Longevity Trends: March 2025

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Introduction

This month, we take a deep dive into skin aging and explore ways to maintain a youthful appearance. When people think of skin aging, they often picture wrinkles, sagging, and pigmentation changes. While these are prominent features, aging skin undergoes many other transformations, including loss of lip fullness, the development of small dilated blood vessels (*spider veins*), and a reduction in fat tissue (Ng *et al*., 2025).

Although this article focuses on the cosmetic aspects of skin aging, it is important to acknowledge its broader health implications. Aging skin is more susceptible to certain diseases, and many preventive measures that slow visible aging also reduce the risk of these conditions.

One well-documented risk factor is **UV exposure**, which significantly increases the likelihood of skin cancer. A single day in the sun can cause up to **100,000 UV-induced DNA damages per cell** (Hoeijmakers, 2009). Just **four tanning bed sessions per year** raise the risk of basal cell carcinoma by **15%** and squamous cell carcinoma by **11%** (Curti *et al*., 2022). Additionally, experiencing **five or more sunburns doubles the risk of skin cancer** (D'Orazio *et al.,* 2013). UV radiation is estimated to be responsible for **65% of melanoma cases**—the deadliest form of skin cancer—and up to **90% of non-melanoma skin cancers** (D'Orazio *et al*., 2013). Overall, skin cancer is among the most common cancers worldwide, with approximately **1.5 million new cases reported in 2022** (IARC, 2022).

Beyond skin cancer, aging also **impairs wound healing**, a problem further exacerbated by smoking. Cigarette smoking accelerates visible skin aging while simultaneously reducing the skin's ability to repair itself.

By understanding the mechanisms of skin aging and adopting protective habits, one can not only maintain a youthful appearance but also promote overall skin health and longevity.

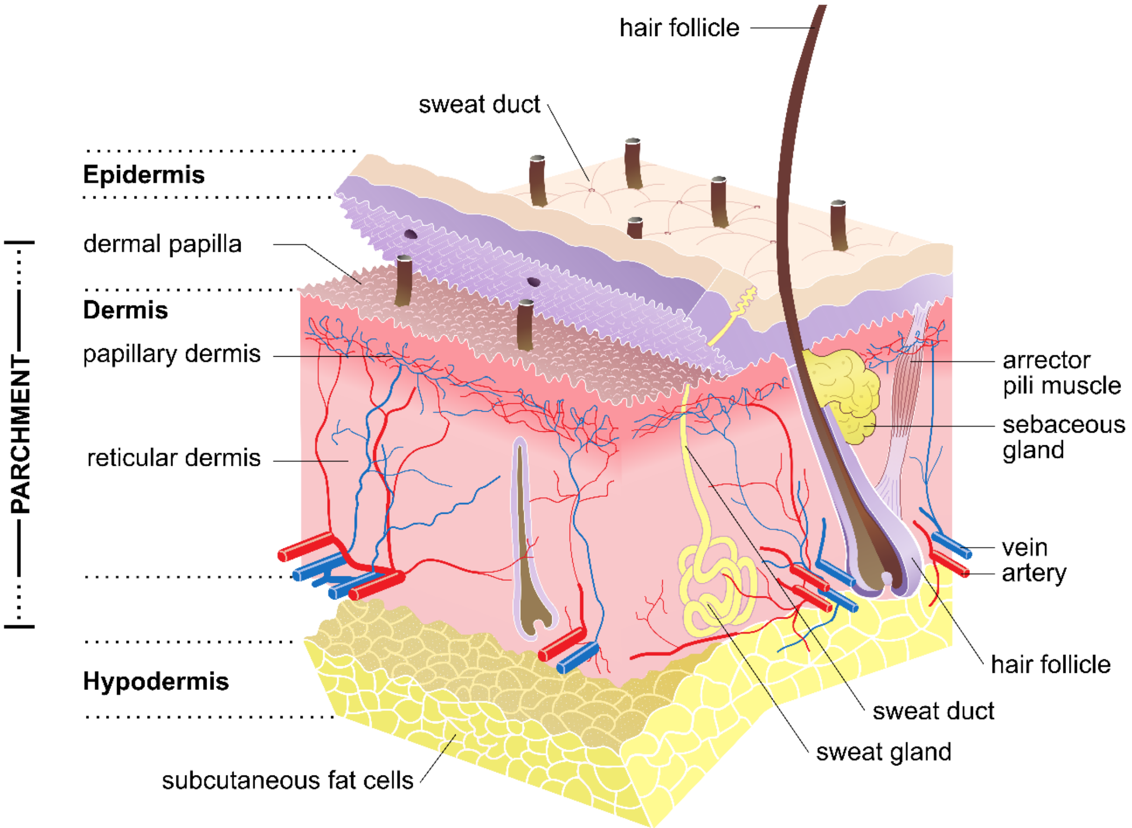
The structure and function of the skin

The skin is one of the body's largest organs, consisting of three primary layers: the **epidermis**, the **dermis**, and the **hypodermis**.

- The **epidermis** serves as a protective barrier, shielding the body from infectious agents, harmful chemicals, UV-light, and mechanical damage. It is composed of multiple layers, with the outermost layer consisting entirely of dead cells that form a strong, protective barrier. However, this barrier also makes it challenging for many topical treatments to penetrate deeply enough to influence skin aging. At the deepest layer of the epidermis, specialized cells called **melanocytes** produce the pigment

eumelanin, which determines skin color and provides **natural UV protection**. Individuals with darker skin tones have more eumelanin, offering greater resistance to UV damage. However, other factors—such as **carotenoids** and **blood vessel density**—also influence skin tone.

- The **dermis**, located beneath the epidermis, is primarily composed of **collagen and elastic fibers**, along with other molecules like **hyaluronic acid**, which help maintain skin strength and elasticity. It houses **sweat and sebaceous glands, hair follicles, nerve endings** (responsible for sensations such as pressure, pain, and temperature), **lymphatic and blood vessels.** Damage to the dermis, in contrast to the epidermis, results in the formation of scar tissue.
- The **hypodermis** is the deepest layer of the skin. Like the dermis, it contains **collagen and elastin fibers**, as well as **nerves, lymphatic, and blood vessels**. Additionally, it houses **fat cells**, which provide **insulation and cushioning** while connecting the skin to underlying muscles and bones.



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Dermatologists classify skin's response to UV exposure using the **Fitzpatrick Scale**, which categorizes skin into **six phototypes** based on melanin levels and susceptibility to sunburn. People with **phototypes I and II** (fair skin) are **highly vulnerable to UV damage**—over **90% of non-melanoma skin cancers** occur in individuals with these skin types (WHO, 2002).

Beyond its protective role, the skin also plays a **crucial role in Vitamin D production**. Upon exposure to sunlight, the skin synthesizes **Vitamin D**, which is essential for bone health and immune function. However, this process is **self-regulated**—prolonged sun exposure converts excess Vitamin D into inactive molecules, preventing an overdose (Mostafa and Hegazy, 2015).

Skin aging

Skin aging can be broadly divided into **intrinsic and extrinsic aging:**

- **Intrinsic aging** refers to natural, biological aging processes that occur **independently of environmental factors**.
- **Extrinsic aging** is influenced by external factors, with **photoaging** (UV-induced damage) being the most well-known. However, photoaging is **not** the only form of extrinsic aging—other factors such as **smoking, pollution, and poor nutrition** also accelerate skin aging.

As we age, the skin undergoes several **degenerative changes**, including:

- **Loss of elasticity**, leading to **wrinkles and sagging**
- **Thinning of the skin**, making it more fragile
- **Impaired barrier function**
- **Reduced sebum production**, leading to **dry skin**
- **Pigmentation changes**, including **age spots (solar lentigines)**
- **Appearance of red 'spider veins' (telangiectasia)**
- **Slower wound healing**

On a **microscopic level**, one of the most significant changes is the **loss of collagen and elastin**:

- **Collagen** provides **structural strength** to the skin.
- **Elastin** gives the skin **its ability to stretch and bounce back**.

From early adulthood onwards, collagen levels in the skin decrease by approximately 1% per year (Shuster *et al*., 1975).

Additionally, the skin contains many **immune cells**, which play a key role in **defense against infections**. With age, their function declines, increasing **susceptibility to skin infections** (Chambers and Vukmanovic, 2020).

Certain diseases can significantly speed up the aging process of the skin. Segmental progeroid syndromes, such as **Hutchinson-Gilford Progeria Syndrome** and **Werner Syndrome**, are hereditary conditions characterized by extreme premature aging, including accelerated skin aging (Lessel and Kubisch, 2019). While these genetic disorders cannot currently be prevented, other conditions linked to premature skin aging can be managed or mitigated.

One such condition is **type 2 diabetes mellitus (T2DM)**. In individuals with T2DM, chronically elevated blood glucose levels damage collagen and other extracellular matrix (ECM) proteins in the skin through a process called non-enzymatic glycation (Sjöberg and Bulterijs, 2009). As a result, T2DM patients tend to have reduced skin elasticity and deeper wrinkles compared to those with normal blood sugar levels (Moraes et al., 2023). Additionally, T2DM may increase susceptibility to solar lentigines—darkened patches of skin caused by excessive sun exposure (Moazzami *et al*., 2017).

By managing preventable diseases such as diabetes, individuals can not only improve their overall health but also slow down premature skin aging.

Slowing down skin aging

Skin aging is highly influenced by lifestyle factors. Below, we will focus on two main modifiable contributors to skin aging namely smoking and UV exposure. However, other factors such as air pollution and nutrition also play a role in skin aging (Wong and Chew, 2021). For example, up to 30% of wrinkle formation may be influenced by dietary choices (Perner *et al*., 2011). We will finish this section with a discussion on several interventions that can be used to slow down skin aging.

Smoking

Smoking accelerates visible aging significantly. Research indicates that every 10 years of smoking adds approximately 2.5 years to a person's apparent age (Rowe *et al*., 2010). Another study found that individuals who smoke 20 cigarettes a day can appear up to 10 years older than non-smokers (Leung and Harvey, 2002).

Smoking has numerous detrimental effects on the skin, including **increased dryness**, **delayed wound healing**, **reduced skin barrier function**, and the **formation of lines and wrinkles** (Morita, 2007; Sorensen *et al.*, 2009). Cigarette smoke reduces collagen production while simultaneously increasing its breakdown, leading to a loss of skin structure and elasticity. A study applying cigarette smoke extract to mice three times a week for six months observed a significant loss of collagen (Tanaka *et al*., 2007), demonstrating the destructive impact of smoking on skin integrity.

Sun exposure

While the dangers of sun exposure in relation to skin cancer are widely known, its role in premature aging is less recognized. For example, a study in Greece found that 66% of mothers of pediatric patients were aware of sun exposure's link to skin cancer, yet only 5% knew it contributed to skin aging (Kakourou *et al*., 1995). Similarly, a recent study from the Arabian Peninsula revealed that although over 80% of respondents acknowledged the connection between sun exposure and skin cancer as well as skin aging, more than half still believed that a suntan could be healthy if sunburn was avoided (Sultana, 2020). In Malta, nearly half of respondents held the same misconception (Scerri *et al*., 2002). Another misconception is that a suntan will protect your skin from further sun damage. Even a deep tan on fair skin provides no more than SPF 4—far less than the SPF 50+ offered by many sunscreens (WHO, 2002).

In reality, **tanning is a biological response to sun-induced damage**, meaning any level of tanning reflects compromised skin health. Another common misconception is that sun protection is unnecessary on cloudy days. In fact, clouds block visible light more effectively than UV radiation. Under certain conditions, they may even enhance UV exposure (Calbó *et al*., 2005).

Ultraviolet radiation is classified into three types based on wavelength:

- **UVC (200-280 nm):** Does not reach the Earth's surface.
- **UVB (280-320 nm):** Affects the upper layer of the skin (epidermis) and is strongest in summer.
- **UVA (320-400 nm):** Penetrates deeper into the dermis and remains relatively constant year-round (SCENIHR, 2012; Nicolaidou *et al.*, 2006).

Approximately 90-95% of UV radiation that reaches the Earth's surface is UVA, while only 5-10% is UVB (D'Orazio *et al*., 2013). Though UVB is blocked by glass, UVA can pass through windows, leading to significant exposure even indoors (Nicolaidou *et al*., 2006). Specialized window coatings can help mitigate this effect.

UVB primarily causes DNA damage by inducing the formation of thymine dimers, while UVA generates reactive oxygen species (ROS, such as singlet oxygen), which can damage DNA and other cellular structures. These harmful effects highlight the importance of year-round sun protection, regardless of weather conditions or indoor environments.

Some individuals are more vulnerable to the harmful effects of UV radiation than others. People with lighter skin tones, red or blond hair, or blue, green, or gray eyes are at higher risk of UV-induced damage. Additionally, individuals with a greater number of moles face an increased likelihood of developing melanoma—the deadliest form of skin cancer—following sun exposure.

The **Global Solar UV Index** is a useful tool for determining the strength of UV radiation at a given time and location. The World Health Organization (WHO) provides the following guidelines for sun protection based on UV levels (WHO, 2002):

- **Low (0-2):** Safe to be outdoors, but sunscreen (SPF 15+), sunglasses, and protective clothing are still recommended.
- **Moderate (3-5):** Take precautions—use SPF 30+ sunscreen, wear sunglasses and a hat, seek shade, and limit midday sun exposure (10 a.m.–4 p.m.).
- **High (6-7):** Increased protection is necessary. Avoid being outside during midday hours! Follow all previous recommendations and be extra cautious.
- **Very High (8-10):** Sun damage occurs quickly. Adopt stringent protective measures.
- **Extreme (11+):** Maximum protection is required. Avoid sun exposure when possible and rigorously follow all safety recommendations.

The UV Index is a linear scale meaning that someone who would get a sunburn after half an hour of exposure at UV Index 6 radiation would be expected to get the same sunburn after only 15 minutes at UV Index 12 radiation. The UV Index is highest near the equator and decreases with increasing latitude. However, altitude also plays a significant role—UV levels rise with elevation, making exposure more intense on mountains or at high altitudes, such as in airplanes. UV radiation is strongest when the sun is highest in the sky, meaning it varies by time of day and season. Outside the tropics, the UV Index is highest around midday and during summer (WHO, 2002).

Even if you're in the shade, UV radiation can still reach you through reflection—especially from certain surfaces like snow, sand, and water. Fresh snow can bounce back as much as 80% of UV radiation, while seafoam 25% and dry beach sand 15% (WHO, 2002).

Airline pilots and cabin crew have been found to experience approximately **double the incidence of melanoma** compared to the general population, likely due to increased UV exposure at high altitudes (Sanlorenzo et al., 2015). At **9,000 meters (30,000 feet), UV radiation levels are about twice as high** as those at ground level. This risk is further heightened when flying over dense cloud cover or snow, as these surfaces reflect additional UV radiation.

<u>Preventing photoaging</u>

Since **UV radiation is one of the primary causes of skin aging**, minimizing sun exposure is essential. The most effective protection combines **avoidance and shielding**.

1. Avoidance: Limiting Direct Sun Exposure

- **Stay indoors** when the **UV index is highest** (10:00 a.m. – 2:00 p.m.).
- **Seek shade** when outdoors, but be aware that shade still allows exposure to **up to 50% of ambient UV radiation**, especially near reflective surfaces like water, sand, or concrete (Debuys *et al*., 2000).

However, despite these recommendations, surveys show that most people do not stay indoors during midday hours (Kakourou *et al*., 1995; Robinson *et al*., 2000).

2. Shielding: Physical & Chemical Protection

Physical protections:

- **Clothing provides excellent UV protection,** but effectiveness varies based on fabric type, weave density, and color.
- **Darker, tightly woven fabrics offer better protection:**
  - **White cotton T-shirt:** UPF 7
  - **Green cotton T-shirt:** UPF 10
  - **Dark blue denim:** UPF 1700 (Berne and Fisher, 1974)
- **Best fabric choices:** Polyester, wool, and nylon outperform bleached cotton (Hoffmann *et al*., 2001).
- **Special sun-protective clothing** (with a **UPF label**) offers superior shielding. UPF 50-rated fabrics block **98% of UV radiation**. In the EU, clothing must have **at least UPF 30** to be labeled as sun-protective (Hoffmann *et al*., 2001). Outdoor supply shops are often great places to look for special sun-protective clothes.
- **Sun protective gloves** can be used to shield the hands from sunlight.

- **Clothing loses protection when wet**—cotton fabric can **lose up to 50%** of its UV protection when soaked (Adam, 1998).
- When it comes to hats and sunglasses: **the bigger, the better**.
- **A wide-brim hat (7.5 cm+) provides:**
    - **Nose SPF:** 7
    - **Cheeks SPF:** 3
    - **Chin SPF:** 2
    - **Neck SPF:** 5 (Debuys *et al*., 2000)
- **Sunglasses with side panels** provide better protection against **UV damage to the eyes**, which can contribute to **cataracts**.

Chemical protection (sunscreen) are categorized into two main types:

1. **Organic (Chemical) Sunscreens** – Absorb UV radiation and convert it into heat.
2. **Mineral (Physical) Sunscreens** – Contain **zinc oxide** or **titanium dioxide**, which reflect and scatter UV radiation.

Recommendations for a good sunscreen:

- Choose a sunscreen with a **wide filter (UVB & UVA).** Additionally blue light filters exist (see below).
- Choose a sunscreen with a **high SPF (e.g. SPF 50+).**
    - SPF 15 blocks 93% of UVB
    - SPF 30 blocks 97% of UVB
    - SPF 50 blocks 98% of UVB
    - SPF 100 blocks 99% of UVB
- Sunscreen should be applied to **all exposed areas**, including ears, eyelids, neck, hands, and lips (Whiteman et al., 2019). For the lips, special **UV-protection lip balms** exist.
- **Apply 15-30 minutes before sun exposure.**
- **Reapply every 2-3 hours**, especially after swimming, sweating, or toweling off. Towel drying can remove up to 85% of sunscreen.
- **Apply a generous amount**: Most people use too little sunscreen (0.5 to 1.5 mg/cm^2), while SPF ratings assume **2 mg/cm^2** (Stenberg and Larko, 1985; Azurdia *et al*., 1999). A full-body application requires approximately **35 mL (one full shot glass)** of sunscreen (Palm and O'Donoghue, 2007).
- **Reapply sooner than expected**: Research suggests that **optimal sun protection is achieved if the first reapplication occurs within 15-30 minutes of sun exposure** (Diffey, 2001).
- Sunscreen can be used under clothing for extra protection.

Sunscreen plays a crucial role in protecting the skin from harmful UV radiation. However, **no sunscreen offers complete protection**, and **long-wavelength UVA (UVA I) remains particularly difficult to block**.

While sunscreen is an essential tool for protecting the skin, **it should not be used as an excuse to stay in the sun longer**. Many people feel overly protected when wearing sunscreen, which can lead to excessive sun exposure and increased UV damage.

A study calculated that using an **SPF 8 sunscreen** (which protects against both UVA and UVB radiation) increases the time one can stay in the sun **without developing redness** from about **20 minutes to 2.5–3 hours**. However, despite offering UVA protection, the **total UVA dose absorbed by the skin actually increases**.

- **Without sunscreen (20 min exposure):** UVA dose ≈ **6 J/cm^2**
- **With SPF 8 sunscreen (2.5–3 hours exposure):** UVA dose ≈ **15 J/cm^2** (Gasparro *et al*., 1998)

This example highlights a **major concern**: **sunscreens can create a false sense of security**, leading to longer exposure and **potentially greater cumulative UVA damage**—a key factor in **skin aging and skin cancer risk**.

"*Sunscreen should never be used to prolong the duration of sun exposure*" (WHO, 2002).

Indeed, in one study, volunteers received SPF 30 sunscreen followed by UV exposure that should just induce redness in individuals protected by SPF 15 but not at SPF 30. Indeed, the individuals wearing SPF 30 sunscreen did not show redness after UV exposure but biopsies showed dying (apoptotic) cells demonstrating that even exposure to sunlight at doses below which redness occurs already results in significant skin damage (Kaidbey, 1990).

SPF (Sun Protection Factor) measures a sunscreen's ability to protect against **sunburn**. Because sunburns are mainly caused by UVB and not UVA radiation, the SPF does not indicate the protection offered against UVA rays (Gasparro *et al*., 1998).

To address this, the **Protection Grade of UVA (PA) system** was introduced. The PA rating is based on how well a sunscreen protects against tanning, which is primarily caused by UVA exposure. It ranges from **PA+ (weakest) to PA++++ (strongest protection)**. One plus indicates that the use of the sunscreen allows you to sustain between 2 and 4 times as much UVA compared to when not using the product while four plusses indicate 16 times or more protection.

Sunscreen is needed in surprising places, such as inside cars or near reflective surfaces like water and snow. A 2016 study found that while the windscreen of cars generally offered good UV protection, the side windows were considerably less protective and the protection factor differed strongly between brands (Wachler, 2016). Clouds reduce UV light but don't block it entirely, so sun protection is necessary even on overcast days. Finally, most people are probably aware that snow reflects UV light and so that solar protection is needed during outdoor activities in the snow such as skiing but snow is not the only reflective surface. Water for example is another reflective surface.

Many people focus on protecting their **faces** but neglect their **hands**, which receive frequent sun exposure. This often results in **visible aging** on the hands, revealing one's true age. **Using sunscreen and wearing gloves can help preserve youthful-looking hands.**

In addition to sun exposure, there are a few other sources of UV light including **indoor tanning, germicidal UV lamps, and welding**. Shockingly, approximately 36% of adults have engaged in indoor tanning at one point in their lives and among university students this is even higher at 55% (Wehner *et al.*, 2014).

Finally, one important consideration is that complete sun avoidance may lead to vitamin D deficiency. To maintain optimal health, it's advisable to check your vitamin D levels and supplement if necessary.

Visible light contributes to skin aging

Visible light has been shown to **induce reactive oxygen species (ROS) production, inflammation, and enzymes that degrade the skin matrix**. However, it requires significantly higher doses compared to **UVA/UVB exposure**. Specifically, studies have found that it takes **30 times more visible light (180 J/cm²) to generate the same level of ROS and inflammation** as UVA/UVB exposure.

Interestingly, even at the lowest tested dose (**65 J/cm²**), visible light still triggered a **significant 5-fold increase in ROS** and a **2-fold increase the release of matrix metalloproteinase-1 (MMP-1)**, an enzyme that breaks down collagen and contributes to skin aging. Notably, **UVA/UVB sunscreens provided minimal protection against the harmful effects of visible light**. The authors also extended their findings to **humans** by measuring free radical production in forehead skin. Treatment with **visible light increased free radicals by almost 86%** (Liebel *et al.*, 2012). In contrast to UV radiation, visible light penetrates deeper into the dermis and consequently could have a substantial effect on skin aging. For a more in-depth discussion on **visible light-induced photoaging**, we recommend an excellent review by Pourang *et al.* (2022).

A common question is whether the light doses used in laboratory studies are realistic compared to daily sun exposure. To answer this, we can calculate **real-world visible light exposure levels**:

- The **power density** of visible light from the sun at the Earth's surface is approximately **50 mW/cm²** (Austin *et al*., 2021).
- To determine the **total dose**, we multiply this by **exposure time (in seconds)**.
- **One hour (3600 seconds) of sunlight exposure results in a dose of ~190 J/cm²**. Approximately 50 J/cm2 of this is blue light (Pourang *et al*., 2022).

This calculation shows that the visible light doses used in in vitro studies **are highly relevant to real-world conditions**. A person **exposed to sunlight for an hour on a regular day** can easily experience similar light doses as those tested in studies, reinforcing the importance of **broad-spectrum sun protection** that includes defense against visible light.

With increased screen time, concerns have emerged about the potential **harmful effects of blue light exposure** (Arjmandi *et al*., 2018; Kumari *et al.*, 2022). While **LED screens emit significant amounts of violet-blue light**, the total **blue light dose from screens is still much lower than outdoor sunlight exposure** (Dain, 2020).

Blue light penetrates deeper in the skin than UV light (SCENIHR, 2012). Exposure to blue light induces ROS production in skin cells and potentially distorts the circadian rhythm in skin cells (Kumari *et al*., 2022). Some sunscreens also offer protection against blue light (Ferreira *et al*., 2024). If you wish to reduce blue light exposure from screens, you can switch on the night modus.

Oral collagen supplements

In a meta-analysis it was found that oral collagen peptides significantly improve **skin hydration and elasticity** while they **reduce wrinkles** (de Miranda *et al*., 2021). A later meta-analysis, that included more studies, confirmed these findings (except they did not study the effect of collagen peptides on wrinkles) (Pu *et al.*, 2023). However, it should be pointed out that many studies on oral collagen supplements have **limitations**, including **small sample sizes** (21–134 participants), **short durations** (2–16 weeks), and a **lack of male data**—only about 3% of participants in a meta-analysis of 26 studies were male (Pu *et al*., 2023). While collagen peptide supplementation appears safe, current evidence for its effectiveness remains limited and requires further high-quality research.

Astaxanthin

Astaxanthin belongs to the carotenoids, a family of pigments found in various plants, algae, bacteria, and fungi. Astaxanthin more specifically is found in certain algae and in animals that feed on them such as salmon and crustaceans where it is responsible for their red-orange color. Astaxanthin is a powerful antioxidant that may prevent UV-induced damage to the skin (Li *et al*., 2020). A meta-analysis concluded that oral astaxanthin use **improves moisture content and skin elasticity but does not improve wrinkles** (Zhou *et al*., 2021). However, the evidence here is even lower compared to the collagen peptide as the meta-analysis only included 86 astaxanthin-treated participants in the moisture content and 126 participants in the skin elasticity analysis (with individual studies contributing only 16-49 participants in the placebo and control group combined). Hence, more research is needed before we can draw conclusions about the effectiveness of oral astaxanthin on skin aging.

Vitamin A derivatives

Topical vitamin A derivatives are among the most widely used anti-aging treatments. Over-the-counter options include retinol and retinaldehyde, while prescription-strength all-trans retinoic acid (tretinoin) is significantly more potent—hundreds of times stronger than its non-prescription counterparts (Motamedi *et al*., 2021). Newer synthetic retinoids, such as adapalene, have been developed to provide similar benefits with fewer side effects (Tu *et al.*, 2001).

A **randomized, placebo-controlled trial** in individuals with moderate to severe photoaging found that **daily application of tretinoin (0.05%) for two years** significantly improved fine and coarse wrinkles, pigmentation irregularities, and skin sallowness (Kang et al., 2005). These findings were further validated by a **meta-analysis of seven randomized controlled trials** (Sitohang *et al*., 2022).

Interestingly, a **split-face study** demonstrated that **retinol at a concentration 10 times higher than tretinoin** was equally effective in reducing photodamage (Babcock *et al.*, 2015). Another study found that a **1.1% tri-retinol serum** provided results comparable to **0.025% tretinoin** (Ho *et al*., 2012).

Despite their effectiveness, **vitamin A derivatives can be harsh on the skin**, often causing dryness and peeling. To minimize irritation, **a hydrating moisturizer** should be used alongside retinoids. Since these compounds increase **UV sensitivity**, they should only be applied in the **evening**, and **daily sun protection** is essential.

Vitamin C serum

Vitamin C is one of the most widely used ingredients in anti-aging skincare. It exists in multiple forms, including its **free acid form (ascorbic acid)** and various **esters** (e.g., magnesium ascorbyl phosphate and ascorbyl tetraisopalmitate).

While **ascorbic acid**, the natural form found in citrus fruits, has potent antioxidant properties, its penetration into the skin is **low**. However, this can be improved by formulating it at a **pH below 3.5**. Another major drawback is its **instability—**ascorbic acid degrades easily upon storage. To counteract this, stabilizing antioxidants such as **vitamin E** and **ferulic acid** are often added.

To enhance stability and absorption, researchers have developed **various vitamin C derivatives**, mainly through two types of modifications:

1. **Phosphate or glucose groups** – These protect the molecule from oxidative degradation.
2. **Lipid chains** – These improve penetration by increasing its affinity for skin lipids (Enescu et al., 2022).

Despite these advances, there is **no clear consensus** on which form of vitamin C is most effective for anti-aging, as studies on absorption and efficacy often show **conflicting or biased results** (Enescu *et al*., 2022).

A systematic review identified three studies that investigated the effect of vitamin c on photoaging. Improvements in **fine wrinkling, sallowness, and hydration** were observed (Correia and Magina, 2023). However, the total study population over the three studies was only 49 participants and assessment was done by visual scoring rather than more objective computational image analysis. In a double-blind, randomized placebo-controlled split face trial, women were given a placebo cream and a cream containing 1, 2 or 3% tetra-isopalmitoyl ascorbic acid. After 8 weeks, the side of the face treated with the tetra-isopalmitoyl ascorbic acid cream showed an **improvement in wrinkles around the eye** (Yokota and Yahagi, 2022).

Vitamin C supports skin health through several key mechanisms:

1. **Antioxidant Protection** – Neutralizes harmful reactive oxygen species (ROS), reducing damage to skin macromolecules.
2. **Collagen Synthesis** – Acts as an essential co-factor in collagen cross-linking, an essential process in the maturation of newly formed collagen.
3. **Hyperpigmentation Reduction** – Inhibits **tyrosinase**, the enzyme responsible for melanin production, helping prevent dark spots and uneven skin tone (Pullar et al., 2017).
4. **Photoprotection** – Shields the skin against harmful **UVB radiation**, further preventing premature aging (Elmore, 2005).

While vitamin C holds great promise for anti-aging, more research is needed to determine the most **effective formulation** for optimal skin benefits.

Senolytics and senomorphics

As we age, the number of **senescent cells** in the skin increases. These cells lose their ability to divide and contribute to aging by secreting inflammatory and tissue-degrading molecules, collectively known as the **senescence-associated secretory phenotype (SASP)**.

Senolytics are compounds that selectively target and eliminate senescent cells. **Navitoclax (ABT-263)** is one such senolytic that has shown promise in improving skin healing. A recent study found that **topical pretreatment** with ABT-263 significantly enhanced wound healing in mice. **By day 18**, one-third of the treated mice had fully healed wounds, whereas none of the control mice had healed. RNA sequencing (RNA-seq) revealed that ABT-263 **stimulated collagen synthesis**, suggesting its potential in promoting skin repair and rejuvenation (Shvedova *et al.*, 2025).

Unlike senolytics, **rapamycin** does not kill senescent cells but instead **suppresses the SASP**, reducing inflammation and tissue degradation (Wang *et al*., 2017). A small clinical trial investigated the effects of **topical rapamycin (10 μM)** applied to the hands of human volunteers. The treatment led to: a reduction in senescent cell markers, increased type VII collagen levels, and visible improvements in skin aging. The visual improvements included a **reduction in fine wrinkles, increase in dermal volume, less sagging, and a more even skin tone** (Chung *et al*., 2019).

These findings suggest that both **senolytics (e.g., ABT-263)** and **SASP inhibitors (e.g., rapamycin)** hold potential as anti-aging treatments by either eliminating senescent cells or mitigating their harmful effects.

Chemical peels

Chemical peels involve the application of acidic solutions to the skin, creating a **controlled injury** that stimulates skin regeneration. They are categorized into **superficial, medium, and deep peels** based on their depth of penetration.

- **Superficial peels** target the **outermost layer of the skin (epidermis)** and are commonly used to treat **fine wrinkles and uneven skin tone**. These peels often contain **alpha-hydroxy acids (AHAs)** such as **glycolic acid**.
- **Medium-depth peels** penetrate deeper, removing the **epidermis and the upper portion of the dermis**. One of the most widely used medium-depth peels is **35% trichloroacetic acid (TCA)**.
- **Deep peels**, such as the **phenol-Croton oil peel**, provide **long-lasting and dramatic improvements** in **photoaging and acne scars** (Wambier *et al.*, 2019). However, **phenol-based peels** carry risks, as **phenol is toxic to the heart, kidneys, and liver** (Mayo Clinic). Additionally, deep peels have a **higher risk of scarring** (Starkman and Mangat, 2019). Due to these risks, deep peels should be **performed by experienced professionals**, and patients should carefully consider the potential benefits and side effects.

Conclusion

Skin aging is not only a cosmetic concern but can also contribute to serious health issues, such as an increased risk of skin cancers and infections. As such, prioritizing skin health is essential by minimizing UV exposure, avoiding pollution, quitting smoking, and maintaining a nutritious diet. Additionally, we explored various interventions that could help slow down the aging process of the skin.

Due to space limitations, we were unable to cover hair aging (graying and loss) and other interventions like platelet-rich plasma, Botox, fillers, red light therapy, and ablative lasers. Nor did we discuss the role of diet in skin aging. These topics require more detailed exploration and might be topics of future editions.

Don’t miss out on next month’s deep dive into the exposome and its role in biological aging—subscribe now so you don’t miss any of our expert insights!

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