss of elasticity, reddened appearance with initially light wrinkles, which later deepen, thus showing loss of collagen fibers |
| Epidermis           | Thin and viable; Thinner than normal with lower cell growth, minor abnormalities in keratinocyte regularity; Normal stratum corneum; There is loss of rete pegs here as well                         | Marked acanthosis, cellular atypia; Thick skin, with acanthosis followed by atrophy of the cells; High basal keratinocyte irregularity; Stratum corneum appears compact; There is loss of rete pegs here as well                     |
| Elastic tissue      | Increased, but almost normal   | Tremendous increase, degenerates into amorphous mass   |
| Reticular dermis    | Thinner, fibroblasts decreased, inactive mast cells decreased, no inflammation; Elastin fibers appear irregular in their arrangement, whereas collagen fibers begin to lower in number and thickness | Thickened, elastosis, fibroblasts increased, hyperactive mast cells; Excessive production of elastin fibers in an improper orientation, collagen fibres appear to thicken and then wear out soon; Appearance of grenzzone            |
| Collagen            | Bundles thick, disoriented   | Marked decrease of bundles and fibers  |
| Glycosaminoglycans  | Slightly decreased   | Markedly increased   |
| Papillary dermis    | No grenz zone  | Solar elastosis with grenz zone,   |
| Microvasculature    | Moderate loss  | Great loss, abnormal and telangiectatic  |

### 2.2. Factor Involved in Skin Aging

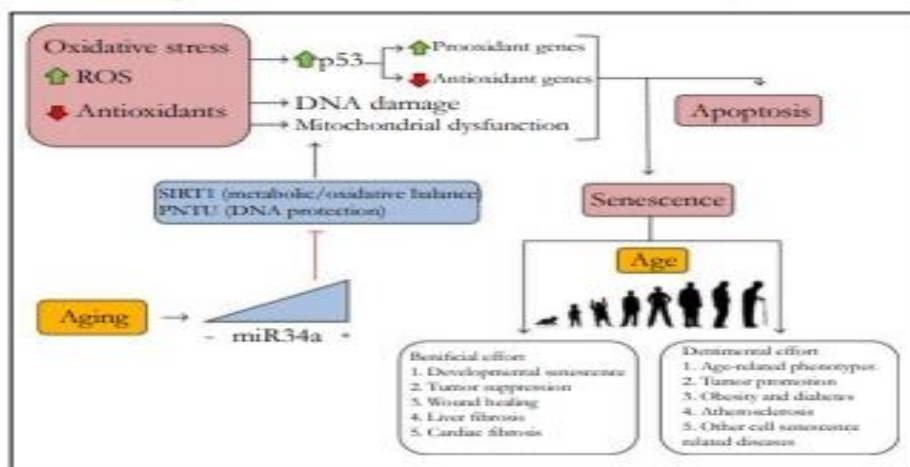
There are two factors that can be involved in skin aging: external factor (photoaging) and internal factor (chronological aging).

**External skin aging** is due to chronic exposure to UV light, pollution of water or air, smoking (vaping), stress, unhealthy lifestyle, continuous muscle contractions (smiling and frowning), wrong sleeping positions and skin disorders. All of that could make ROS-mediated cellular senescence and inflammation.

**Figure 1.** Pathogenesis of premature/extrinsic skin aging (Mohiuddin, A.K., 2019)



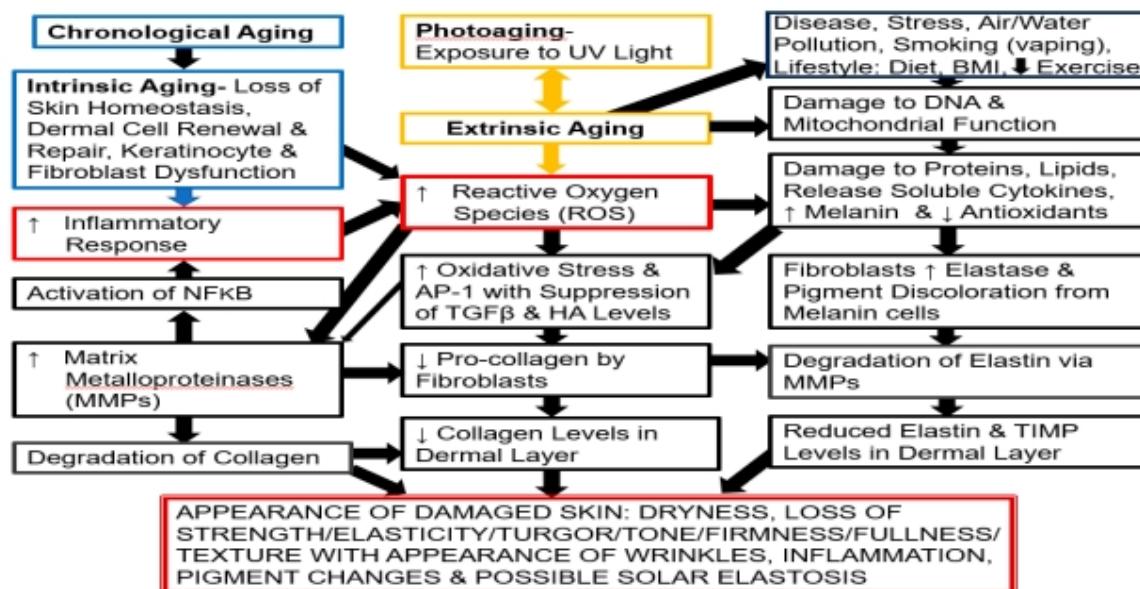
**Figure 2.** Mechanism Aging Mediated ROS (Mohiuddin, A.K., 2019)



**Chronological** skin aging is a natural-occurring process. This can be caused by inherited genes, metabolism disorder, hormonal, immunological causes, stress, or degenerative diseases. On the skin, these intrinsic factors cause a decline in dermal thickness, change of keratin layer, change of epidermal and dermal junction, lack of collagen, elastin and hyaluronic acid. (Knagg, H. & Lephart, E.D., 2023).

**Figure 3.** Mechanism Cellular/Moleccular of Skin Aging by Internal and External Factors

(Knagg, H. & Lephart, E.D., 2023)



Skin aging treatment strategies include healthy lifestyle habits, chronotherapy, endogenous antioxidant molecules, natural topical antiaging skincare, and regenerative medicine. (Karimi, N., 2023)

There are four factors of lifestyle health: the first factor is nutrition and diet, the second factor is rest, relaxation, recovery (RRR) and stressor management, followed by physical exercise, and the last factor is social and community. (Knagg, H. & Lephart, E.D., 2023)

### 3. Physical Exercise Effect in Skin Aging

Regular and moderate exercise has positive influences on skin rejuvenation, wound healing, and aged-related skin disorders. Regular physical exercise can improve blood flow to help nourish the cells, get rid of toxins through skin, stimulate collagen formation, improve skin elasticity and its barrier. Regular physical exercise can also inhibit ROS and reduce MMP. Overall, physical exercise may help to make the skin look healthy. (Knagg, H. & Lephart, E.D., 2023)

## 4. Methods

### 4.1 Search Strategy

This study is a systematic review. Sources of information and data are obtained from some literature obtained via the internet. A literature search was conducted by searching scientific research articles using ResearchGate and PubMed in electronic form. The following words were utilized: “exercise effect in aging skin”, “exercise and skin aging” and “physical exercise and skin aging”. The returned results were screened

by all the three authors using the inclusion and exclusion criteria. Any disagreements that arise between review authors are resolved through discussion.

#### 4.2 Inclusion and Exclusion Criteria

The selected studies must be in accordance with the inclusion criteria: (1) The year of publication of the literature should be within the range of 2013 to 2023; (2) Studies about skin aging and age-related skin disease are included; (3) If the study uses exercise intensity and duration, objective measures of exercise intensity and duration should be used; (4) The articles were written in Bahasa or English. Studies will be eliminated if any of the exclusion criteria below were met: (1) articles did not include a full-text description of the study; (2) not in English or Bahasa; (3) publications over 10 years old; (4) the study presented no extractable data.

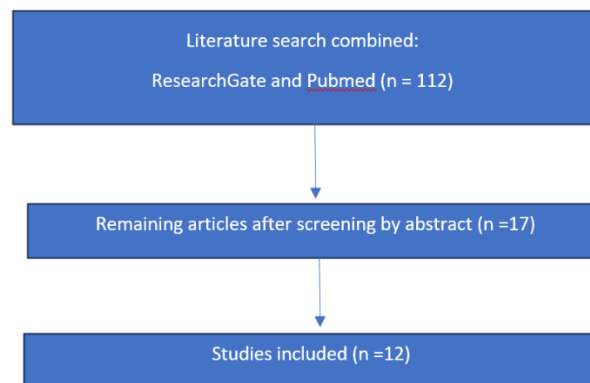
#### 4.3 Data Extraction and Quality Assessment

All data from each paper regarding study characteristics (skin aging characteristics or characteristics related to skin aging), research objects or subjects, intervention method, duration, and the results were extracted. The three authors also determined the implication of the study for skin aging. Any possible risks of bias were assessed independently by all three authors.

### 5. Results

Initially, this search yielded 112 articles. Through abstract selection, the authors identified 18 articles that met the inclusion and exclusion criteria. These articles were then re-evaluated and reviewed, led to 12 relevant in vivo, ex vivo, and clinical studies articles (Figure 5), which are summarized in Table 3. Summary of Evidence.

**Figure 4.** Study Selection Method



**Table 3. Summary of evidence**

| Authors (year)        | Skin Aging Characteristics/ Characteristics Related to Skin Aging   | Research Subject/ Objects  | Intervention & Duration  | Study Results   | Implications on Skin Aging   |
|-----------------------|---|--|--|---|--|
| (Alam et al., 2018)   | Photodamaged skin, with mild to moderate facial atrophy             | 16 healthy female participants (40-65 years) with photodamaged skin and mild to moderate facial atrophy  | Daily 30 minutes facial exercise (32 exercises), for 8 weeks (about 2 months) at home. Continued 3-4 times per week during weeks 9-20. Outcome measured by standard photographs using Merz-Carruthers Facial Aging Photoscales (MCFAP).  | Modest improvement in upper and lower cheek fullness  | Daily facial exercises can be useful in rejuvenating aging skin                                  |
| (Wong et al., 2019)   | Impaired wound healing  | 3 group of mice consist of young female mice group, adult mice group and old mice group<br><br>Epidermal cells and dermal fibroblasts from female C57Bl/6 mice | Old mice treated group:<br>Daily regular exercise (15-degree incline rodent treadmill, 16 m/min) + rmIL-15 (25 ng/kg) via tail intravenous injection (IV) before exercise, 33 days (about 1 month) before wounding surgery. Intervention continued post-surgery for 5 days (only 8m/min) | Old mice treated group: the size of the wounds was found smaller 9 days post-surgery, compared with old mice control group; indistinguishable from young mice control group.<br><br>Wound closure reached at the same time with young mice control group, 2 days faster than old mice control group.<br><br>Biomarkers of senescence: reduced HMGB1 staining was not found in old mice treated group, partially reduced loss of Lamin B1 in epidermis | IL-15 mimics exercise effect; exercise can help improve wound healing and reduce senescent cells |
| (Skroza et al., 2020) | Non-melanoma skin cancer (NMSC) caused by UVR exposure (photoaging) | 162 NMSC outpatients and 167 healthy subjects (control group)  | Data collection by face-to-face interview  | Only 33 (20,4%) NMSC outpatients practice physical activity, compared with 60 subjects (35,9%) from control group   | Regular exercise may have potential protective effect from malignancies caused by photoaging     |

|                                   |   |   |  |   |   |
|-----------------------------------|---|---|--|---|---|
| <b>(Nabila et al., 2021)</b>      | Skin aging signs based on Glogau's criteria   | 100 participants:<br>Glogau's scale 1 = 38 participants (control group)<br>Glogau's scale 2 = 35 participants (case group)<br>Glogau's scale 3 = 27 participants (case group) | Data collection by interviews with questionnaires  | Statistical comparative analysis $p = 0,101$ ( $p > 0,05$ ), indicating that exercise does not cause skin aging                             | Exercise doesn't cause skin aging   |
| <b>(Ishikawa et al., 2021)</b>    | ROS production, SIRT-expression, skin moisture content, skin texture, skin elasticity             | 48 healthy women (20-59 years)  | Subjects were asked to participate in hot yoga lessons (35°C, 60% humidity, basic or beginner course) for 60 minutes, twice per week, 12 weeks (about 3 months). Subjects maintained the same sleep duration, lifestyle, and diet patterns. Application of any skincare products was prohibited. Skin assessment, skin replicas, and blood samples were taken before and after intervention. | ROS production, Adrenaline & noradrenaline levels, SIRT6 mRNA level, skin texture depth, skin moisture content, skin texture & elasticity - | Exercise may prevent skin aging because it has:<br>anti-senescence and protective effects against oxidative stress, anti-wrinkle and rejuvenating effects |
| <b>(Nishikori S. et al. 2023)</b> | Dermal structure and thickness, skin elasticity   | 56 middle aged-Japanese women:<br><br>Aerobic Training (AT) group = 26 subjects<br><br>Resistance Training (RT) group = 30 subjects   | Training was done twice per week for 16 weeks (about 3 and a half months)  | Skin elasticity and upper dermal structure increased significantly both AT and RT Group.  | Aerobic and resistance training can prevent skin aging  |
| <b>Crane, J.D., et al. (2015)</b> | Skin structure, tissue mitochondria, stratum corneum thickness, reticular dermis collagen content | Subject is 65-86-year-old   | 2x per week aerobic training for 12 weeks (about 3 months)   | $p < 0,05$ , indicated a significant difference between groups  | Short term aerobic exercise can prevent skin aging with increased IL-15 in circulation and control by AMPK  |

|                        |   |   |  |  |   |
|------------------------|---|---|--|--|---|
| Ryosuke, et al (2021)  | Impaired skin barrier function and TEWL lead to skin dryness                                      | 86 participants with age between 20 to 62 (72 women and 14 men) with normal skin condition  | Comparisons of participant's activity levels with skin hydration and TEWL. Activity level were measured using IPAQ-SF (Japanese version). Skin hydration were measured after 20 minutes in the room temperature. TEWL were measured using Tewameter TM300                                  | There is a significant correlation between physical activity and hydration levels of the skin. The higher the participant's activity level, the higher the skin hydration level. | Physical activity can help prevent age-related skin dryness   |
| Szygula et al (2020)   | Changes in the structure and function of the microcirculation system cause impaired wound healing | 48 male subjects who had stable and controlled ischemic heart disease lasting at least one year, without ever experiencing ACS. Divided into two groups, 24 subjects each group | Research group: aerobic exercise 3x/week or 8 weeks, 30-40 minutes each session. Skin microcirculation measurements were carried out 3x: before the experiment, after 8 weeks of physical activity, and after 8 weeks of physical inactivity using a Periflux 4001 Doppler laser flowmeter | RF increased after exercise by 20.21%. increase in PRHmax of 8.76%; increase in THmax of 5.38%. Endothelial rhythm signal strength increased by 19%                              | Aerobic exercise improved skin microcirculatory reactivity and may help improve wound healing in aging skin               |
| Couppé, C., et al 2014 | AGEs that accumulate during the aging process cause skin tissue damage                            | Two groups of healthy elderly: 15 trained athletes and 12 untrained athletes. Two groups of healthy young men: 10 trained athletes and 12 untrained young athletes.             | Comparison of AGE levels on subject's forearm skin using an AGE reader   | The density of AGE cross-links in collagen in the skin of older subjects was 45% higher, but 11% lower in the trained athletes group   | Endurance exercises, e.g. running, may reverse aging process in skin connective tissue by reducing AGE cross-link density |
| Ishiuchi-Sato, 2021    | Structural changes and collagen degradation contribute to formation of wrinkles                   | 8-week-old male mice: sedentary group and exercise group. 5-6 mice per group.   | Previously, mice were acclimatized to a 12 hour light cycle. Exercise group : forced treadmill at speed 15 cm/s for 30 minutes.  | There was a significant increase in Colla1 gene expression in skin around 3.5- times greater in the forced exercise group compared with sedentary control group                  | Single exercise can may induce Colla1 expression in skin and reduces collagen degradation and reverse aging sign          |

|                                |  |  | Mice were anesthetized and sacrificed immediately after  |   |  |
|--------------------------------|--|--|--|---|--|
| <b>Asnindari, et al., 2018</b> | Decreased estrogen levels in aging women cause a decrease amount of keratinocytes, and fibroblasts as well as impaired wound healing and immune response | 3 month-old female Sprague Dawley: 2 groups, 4 rats in each group. | Group 1 : ovariectomy, no physical exercise.<br>Group 2: ovariectomy, regular physical exercise (run on a treadmill, 5% incline at a speed of 18 m per minutes, 60 minutes per day, 5x a week, for 12 weeks) | Higher number of fibroblasts found in Group 2. No significant differences in serum estrogen levels, skin ER $\beta$ levels and epidermis and dermis thickness between groups were observed. | Regular and measurable exercise improves estrogen levels and provides benefits in age-related skin condition |

## 6. Discussion

All analyzed studies show that physical exercise may have some beneficial effects on aging skin. Based on the literature obtained by the authors, the effect of physical exercises in preventing and treating skin aging are: (1) skin rejuvenating, (2) wound healing and (3) age-related skin disorder.

### *Skin Rejuvenating*

Exercise with sufficient intensity and duration is reported to be able to elevate markers of oxidative stress and inflammations, but in contrast, it is also reported to be able to activate the antioxidant system and enhance its production (McKenzie et al., 2014). Although exercise is more often associated with healthier and younger looking skin. This argument is strongly supported by a case-control study performed by Nabila et al. The study involves 100 participants with Glogau Photoaging Scale ranging from scale 1 to scale 3. Glogau Photoaging Scale is a subjective scale that classifies photoaging skin by wrinkles assessment done by researchers. Type I defines early photoaging with no wrinkles, type II defines early to moderate photoaging with wrinkles are only visible during movement, type III defines advanced photoaging with wrinkles are visible even at rest, and type IV defines severe photoaging with more and deeper wrinkles. (Oliveira et al., 2023) In the study, 100 participants involved have Glogau Photoaging Scale ranging from type I (mild skin aging; 38 participants, as a control group) to scale 2 and scale 3 (severe skin aging; 35 and 27 participants, respectively, as case groups). The statistical comparative analysis showed that exercise does not cause skin aging, although they did not explain the underlying mechanism. (Nabila et al., 2021) On the contrary, exercise can actually help prevent skin aging.

Clinical studies show that physical exercise can prevent skin aging by increasing levels of skin hydration, preventing TEWL or trans-epidermal water loss (Oizumi et al., 2021), improving skin structure (Alam et al., 2018) (Crane et al., 2015) (Nishikori et al., 2023), reducing the AGE cross-link density (Couppé et al., 2014) and because it has anti-senescence and protective effects against oxidative stress. (Ishikawa et al., 2021) (Wong et al., 2019)

Hot yoga or a yoga that is performed in both an elevated temperature and a high humidity condition was shown to be beneficial in preventing skin aging by significantly reducing ROS production, levels of adrenaline and noradrenaline, and also by increasing SIRT6 mRNA level. Since adrenaline and noradrenaline are also producing ROS, a decrease in adrenaline and noradrenaline levels will lead to a decrease in ROS production, thus, hot yoga might have anti-senescence and protective effect against oxidative stress. Expression of SIRT6, one of sirtuin family members, can help suppress cellular senescence, therefore, an increase of mRNA expression of SIRT6 induced by hot yoga may help inhibit skin aging directly. Hot yoga can also help prevent wrinkle formation and rejuvenate the skin because it can reduce the depth of skin texture points, improve skin texture, skin moisture content and skin elasticity. These studies show that physical exercise has benefits to reverse and prevent skin aging process.

(Ishikawa et al., 2021)

Apart from yoga which involves the whole body, facial yoga or facial exercise is believed to be useful to treat aging skin as well. Aging causes a decrease of facial muscles' performance, while repetitive use of facial muscles can also cause wrinkles. (Uysal et al., 2023) Daily 30 minutes facial exercise for 20 weeks (about 4 and a half months) demonstrated a modest improvement of upper and lower face fullness, supposedly caused by inducing hypertrophy of cheek and other underlying muscles. (Alam et al., 2018) This implies the potential usefulness of facial exercise to help rejuvenate the aging skin. Unfortunately, public awareness about the benefits of facial exercises is still low. (Uysal et al., 2023) Not limited to facial exercise only, acute physical exercise involving the whole body can also rejuvenate the skin through the mechanism of reducing collagen degradation and increasing Colla1 gene expression. (Ishiuchi-Sato and Nedachi, 2021)

Additionally, physical exercise was shown to be beneficial in treating skin aging by regulating estrogen levels in women. In aging women, there is a reduction in estrogen levels which causes various changes in the skin such as reduced thickness of the dermis and decreased number of fibroblasts. Regular and measurable physical exercise can increase serum estrogen levels and give benefit on this aging condition. (Asnindari et al., 2018)

### *Wound Healing*

Impaired wound healing is one of several signs commonly found in aged skin, which can prolong post-surgery recovery and increase infection risk (Wong et al., 2019, Khalid et al., 2022). Prolonged wound healing in aged skin is thought to be driven by mitochondrial defects, a decrease in cell proliferation and by the accumulation of senescent cells that result in a compromised reepithelization. (Wong et al., 2019) Regular exercise can improve this impaired wound healing ability with the help of interleukin-15 (IL-15) which the production is induced during exercise and known to be able to increase skin mitochondria. Wong et al. have proven this through their *in-vivo* experiments on female young, adult and old mice (C57BL/6), using low doses of IL-15 (recombinant mouse interleukin-15) which mimic exercise physiological effect. IL-15 is found to be downregulated in old, aged mice. Compared with old mice in control group, injection of rmIL-15 to old mice treated group showed smaller wounds size at 9 days post-surgery, very similar to young control mice group. Biomarkers of senescent cells, such as the depletion of Lamin B-1 and HMGB1, were also reduced. (Wong et al., 2019) Physical exercise can also help improve skin microcirculation and help regulate eosinophils that are essential in wound healing and predominantly involved in the inflammatory and granulation stages of wound repair. (Wong et al., 2019, Szyguła et al., 2020) These findings indicate that impaired wound healing as an effect of ageing can be improve with physical exercise.

### *Age-Related Skin Disorder*

In line with an increase of UVR exposure, the incidence of malignancies, such as non-melanoma

skin cancer (NMSC) in elderly is increased. Preventive measures, e.g., sunscreen, topical or oral vitamins and antioxidants, remain as one of the main options. (Todorova and Mandinova, 2020) However, other options such as exercise can also be used as a preventive therapy choice. A case-control study involving 162 NMSC-diagnosed outpatients and 167 healthy subjects (control group), found that only 33 people (20,4%) from NMSC outpatients perform daily physical activity for more than 30 minutes per day, compared with 60 subjects (36,6%) from control group. This data may suggest a possible protective effect of regular exercise from malignancies. The ability of exercise to influence cancer risk is thought to be obtained from its ability to regulate immune function, hormones, and cytokines. (Skoza et al., 2020).

Previous research was also demonstrating that physical exercise may be recommended in other skin disorders associated with aging, such as venous leg ulcer, psoriasis, and attenuated skin aging (Yeh, C., et al 2022).

## 7. Conclusion

Skin aging is caused by numerous factors. Internal factors are a natural-occurring aging process and determined by genetics, whereas external factors can be prevented and controlled. This review discusses the effect of maintaining a healthy lifestyle with exercise to prevent and to treat skin aging.

Regular and moderate exercise has positive influences on skin rejuvenation, wound healing and aged-related skin disorders. This activity also benefits skin health in many ways. Exercise can increase skin hydration, prevent TEWL, improve skin structure, reduce ROS production, help prevent wrinkle formation by reducing collagen degradation and regulating estrogen levels. Exercise also has anti-senescence effects, protective effects against oxidative stress and can help improve wound healing. Moreover, exercise may also have a protective effect against age-related skin disorders and malignancy. Thus, we concluded that physical exercise has beneficial anti-aging effects and can be considered as one of main treatments and effective preventive therapies for skin aging in the future.

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