Kostrzewska Paulina, Mandera Amanda, Pawlikowska Anna, Szuster Ewa. Sunscreens as a prevention of the photoaging. Journal of Education, Health and Sport. 2020;10(8):11-16. eISSN 2391-8306. DOI http://dx.doi.org/10.12775/JEHS.2020.10.08.001
https://apcz.umk.pl/czasopisma/index.php/JEHS/article/view/JEHS.2020.10.08.001
https://zenodo.org/record/3967765

The journal has had 5 points in Ministry of Science and Higher Education parametric evaluation. § 8. 2) and § 12. 1. 2) 22.02.2019.

Received: 05.07.2020. Revised: 15.07.2020. Accepted: 30.07.2020.

Sunscreens as a prevention of the photoaging

Kostrzewska Paulina, Mandera Amanda, Pawlikowska Anna, Szuster Ewa

Wroclaw Medical Univeristy, Wrocław, Poland

Abstract

Proper aging is genetically determined, progresses over time and cannot be stopped. External aging, on the other hand, is caused by factors affecting the organism from the outside, such as permanent exposure to the sun, stress, diet. This factors are modifiable. Exposure to UV radiation is one of the main factors responsible for skin aging. It causes also skin cancers like melanoma, basal cell cancer and sunburns. In this review, we have discussed the skin aging mechanisms and using sunscreens as a prevention of the photoaging and another serious effects like skin cancer. Sun Protection Factor (SPF) is used to describe the sun protection ability and it measures the fraction of sunburn-producing UV rays that reach the skin. Sunscreens with high SPF protect the skin by absorbing or reflection of harmful UV radiation from the sun. They minimize damaging effects and prevent sunburns, loss of elasticity and wrinkles.

Key words: ultraviolet; spf; sunscreen; aging photoaging.

Skin is the biggest organ of the human's body but it is also very sensitive to many factors. Nowadays anti-aging methods of skincare are very desired and still developing issues. UV radiation is one of the risk factors of the skin aging. Skin aging is associated with the reduced thickness of the skin, limited collagen synthesis and weakening of the repairing processes. [1]. In this review we would like to discuss on the skin aging mechanisms and prevention of the photoaging.

Ultraviolet radiation

The effect of ultraviolet radiation on the skin depends on the wavelength. The range of ultraviolet waves is divided into three ranges:

UVC (200-280 nm), almost entirely absorbed by the atmosphere;

UVB (280-320 nm), the so-called short ultraviolet, accounting for 5% of all ultraviolet radiation reaching the earth's surface,

UVA (320-400 nm), the so-called far ultraviolet radiation, which is the remaining 95% of the ultraviolet radiation.

For many years it was believed that UVB radiation was the main cause of unfavorable changes caused by the action of the sun. It was not until the end of the 1990s that it was understood that UVA radiation played a large part in this as well.

UVB radiation acts on the skin surface (it only penetrates the epidermis). It causes damage to the epidermis and its excessive keratinization, inflammation of the skin ("burn" effect), is mutagenic, carcinogenic and genotoxic, and at the molecular level it causes DNA damage [2]. On the other hand, longer UVA radiation penetrates the skin proper - we do not feel their direct effects. UVA causes damage to collagen and elastin fibers and the walls of blood vessels, is the main cause of phototoxic and photoallergic reactions, contributes to exogenous skin aging, is mutagenic and carcinogenic. The damage caused by them is irreversible and most often manifests itself after many years [2].

Among all types of solar radiation, ultraviolet radiation has the biggest impact on the human body and the effects of its impact on the human body can be both beneficial and very harmful. The beneficial effect of ultraviolet is mainly anti-rickets action [3]. Ultraviolet radiation also destroys microorganisms, accelerates the healing of wounds and ulcers, and alleviates the symptoms of some skin diseases (e.g. psoriasis).

On the other hand, too long or inadequate exposure to ultraviolet radiation creates health risks that outweigh the benefits mentioned above. The unfavorable effects of UV radiation on the human body include, first of all, faster skin aging and stimulation of the development of its neoplasms, the possibility of eye damage, even leading to blindness, inhibition of the immune system functions, which in turn increases the sensitivity to various types of infections and reduces the effectiveness of the system in the fight against neoplasms that may arise in the skin [4]

One of the most sensitive organs of the human body to UV radiation is the skin. The skin is an organ with a complex and layered structure: outer - epidermis, middle - dermis and inner - subcutaneous tissue.

As a result of changes caused by long-term exposure to UV radiation, the properties of all layers of the skin are significantly destroyed [5].

One of the main negative effects of UV radiation on the skin is photoaging. Skin aging, just like that of the whole organism, is twofold - as an intrinsic process, also called proper, physiological or natural aging, and as an external process, referred to as inappropriate aging. Proper aging is genetically determined, it is an inevitable process, it progresses over time and cannot be stopped. External aging, on the other hand, is caused by factors affecting the organism from the outside, such as stimulants (alcohol, drugs, tobacco), inadequate nutrition and permanent exposure to the sun.

Among the external factors, ultraviolet radiation is considered the most harmful to the skin. It is believed that up to 80% of the signs of skin aging are caused by the chronic effects of ultraviolet rays [6].

The skin which is protected against UV radiation and other harmful external factors ages differently than the skin which is chronically exposed to UV radiation. The skin, which ages by an endogenous process, is smooth and without discoloration, the face geometry is unchanged, with slightly sharpened expression lines.

The consequences of exogenous aging are most visible on exposed parts of the body, such as the face, cleavage and arms. In the process of skin aging caused by exposure to UV radiation, to reduce procollagen synthesis and excessive collagen degradation by metalloproteinases. The effect of this is the deepening of wrinkles and folds; the skin becomes rougher and thickened, pores are dilated, and healing is impaired [6]. These changes are accompanied by an increased number of telangiectasias (widening of blood vessels). The uneven distribution of melanocytes causes the observation of areas of hyperpigmentation (freckles, lentil moles, chloasma) and hypopigmentation (discoloration) [7].

In the process of skin photoaging, specific skin changes may occur as a consequence of solar elastosis [8]. Solar elastosis consists in an excessive accumulation of incorrect elastic fibers in places exposed to solar radiation. Clinically, it may reveal themselves with deep furrows forming diamond-shaped patterns in the neck area - the so-called farmer's neck (cutis romboidalis nuchae).

Skin aging

Skin aging is a complex biological process caused by many cumulative factors, both endogenous or intrinsic and exogenous or extrinsic. Intrinsic factors are endogenous mechanism of aging due to genetic factors, cellular metabolism, hormone and metabolic processes. Extrinsic factor it is an exogenous mechanism of aging due to chronic ultraviolet (UV) radiations, pollution, ionizing radiation, chemicals, toxins. It lead to progressive changes in each skin layer, also changes in skin appearance, above all on the sun-exposed skin areas. [1]

Lifestyle is important in many aspects of health, including aging. Smoking, lack of exercise, alcohol consumption, unhealthy diet, toxins, pollution, stress contributes to aging. These factors can lead to increase or decrease in the rate of telomere shortening. Whereas nicotine, carbon monoxide and other toxic substances in cigarette smoke result in vasoconstrictive and hypoxic effects on the skin.[1]

The main signs of aging are wrinkles and sagging of the skin. Fundamental mechanisms of their formation are still poorly understood. In wrinkled skin has been observed accumulation of altered elastic fibers and degradation of collagen bundles in the dermis. Wrinkle formation

is closely associated with enhanced elastase activity in dermal fibroblasts and the loss of skin elasticity, which is induced by repetitive UVB exposure. It has been suggested that UV radiations contribute about 80% of facial ageing and skin cancer.[1,9]
Frequent sunlight exposure causes keratinocytes to secrete IL-1α and GM-CSF which penetrates into the dermis to stimulate the expression of skin fibroblast elastase, cleaves the elastase fibers leading to a loss in its configuration.This results in reduced skin elasticity and leading to wrinkle formation.[9]
Oxidative stress has been linked to age-related loss of skin elasticity. The presence of excessive reactive oxidative species (ROS) is the main cause of oxidative stress. It triggers cellular damage pathways, causes defective cellular signaling and senescence of cells which may lead to photoaging.[10]

Sunscreens

Sunscreens protect the skin by absorbing or reflection of harmful UV radiation from the sun. They are minimalizing damaging effects and preventing sunburns, loss of elasticity and wrinkles. Sunscreens are highly recommended to protect the skin. [1]
The sunscreen are divided into two types: inorganic (physical) blockers and organic (chemical) absorbers.
Organic filters consist substances that can absorb UV radiation. Molecules absorb UV energy and transform to higher energy state. Surplus energy is emitted by isomerization and heat release. Organic sunscreens consists derivatives of anthranilates,benzophenones, camphor, cinnamates, dibenzoylmethanes, paraaminobenzoates and salicylates.
Inorganic filters include titanium dioxide, red veterinary petrolatum, zinc oxide, iron oxide, kaolin and calamine. This filters protect from UV by scattering and reflection. [1]

Sun Protection Factor (SPF) is used to describe the sun protection ability and it measures the fraction of sunburn-producing UV rays that reach the skin. Properly applied SPF 15 lets 1/15 UV rays reach the skin (93% protection), SPF30 lets 1/30 (97%), and SPF50 lets 1/50 (98% protection). Also differences between SPF 30 and SPF 50 are minimal.[11] In the other words sun protection factor (SPF) is described as a ratio of the minimal amount of ultraviolet energy required to produce a minimal erythema on skin protected by sunscreen to the amount of energy required to produce the same erythema on unprotected skin.[12]

Maximum daily ambient UV levels are expressed in units of standard erythema. The standard erythema dose (SED) is equivalent to an erythemal radiant exposure of 100 J.m-2. SED is independent of skin type. Particular SED may caused erythema in fair skin and none in darker one. [4]Under clear, summer sky the standard erythema dose in tropics is about 70, about 60 in southern Europe. The SED about 1.5 caused perceptible erythema in skin type I (people who burn easily and never tan, about 2 in skin type II (people who burn easily and tan minimally, about 3 in skin type III (people who will burn but tan readily). It is almost impossible to receive maximum ambient exposure dose because it is very difficult to lie all day in the sun without moving. Even the extremely sunbathing person can receive just 50 % of ambient. So in southern Europe may receive just about 20 standard erythema dose over much of the body surface.

As previously mentioned espouser of 2-3 SED causes erythema is the most common skin types, so photoprotective device need to has just SPF10 to protect against sunburn.[12]
So why people still get sunburned even using sunscreens higher than SPF15? The effect of sunscreens with sun protective factor was examined in vivo at an internationally agreed application thickness of 2 mg/cm2. There is number of scientific studies which has shown that customers apply not enough and not properly (typically between 0.5-1.3mg/cm2). [13] Antony R. YOUNG with coworkers perform the study with representative sunscreen-user application. A SPF formulation was applied at 0.75, 1.3 and 2.0 mg/cm2. Control sample with unprotected skin was exposed to SED 4 and Sunscreen treated sample to 30 SED. In comparison with unprotected control sample, sunscreen significantly ($p<0.001$-0,05) reduced causes of harmful UV radiations at 1.3 and 2.0 mg/cm2 in all cases. Furthermore typical sunscreen use (0.75 mg/cm2) has non- significant reduction. [14]
In conclusion there is very important as well SPF as proper application.

Summary

Although there are many beneficial and essential for life effects of the UV radiation, there are also many disadvantages of the overexposure for the sun. However the most important is the real effectiveness of a sunscreen in reducing biological effects which can caused skin cancer. Education is the key to minimize the morbidity. The use of sunscreen should not be the only protection against sun. It is also very important to wear sunglasses, protective clothing, hat and drink water.

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