Impacts of sun damage and benefits of sunscreen

Abstract

Sun damage is a cumulative process, meaning that every moment of exposure has a long-term impact. Overexposure to the sun's harmful ultraviolet (UV) radiation can cause burns, diseases, and cancers-substantially contributing to mortality rates in fair-skinned populations. The severity of skin cancer is real; there are more new cases of skin cancer than the combined figures for lung, breast, prostate, and colon cancers each year (Bell, 97). Helping to protect against sunburn and skin cancer, sunscreen is a topical product that absorbs or reflects the sun's UV light. This article will address the global impact of sunscreens, while focusing on the scientific/engineering principles of the sun-care product and its effects. It will review some of the recent advances in photoprotection, including the development of broad-spectrum sunscreen and the sun protection factor. Although sunscreens have been around for over 70 years, its health applications are still being explored.

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Rubbing It In: Modern sun-protection

Introduction

Our sun-the most powerful entity in our corner of the universe-is dangerous. Just about everyone comes into contact with its rays every day. Whether you’re outside walking your dog or in a sports arena watching a 3-hour college football game, your skin is at risk. It is well-known that solar radiation is harmful; you’ve probably taken a few precautions in the past to protect yourself from the sun’s intensity by wearing brimmed hats, polarized sunglasses, or high-SPF sunscreens (Figure 2). For many, lathering on sunscreen lotion may seem like a chore. But what exactly are you applying “ liberally” to your body? How much protection does sunscreen really have to offer against sunburn and skin cancer, and how long will these safeguards last? The answers to these questions can be understood when you consider the scientific/engineering aspects behind the $1. 9 billion industry skin-care product: Sunscreen.

A Harmful Sun

Natural sunlight contains, among other things, ultraviolet photon particles of light. These photons are shorter in wavelength and have a much higher energy than visible light, giving it the ability to directly cause DNA damage in skin cells. Ultraviolet radiation is broken down into the following three types of wavelengths:

Ultraviolet, Type A (UVA)

Ultraviolet, Type C (UVC)

UVC (wavelength 100-280 nm) rays are completely absorbed by the atmosphere and never reach us on the Earth’s surface. The UV rays that we

are exposed to consist of UVB (280-315 nm) and UVA (315-400 nm) photons. The shorter wavelength UVB rays cause significant damage to DNA and are the primary cause of sunburn and skin cancer. The longer wavelength UVA rays cause tanning and penetrate the deeper layers of skin. Because UV light falls outside of the visible spectrum (400-700 nm), the human eye cannot perceive them. Humans are also unable to feel UV radiation, and thus, your body has no mechanism to warn itself against overexposure.

The Sun's Effects on Our Skin

Our skin is highly susceptible to critical damage from the sun's ultraviolet rays. Any exposure to UVA or UVB light can alter or damage the skin. Without protection, long-term exposure to natural sunlight inflicts the skin cells, causing them to tan, burn, and peel.

Although a suntan is often considered an emblem of good health, tanning for its own sake has no health benefit and is actually a health hazard (MacNeal). Tanning is your skin's defense mechanism against the sun, and any change to your natural skin color is a sign of skin damage. When exposed to moderate levels of radiation, a chemical reaction in your skin's cell system occurs. Your skin protects its complex structure of sensitive cells by producing a brownish pigment, melanin, which absorbs and reflects UV rays, dissipating the energy as harmless heat. This is one of the reasons you heat up in the sun. Special pigment-producing cells called melanocytes (depicted in Figure 3) manufacture color capsules and send them to the surface of your skin, thus acquiring a " tanned" color.

Dark-skinned people tan quicker because they already have more melanin in their skin. Fair-skinned people burn easier because they have less melanin in their skin to protect against the burning rays of the sun (Kuhta, 6). Although tanning triggers your body's manufacture of melanin, this process takes time-days to weeks-for your body to build up its supply, and if you are in the sun for an extended period of time, burning may occur.

As anyone who has had sunburn knows, this localized skin injury leaves your skin red and extremely painful. When you get sunburn, what you are really getting is cellular damage caused by overexposure to the sun's ultraviolet rays. When you stay out too long, you get burned and your skin gets damaged. To attempt to cool the heated skin area, your blood flow increases. The body sends blood to the surface of the skin so that it can be cooled by evaporation and returned to cool the organs-similar to the way a car radiator system works. Sometimes so much blood is pumped to the surface of the skin that it pushes right through the thin walls of your blood vessels to permeate the other tissues and your skin takes on a reddish color. Your skin's immune system then releases chemicals like histamine and serotonin, which trigger inflammation and additional chemical production. And within twelve hours, skin cells begin to die, and inflammation turns the skin a darker red (Reader's Digest).

Peeling after sunburn is your body's way of getting rid of damaged cells. This abrupt acceleration of the natural cycle of cell replacement causes gobs of dry skin to curl up and flake off (as shown in Figure 4). This process is necessary because the damaged skin cells are at risk of " losing control" and becoming cancerous. Due to this danger, all damaged cells are instructed to

commit “ cell-suicide.” This mass suicide of skin cells results in whole layers of damaged skin peeling off, to be replaced by other cells underneath those layers. Sometimes, the repair mechanisms themselves may be damaged by the UV rays, which prevent the cells from committing suicide in the future and allowing cancerous cells to replicate.

Cancer Risks

Skin cancer, the uncontrolled growth of skin cells, is the most common cancer in the world today, and the number of cases worldwide is growing each year. This year alone, over 1. 3 million Americans will be diagnosed with skin cancer, and one of every five Americans will be afflicted with skin cancer at least once during their lifetime (Bell, 97).

Repeated exposure to UV rays can cause cancerous mutations such as malignant melanoma, the deadliest form of skin cancer. Some parent cells replicate through cell division repeatedly and the inordinate mass they produce is called a tumor. Once started, tumors keep growing in an irregular, shapeless way (Kuhta, 30). Melanoma is a skin tumor that develops in the melanocytes- pigment producing cells in the skin-and has a very high tendency to spread to other parts of the body. A study at the Anerson Cancer Center in Houston, Texas concluded that about one in 105 Americans will develop melanoma, and 20 percent of them will die from it (T. Adler). Interestingly, malignant melanoma has been found more frequently in sunscreen users than in non-users in some studies. This is because some sunscreens block the natural warnings and adaptations mediated by UVB, but allow damage from UVA to go unchecked. By preventing the pain and

redness of sunburn, sunscreen may enable people to stay longer in skin-scorching sunlight, putting them at higher risk for developing melanoma.

Prevention: How Sunscreen Works

Sunscreens with broad-spectrum protection are most effective to protect against sunburn and skin cancer. Many of the sunscreens available in the U. S. today combine several different active chemical sunscreen ingredients in order to provide broad-spectrum protection, which block both UVA and UVB rays. Sunscreens work by absorbing the UV radiation in the chemical bonds of their ingredients. Different brands of sunscreen contain different combinations of active ingredients that work together to minimize the impact of harmful rays of light from the sun. Some of these ingredients will deflect the UV light while others will absorb it.

Most sunscreens work by containing either an organic chemical compound that absorbs ultraviolet light (such as oxybenzone) or an opaque material that reflects light (such as zinc oxide), or a combination of both. This general structure of the principal ingredients allows the molecules to absorb high-energy ultraviolet rays and release the energy as lower-energy rays, thereby preventing the skin-damaging radiation from reaching the skin (Zenitech, 46). Like a screen door, sunscreen filters the light from the sun so that less of it reaches the deeper layers of your skin. The principal ingredients in sunscreens are usually aromatic molecules conjugated with carbonyl groups, which prevent significant chemical change and allow the ingredients to retain their UV-absorbing potency without significant photo-degradation (Zenitech, 48).

As its ingredients absorb UV energy, sunscreens begin to deteriorate and lose effectiveness. Sunscreen must be applied early enough before sun exposure to bind to the skin. In order to be effective in preventing skin cancer and sunburn, sunscreen must be reapplied every two hours regardless of their assigned SPF (PrincetonOL). Sunblock, on the other hand, remains on the surface of the skin to reflect the UV radiation. Its sunblock agents-titanium oxide (TiO2) and zinc oxide (ZnO) -reflect the light away so that it doesn’t reach the skin at all. Since they do not need time to bind to the skin, they are very effective in blocking all types of UV immediately upon application. However, because they remain on the surface, they are subject to removal by perspiration and friction from towels, clothing, or usual daily activities.

The term SPF that appears on sunscreen labels stands for Sun Protection Factor, and is a worldwide standard for measuring the effectiveness of a sunscreen’s ability to prevent UVB radiation from damaging the skin. The higher the SPF, the more protection a sunscreen will provide against UVB radiation and sunburn. For example, if it takes 20 minutes for your unprotected skin to start turning red, using an SPF 15 sunscreen theoretically prevents reddening 15 times longer-about five hours. SPF 15 blocks 93% of all incoming UVB rays, SPF 30 blocks 97% and SPF 50 blocks 99% (The Skin Cancer Foundation). As you can see, no sunscreen can block all UV rays.

Because the SPF only accounts for UVB rays, certain sunscreens may not protect against UVA rays which are known to cause photoaging, wrinkles, brownspots, and melanoma. This curtailed protection is why protecting

against sunburn does not necessarily protect against skin cancer. To deliver true broad-spectrum protection, products must also protect against UVA radiation in addition to UVB radiation.

Conclusion

Despite its dangers to skin cells, the sun is an important ally when it comes to good health. Optimal physical and mental wellbeing requires some exposure to the sun. Ultraviolet light enables the body to produce Vitamin D, a vital substance that works against the formation of tumors and aids in the absorption of calcium. Some scientists have suggested that short periods of unprotected sun exposure are beneficial, as they will enhance the body's Vitamin-D-production capabilities (Kuhta, 40). Not only does sunlight strengthen our physical defenses against disease, but it also enhances our mental/emotional defenses against depression and fatigue. Bell Labs, Inc. has demonstrated sunlight to be a significant factor in maintaining a healthy mood and energy level (Bell, 101).

The scientific/engineering aspects of sunscreen illustrate an impactful solution on a global scale, prolonging the lives of many by rejuvenating dead skin cells to deter skin cancer development. Utilizing chemical properties, sunscreen protects the skin by absorbing harmful UV radiation, effectively screening out the sun's rays. And with new, emerging sun-care technologies such as the Sun Pill™, a convenient daily-dose tablet that has been developed to offer medicinal protection from the sun, we can minimize the sun's harmful effects easily. By practicing routine skin protection, one can aim for a healthy level of sun exposure. Because like most things in life, sunlight is best enjoyed in moderation.