

## STUDY ON PHOTOPROTECTION: THE ROLE OF SUNSCREENS IN PREVENTING ULTRAVIOLET IRRADIATION OF THE SKIN

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### RESEARCH ARTICLE

#### Abstract

*Photoprotection is a set of measures that are applied to protect the skin from the side effects caused by exposure to ultraviolet radiation from natural or artificial sources. The purpose of this study is to highlight the role of solar photoprotection through the use of both cosmetic products and other photoprotective methods and to find out the level of information of the population regarding protection measures against ultraviolet radiation, the main risk factors that should be avoided and the consequences of uncontrolled exposure to the sun and other sources of UV radiation. One hundred people (61 women and 39 men) from the western side of Romania, aged between 18-65 years, were enrolled in a survey between April and May 2021. The recruited people answered a questionnaire consisting of 17 questions. The study shows that the people surveyed are well informed about risk factors (period of sun exposure, skin phototype, medications, diseases), photoprotection measures (SPF creams, appropriate clothing, accessories such as hats, sunglasses) and pathologies that could develop due to uncontrolled exposure to the sun (sunburn, pigment spots, dysplastic nevi, skin cancer, etc).*

**Keywords:** solar radiation, skin photoprotection, skin disorders, questionnaire.

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#### INTRODUCTION

The skin is the largest organ of the body, a conjunctive-vascular membranous tissue that covers the entire body, providing protection against physical, chemical or biological environmental factors (Douglas & Douglas, 2004; Dragomirescu, 2020). One of the most important factors affecting the skin is exposure to the sun, due to the ability of solar radiation to generate energy and free radicals (Solano, 2020). Solar radiation constantly reaches the Earth's surface and therefore the Earth is constantly receiving electromagnetic energy from the sun which includes ultraviolet light (UV, 8%, wavelength 100-400 nm), visible light (Vis, 42%, 400-780 nm) and infrared light (IR, 50%, 780 nm-1 mm), with different impact on the environment and on humans (<https://www.fondriest.com>; Gonzales et al, 2008; Solano, 2020). Radiation with shorter wavelengths has higher energy than longer ones, and that is the reason why the UV radiation is the most harmful to living organisms (<https://www.fondriest.com>; Solano, 2020; Mogollon et al, 2014; Bosch et al,

2015). Ultraviolet radiations of type A (UVA 320-400 nm) and type B (UVB 280-320 nm) reach the Earth's surface in high amounts, while ultraviolet radiation of type C (UVC 200-280 nm) is largely absorbed by the atmospheric ozone layer (Nichols & Katiyar, 2010; <https://www.fondriest.com>).

In the human population, UV radiation is absorbed by various chromophores in the skin (e.g. melanin, DNA, RNA, proteins, aromatic amino acids, etc.), with DNA molecules being the main target of UV radiation. This triggers reactions to destroy these molecules that generate reactive oxygen species, with harmful effects on the body (Gonzales et al, 2008). In recent years, researchers have found increasing evidence to support the view that UV levels are increasing due to stratospheric ozone depletion and climate change (Mogollon et al, 2014).

Clinical manifestations resulting from acute exposure of the skin to UV radiation are erythema (sunburn), edema, stimulation of melanin synthesis (skin tanning) and vitamin D biosynthesis. Chronic exposure to the sun or other sources of ultraviolet radiation can lead to skin aging known as photoaging, which includes multiple skin disorders such as wrinkles,

dryness, immunosuppression, pigment spots or dysplastic nevi, as well as photo carcinogenesis – the development of malignant skin tumors, such as basal cell carcinoma, squamous cell carcinoma and malignant melanoma. While skin aging is a subject of interest only from an aesthetic point of view, skin cancer represents a direct threat to the patient's health. Skin cancer is the most common malignant condition in the white race (Caucasian population) all over the world, and UV radiation is the main factor responsible for triggering such a pathology (Mogollon et al, 2014; Nichols & Katiyar, 2010; Passeron et al, 2020).

The prevention of premature aging of the skin and its consequences is increasingly important for the population, therefore in recent years special attention has been paid to photoprotection. Photoprotection is the set of all measures that are applied to protect the skin from the unwanted effects caused by exposure to ultraviolet radiation from natural or artificial sources. Various strategies can be applied to protect the skin from the harmful effects of the sun's rays. World Health Organization (WHO) recommends wearing sun-protective clothing, sunglasses, sun protection for the head (broad-brimmed hat), avoiding the sun between 10 a.m. and 4 p.m., seeking shade and applying sunscreens (<https://www.who.int/>; Krutmann & Yarosh, 2006; Mogollon et al, 2014; Krutmann et al, 2020; Tsai & Chien, 2022).

The increased mortality and morbidity associated with skin cancer in patients may be caused by lack of awareness, late diagnosis, malignancies discovered at advanced stages, or lack of access and information about sources of photoprotection. The purpose of this study is to highlight the importance of photoprotection through the use of both cosmetic products and other photoprotective methods. The study presents the level of information of population in Western Romania regarding protection measures against ultraviolet radiation, the main risk factors and the consequences of uncontrolled exposure to the sun and other sources of UV radiation.

## MATERIAL AND METHOD

In order to assess the level of awareness of the population to the risks of exposure to UV radiation and the knowledge related to protection methods, a questionnaire consisting of 17 questions was drawn up. The questions were addressed to a number of 100 people of

different ages and belonging to different social categories. The study was carried out between April and May 2021 (Brudar, 2021).

## RESULTS AND DISCUSSIONS

This study encourages not only advising patients in the pharmacy, but also increasing their interest in this subject, so that they will be able to request correct and scientifically validated information about the risks of exposure to sunlight, electromagnetic radiation being the main promoters in many skin pathologies, such as melanoma. Assimilation of vitamin D through exposure to the sunlight should not be confused with prolonged exposure for several hours and especially with exposure during peak hours when UV radiation is strongest. Study participants answered some mandatory questions marked with the symbol „\*” and optional questions without this symbol. Single-answer questions have the symbol ☐ and multiple-choice questions have the symbol ☐, with respondents having the option to mark more than one answer. Some questions had blank fields where respondents could express their answer. The first four questions include the socio-demographic characteristics of the 100 respondents (Brudar, 2021).

*Q1. Please mention your age.* \* The people enrolled in this survey were between the ages of 18 and 65 (Figure 1).

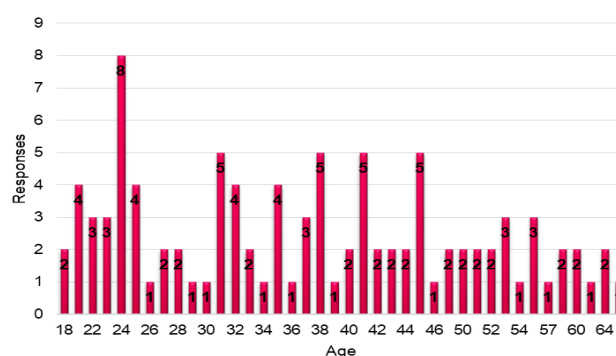


Figure 1 The age of the people surveyed

*Q2. Please specify your gender.* \*

☐ female

☐ male

Of the 100 people, 61 were women and 39 were men (Figure 2).

*Q3. Please specify the social background you come from.* \*

☐ rural

☐ urban

A number of 56 respondents live in urban areas, and 44 in rural areas (Figure 2).

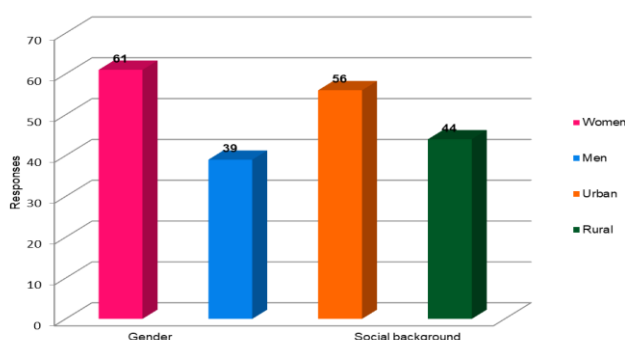


Figure 2 The gender and social background of respondents

Q4. Please specify the last level of education you completed. \*

- ☐ middle school
- ☐ high-school
- ☐ post-secondary school
- ☐ university
- ☐ post-university (master, PhD, postdoc)

The respondents are graduates of higher education (university, post-university) in percentage of 63%, high school 21% and post-secondary education (post-high school) 12%. The fewest (4%) are middle school graduates (Figure 3).

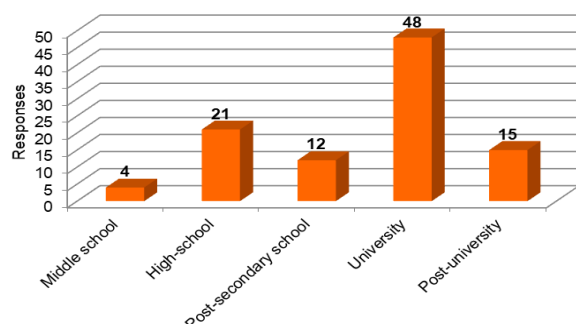


Figure 3 Education level of respondents

Q5. During what hours should you avoid the exposure to the sun? \*

- ☐ 7-11
- ☐ 11-16
- ☐ 16-20

All respondents agreed that between 11:00 a.m. and 4:00 p.m. it is healthy to avoid exposure to solar radiation. None of the people who took the questionnaire checked the intervals 7-11 a.m. and 4-8 p.m. (Table 1).

Table 1

Time to avoid exposure to the sun

Hour interval	Percentage of respondents (%)
7-11	0
11-16	100
16-20	0

Q6. Do you think you are exposed to UV radiation during cloudy times of the day or when you are indoors and the sun's rays come through the window? \*

- ☐ yes
- ☐ no

Regarding the ability of solar radiation to pass through glass or through the layer of clouds, 76 of the people surveyed believe that UV radiation also affects us in these circumstances, and a number of 24 are not informed about this aspect.

Q7. Which of the following factors do you think are responsible for sensitivity to UV radiation? \*

- ☐ skin phototypes
- ☐ the period of exposure to the sun
- ☐ medicines (e.g. tetracyclines, fluoroquinolones, contraceptives, tricyclic antidepressants, sulfonamides, etc.)
- ☐ autoimmune diseases (e.g. lupus erythematosus)

Among the factors responsible for triggering sensitization and possible pathologies, the respondents believe that the exposure period (90 answers) and skin phototype (68 answers) are predominant. Medicines and autoimmune diseases, although equally important, are less well known. Therefore, it is essential when drugs with a photosensitizing effect are dispensed from pharmacies, the patient is warned and informed of these possible consequences (Figure 4).

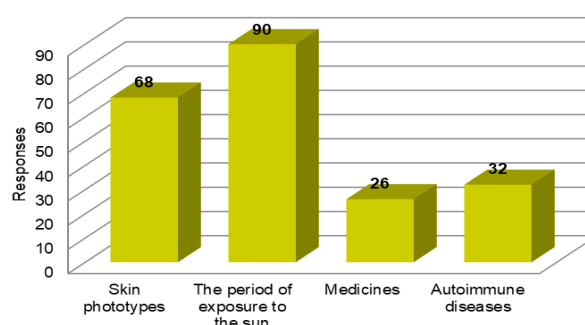


Figure 4 Factors responsible for sensitivity to UV radiation

*Q8. Do you know the main methods of protection against UV radiation (creams with sun protection factor SPF, clothing made of natural material, accessories such as hats, sunglasses with polarized lenses, etc.)? \**

- ☐ yes  
☐ no

Almost all respondents know the methods of protection against UV radiation (97 affirmative answers). This means that people are significantly informed about the WHO's recommendations they can follow to protect themselves from injuries caused by solar radiation.

*Q9. What methods do you follow to protect yourself from solar radiation? \**

The most frequently used methods are sun creams with a high protection factor (57 answers), accessories (45 answers) and appropriate clothing (26 answers). The methods are effective and help prevent serious skin pathologies. A small number of people (5 answers) do not use any protection against solar radiation (Table 2).

a result, may not give the desired result. In addition, it should be emphasized that a number of 35 respondents study the ingredients of the products and give them due importance (Figure 5).

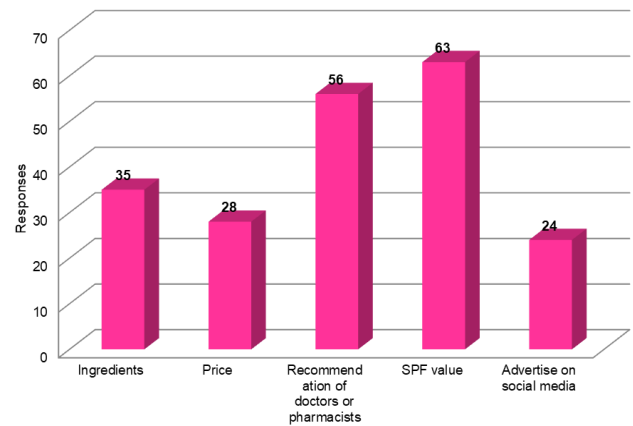


Figure 5 **Criteria for choosing the brand of cosmetic products**

Table 2  
**Methods of protection against UV radiation used by the respondents**

Method of protection	Percentage of answers (%)
Cosmetic products (SPF 30, 50+)	57
Accessories (hat, sunglasses, etc.)	45
Appropriate clothes	26
Avoiding exposure to solar radiation	10
Do not use any protection methods	5

*Q10. What are the criteria you follow when choosing the brand of cosmetic products for sun protection? \**

- ☐ ingredients  
☐ price  
☐ recommendation of doctors or pharmacists  
☐ SPF value  
☐ advertise on social media  
☐ other

In order to choose a photoprotective cosmetic product, the respondents stated that the SPF value is the main criterion (63 answers), followed by the doctor's or pharmacist's recommendation (56 answers). It is also found that advertising on social media and the price of products are taken into account when choosing a cosmetic product, although these criteria do not always provide the proper product to the skin type of the consumer and, as

*Q11. What is your favorite cosmetic brand?*

- ☐ Avene  
☐ SVR  
☐ Bioderma  
☐ La Roche Posay  
☐ Elmiplant  
☐ Gerovital  
☐ Mustela  
☐ Vichy  
☐ Nivea  
☐ Altruist  
☐ another brand

Although this question is not part of the set of mandatory questions, it is useful to establish a link between the brands used and the photoprotective compounds contained in these cosmetics (Table 3). The most frequently used products are those marketed by companies such as Nivea (36 answers), La Roche Posay (35 answers), Bioderma (29

answers), Gerovital (22 answers) and Avene (21 answers), products with a good quality/price ratio. Among the ingredients of these products are various organic filters with photoprotective action, the goal of the companies being the formulation of a product with high photo protective capacity and minimal toxicity for both marine life and humans. Smaller amounts of each photoprotective compound will significantly reduce the toxic effect (Figure 6, Table 3).

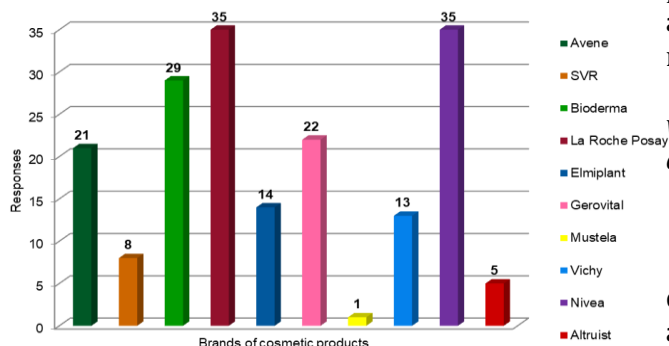


Figure 6 The most frequently brands of cosmetic products used by respondents

Q12. Do you know the risks of prolonged exposure to UV radiation (sun allergies, sunburns, pigment spots, premature aging of the skin, dysplastic nevi, basal cell carcinoma, squamous cell carcinoma, malignant melanoma)? \*

☐ yes

☐ no

The risk of developing various skin pathologies due to prolonged exposure to solar radiation is recognized by a significant proportion of respondents (93 affirmative answers), only 7 of them answering that they do not know such risks (Figure 7).

Q13. Have you experienced or know people who have been diagnosed with skin diseases caused by exposure to solar radiation? \*

☐ yes

☐ no

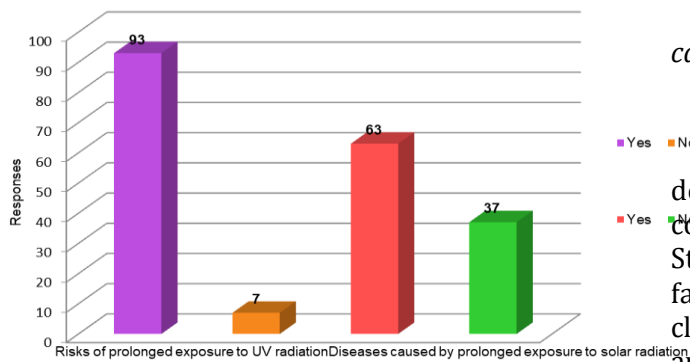
The number of people who have developed a more or less serious skin pathology after exposure to the sun is quite large. Sixty-three respondents (out of 100) stated that they had faced such a situation (Figure 7).

Table 3

The UV filters contained in the cosmetic products most used by the people surveyed

Cosmetic product	UV filters
Nivea Sun Protect Water gel SPF 50+	Ethylhexyl triazone (UVB), diethylamino hydroxybenzoyl hexyl benzoate (UVA), ethylhexyl methoxycinnamate (UVB)
Nivea Sun Protect and Moisture	Avobenzone (butyl methoxydibenzoylmethane, UVA), octocrylene (UVB, UVA), ethylhexyl salicylate (UVB), homosalate (homomenthyl salicylate, UVB), bisdisulizol disodium (disodium phenyl dibenzimidazole tetrasulfonate, UVA)
La Roche-Posay Anthelios Clear Skin Dry Touch Sunscreen SPF 60	Octocrylene (UVB, UVA), ethylhexyl salicylate (UVB), homosalate (homomenthyl salicylate, UVB)
La Roche-Posay Anthelios Mineral Sunscreen SPF 50	Titanium dioxide (TiO <sub>2</sub> , UV)
Bioderma Photoderm Mineral SPF 50+	Zinc oxide (ZnO, UVA), titanium dioxide (TiO <sub>2</sub> , UV)
Bioderma Photoderm Max Aquafluide SPF 50+	Avobenzone (UVA), octocrylene (UVB, UVA), bisoctrizole (2,2'-methylenebis[6-(2H-benzotriazol-2-yl)-4-(1,1,3,3-tetramethylbutyl)phenol], UV), bemotrizinol (tinosorb S, bis-ethylhexyloxyphenol methoxyphenyl triazine UV)
Gerovital Cream Hidra-Protect SPF 50	Ethylhexyl triazone (UVB), diethylamino hydroxybenzoyl hexyl benzoate (UVA), ensulizole (phenylbenzimidazole sulfonic acid, UVB), ethylhexyl salicylate (UVB), bisoctrizole (UV), bemotrizinol (tinosorb S, UV)
Avene Cleanance Sunscreen SPF 50	Iscotrizinol (diethylhexyl butamido triazone, UVB, UVA), avobenzone (UVA), bisoctrizole (UV), bemotrizinol (tinosorb S, UV).





**Figure 7 Understanding the risks of prolonged exposure to UV radiation and diseases caused by prolonged exposure to solar radiation**

*Q14. If "yes" is the answer to the previous question, please indicate the pathologies you have developed.*

The most frequent pathologies mentioned by the surveyed subjects are presented in Table 4. As can be seen, sunburns and pigment spots (22 cases) are the conditions most often faced by patients. These pathologies are closely related since the pigment spots are developed in those areas of the skin that have suffered severe damage due to sunburn. Solar allergy (7 cases) is a pathology that currently has an increasing incidence. If contact with the allergen is stopped at the first signs, it does not have serious side effects. Certainly, the most worrying skin conditions caused by solar radiation are skin cancers (basal cell carcinoma - 1 case and malignant melanoma - 2 cases), some of them with a lethal effect on the patient.

*Q15. Are there cases of dysplastic nevi/skin cancer in your personal or family history? \**

☐ yes  
☐ no

A considerable number of subjects (21%) declared that there are such dermatological conditions in their family or personal history. Studies showed that, along with environmental factors, genetic factors are involved in the clinical manifestations of skin cancer. Family and personal history of skin cancer is often used to assess a person's risk of developing a malignancy. For example, family history of cancer remains associated with an early onset of basal cell carcinoma.

*Q16. If you are a parent, how do you protect your child from solar radiation? \**

- ☐ avoid sun exposure of babies under 6 months
- ☐ apply SPF 50+ cream and avoid sun exposure between 11am and 4pm for young children
- ☐ loose clothes to cover the body as much as possible and a hat
- ☐ children are resilient enough and no additional precautions are necessary
- ☐ I am not a parent
- ☐ other

Accumulated over several years, exposure to the sun can have side effects on the skin and hence the importance of parents knowing the measures that should be taken to protect children from the harmful effects of UV radiation from the time they are newborns.

Table 4

Skin diseases caused by solar radiation	
Pathology indicated by the respondents	Number of cases
Sun burns	11
Pigment spots on the skin	11
Solar allergy	7
Benign moles	5
Solar lentigo	2
Malignant melanoma	2
Insolation	2
Summer glow	1
Lupus erythematosus	1
Basal cell carcinoma	1
Actinic keratosis	1

A total of 44 subjects are parents. They apply sunscreen with high SPF to children and avoid the sun's rays between 11 am and 4 pm (35 responses). Although only 16 parents indicated this answer, it is important not to expose directly to the sun's rays and do not apply protective creams to babies under 6 months. Another method of protection indicated by 28 parents is physical protection through appropriate clothing that covers the body and head (Figure 8).

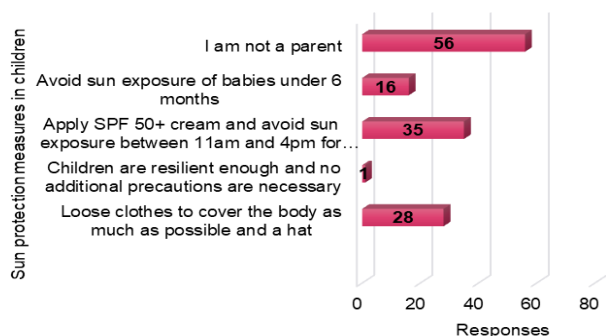


Figure 8 Sun protection measures chosen by parents for their children

Q17. Do you use any artificial tanning methods (e.g. tanning bed)? \*

- ☐ once or maximum 2-3 times a year
- ☐ several times a year
- ☐ once a month
- ☐ several times a month
- ☐ once a week
- ☐ I do not use
- ☐ other

Tanning beds represent a faster tanning alternative and there is a tendency to correlate

## CONCLUSIONS

Many studies show that the intensity of ultraviolet radiation between 10 a.m. and 4 p.m. is much higher than during the rest of the day, and respondents are very well informed (<https://www.who.int/>; Gontijo et al, 2009). Equally important is the fact that ultraviolet radiation is not enough filtered during cloudy periods and can also penetrate through the glass, and therefore it is necessary to protect ourselves even indoors (e.g. in the car, at the office, etc.) and respondents know that (more than 50%).

In order to avoid possible pathological conditions caused by exposure to ultraviolet radiation, it is necessary for the population to be informed about the main risk factors and to

the short period of exposure to radiation with a lower risk. When choosing an artificial tanning method, it is important for patients to know the risks they are exposed to. UVA and UVB radiation emitted by the lamps of tanning devices are often much more intense than those emitted by sunlight, it reaches the entire surface of the skin and is directed exclusively at the body and this procedure might increase the risk of melanoma, pigment spots and photoaging. Among the subjects of the study, 78% do not use any artificial tanning methods and only 9 people use the tanning bed several times during a year (once or a maximum of 2-3 times). Four subjects use the tanning bed monthly and 2 people use it weekly. Self-tanning creams are an alternative that stimulate the formation of a safe tan, but often have a low SPF and offer protection against radiation for a short period of time and therefore the indication is to be associated with other photoprotection methods. A number of 3 people answered that they use such creams (Figure 9).

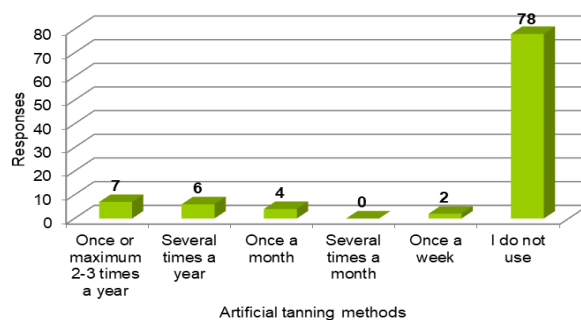


Figure 9 Artificial tanning methods used by respondents

understand the importance of photoprotection. Respondents consider exposure period and skin phototype as the main factors that cause sensitivity to UV radiation, although there are drugs that can cause side effects such as photosensitivity or certain diseases that can be aggravated by exposure to ultraviolet radiation that should not be neglected. These factors can be avoided by knowing the methods of protection; therefore, it is indicated that pharmacists advise the population how to protect themselves from the harmful effect of solar radiation. In addition, counseling the patient in choosing a product with photoprotective action should be a frequent practice in pharmacies, so that the patient obtains the expected result according to the

needs, age and the pathologies he is dealing with.

Respondents also know the main conditions caused by improper exposure to the sun, the most common being sunburns, pigment spots, sun allergies and benign moles. The family history of patients, as well as skin areas that have suffered burns from a young age (under 18 years) can trigger the development of pathologies such as skin cancer. Therefore, the photoprotection measures for children are the responsibility of the parents and it is recommended that they know and implement them.

The use of an artificial method of tanning can be a dangerous means of exposure to ultraviolet radiation because, through the tanning bed, the skin tissue could be exposed to unfiltered radiation and with an even greater intensity than that emitted by the sun between 10am and 4pm. Self-tanning creams used by some respondents have a safer use and a lower risk of side effects (<https://www.who.int/>).

We can conclude that the surveyed population is well informed about the risk factors to be avoided, the photoprotection measures to be applied and the pathology developed due to uncontrolled exposure to the sun.

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