

Review

Enhancing Skin Anti-Aging through Healthy Lifestyle Factors

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Abstract: Lifestyle health has been recognized as an evidence-based innovation that defines how everyday behaviors and routines influence the avoidance and therapy of illness and provides an important adjunctive component to overall health. Specifically, an approach with small changes over time can have a dramatic impact on the health and well-being of individuals not only, in general, but also can be applied to skin health. However, lifestyle health factors to improve skin well-being have not been discussed extensively and/or well promulgated. The narrative for this overview focuses on providing a summary for topic background information, but more importantly, presents four lifestyle factors that can improve dermal health [i.e., factor 1: nutrition—diet; factor 2: rest (sleep); factor 3: movement/physical exercise, and factor 4: social and community associations]. This was accomplished by identifying preceding journal reports/reviews covering especially the last five years (January 2018 to July 2023; 164 out of 205 references cited or 80%) using scientific search databases. The main conclusions of this overview encourage the concept that lifestyle health factors such as nutrition/diet, rest/sleep, movement/physical exercise, and community/social interactions support enhanced skin health and well-being with aging. Plus, social media interventions that aim to promote dietary, sleep and physical activity changes might be an application to improve skin health in the future.

Keywords: skin; anti-aging; health; lifestyle factors; diet; sleep; exercise; social interactions; polyphenols; vitamins



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1. Introduction

Everyone ages, the skin (being the largest organ of the body) is the most conspicuous visual indicator of aging, especially in the facial/neck and hand/arm/leg regions [1–3]. However, habits and actions (that may be positive or negative) have profound influences on short-term and long-term health and quality of life (QOL) [4,5]. This perspective is supported by numerous scientific studies and evidence-based guidelines for the prevention and/or treatment of age-related diseases [4–21]. For example, many studies have examined factors such as: (a) good nutrition via dietary choices [4–10], (b) regular rest with good sleep cycles for restoration and managing stressors [4,5,7–10,13,14,21], (c) physical activity including moderate to vigorous exercise to enhance cardiovascular health and to manage/control body weight [4,5,7,9,10,15–17,21], and (d) the importance of positive social relationships to stay mentally/emotionally connected with community associations with ideals engaged in worthy activities among like-minded people [4,5,10,12,14,16,18–21].

The concept of lifestyle choices was first proposed in 1999 by James Rippe in the textbook “Lifestyle Medicine”, which defined how daily habits and practices impact both the prevention and treatment of disease and provides an important adjunctive component to overall health [21]. In fact, a recent report presented at the annual meeting of the American Society of Nutrition 2023 looked at the lifestyle behaviors of nearly 720,000 military veterans between the ages of 40 to 99 years of age in the “Million Veteran Program”, a longitudinal study designed to investigate the health and wellness of United States (US) veterans [21].

The investigators found that lifestyle habits (like the list of factors outlined above) build on each other and could add up to 24 years of life extension, enhancing longevity and the QOL [21].

While healthy lifestyle factors have been examined for the prevention and/or treatment of age-related disease, this paradigm has been lacking for skin aging. Thus, this narrative overview examines the latest existing knowledge about how lifestyle factors influence skin aging, and how different modalities of daily habits and choices coalesce to advance/build various components to boost skin anti-aging toward better overall health. Specifically, the purpose of this review is not to present comprehensive coverage, but to provide an updated general summary on: (a) aging, (b) skin aging, and the four factors that can influence skin aging such as (1) nutrition and dietary selections, (2) rest (sleep), relaxation/recovery/rejuvenation and protection against stressors, (3) movement (exercise-moderate to vigorous levels to improve cardiovascular, weight control and well-being), and (4) community (covering social and community associations) to “become” better in managing the challenges of aging. This overview identified previous journal articles and reviews (with emphasis over the past five years) from January 2018 through July 2023 using the keywords: lifestyle health/medicine, skin, dermal, human and/or using different keyword combinations (retrieved from 1 July to 10 August 2023). The following databases were utilized: PubMed maintained by the US National Library of Medicine at the National Institutes of Health; Science Direct and Scopus by Elsevier and from Google Scholar. Also, background references (where appropriate) include the keywords: lifestyle health/medicine, diet, sleep, isolation, exercise, estrogens, skin aging, microbiome, phytoestrogens, phytochemicals, polyphenols, and/or combinations (without a year-limit range for searching the background topics). This overview is based on previously conducted studies and does not contain new data/results of human participants or animals performed by the authors.

2. Skin Aging

2.1. Skin

Of all the organs, the skin is the most conspicuous to display signs of aging or dermal changes [1–3]. Skin covers an area of around 2 m² (however, more recent estimates accounting for dermal pores suggests 25 m²) and represents one-sixth of the total weight for an adult [2,3,22,23]. The skin serves a variety of functions such as acting as the body’s initial barrier protecting against foreign agents (pathogens), ultraviolet (UV) light, chemicals, mechanical or other injury, and it helps to maintain body temperature, prevent water loss from the body, produce vitamin D, detect/fight infections, and provides sensory information (touch, pressure, temperature, and pain-nociception) [2,3,22,23]. Trans-epidermal water loss (TEWL) has been determined to range from 120 to 240 g/m²/day, which is important for skin hydration [24,25].

There are seven skin layers, which are displayed in Figure 1. In summary, the epidermis is the major outer layer with keratinocytes as the major cell type (at 75–125 microns thick). The epidermis is further stratified into 5 distinct layers.

The first skin layer is the stratum corneum- keratinocytes become corneocytes, which are strong (dead keratinocytes) that provide barrier protection and prevents TEWL [2,3,22–25]. The water content of the stratum corneum (about 20–30%) is part of the natural moisturizing factor (NMF) array that maintains adequate skin hydration [2,3,22,23].

The stratum lucidum, the second skin layer is a thin, transparent layer of keratinocytes only found on the palms of the hands and soles of the feet [3,22].

The third layer- the stratum granulosum- contains glycolipids (keratohyalin granules) that keeps the skin layer together (these are filled with histidine and cysteine rich proteins to bind the keratin filaments together), along with desmosomal connections that help form a waterproof barrier [3,22,23,26] (see Figure 1).

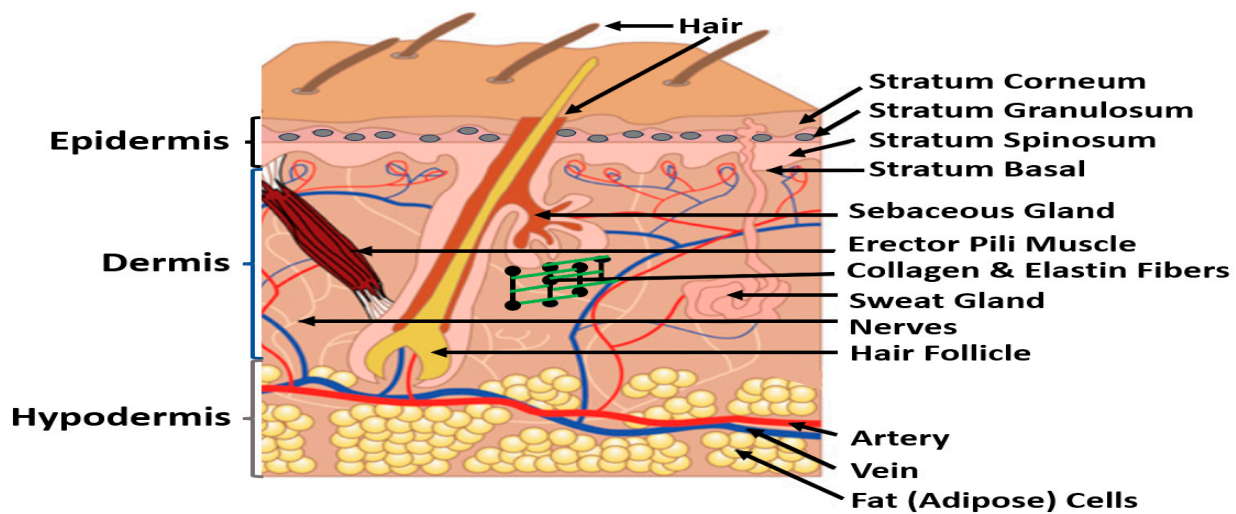


Figure 1. Cartoon Structure/Component(s)/Layers of Human Skin. Note: the stratum lucidum is not shown because it is only found on the palms of the hands and soles of the feet.

The stratum spinosum, the fourth layer is 8 to 10 cells thick held together by sticky proteins called desmosomes, helping the skin be flexible and strong along with an abundant number of dendritic cells (Langerhans cells) for immune defense [3,22,23,27].

The fifth skin layer is the stratum basal- this is a single row of stem cells, continually producing keratocytes, and contains melanocytes (10–25% of the cells herein) [responsible for melanin pigment] [2,3,22,23].

The dermis represents the sixth layer comprised of collagen and elastin fibers, which are secreted by fibroblasts providing the structural components for flexibility and strength [1–3,22,23,28].

The dermis is composed of two regions or zones, the papillary dermis (that has fewer structural fibers and contains vascular networks that serve two functions-support the avascular epidermis with vital nutrients and thermoregulation) and the reticular dermis (that contains dense structural fibers, which provides the skin with overall strength and elasticity) [2,3,22,23] (see Figure 1).

The hypodermis (the seventh dermal layer) is the deepest situated below the dermis that contains adipose (fat) cells, hair follicles, nerve endings, sweat glands, bursa, loose connective tissue (collagen and elastin) and blood vessels (plus lymph vessels-immune function [2,3,22,23].

Finally, emerging evidence suggests that skin is a ‘neuro-endocrine-immune’ organ [3], especially since advances in microbial research have linked chemical messengers (hormones) to the gut-skin microbiome to influence dermal health [23].

2.2. Skin: Chronological Aging and Photoaging Aging

Skin aging is a complex process due to chronological (intrinsic) and photoaging (extrinsic) mechanisms that have been reviewed elsewhere, but will be covered herein, in brief [1–3,29–35].

2.2.1. Extrinsic Skin Aging

Extrinsic aging is an important collateral factor in cosmesis, appearance, diagnosis, and management of the skin in aging individuals, which is due mainly to the chronic exposure to various environmental elements such as the sun (UV light including tanning bed), air/water pollution, smoking (vaping), diet/exercise/stress, lifestyle, repetitive muscle contractions (smiling, frowning, etc.), gravity, sleeping positions and cutaneous or general diseases/disorders [2,7,29,31,34,35]. However, the main environmental element associated with extrinsic aging is photo-aging (exposure to UV light) resulting in a cascade of cellular and molecular signaling mechanisms that increase oxidative stress and

inflammation [2,29,31,35,36]. These extrinsic aging factors may be independent of hormonal status and should be considered in the clinical management of aging skin [2,29,31,35,36].

2.2.2. Intrinsic Skin Aging

Intrinsic or chronological aging is a natural process caused by the accumulation of reactive oxygen species (ROS) resulting from oxidative cellular metabolism [36] and is influenced by genetics, metabolism, hormonal, immunological, cardiovascular, gastrointestinal, psychogenic (involving stress or affective disorders), degenerative, or neoplastic disease [2,29,35,36].

In women, the skin thickens to 25 to 30 years of age, then there is a progressive decline of all skin layers during aging [2,29,30,35,36]. Chronological or intrinsic aging is an inevitable biological process where deteriorating alterations in the production, quantity, and preservation of dermal cellular/protein elements takes place [2,29,32,35,36]. Throughout dermal aging, keratinocytes change shape, and the epidermal-dermal junction (rete pegs) becomes compressed, while there is a decline in the dermis thickness because of the deficit of collagen, elastin, and hyaluronic acid (elastosis). It is more noticeable in sun-exposed areas (solar elastosis) [2,29,32,36,37]. Skin turgor declines along with the increased appearance of fine lines/wrinkles, especially along normal areas of stress, gravity, and mechanical muscle contractions especially around the eyes and mouth [2,29,32,36]. Matrix metalloproteinases (MMPs) cause destruction of collagen and elastin fibers that in turn enhance mitochondrial oxidative stress and deletions of mitochondrial DNA via the c-Jun/AP-1 pathway in dermal fibroblasts [29–32] (see Figure 2).

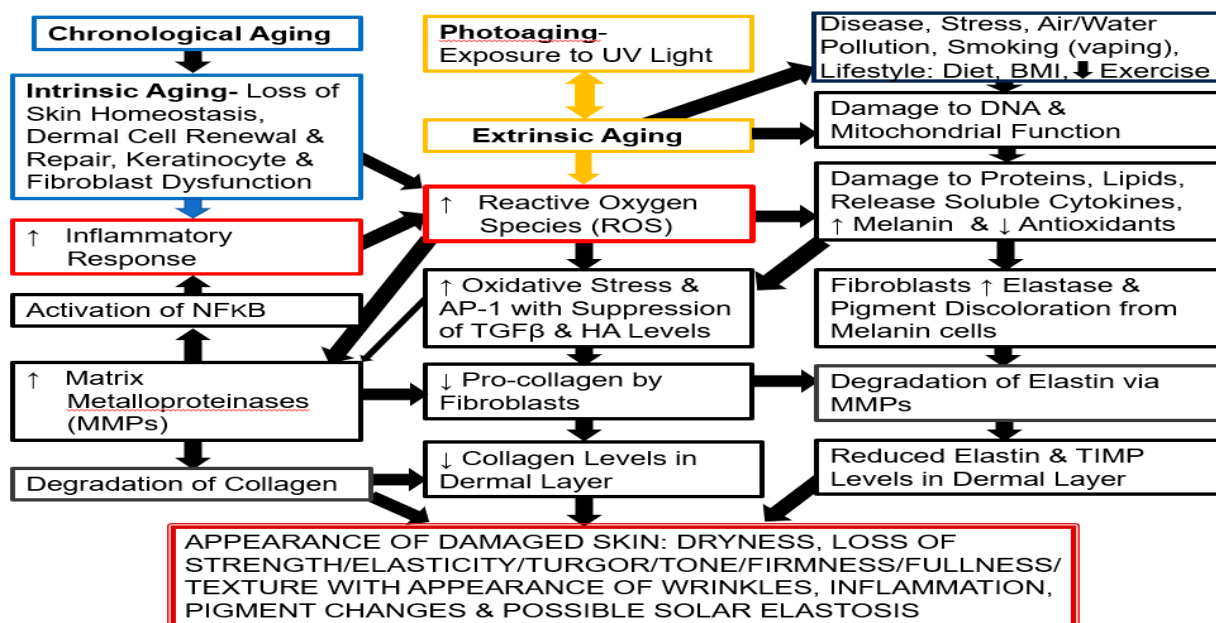


Figure 2. Chronological aging via the loss of skin homeostasis/oxidative metabolism, photo-aging by exposure to UV light and extrinsic aging (due to external factors and lifestyle) through cellular/molecular signaling mechanisms are shown. This diagram displays the sequence or production of reactive oxygen species (ROS) that is more commonly called oxidative stress (OS). Oxidative stress (OS) is the major factor associated with inflammation and alterations in the decline of collagen and elastin resulting in wrinkles. Abbreviations: Proinflammatory transcription factor (NFκB), AP-1 nuclear transcription element, Activator Protein—1 (AP-1), hyaluronic acid (HA), Tissue Inhibitor of Matrix Metallo-proteinase (TIMP) and Transforming Growth Factor beta (TGFβ). Estrogens and Selective Estrogen Receptor Modulators (SERMs) provide protection by binding especially to estrogen receptor (β) in chronological, photo-aging, and extrinsic aging. Adapted with permission from Lephart E.D. Naftolin, F. Factors Influencing Skin Aging and the Important Role Estrogens and Selective Estrogen Modulators (SERMs). *Clin. Cosmet. Invest. Dermatol.* 2022, 15, 1695–1709 [2].

Finally, blood vessels in the dermis become more fragile, leading to bruising (senile purpura), sebaceous glands produce less oil, sweat glands produce less sweat (challenging to keep cool), less subcutaneous fat layer reduces the ability to maintain body temperature and skin tags, pigmented spots (liver spots/lentigos) can appear with aging [2,29,31,33,36].

2.3. Hormonal Benefits/Changes with Aging (Estrogen in Women)

17β -Estradiol has numerous cutaneous benefits that are detailed elsewhere [2,38,39]. Recall 17β -estradiol is the most potent sex steroid hormone in humans and the major estrogen produced by the ovaries during the reproductive years [2,39,40]. 17β -Estradiol levels reach a maximum around the mid to late 20 s [2,39,40]. Interestingly, the levels of skin collagen and elastin also follow the estrogen profile during this interval. [2,38–42] (see Figure 3A,B). Around 30–35 years of age, estrogen levels begin to decline, and there are corresponding changes in the skin; wrinkles appear because of the declination in collagen and elastin fibers in the dermal layer (Figure 3A) [2,38–43].

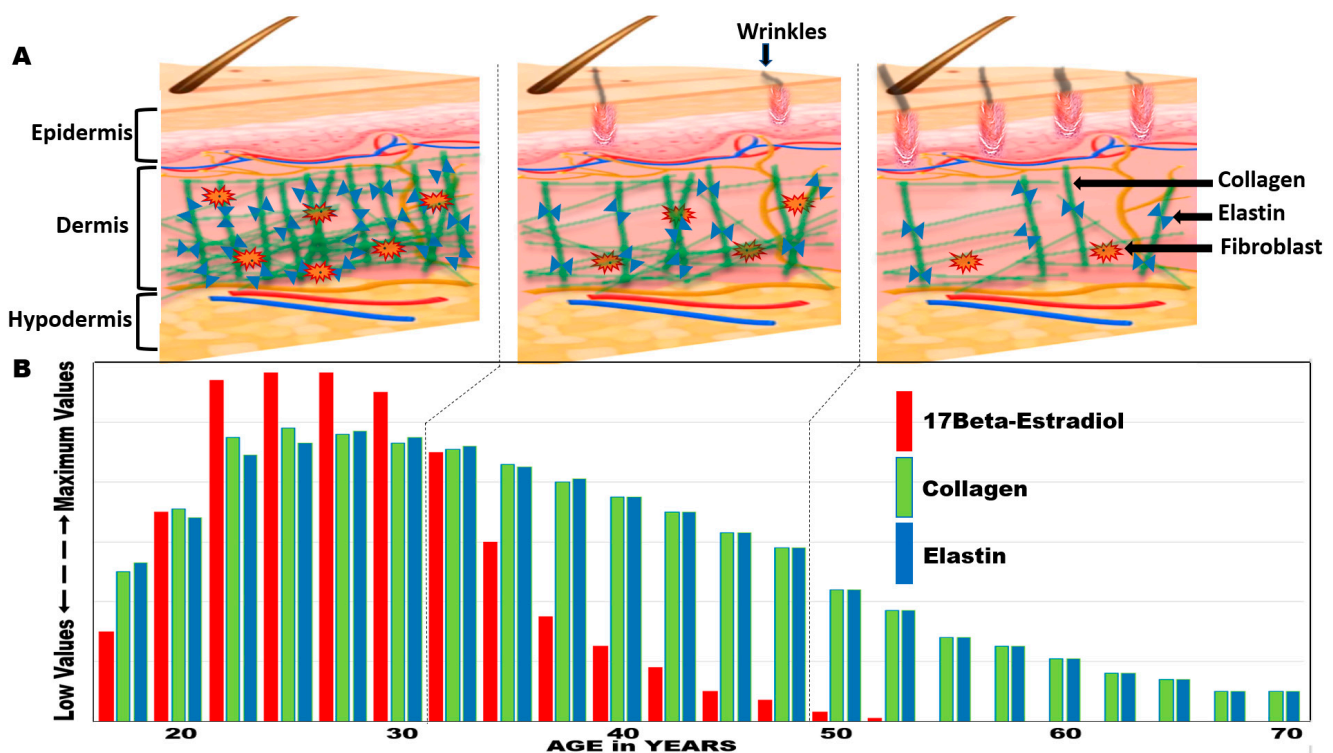


Figure 3. (A) Upper Panel displays the progressive decrease in dermal collagen and elastin fibers and the appearance of fine lines and wrinkles with the passage of time. (B) Lower Panel displays the levels of ovarian 17β -estradiol levels (red histogram bars) in women from the late teenage years to seventy years of age. After menopause the low estrogen levels (not shown) are derived from the aromatization of androgens in peripheral fat tissue sites. The profile of collagen expression in skin with aging is displayed (green histogram bars) while the elastin levels (blue histogram bars) follow the pattern of ovarian estrogen production with aging. Adapted with permission from Lephart E.D. Naftolin, F. Factors Influencing Skin Aging and the Important Role Estrogens and Selective Estrogen Modulators (SERMs). *Clin. Cosmet. Invest. Dermatol.* 2022, 15, 1695–1709 [2].

17β -Estradiol production from the ovarian follicles declines after 35 years of age, and there is a progressive declination in estrogen levels by around 45 years [2]. Then there begins to be inconsistent oscillations in ovarian estrogen production as the follicles respond to gonadotrophins waves until they become exhausted with the onset of menopause (in the USA this milestone is around 51 years of age \pm 4 years) [38,39,41,43] (Figure 3B). After menopause, estrogen production occurs not in the ovaries but at peripheral adipose tissue sites [36,38,39,43]. While it is known that skin cells can produce estrogens locally,

the aromatase enzyme activity is dramatically reduced to approximately 30-times lower than in premenopausal ovarian follicular tissue [39,44]. Also, it should be noted that androgens have a negative influence on skin cells especially on collagen and elastin via the 5α -reductase type I enzyme located in fibroblasts. This enzyme can counteract the positive estrogenic influence, especially after menopause [2,38,39,43]. The lack of estradiol and/or agonist influences by selective estrogen receptor modulators (SERMs) actions, especially via $ER\beta$ activation, has been shown to account for the vivid loss in dermal fibers such as collagen and elastin causing atrophy, wrinkles, poor wound healing/barrier function/hydration [2,38,39,43,45] (Figure 3A) The decline of skin components is heightened by intrinsic and extrinsic aging, which are reviewed elsewhere [2,29,36,38].

Estrogens send their chemical hormonal messages via estrogen receptors (ER) throughout the body. Notably, it has been reported that there is specific-tissue regulation of how ERs are synthesized in humans; also, it is known that ER beta is more abundant in the epidermis and fibroblasts (and in the scalp region) compared to ER alpha [2,38,46]. In fact, ER beta activation has been shown to promote wound healing and cellular/tissue restoration in human skin via dermal structures such as collagen and elastin that occur via biomechanical processes [2,36,38,39,47–49]. Plus, $ER\beta$ agonists via SERM actions are known to provide similar positive actions on skin health compared to 17β -estradiol, which are seen in plant-derived molecules such as polyphenols (resveratrol, flavonoids and isoflavonoids, etc.) or phytoestrogens that selectively bind/activate $ER\beta$ in human skin [2,36,38,39,49,50]. Finally, the effects and benefits of 17β -estradiol on skin are shown in Figure 4.

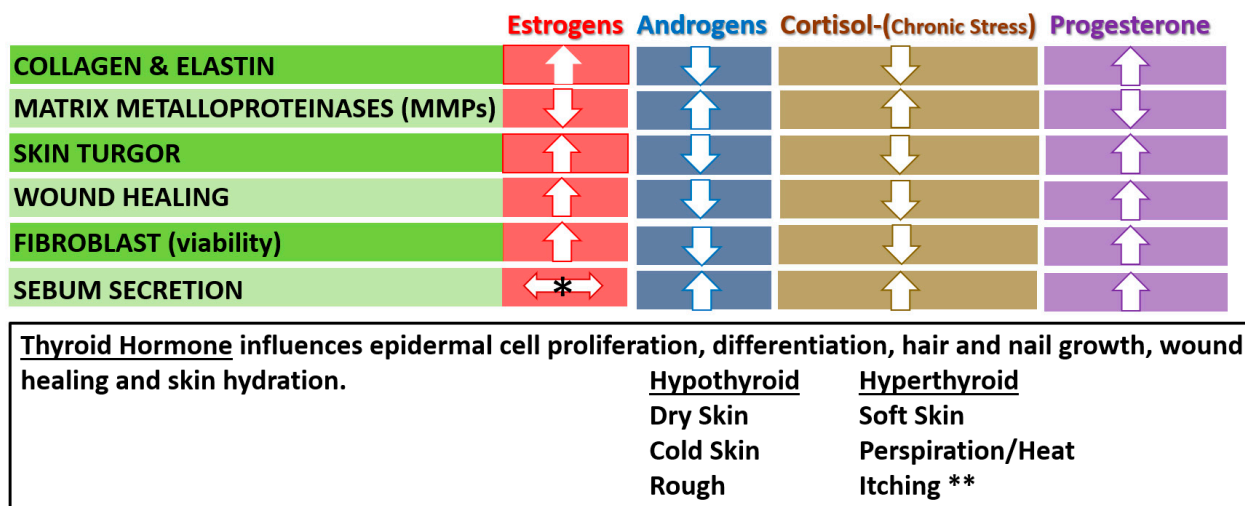


Figure 4. Effects and Benefits of 17β -Estradiol on Skin. Adapted, in part, from VectorStock license 3,264,406 to ED Lephart.

2.4. Other Hormonal Influences on Skin

While 17β -estradiol is the most potent steroid hormone in the body, the skin is an endocrine organ that contains the biochemical enzymes for local hormone production to influence regional immune function [50,51]. Conversely, there are several hormones produced by the endocrine system from glands that secrete chemical messengers into the bloodstream that bind specific receptors in cells/tissues to maintain homeostasis, but other hormones are also known to influence the skin [36,50,52–55]. In addition to estrogens, androgens, cortisol (the stress hormone), progesterone and thyroid hormone are known to influence skin health (see Figure 5). Androgens along with cortisol are known to have a negative impact on skin where they decrease collagen and elastin, skin turgor, wound healing, and fibroblast viability, but increase MMPs, wrinkle formation and sebum production [2,36,38,39,54,55] (Figure 5). Progesterone like estrogens has positive influences on skin except that it stimulates sebum production [56–58]. Finally, thyroid hormone regulates the metabolic rate of the body and helps regulate epidermal cell proliferation,

differentiation, hair and nail growth, wound healing, and skin hydration by affecting the function of dermal fibroblasts [50,52,53]. Thus, while estrogens play a leading role in skin, other hormones also have a significant influence on dermal health (Figure 5).



* High estrogen levels decrease sebum secretion

Several inflammatory conditions can be triggered or aggravated by stress, such as: psoriasis, atopic dermatitis, acne, contact dermatitis, alopecia areata, pruritus and erythema

** Hyperthyroid skin conditions can include, itchy rash, hives, changes in pigmentation and erythema

Figure 5. Other Hormonal Influences on Skin.

3. Health Lifestyle Factors

3.1. Aging

Various health and governmental agencies worldwide devote a broad scientific effort to understand the nature of aging and to extend healthy active years that enhance the quality of life (QOL). Aging has many aspects, but in general, it is defined as the gradual physical, psychological, and social changes in persons that lead to increased risk of weakness, disease, and ultimately death [59].

3.2. Population Aging around the World

The United Nations department of economic and social affairs announced on 20 February 2023, that “population aging is a defining global trend of our time” [60]. Where Asia is at the forefront of this trend with Hong Kong, South Korea, and Japan predicted to have the highest share of people aged 65 and older by 2050 [60] (see Figure 6).

3.3. Aging Related-Disorders

From a more biological perspective, aging is the progressive physiological changes in an organism that lead to senescence [40,61–63]. Or, in other words, a decline of biological functions and the lack of an organism’s ability to maintain homeostasis and adapt to various stressors (such as age-related disorders of the body’s organs/systems/tissues/cells involved in the operational aspects of metabolism/defense and unregulated growth like cancer) [40,61–63]. The nine hallmarks of aging have been reviewed elsewhere [40,61–63] that cover (1) gene variability, (2) shortening of telomers, (3) epigenetic factors, (4) protein instability or weakening of large molecules, (5) lack of detecting nutrient and metabolic communications, (6) cellular apoptosis, (7) fatigue/collapse of stem cells, (8) mitochondrial trauma/abnormality/impairment, and (9) breakdown of signaling between cells [40,61–63]. However, other investigators have proposed that the major cause of aging and age-related disorders is due to oxidative stress at the molecular level [62].

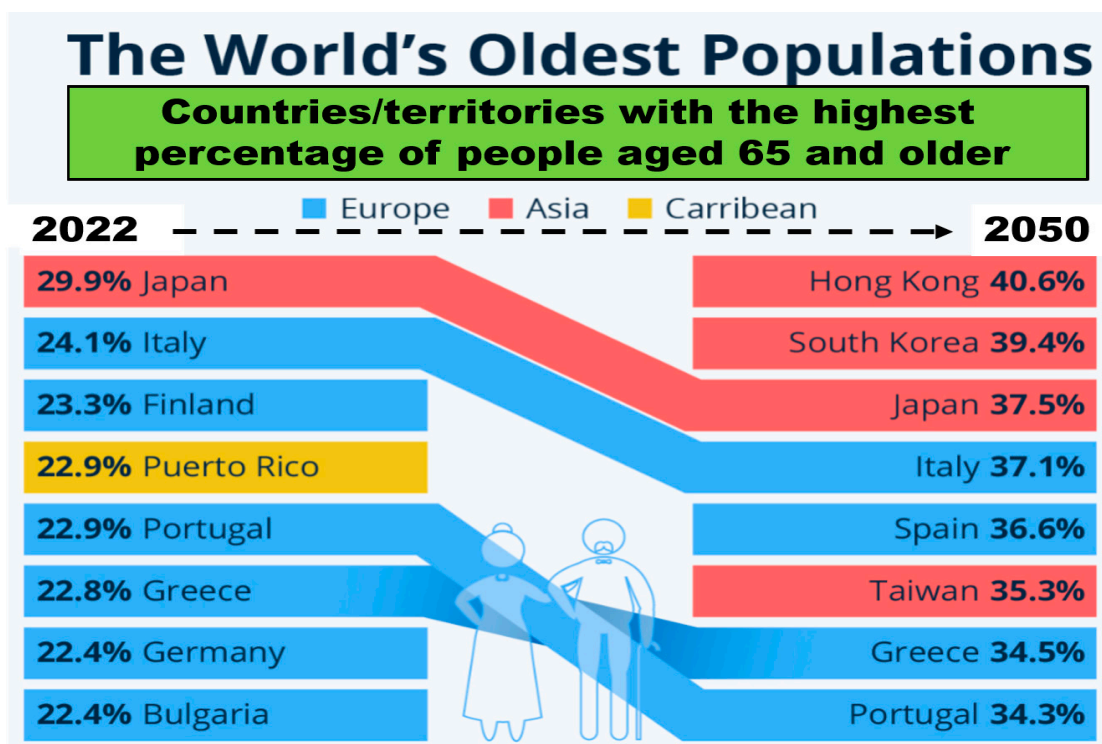


Figure 6. The World's Oldest Populations. Only includes countries/territories with a population of more than 1 million people. Source: United Nations Population Division [60]. Adapted with permission.

3.4. Aging and the Global Burden of Cancer Attributable to Lifestyle Risk Factors

Cancer is the second leading cause of death worldwide, and exposure to risk factors plays an important role in the burden of many cancer types [64,65]. Also, it is well established that cancer is more common as people age [64]. To gain a perspective on the magnitude and importance of lifestyle factors a recent study published in the Lancet 2022 analyzed 369 causes of death and disability along with 87 risk factors from 204 countries and territories on the global burden of cancer. In 2019, the top risk factors were (1) smoking (vaping), (2) alcohol use, (3) high body-mass index, (4) unsafe sex, (5) high fasting plasma glucose levels, (6) ambient particulate matter pollution, (7) occupational exposure to asbestos, (8) dietary intake low in whole grains, (9) dietary intake low in milk, (10) second-hand smoke, and (11) dietary intake low in fruits [65]. Remarkably, overall, 44 % of the cancer deaths were due to modifiable risk factors where behavioral and dietary/metabolic risk factors had the highest rates (that accounted for the most cancer deaths), while exposure to pollution represented moderate rates of cancer deaths [65].

In 2011, Alegria-Torres et al. published a landmark review on epigenetics and lifestyle, which predicted and supports the 2022 Lancet study on the global burden of cancer [66]. Notably, Alegria-Torres outlined environmental and lifestyle factors such as diet/nutrition, behavior (physical activity, sleep, working habits, stress, etc.), and smoking (vaping), and alcohol consumption that affects human health [66].

4. Factors of Lifestyle Health

Different Types of Lifestyle Health

Different lifestyle aspects leading to healthy outcomes have been reported from multiple perspectives. Kassis et al. (2023), reported how aging impacts five key biological functions (immune, digestive, nervous, musculoskeletal, and cardiovascular) with preventive strategies that focused on dietary intake, physical activity, and sleep quality [67]. Loeff et al. (2023), found in a 30-year study that predictors of healthy aging suggested that

long-term cardio- and metabolic parameters such as overweight and cholesterol levels were the most significant factors in predicting healthy physiological aging [68]. In 2019, Bosnes et al. examined lifestyle predictors of positive aging in a 20-year prospective study that found among the midlife variables (smoking, physical activity, alcohol consumption, obesity, and social support) that non-smoking and social support were the most significant predictors of successful aging [69]. When modification of lifestyles was studied in older age (40–80 years) individuals, Katz and Sakaniwa et al. found that adopting healthy lifestyles was correlated with lifetime benefits among subjects even with major co-morbidities (e.g., cardiovascular disorders, cancer, diabetes, and kidney disease) [70,71]. Furthermore, Wahl et al. reported in humans the intake of the Mediterranean, Finnish, and Okinawan diets were associated with improved age-related health variables and suggested that neurodegenerative disease including dementia could be ameliorated [72]. Finally, Buettner and Skemp, in 2016, reported the discovery of 5 places around the world where people consistently live over 100 years old [73]. The common factors among the 5 locations among the world's centenarians include: (1) movement, (2) purpose in life, (3) managing stressors in life, (4) controlled decreased volume of dietary intake of plant-based foods, and (5) belonging to and interacting within a social community with strong relationships [73].

5. Four Factors of Lifestyle Health

5.1. Factor 1: Lifestyle Health—Nutrition, Diet and Skin Health

The purpose of this section and later sections is not to present comprehensive coverage on various aspects of lifestyle/habits and factors, but to summarize the recent progress reported in the scientific literature and how this applies to skin health and anti-aging.

5.2. Nutrition-Diet Lifestyle Benefits

Eating is directly associated with health. Good nutrition is essential to keeping current and future generations healthy across the lifespan [74]. A healthy diet helps children grow and develop properly and reduces their risk of chronic diseases. Adults who consume a healthy diet live longer and have a lower risk of disorders and certain cancers [30]. Additionally, healthy eating can help people with chronic diseases manage these conditions and avoid complications [59]. In other words, nutrition plays a key role in lifestyle habits and practices that impact virtually every chronic disease [4], and there is strong evidence for the role of nutrition in cardiovascular disease, diabetes, obesity, and certain cancers, among many other disorders [5,66]. For example, in 2022, La Vignera and Basile presented a report entitled “Diet and prostate health: an underrated tool?”, which described how dietary changes can notably impact prostate health and improve the benefit of traditional medical care (as reviewed by Stewart and Lephart, 2023) [75].

While diet has become a focus to enhance human health, the attention on what types of diets yield the best outcomes is paramount from the perspective of consumers. The “Mediterranean or Eastern” diets versus a “Western diet” have gained popularity to increase the general health status and well-being and address many diseases and disorders [8,66,76–80] (Figure 7). For example, the Mediterranean diet is one of the most widely described and evaluated dietary patterns in the scientific literature with validated health benefits [8,76,77,79,80]. It is characterized by high intakes of vegetables, legumes, fruits, nuts, whole grains, fish, some olive oil, moderate intake of red wine, where most proteins and fats are derived from vegetable sources with low intake of red meat, potatoes, processed meat, refined carbohydrates, and sweets [77,79,80]. Additionally, the Eastern (Asian) diet has high intake of plant-based foods (source of protein from vegetables like bean sprouts, spinach, eggplant, bok choy, cabbage, kale, snow peas, leeks, and mushrooms). Fruits and legumes, grapes, melons, cherries, dates, mangoes, etc.; steamed or stir-fried produce along with nuts, seeds, beans (soy, mung), lentils, tofu, or tempeh, plus rice and whole grains. Moderate intake of fish (dependent upon country's coastline), dairy, eggs, and poultry. Very low intake of meat, processed meat, refined carbohydrates, and sweets [8,76,77]. Conversely, the Western diet, prevalent in high-income countries, contains

refined carbohydrates, red meat, processed meats, fats/lipids/cholesterol, which increase sympathetic nervous system, oxidative stress, and inflammation and low intake of fruits and vegetables [75–77] (Figure 7). Additionally, a traditional Eastern European diet (in Russia, Poland, and the Czech Republic) may contribute to poor health status, particularly for the high cardiovascular disease rates reported by Stefler et al. in 2021 [81]. Notably, Europe and Central Asian (from the Caspian Sea in the west to Western China and Mongolia) are regions, where cardiovascular disease is responsible for more than half of all deaths across this area due to poor diets and daily habits (smoking) [82].

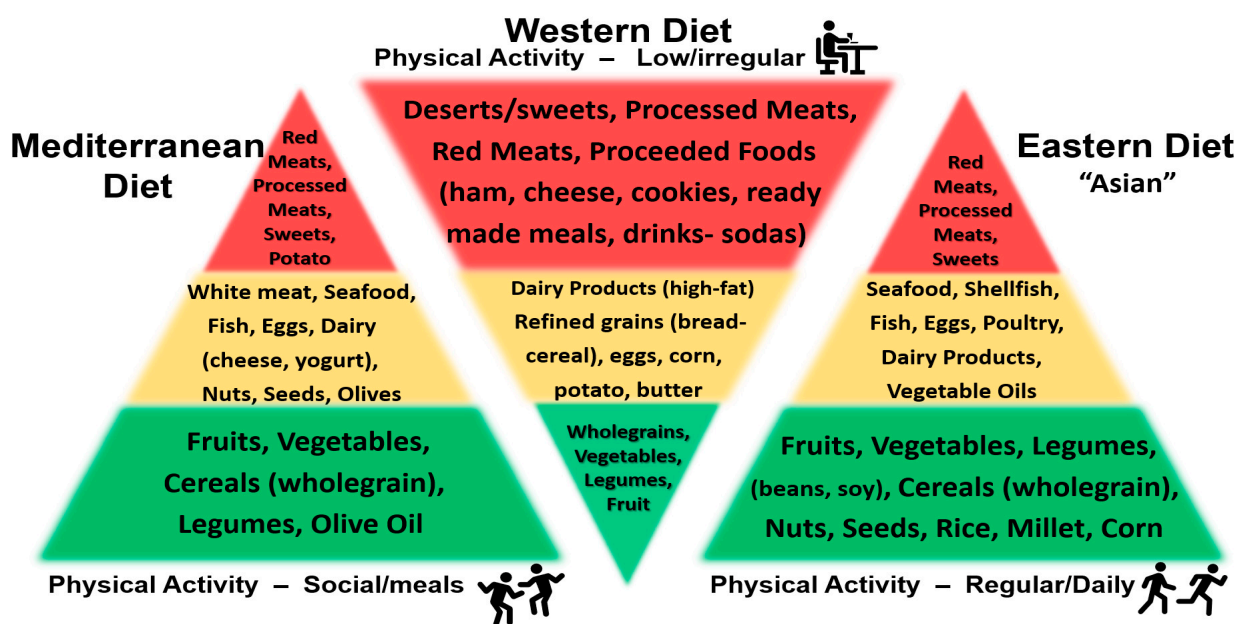


Figure 7. Comparison Among Mediterranean, Western and Eastern (Asian) Diets. Adapted with permission from Stewart, K.L.; Lephart, E.D. Overview of BPH: Symptom relief with dietary polyphenols, vitamins, and phytochemicals by nutraceutical supplements with implications to the prostate microbiome. *Internat. J. Mole. Sci.* 2023, 24, 5486. <https://doi.org/10.3390/ijms24065486> [75].

5.3. Nutrition, Diet and Skin Health

A reasonable balanced diet provides the nutritional components to delay aging, prolong life and enhance the QOL [4,8,34]. This narrative overview for this section demonstrates that a healthy diet is one of the most important factors to achieving healthy skin [8,34,76,83]. Certain nutrients, vitamins, minerals and other compounds/molecules and factors will be described herein, previous journal reports have presented more detailed information elsewhere as cited.

Various nutritional elements such as water, protein, trace elements (iron, iodine, zinc, copper, selenium, etc.), vitamins (A, B complex, C, D, and E) other dietary, daily habits and lifestyle health choices are known to impact skin health.

For example, does dietary fluid intake affect skin hydration? The answer is basic and complex due to the nature and importance of water in the human body for normal physiological function, maintaining body volume (intracellular and extracellular), thermoregulation, and acting as a lubricant and shock absorbent [84,85]. It is also important in the character/composition of the avascular epidermis [2,22]. Drinking enough water is important to your overall health and to your skin (most individuals do not drink 8 to 10 glasses of water per day); however, it's not clear whether drinking extra water affects skin hydration in healthy people [86]. Your skin is also affected by your diet, lifestyle, environment, and skin care routine [84]. However, in the case of the elderly or in obesity, dry skin is a common complaint [84]. Higher water intake in a regular dietary routine might positively impact skin physiology especially for its hydration and biomechanical properties, particularly in individuals with lower daily water consumption [84].

What about dietary protein intake? Protein is a critical nutrient for human growth, development, maintenance, and repair of body tissues/cells, which perform a large array of functions (as enzymes, structural components, transport/signaling, hormones, proper fluid, and acid-base balance, immune, and DNA replication) [87]. It is no surprise that protein intake is essential for healthy skin, particularly the two amino acids, i.e., lysine and proline that support collagen composition [88,89]. Notably, collagen is the most abundant protein in the body [88]. Protein deficiency in developed countries is rare, however, low-protein diets are associated with poor wound-healing and other skin problems, especially with aging [34]. Finally, oral intake of collagen supplements has been reported to enhance skin, nail, and hair health [88,90–92].

Vitamins in both topical and oral forms play a key role in many dermatological conditions [89,93]. Vitamin deficiencies can occur. Deficiencies of water-soluble vitamins, such as most B vitamins and vitamin C, may develop after weeks to months of under-nutrition, while deficiencies of fat-soluble vitamins, such as vitamins A, D, E and B12, can take up to a year to develop due to the body storage capacity for these nutrients [89,93]. Numerous reports suggest that oral supplementation of various vitamins can enhance general skin health and treat dermatological disorders [89,93–95]. In general, vitamins can have anti-aging effects such as [88,89,93–95], antioxidant, anti-inflammatory, hydration, skin barrier, turgor/tone/radiant, and repair/wound healing properties that are beneficial for skin health.

In fact, feeding the skin is a new trend in food and cosmetic treatments, where beauty is no longer dissociated from well-being, and where consumers consider nutrition as an important pillar in skin health. This is especially the case when ingredients/products contain food extracts or natural plant sources having nutricosmetic and/or nutraceutical benefits. [35,50,94,95].

Lifestyle health routines of dietary intake of plant-derived compounds such as carotenoids (astaxanthin, lutein, zeaxanthin, lycopene), chlorophyll, and polyphenols (resveratrol, flavonoids, isoflavonoids, green tea, etc.) have been shown to benefit skin health in a variety of ways [50,88,94,95] such as decreasing fine lines/wrinkles, dullness and roughness while enhancing healing, hydration, pigmentation, and radiance [36,50,88,94–101]. The mechanisms by which plant-derived compounds enhance skin health include: anti-aging (sirtuin activation), protection against UV damage, direct antioxidant actions and/or stimulation of nuclear factor erythroid 2-related factor (Nrf2) that is the master regulator for antioxidant responses, anti-inflammatory [by blocking nuclear factor- κ B (NF κ B) and activator protein 1 (AP1), interleukins and oxidative stress], stimulation of collagen, elastin, tissue-inhibitor of matrix metalloproteinase(s) (TIMPs) and superoxide dismutase (SOD), blocking androgen hormone action and enhancing skin parameters (hydration, smoothness, radiance, pore size, firmness, and frown lines/wrinkles) [2,8,23,35,36,38,43,47,49,76,79,83,95–103].

Interestingly, chlorophyll, the most abundant plant pigment responsible for giving plants their green color, also blocks assaults to DNA from carcinogens, and chlorophyllin is a water-soluble derivative of chlorophyll [102]. Finally, chlorophyll also plays a role in regenerating Co-enzyme Q 10 (CoQ10) [102], where CoQ10 as an oxidant has been shown to: (a) reduce the production of free radicals, (b) be involved in the regeneration of vitamin E, (c) reduce keratinocyte DNA damage, (d) reduce UVA-induced MMP production from fibroblasts, (e) enhance collagen and elastin expression, inhibit IL-1 α , IL-6 production, and melanin synthesis, and (f) inhibit MMPs and regulate the sulfide oxidation pathway [88].

Probiotics are active microorganisms that have beneficial effects on the host by altering the microbiota composition of a specific portion of the host's flora [104]. Numerous studies have found a close relationship between the skin microbiome and skin health benefits along with the gut-skin axis, where the gut microbiome can influence the skin via various chemical messengers including hormone and immune signaling [23,104,105]. Several skin-related topics (acne, antioxidant activity, atopic dermatitis, barrier function, enzymatic regulation of the extracellular matrix, moisturization, photo-aging, pigmentation, rosacea,

TEWL, suppression of pathogens, and UV protection, etc.) have been covered in diverse reviews on topical and oral probiotics in skin health [104–109]. Therefore, it is beyond the scope of this narrative overview to describe this topic further.

Diet lifestyle factors such as the role of whole-food, plant-based (WFPB) diet on skin health parameters was reported by Solway et al. in 2020 [102]. This WFPB diet was defined as “eating plant foods in their whole, unprocessed form, such as vegetables, fruits, beans, lentils, nuts, seeds, whole grains, and small amounts of healthy fats. It did not include animal products, such as red meat, poultry, fish, dairy, eggs or processed foods or sweets” [102]. Their findings showed that a WFPB diet maximized the antioxidant potential by providing the essential vitamins (A, C, and E) to help combat oxidative stress, advanced glycation end products (AGEs) and methylglyoxal [110–113], which resulted in lengthening telomeres that contributed to healthier, younger-looking skin [102]. The findings by Solway et al. are supported by numerous other scientific reports that have examined different aspects of diet/lifestyle health and skin parameters [3,34,42,83,95,108,114–117].

From a clinical perspective, there are some reports that investigated the role of lifestyle and nutrition (especially vitamins, minerals, and dietary supplementation) on dermatological conditions such as photo-aging, psoriasis, acne vulgaris, atopic dermatitis, rosacea, and hidradenitis suppurativa, etc. [118–121].

5.4. Lifestyle/Daily Habits- Negative Impact on Skin Health [AGEs, Alcohol, Smoking, High Fat, Body Mass Index (BMI)]

Advanced glycation end products (AGEs) are well studied toxins, where glycation is a non-enzymatic chemical process that involves the formation of a covalent bond between a sugar molecule (e.g., glucose or fructose) and a protein or lipid [110–112]. This differs from physiologic glycation that is under enzymatic control [102]. AGEs can accumulate within tissues/organs to disrupt structures and function, but in the skin, it causes alterations in collagen, elastin, vitronectin and laminin structures, delayed wound healing and decline of skin strength and flexibility [114,115]. Remarkably, external factors such UV irradiation, cigarette smoking, poor dietary choices (Western diets), alcohol, obesity, and cooking methods can increase the rate or abundance of AGEs, whereas whole-food plant-based (WFPB), Mediterranean or Eastern diets contain the least number of AGEs [102,122–124].

Alcohol consumption (two drinks per day) and smoking have damaging influences on skin health [115,116,125]. Alcohol’s two major effects on skin: (a) dehydration (diuretic water loss along with decline in vitamins and minerals) and (b) inflammation (increased oxidative stress along with peripheral vasodilation), which can impair quality of sleep, skin cell turnover and alter carotenoid concentrations to lessen antioxidant defense [115,116,125].

There are zero health benefits associated with smoking [125,126]. Smoking’s detrimental influence on skin is dependent upon history and level of use, which causes severe signs of aging (loss of skin tone/turgor and appearance of lines/wrinkles) [125]. Even in individuals with the shortest smoking history, facial and perceived age was advanced compared to their chronological age, especially in the facial region around the mouth and eyes [125]. Unfortunately, smoking and vaping have similar harmful influences on skin health [126], and a growing body of research has found that e-cigarettes (vaping), like regular cigarettes, results in serious respiratory disorders especially in youth and young adults [127].

Astonishingly, Gunn et al., in 2016, conducted a twin study entitled “Mortality is Written on the Face”, where nurses rated the perceived age of each twin from photographs and selected which twin had survived the other twin. The conclusions of study suggested that facial cues are the most important in linking perceived age and survival [128]. Notably, for women there is a strong link between estrogen levels with aging, attractiveness, facial appearance, and coloration, which are negatively influenced by alcohol and smoking [39,129,130].

High fat dietary intake and obesity (body mass index; BMI \geq 30) have been linked in reference to lifestyle health, an extensive range of chronic diseases, including dermal disorders [83,131–134]. In brief, obesity is now considered to be a global epidemic and

is increasing in prevalence (by 2035 more than 50% of the world's population will be obese) [132,133]. In general, the effect of a high-fat diet results in aging of the skin by inflammatory damage [83]. Almost 60–70 percent of obese patients present with a variety of skin disorders, such as eczema, psoriasis, atopic dermatitis, infections, poor wound healing, and other skin malignancies like melanoma [134,135]. Specifically, obesity is one of the important casual factors of many inflammatory diseases [136,137]. In the skin, functional changes in adipocytes, lymphatic vessels and epidermal keratinocytes are involved in obesity-induced exacerbation of skin inflammation [135–137]. Particularly, skin barrier health is directly related to the changes that occur in the composition and function of dermal immune cells that decline with aging [138,139]. Therefore, the profound impact of increased fat deposition and obesity on cutaneous immunology and its role in the pathophysiology of various chronic inflammatory dermatological conditions is without question [134–139]. However, semaglutide, a glucagon-like peptide 1 (GLP-1) receptor agonist, approved for the treatment of type 2 diabetes mellitus (T2DM) and more recently utilized for weight loss in overweight/obese individuals, has been shown to be highly effective against severe psoriasis in T2DM patients [140,141]. Thus, the importance of lifestyle health factors that may ameliorate the harmful influences of obesity and overweight conditions warrants further research and development of aids and treatments not only for the range of chronic diseases but to improve skin health [134].

Finally, all nutrients, dietary supplement ingredients or daily habits covered in the section above are summarized in Table 1 that display the various influences on the skin along with the cited reference(s).

Table 1. Summary of Key Nutrients/Vitamins/Dietary Intake and Other Factors Influencing Skin Aging.

Nutrient/Diet/Habit	Influence on Skin Health	Reference
Water	skin hydration-biomechanics	[2,22,84,85]
Proteins	support/repair, extracellular matrix (collagen/elastin)	[88,90–92]
Trace Elements		
Copper	extracellular matrix/angiogenesis	[89,94,95]
Iron	wound healing/antioxidant capacity	[89,94,95]
Selenium	keratinocyte function/antioxidant function	[88]
Zinc	/development-keratinocytes	[88]
Vitamins and Other Compounds		
A	aging, improves wrinkles, stimulates dermis	[89,93–95]
B-Complex (below)		[88,89,94,95]
B1 (thiamine)	hydration/anti-inflammatory	
B2 (riboflavin)	skin tone/radiant balance	
B3 (niacinamide)	keratin/barrier function	
B5 (pantothenic acid)	hydration/wound healing/anti-inflammatory	
B6 (pyridoxine)	anti-inflammatory/skin balance	
B7 (biotin)	if deficiency-improves skin, hair/nails	
B9 (folate)	skin support/tone/turgor	
B12 (cobalamin)	collagen/hydration, anti-inflammatory, deficiency-hyperpigmentation	
C	antioxidant/boost collagen/hydration	[89,93–95]
D	anti-inflammatory, skin protectant	[89,93–95]
E	antioxidant, anti-aging, improves wrinkles	[89,93–95]

Table 1. Cont.

Nutrient/Diet/Habit	Influence on Skin Health	Reference
Dietary Intake/Supplementation		
Coenzyme Q 10 (CoQ10)	antioxidant (↓ oxidative stress), enhance vitamin E	[88]
Collagen peptides	boost collagen and elasticity (skin, hair, nails)	[88,90–92]
Carotenoids	antioxidant, increases collagen, elastin,	
Astaxanthin, Lutein	reduces appearance of wrinkles by inhibiting	
Zeaxanthin, Lycopene	oxidative stress and MMPs	[88,97–101]
Chlorophyll	antioxidant/anticancer	[102]
Polyphenols	antioxidant, anti-inflammatory, boost collagen and	
Resveratrol, Flavonoids,	elastin, TIMP, SOD, Nrf2, inhibits oxidative stress,	
Isoflavonoids, Green Tea, etc.	NFkappKB, Matrix Metalloproteinases (MMPs)	[8,36,50,75,96,98–101]
Probiotics	reduces oxidative stress and photoaging	[104–106]
Daily Habits/Negative Impact		
Advanced Glycation	toxins causing skin damage	
End Products (AGEs)	skin inflammation/stiffening	[114,115]
Alcohol	dehydration/inflammation decrease skin barrier	[115,116,125]
Smoking (vaping)	damage skin/skin aging many negative influences	[125,126]
High Fat	skin inflammation/damage/infections	[83,134–137]
Increased BMI (Obesity)	skin inflammation/damage/infections	[83,134–137]

6. Factor 2: Lifestyle Health—Rest, Relax, Recover (RRR) and Manage Stressors

Another important lifestyle health factor is rest, and the most important aspect of rest is sleep, which is essential for health and well-being [142–144]. Sleep is a fundamental physiological need to which humans devote approximately one-third of their lives. Sleep duration and quality of the sleep cycle determine health outcomes, because without this critical rest interval the body's cells/tissues/organs, etc. and functions are adversely affected [142–144].

Each sleep cycle begins with non-REM sleep (for memory consolidation), while REM sleep is critical for processing sensory impressions and each cycle lasts between 70–100 min with an average of four to six cycles per night [142,143]. The sleep interval in healthy people decreases with aging, where newborns need 14–17 h of sleep per day, while adults sleep 7–9 h [142,143]. Less than 7 h of sleep is associated with poor health and decreased well-being [142–144].

For example, the function of sleep has many components which include: (a) reduction in energy consumption, body temperature, blood sugar, helps to control body weight and strengthens your heart, (b) immune cell production, restores defense mechanisms, decreases inflammation/stress and repairs cells/tissues, (c) removal of toxins from the brain (produced by cellular respiration) by increased blood flow to this organ, and increases memory consolidation/formation, (d) boosting mechanical/hormonal balance, executive functions, performing tasks on vigilance, motor speed, and post-exercise recovery [142–144].

It is estimated between 37 to 43 percent of the general population have sleep problems that contribute to a variety of mental and physical health disorders [142,144,145]. One of the potential integrative treatments for sleep disturbance is lifestyle health interventions because the encouragement is to make small changes in one's routine that can have a large impact long-term for many disorders including skin health [1,33,142,145].

What are the factors that enhance sleep disturbance or improve the quality of sleep? First, a general list of factors that can impact sleep quality include a) diet (fats, protein, and carbohydrates), while caffeine, low vitamin D levels, alcohol, nicotine, enhanced

calorie intake and obesity impair sleep quality [142,145–157]. Whereas a balanced diet with adequate vitamin intake and regular physical activity provides weight loss, enhanced melatonin levels, memory consolidation and improved quality of sleep [142,145–157] (Table 2). Assuredly, there are many other factors that influence sleep, but such coverage would be beyond the scope of this overview.

Table 2. Factors Influencing Sleep Quality.

	Factors Improving Sleep Quality	Factors Deteriorating Sleep Quality	References
Diet			
	Balanced diet	Intake of inflammatory foods (sugar, alcohol, etc.)	[146,147]
Carbohydrates		Low-carb diet and High-carb diet (>70% energy)	[146,147]
Fats	Polyunsaturated Fatty Acids (PUFA) (omega-3 > than omega-6 fatty acids)	Saturated Fatty Acids Trans Fats	[146,148] [146,148]
Proteins	Appropriate intake of proteins	Too Low Protein or Too High Protein Intake; Red Meats and Processed Meats	[146,149]
Other Factors:			
		Caffeine (chocolate, coffee, tea, energy drinks)	[146,150]
	Adequate Vitamin D Levels	Low Vitamin D Levels	[151]
		Alcohol (beer, wine, etc.)	[152,153]
		Nicotine (cigarettes, chewing gum, e-cigarettes)	[154,155]
	Regular Physical Exercise	Lack of exercise or obesity	[156,157]

6.1. Sleep and Skin Health

Sleep is vital for health and healing because it has a bidirectional impact: poor sleep increases the risk of disease and illness as well as the converse, disease, illness, and other factors disrupt sleep [158]. The concept of lifestyle health where diet and exercise are beneficial, however, when individuals are fatigued and not mentally focused this lifestyle plan is unlikely to succeed. Sleep is vital in regulating skin physiology such as the skin surface pH, TEWL, blood flow and skin temperature [158,159]. For example, in reference to skin health a clinical study of post-menopausal women showed that those who slept less than five hours per day had higher TEWL loss, decreased skin barrier function and longer recovery after UV-induced erythema [159]. Even after a single night of disrupted sleep, periorcular areas are known to show dark circles giving a tired appearance [160]. Sleep impairment is associated with chronic inflammatory skin conditions such as atopic dermatitis, eczema, psoriasis, rosacea [161–165]. In this regard, sleep deprivation is known to increase cortisol levels that suppress the immune response along with impairment of T cell function and antigen presentation that result in increased infections. Additionally, sleep loss has been shown to increase proinflammatory cytokines that further increase inflammatory skin disorders like psoriasis and eczema [163]. Finally, isotretinoin, a drug widely used in dermatology to treat acne, had been found to cause sleep disturbances [163].

6.2. Skin Health and Circadian Factors

Organisms have conserved over millennium an internal rhythm that helps them anticipate (to changes in radiation, temperature, and food availability) and adapt to daily changes in the environment [166]. Light synchronizes this internal circadian clock, when photons processed by the retina send neural information to a part of the brain called the suprachiasmatic nucleus (SCN) in the anterior hypothalamus [165]. Other factors (food intake, exercise, temperature, aging, trauma/injury, etc.) also affect “clocks” in peripheral tissues, including the skin [166–168]. The communications between the central SCN clock and the skin clock(s) coordinate various functions (i.e., homeostasis, proliferation/repair,

immune and stress responses) [166–168], Notably, the circadian skin clock(s) in the epidermis, dermis and hypodermis can be altered/disrupted by sunburn (UV-induced erythema), aging, infections, hydration, inflammatory dermal disorders, food intake, sleep, and injury/wound healing [166–172]. The biological rhythms in the skin and skin clock genes have been reviewed in detail elsewhere [166,168–170]. However, the fluctuation in human skin characteristics as they cycle through the day and night (as regulated by skin clock genes) is shown in Figure 8. For example, in the epidermis, cellular proliferation in keratinocytes is 30-fold higher at night than at noon (12 PM) and epidermal stem cells show a similar pattern and have a higher rate of proliferation at night versus day [169]. Also, the circadian rhythms via modulation associated with skin clock genes altered aquaporin 3 (AQP3) expression impacting skin hydration [167]. Interestingly, it was shown that UV exposure, aging, and low temperature resulted in increased TEWL, while vitamin C, collagen and probiotics increased ceramide production and improved skin hydration [167]. Finally, understanding the role of circadian clock genes in the skin will provide new insights to the pathogenesis of skin disorders and novel aids and treatment, especially via lifestyle health approaches.

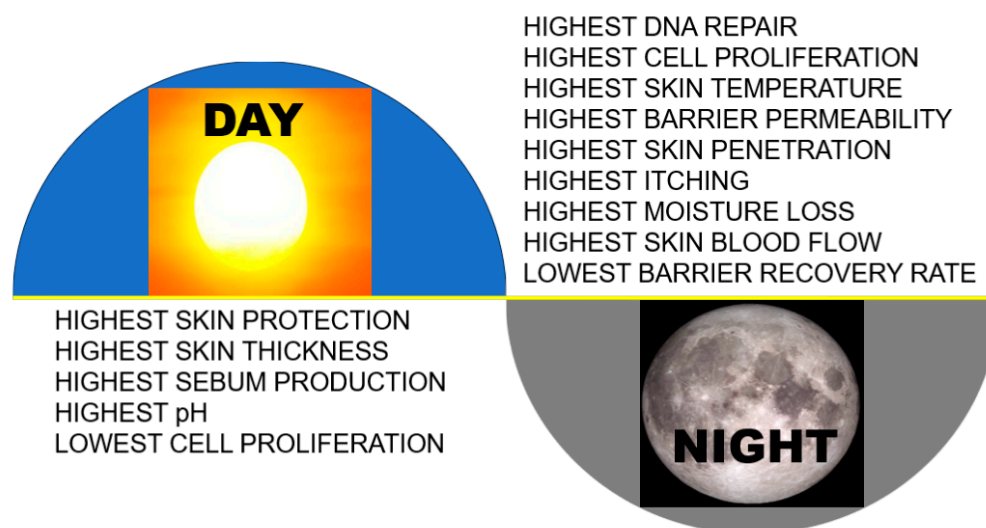


Figure 8. The fluctuation of human skin characteristics as they cycle from day to night in a circadian pattern [170]. Adapted with permission from, Pernodet, N.; Pelle, E. *Chronobiology of the Skin, Skin Circadian Rhythm and Clock Genes: A New Approach to Slowing Down the Aging Process*, 9th ed.; Chemical Publishing. Los Angeles, CA, USA, 2015, Volume 2.

6.3. Skin Health and Exposome Factors (Stressors)

Miranda A. Farage from Procter and Gamble reported in 2008 that 50 to almost 70% of women reported skin sensitivity worldwide [173]. Later in 2013, Farage et al. confirmed their earlier findings, but also recognized that psychosocial influences, as well as biological and environmental factors contribute to skin sensitivity [174]. The first published reports on air pollution and skin aging appeared in the *Journal of Investigative Dermatology* in 2010 [175,176]. Both reports suggested that air pollution exposure was significantly correlated with extrinsic skin aging, particularly to pigment spots on the face and hands and, to a lesser extent, for wrinkles [175,176]. However, more recently a much broader perspective of skin aging includes the concept of the exposome. For example, the exposome can be defined as the measure of all the exposures of an individual in a lifetime and how those exposures relate to health. An individual's exposure begins before birth and includes insults from environmental and occupational sources, etc. Understanding how exposures from our environment, diet, lifestyle, etc. interact with our own unique characteristics such as genetics, physiology, and epigenetics impact our health is how the exposome will be articulated [177]. Thus, exposome factors that lead to stressed skin (via oxidative stress

mechanisms) can be defined as any disturbance to skin homeostasis from environmental (meteorological factors like temperature, humidity, etc.), photo-aging, water/air pollution (external and household), tobacco use (smoking and/or vaping) and internal exposure like (unhealthy diets, hormonal variations/changes with menopause), lack of sleep, psychosocial or cultural stresses [2,14,116,178–180]. In general, exposome stress factors can influence six key skin functions, namely the skin barrier, pigmentation, defenses (antioxidant, immune cell mechanisms, microbial and microbiome maintenance), structure (extracellular matrix components), neuroendocrine and thermoregulatory functions [179,180]. The physical signs of stressed skin include dry skin, fine/moderate lines/wrinkles, oily skin, sensitive skin, pruritus, erythema, pale/dull skin, edema, and inflammatory skin conditions such as acne, atopic dermatitis, pigmentation disorders, rosacea, and skin infections [178–180]. Parreson et al., in 2021, suggested how to avoid exposome factors/stressor by: (a) getting adequate sun protection (sunscreen, sun avoidance, and protective clothing), (b) adopting a healthy lifestyle (eating a balanced diet, sleeping well, acquiring and using personal stress management skills and utilize psychosocial interventions for obtaining and exchanging ideas), and (c) enhancing the skin's physical barrier and defenses against exposome factors with topical and oral antioxidants, antipollution products, probiotics, moisturizers and other personal care products [180].

Finally, in this regard, the emerging strategies for photoprotection (using sunscreens) [181,182], lifestyle health interventions [2,14,116,158,183] and the use of bioactive textiles to enhance the skin's microbiota [184], along with the effects of spaceflight's influence on human skin [185] have been reported.

7. Factor 3: Lifestyle Health—Physical Exercise and Skin Health

Regular moderate to intense exercise levels have long been known for its active role in improving physical fitness, sustained health and is widely accepted as a preventive and therapeutic strategy for many chronic and age-related diseases [186,187]. It has been proposed that exercise sustains health by: (a) helping to control body weight, (b) enhancing circadian rhythms, (c) promoting repair/regeneration, (d) protecting the integrity of barriers (from organelles to cells/tissues and organs), (e) benefiting turnover and recycling of cells/tissues, (f) providing cardiovascular and immune protection, (g) improving resilience, (h) boosting energy, (i) improving mood, (j) providing better sleep and (k) maintaining the body's homeostatic balance of functional systems [186,187]. The concept and topic of the health benefits of exercise is easy to follow and understand, especially since the mitochondria with each cell in the body produces the energy needed [via the synthesis of adenosine triphosphate (ATP)] to carry out cellular respiration and the functions/thousands of biochemical reactions each second of life [188]. Each cell in the human body uses about 10–15 million molecules of ATP every second [188].

In dermatology, exercise has positive influences on: (a) skin aging, (b) skin cancer, (c) psoriasis, (d) venous ulcers, (e) androgenetic alopecia, and (f) skin moisturizing and hydration [189,190]. In brief, the known skin benefits of regular physical exercise include: (a) improving blood flow to nourish cells and remove toxins from the skin, (b) preventing the signs of aging by boosting collagen, elasticity, tone/turgor, the skin barrier, (c) inhibiting the anti-inflammatory actions of oxidative stress and MMPs, (d) decreasing stress by increasing dermal resilience, and (e) maintaining improved overall skin well-being [189–191]. However, it must be pointed out that individuals with inflammatory skin disorders (i.e., acne, atopic dermatitis, eczema, psoriasis, rosacea, etc.) should seek medical guidance before starting an exercise program, plus everyone should be cautious and wear protective clothing and limit their sun exposure [192].

8. Factor 4: Lifestyle Skin Health—Social/Community and Skin Health

Within the framework of lifestyle health, social interactions and/or isolation play important roles in determining an individual's well-being because chronic and age-related disorders/diseases are linked to the lack of social contact with meaningful in person

activities [193,194]. Social isolation is well known and common in older groups, but the increased isolation among younger adults is due to greater social media use [194].

In a recent study by Cudjoe et al., in 2022, found that social isolation in older adults is associated with higher levels of (the inflammatory biomarkers) interleukin-6 (IL-6) and C-reactive protein (CRP) that suggested a link between social isolation and morbidity/mortality [195]. Kottner et al., in 2023, showed that isolation in older individuals displayed skin changes (thinning of the epidermis, flattening of the dermal-epidermal junction, decreases in the fat layer (hypodermis) and collagen and elastin fibers in the dermis [196], which indicated that clinical practice guidelines to promote skin health in older people might be improved [196].

One factor associated with social isolation might be a negative body image that is common in men and women (usually associated with an increase in BMI and/or decreased skin health-lack of dermal elasticity and the appearance of wrinkles) [197]. However, physical activity and exercise, yoga, massage, dance therapy and body awareness therapy represent alternative methods to address negative body image issues, especially in women [197,198].

Social isolation was the norm during the COVID-19 pandemic. This isolation resulted in cutaneous changes in the general public, patients, and health care workers [198–200]. In general, there was an increase in atopic dermatitis, psoriasis, rosacea plus many other skin inflammatory diseases [199–201]. However, much of the increase was due to allergic dermatitis induced by hypersensitivity to personal protective equipment (PPE; masks, goggles, face shields, gloves, heat stress, etc.) [199,200]. Conversely, one study during the COVID-19 pandemic examined the connections between the neurological, neuroendocrine, and immune systems that triggered dermatoses influenced by factors such as stress, fear, negative thoughts, and anxiety, which resulted in skin inflammatory outbreaks not attributed to PPE use [201]. This suggested that a psychological component potentially linked to social isolation was the main cause, which was greater than only among those infected with COVID-19 [201]. This last study opens a perspective of how our environment interacts with human health and the interlinking of humans socially with each as well as through ecosystems like the microbiome, including that of the skin. [202].

Finally, it is well established that social relationships provide a clear link to improved health and well-being [193,194,203], including dermal health [196,201]. Just as the review of combined data for a variety of outcomes found that social media interventions that aim to increase physical activity and well-being were effective [204], this approach might be an application for improved skin health in the future.

9. Conclusions

Lifestyle health has been recognized as an evidence-based innovation that defines how daily habits and practices impact both the prevention and treatment of disease and provides an important adjunctive component to overall health [21]. Specifically, an approach with small changes over time can have a dramatic impact on the health and well-being of individuals not only, in general, but also can be applied to skin health. This narrative overview presented four lifestyle health factors to maintain and improve skin health. Lifestyle health factor 1: nutrition—diet and skin health; factor 2: rest (sleep) and skin health; factor 3: movement/physical exercise and skin health, and factor 4: social and community associations and skin health (see Figure 9).

Lifestyle change is often a gradual process involving multiple forward efforts and some setbacks, but this paradigm is a routine/program rather than an event. Finally, there are many ways to enhance skin health (especially with aging), if people alter their perspective and feelings about making changes based on short duration interventions with healthy goals in mind [2,5,9,11,17,38,49,50,79,96,116,205].

Lifestyle and Skin Health

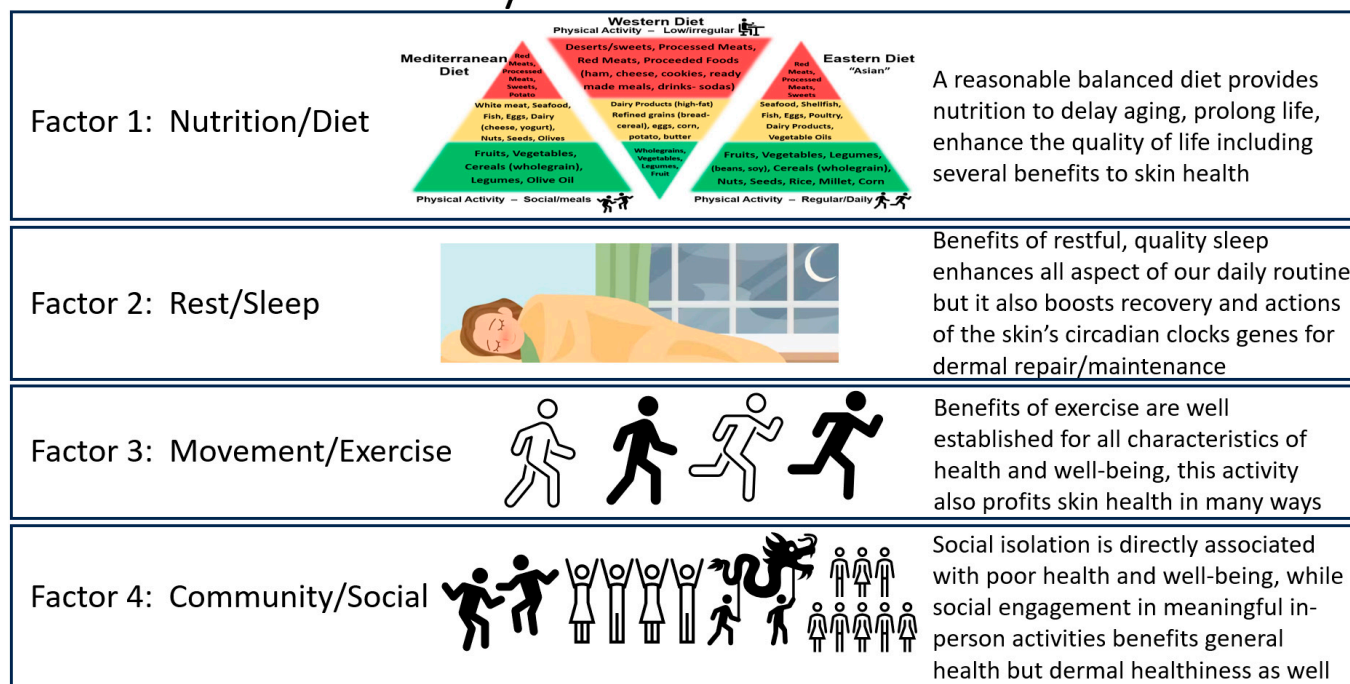


Figure 9. Summary of Enhancing Skin Anti-Aging Through Healthy Lifestyle Factors.

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