

Suntanning and risk of cutaneous melanoma: a literature review

Sonia R P de Souza^a, Frida M Fischer^b e José M P de Souza^c

^aDepartamento de Medicina Preventiva. Faculdade de Medicina. Universidade de São Paulo. São Paulo, SP, Brasil. ^bDepartamento de Saúde Ambiental. Faculdade de Saúde Pública. Universidade de São Paulo. São Paulo, SP, Brasil. ^cDepartamento de Epidemiologia. Faculdade de Saúde Pública. Universidade de São Paulo. São Paulo, SP, Brasil

Keywords

Melanoma, epidemiology. Ultraviolet rays, adverse effects. Health knowledge, attitudes, practice. Research. Databases, bibliographic. Environmental exposure. Melanoma, prevention & control.

Abstract

Epidemiological studies suggest a relationship between suntanning habits and high risk of melanoma. A literature review was carried out for the period between 1977 and 1998 using Medline and Embase (Excerpta Medica) databases. The analysis showed that intentional sun exposure is highly prevalent among youths, despite their awareness of the risks involved in excessive exposure to ultraviolet radiation and their knowledge on skin protection measures. Intentional exposure is a habit fostered by certain beliefs and attitudes towards suntanning and stimulated by peer pressure and aesthetic referents. The most common tanning practices involve a high risk of developing melanoma. It was concluded that the most effective means to prevent melanoma is mass media dissemination of the concept that having a tanned skin is not healthy – since it implies the skin being damaged by solar ultraviolet radiation – and education campaigns for effectively changing people's behaviors and their motivations.

INTRODUCTION

In the last forty years, the incidence of cutaneous melanoma has shown an increasing trend worldwide.^{18,19,24} In countries such as the United States^{54,55} and Australia,^{19,41} in spite of this increasing trend, the mortality associated to the disease has plateaued or declined. In Brazil, on the other hand, melanoma mortality is still on the rise.^{87,98}

Solar ultraviolet (UV) radiation is well known as a complete human carcinogen.⁵³ Of the skin cancers associated with exposure to this type of radiation, the cutaneous melanoma is the severest, due to its high lethality. Although there have been important advances in treatment, this disease is still responsible for a substantial number of deaths.

Epidemiological studies show a strong association between the development of melanoma and the frequency of episodes of severe skin burns caused by UV

radiation.^{38,46,95} The activity most closely related to the occurrence of this type of skin burn is sunbathing, a resource employed for skin tanning.⁶⁹ Anatomical areas exposed to the highest doses of UV radiation are also the areas most commonly burnt,^{32,41,48} and for which the fastest growing time trends in terms of the development of melanoma can be observed.^{16,34,44}

In addition to the exposure to solar radiation, the exposure to artificial sources of UV has also increased. The practice of artificial tanning is spreading rapidly and is now within reach for a considerable proportion of the population. It is argued that artificial tanning is a secure option, since the lamps employed emit only UVA (ultraviolet A), the longer-wavelength ultraviolet radiation. However, recent studies indicate that UVA is important in the generation of melanoma, acting synergically with UVB (ultraviolet B).⁶⁷ Another practice which results in increased exposure to UV radiation is the use of sunscreen.^{6,93} Recent studies provide evidence for the so-called 'sunscreen para-

Correspondence to:

Sonia R P de Souza
Departamento de Medicina Preventiva
Faculdade de Medicina da USP
Av. Dr. Arnaldo, 455
01246-904 São Paulo, SP, Brasil
E-mail: smalka@uol.com.br

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dox', i.e., people who use sunscreen the most are those who suffer burns more often.⁶⁸ Some authors found a positive association between the frequent use of sunscreen and the development of melanoma.^{7,97}

The behavioral changes that have led to increases in both natural and artificial exposure to UV radiation were, to a great extent, encouraged by the aesthetic valorization of tanned skin. Such valorization resulted in the widespread dissemination of outdoor activities and in the use of clothing that exposed greater areas of the body. An immediate consequence of the adoption of such practices is that more people are exposed more frequently to UV radiation, one of the major etiological agents of melanoma.

Articles published in the 1977-1998 period were identified through digital search in the Medline database. A manual search was also carried out in the *Excerpta Medica* manual, in order to identify studies published in the same period. The main keywords used in the search were 'suntanning', 'sunbathing', 'sun exposure', 'sun protection', 'sunscreen', 'sun related behavior', 'sun awareness', 'sunburn', 'sunburning', 'health behaviour', 'skin cancer prevention', 'tanning lamps', 'sunlamp', 'sunbed', 'indoor tanning', 'tanning bed', 'tanning salon', 'ultraviolet exposure', 'ultraviolet radiation', 'solar radiation', 'ultraviolet dosimetry', 'artificial ultraviolet exposure', 'photoprotection', 'photocarcinogenesis', 'malignant melanoma', 'cutaneous melanoma', 'melanoma epidemiology', 'polymorphism', 'DNA photodamage', 'DNA repair capacity', 'oncogene', and 'Case-Control Studies'. The more recent publications on the subject (from 2000 onwards) were used as sources for other references and for important journals dealing with cancer, dermatology, and epidemiology. Of the articles thus obtained, the most pertinent to the present review were selected based on the quality of the experimental and epidemiological studies on which they were based.

The present review is aimed at establishing relationships between experimental studies of carcinogenicity and UV radiation, epidemiological studies of the risk of melanoma among artificial tanning and sunscreen users, and psychosocial studies of habits and behaviors related to solar exposure and tanning. Furthermore, we intend to discuss possible relationships between the results of epidemiological and psychosocial studies.

THE CARCINOGENICITY OF ULTRAVIOLET RADIATION

The spectrum of UV radiation is divided into three bands of wavelengths, designated UVA, UVB and

UVC (ultraviolet C). The first spectral band, corresponding to the longer wavelengths (315 nm to 400 nm), in spite of its lower efficiency in producing erythema and subsequent melanogenesis, is capable of inducing oxidative processes.^{97,100} When absorbed, UVA reacts with molecular oxygen, producing reactive species capable of inducing inflammatory reactions on the skin and DNA damage.⁷⁵ Since UVB-like cutaneous effects are not distributed uniformly across the UVA spectrum, this band was subdivided into UVA-1 (340-400 nm) and UVA-2 (315-340 nm), the latter being more erythemogenic. The second band comprises the intermediate wavelengths (312-280 nm), more efficient in producing direct DNA damage, photo-immunosuppression, erythema, thickening of the stratum corneum, and melanogenesis.^{97,100} The final band, comprising the shorter wavelengths (280-100 nm) includes the wavelength of maximal absorption by pure DNA, which is 260 nm.^{97,100} However, due to its low penetration in the epidermis, it is not as effective as UVA and UVB in stimulating melanin synthesis.⁷⁵

The two mechanisms by which UV radiation may damage DNA are the direct excitation of DNA molecules, which is predominant during exposure to the UVB region, and the generation of highly-reactive oxygen species, which predominates during exposure to the UVA region.^{83,91} Oxidative damage may be mediated by melanin. Cells previously irradiated, first with low and then with high doses of UVA, showed twice the amount of oxidative damage when compared to cells lacking the first irradiation.⁶²

DNA damage, especially direct damage, is promptly repaired by the nucleotide excision/repair system. Low DNA-repair capacity increases the risk of developing melanoma.⁶³ The presence of certain variants of the melanocortin 1 receptor (MC1R) also increases this risk.⁶⁰

The confirmation of the mutagenicity of UV radiation occurred in 1960, with the discovery of the formation of cyclobutane photodimers after irradiation of thymine with 254 nm waves.²⁹ Subsequent studies identified that which would be the hallmark of UV radiation: the production of point mutations in DNA (at sites containing two adjacent pyrimidines), leading to the formation of cyclobutyl pyrimidine dimers and of pyrimidine-pyrimidone photoproducts.^{29,64} The production of photodimers on the human skin, more specifically in keratinocytes and melanocytes,⁹⁹ can be induced by both UVA and UVB.^{39,99}

One of the loci in which UV-induced mutations have been found is the p53 gene. The most important func-

tions of this gene are stopping the cell cycle at the G1 stage for the reparation of damaged DNA and, when damage is extensive, the induction of apoptosis (programmed cell death).^{46,64} Immunohistochemistry assays detected increased expression of mutant p53 in pre-cancerous lesions,⁷⁰ benign cutaneous tumors,^{1,47,70,79} and non-melanocytic skin cancers.^{47,70} These findings indicate that mutations in the p53 gene would be an early event in the carcinogenesis of cutaneous tumors. In the specific case of melanoma, the results of immunohistochemistry assays vary substantially, from the detection of increased expression of the protein codified by the p53 gene in virtually all samples¹ to a minimal proportion of positive outcomes in the specimens examined.⁷⁹ Such variability indicated that other genes, such as proto-oncogene *N-ras*, and tumor suppressing gene *CDKN2A*, may also be targets of UV-induced mutations.⁵⁷

The first documented study of the induction of cutaneous tumors in animal models by UV irradiation was developed by Findlay,¹¹ in 1928. In the following decades, researchers determined the spectrum for cutaneous carcinogenesis in animals, whose upper limit was 320 nm.¹² More recent studies succeeded at inducing pre-cancerous melanocytic lesions and cutaneous melanoma by irradiating the skin of laboratory opossums (*Monodelphis domestica*)^{65,66} and human skin grafted onto murine models.³ The spectrum for the induction of melanoma was determined by Setlow et al⁸⁴ (1993), using the hybrid fish *Xiphororus* as a model. In the UVB region, the curve was similar to that found for direct DNA damage. Efficiency slowly declines in the UVA region, but levels of induction remain high, suggesting the action of indirect mechanisms.

THE EPIDEMIOLOGY OF CUTANEOUS MELANOMA

Melanocytes are dendritic cells which originate in the neural crest and migrate to the epidermis during embryogenesis. The main function of these cells is the synthesis and transfer of melanin granules to neighboring keratinocytes.⁸⁵ Skin color is partly determined by the type of melanin granules synthesized by melanocytes, which may contain eumelanin (black or brown pigment), pheomelanin (yellow or red pigment), or a mixture of both.⁵⁶

The amount of melanocytes in the epidermis varies according to the anatomical area, the head and forearm being the regions with the highest density of such cells.⁵⁶ External stimuli, such as UV radiation, can induce melanocyte proliferation. In individuals exposed to solar radiation, an increase in melanin

density can be observed in the anatomical areas of greatest exposure.²¹

Proliferative changes in the melanocytic system are classified, from least to most aggressive, as: benign melanocytic nevus, dysplastic nevus, radial growth melanoma, vertical growth melanoma, and metastatic melanoma.⁸⁵

Both the benign melanocytic and the dysplastic nevi are considered as markers of melanoma, and their presence increases the risk of developing the disease.^{9,22,36,81,95} The dysplastic nevus is considered as a precursor lesion of melanoma.¹⁵ Indeed, clinical studies which followed the development of cutaneous lesions have been able to observe the evolution of dysplastic nevi into melanoma.⁸⁶

Melanoma corresponds to the final stage of melanocytic carcinogenesis, in which the genetic instability of initiated cells leads to an increase in their proliferative and invasive abilities.¹⁵ During the evolution of the disease, these cells show increasing aggressiveness, progressing through the stages of radial and vertical growth and into the metastatic stage.³³

Cutaneous melanoma is classified into four clinical-histological groups: *lentigo maligna melanoma*, *superficial spreading melanoma*, *nodular melanoma*, and *acrolentiginous melanoma*. The first subtype accounts for 5% of melanomas in Caucasians, and is more frequently diagnosed in women, subjects older than 60 years, and in anatomical areas more intensely exposed to the sun.^{34,89} The most common subtype among light-skinned individuals is the *superficial spreading melanoma*, which accounts for 70% of all diagnosed melanomas. The predominant anatomical area varies according to age: the disease occurs in areas less exposed to the sun (back, arms, shoulders, legs and thighs) in younger individuals, and in more exposed areas (head, neck) in older individuals.^{34,89} The *nodular* subtype is the second most common amongst Caucasians, accounting for 10-12% of all diagnosed melanomas.⁸⁵ As with the *superficial spreading melanoma*, its anatomical distribution varies with age.^{34,89} The rarest subtype is the *acrolentiginous melanoma*.⁸⁵ This subtype is commonest among individuals of African descent, and predominant anatomical areas are palms, soles, and nailbeds.^{26,34,89}

Prognosis is best for the *lentigo maligna* and *superficial spreading* subtypes.^{8,85} The worst prognosis is associated with age above 60 years,^{8,85} male gender,^{8,67,85} lesions located on the trunk,⁸ thicker tumors,^{8,85} and lower socioeconomic level.⁶⁷

The most important risk factors for the develop-

ment of melanoma include: level of skin pigmentation, presence of multiple nevi, propensity towards the development of ephelides, history of severe sunburns, and skin reactions upon exposure to the sun.^{4,20,27,36,82,94,95}

Other important factors are higher education,^{43,94} high socioeconomic status,^{61,76} non-manual occupations,³⁷ work in offices,^{10,73,88} and outdoor recreation.^{35,52,73}

Population based studies conducted in Denmark,⁷⁴ the United States,³³ and Sweden⁵⁸ found the predominant anatomical areas to be the trunk (men) and lower limbs (women). However, when analyzing temporal trends with respect to predominant anatomical areas, a similar pattern is observed for both sexes: an increase in the incidence of melanoma on the upper limbs and trunk.^{16,18,24,44} Apparently, these changes in the pattern of anatomical distribution of lesions may have been influenced by environmental factors, given that areas more continuously exposed predominate in older cohorts, whereas areas intermittently exposed predominate in younger cohorts.^{18,23,33,34}

The pattern observed in terms of the incidence of melanoma by anatomical area seems to be compatible with the amount of radiation to which a given area is exposed during outdoor recreational activities. Some of these areas, such as the back and shoulders, are the areas that are exposed to the greatest doses of UV radiation during open air activities.^{31,40,48}

The anatomical variation of melanoma incidence, in both younger and older subjects, seems to follow the changes in the distribution of sunburns according to age and sex. Melia & Bulman⁷¹ (1995) observed that, among younger subjects (ages 16-24 years), 66% of sunburns occurred on the back and shoulders and 36% on the head and neck area. Among older subjects, sunburns on the head and neck were more frequent (59%), followed by those on the back and shoulders (18%). No preferential area was observed among younger women. However, among older women, areas most frequently burnt were the head and neck (63%), followed by the upper limbs (46%). These authors also observed that sunburns, especially more severe ones, were more tolerated among younger subjects.

ARTIFICIAL TANNING AND CUTANEOUS MELANOMA

The use of UV-emitting devices for tanning purposes has been expanding quickly in the last few years, especially in industrialized countries.^{38,77} In the United States, the first commercial installation dates

back to 1978. In 1988 there were already over 18,000 tanning centers, with an estimated turnout of two million individuals per day.⁷⁷

The first devices employed UVB-emitting fluorescent lamps. However, the serious risk of erythema and ocular damage associated with this type of radiation led to the substitution of this lamp with other models. Although more recent models emit predominantly UVA, small amounts of UVB are still present.³⁰ A quantitative study of the levels of UVA and UVB emitted by commonly used devices indicated that UVB irradiance ranges between 0.21 and 2.5 times that of solar radiation. In the UVA spectrum, irradiance is two to 13 times greater than that of the sun.⁷² Another study found an irradiance in the UVA1 range 1.3 times greater than, and in the UVA2 region practically equal to, that of the midday sun in the Mediterranean region.⁶⁹

Positive associations between the development of melanoma and the use of artificial tanning devices have been found in studies conducted in the United States, Canada, and Europe.^{5,23,90,92} Major risk factors are annual frequency of artificial tanning sessions, and duration of this practice in years. Apparently, beginning artificial tanning before age 30 results in a greater increase in risk. These studies suggest that the risk of developing melanoma is greater among frequent users who begin earlier in life.^{23,90}

SUNSCREEN AND MELANOMA

An event frequently observed by researchers among individuals who expose themselves to the sun is the 'sunscreen paradox': users of sunscreens with higher sun protection factor (SPF) values were more likely to suffer sunburns. Autier et al (1999),⁶ in a double-blind randomized study, provided subjects with SPF 10 and SPF 30 sunscreen. Sunscreen use was associated with greater frequency and duration of sunbathing, both of which were more critical among subjects given SPF 30 sunscreen (25% higher than the other group). Of the participating subjects, 45% reported at least one episode of sunburn, and 85% reported the occurrence of mild erythema.

McCarthy et al⁶⁸ (1999) also verified that, among sunbathers, those which wore sunscreen with higher SPF values had a greater frequency of sunburns when compared to those wearing lower SPFs or not wearing sunscreen at all.

In a study of sunscreen use among children, Autier et al⁷ (1999) found increased numbers of nevi related to increased exposure to the sun and to use of sunscreen. For the highest levels of exposure, nevus

counts of children who always or almost always wore sunscreen were twice those of children who never wore sunscreen.

PSYCHOSOCIAL STUDIES OF THE BELIEFS, MOTIVATIONS, AND RISK PERCEPTIONS ASSOCIATED TO SUNTANNING

In the Nineteenth Century, the dominant aesthetic standards favored light skin, since it was an indicator of higher socioeconomic status.² Due to the involvement in agricultural activities and other types of physical work, a large share of the population was constantly exposed to the sun and, consequently, had tanned skin. Thus, maintaining a tan was associated with poverty. After the Industrial Revolution, in 1837, more people from the less favored socioeconomic strata started to work indoors, away from the sun, and thus light skin ceased to be such a marked indicator of social status.^{2,59}

As late as the first two decades of the Twentieth Century, tanned skin was still associated with inferior social conditions, and richer individuals struggled to keep their skin light. This effort included avoiding regular exposure to the sun and protecting themselves with hats, umbrellas, and more protective clothing. After the 1920's, this stereotype was reversed, with the adoption, in centers of great influence in the field of fashion, such as France, of tanned skin as the desirable aesthetic standard.⁷⁷ Tanned skin thus became a sign of wealth, an indicator of enough free time and financial resources to dedicate oneself to leisure and to attending summer vacation sites.^{2,59} Since suntanning was no longer undesirable, there was a greater level of engagement in outdoor recreational activities. Sunbathing grew more frequent and clothing became smaller, exposing greater areas of the body to the sun.^{2,77} Two major forces behind these changes in behavior were the diffusion of the fashionable status of suntan in 1929 and the introduction of two-piece swimsuits in 1946.⁷⁷

In Brazil, this change took place during the early 1920's, along with the spread of sports and open air recreational activities.⁴² In the 1930's, tanned skin became a new aesthetic standard, and there was an increase in the frequency of bathing in the sea and swimming pools and the development of the first tanning oils.⁴² During this decade, changes in clothing began to expose areas of the body previously covered, such as legs, arms, chest, and back.

The association of tanned skin with health was partly triggered by the advent of heliotherapy in Europe, still in the first decade of the Twentieth Cen-

tury. This therapeutic practice recommended daily sunbathing as a preventive – or even curative – measure for certain diseases, such as tuberculosis and some cutaneous affections.^{2,59}

Population-wide behaviors regarding tanning are partly nourished by three beliefs: that tanned skin makes people more attractive, that tanning is beneficial to health, and that prior tanning prevents the undesirable effects of future exposure to the sun.^{49,80}

Boldeman et al¹³ (1997) reported more frequent use of tanning beds among subjects who considered themselves as less attractive (RR=1.57 95% CI=1.15-2.15), and that the main motivations behind this use were to obtain a tanned complexion (98%) and to relax / obtain good appearance (84%).

In a population-based study conducted in Canada, artificial tanning users reported the following main reasons for using artificial tanning: improving appearance (56.7%), acquiring of a protective tan (27.6%), relaxing (11.8%), and obtaining a healthy aspect (10.8%).

In a survey conducted by Robinson et al⁸⁰ (1997), 68% of subjects answered that “people have better appearance with tanned skin”. This belief was predominant among white male subjects. The healthy appearance created by tanning was appreciated by the majority of subjects of higher purchasing power.

The maintenance of this type of behavior is influenced by how the person feels and by the qualities he or she appreciates. Such behavior is reinforced by the attitude and opinions of the group with which this person interacts or identifies.^{49,59,96}

In the United States, Hillhouse et al⁴⁹ (1997) found the following predictive factors for intentional exposure to risk (sunbathing, artificial tanning) or for protection (use of sunscreen): the subject's own feeling about sunbathing, the desire to be in accord with aesthetic referents, and the perception of being able to control the behavior. In another analysis, Hillhouse et al⁵⁰ (1996) found that sunbathing was predicted by perceptions of sunbathing as relaxing, while sun lamp use was predicted by more positive views of suntans. Group influence on individual tanning-related behavior was investigated by Keesling & Friedman⁵⁹ (1987). According to these authors, such behavior is influenced by the feeling of relaxation, concerns about appearance, high percentage of peers who sunbathe, positive comments regarding the subject's own suntan, and membership in sports clubs. In addition, for this population, to be tan is related to maintain-

ing a self-image of activity, health, and attractiveness. A similar study conducted by Wichstrom⁹⁶ (1994) found that, among male adolescents, the engagement of peers in sunbathing predicts the subject's own engagement, showing susceptibility to group influence. Concerning self-image, Castle et al²² (1999) observed that young women who sought suntanning described themselves as less complex, philosophical, imaginative, and intellectual, and tended to appreciate these qualities in other people to a lesser extent.

When sunbathing, undergoing artificial tanning, or seeking protection with sunscreen, the individual is evaluating the risks involved in the behaviors adopted in relation to the benefits achieved.⁴⁹ In this evaluation, one tends to give more weight to short-term benefits than to long-term ones. A characteristic trait of individuals that habitually seek tanning is their propensity to adopt risk behaviors, which, in their eyes, are associated with an 'active' personality.⁵⁹ Hence, younger people are those who sunbathe or use sun beds the most,^{71,78,80} and men suffer more burns than women.^{68,71} And, despite having suffered adverse reactions, such people are willing to submit to further exposure.^{14,78} Such individuals, when exposing themselves to the sun, do so for prolonged periods and during the hours in which the risk of erythema is highest (from 10 a.m. to 4 p.m.).^{6,14,49,68,80}

Risk behavior was evaluated by Keesling & Friedman⁵⁹ (1987), in a study conducted among beachgoers. These authors observed that exposure to the sun was associated with deriving high personal rewards from risk taking. According to the authors, frequent sunbathers would be persons used to taking risks, and who would not change their behavior even after alerted about the risk of developing skin cancer. Castle et al²² (1999) observed that, in the 16-19 years age group, the perceived benefits of tanning had greater weight than the costs related to such behavior.

Rhains et al⁷⁸ (1999), in a population-based study conducted in Canada, found that the majority of artificial tanning adepts were youngsters, who, even after experiencing adverse reactions, did not intend to abandon the habit. In Scotland, when analyzing the profiles of costumers of artificial tanning centers, McGinley et al⁶⁹ (1998) found that most of these costumers were youngsters. In this study, skin phototypes I and II accounted for 38% of subjects, and a similar proportion reported adverse reactions after using sun beds. The most common usage pattern included 50 yearly sessions (31%), although a significant proportion of users (16%) had more than 100 sessions per year.

Risk behavior can be observed even among individuals at high risk of developing melanoma. Brandberg et al¹⁴ (1996) followed the behavior of subjects with phenotypes indicative of dysplastic nevus syndrome for a 30-day period and found that 84% of these subjects practiced sunbathing for tanning purposes; of these, 61% suffered at least one episode of sunburn. Subjects who suffered from sunburns reported more frequent sunbathing and longer periods of exposure to the sun.

Another characteristic of tanning seekers is poor perception of the risk involved. In the study by Douglass et al³² (1997), only 26% of phototype I subjects considered themselves at high risk of developing skin cancer. Hillhouse et al⁵⁰ (1996), in a study conducted among university students, found that 50.8% of subjects reported their own phototypes as darker than those determined by the researchers. An optimistic bias was also detected by Clarke et al²⁵ (1997). These authors found that subjects, when evaluating their own risk, saw themselves as having a lower risk of developing skin cancer, of developing it at a younger age, and of losing years of life.

Even though women expose themselves more to the sun, they also protect themselves better, have a better perception of risk, and are more likely to change behaviors when compared to men. Douglass et al³² (1997) found that, although women reported severe skin burns more often than men, 67% of women had had less burns at the time of the study than at age 15 years. Among men, no change was observed in the frequency of burns. The low perception of their own risk and the lesser likelihood to change behavior would explain the greater frequency of burns among men. When studying a sample of beachgoers, McCarthy et al⁶⁸ (1999) found that 75% of men and 43% of women were sunburnt upon leaving the beach.

The difference in risk perception observed between genders does not occur between different social strata. Successive exposure is reported to an equal extent by subjects of greater and lesser purchasing power, with variations only in terms of the circumstances of this exposure. Individuals of higher socioeconomic status and with higher educational level are more likely to burn themselves during leisure activities, whereas those from lower strata tend to do so during labor-related activities. Melia & Bulman⁷¹ (1995) found that, among non-manual workers, 14% of sunburns were related to sports, whereas among manual workers, only 8% of burns were related to such activities. Robinson et al⁸⁰ (1997) found that prolonged exposure to the sun during weekends was associated with higher income and indoor labor, and

that prolonged exposure during weekdays was associated with lesser schooling and outdoor labor.

FINAL CONSIDERATIONS

Adolescence is marked by low perception of risk, strong peer influence, excessive concern with appearance, and greater tolerance of severe sunburns. These factors, combined with the strong appeal of the suntan aesthetics still in vogue, lead to the adoption of behaviors that result in excessive solar exposure. This exposure is due not only to the desire to acquire a tan, but also to a lack of concern with skin protection during daily activities. Episodes of severe sunburn, combined with excessive exposure to the sun during childhood and adolescence, are associated with a high risk of developing cutaneous melanoma. Holly et al⁵¹ (1995) found a high risk of developing melanoma in association with frequent episodes of severe sunburn before age 30 years (OR=2.1 (95%CI=1.4-3.1) during childhood, OR=2.7; (95%CI=1.8-4.1) during adolescence, OR=2.7 (95%CI=1.6-4.6) from 18 to 22 years, and OR=2.7 (95%CI=1.5-4.8) from 23 to 30 years).

Substituting artificial tanning for suntanning in order to obtain or maintain a "healthier", "more attractive" complexion is related to an increase in risk, since it leads to increased exposure to UV radiation and to the exposure of individuals with higher risk phototypes. Studies show that the risk of developing melanoma is greater for habitual users, users that begin at an earlier age, and who practice artificial tanning for longer periods. Autier et al⁵ found a 1.77-fold risk for frequent users when compared to subjects who never used artificial tanning.

Although some case-control studies suggest that frequent use of sunscreen reduces the risk of developing melanoma,²⁸ other cross-sectional^{71,73} and experimental^{6,7} studies indicate that sunscreen users have a greater incidence of erythema, especially of the severe type. This apparent inconsistency between different types of study may indicate a different pattern of sun exposure between sunscreen users nowadays and in former times. In the past, when the use of

tanning oils was encouraged, it is possible that individuals who wore sunscreen also adopted other protective behaviors. Currently, the use of sunscreen is associated with the possibility of remaining under the sun for longer periods.

Campaigns centered on the divulgation of risks and on encouraging people to protect themselves and to avoid exposure to the sun during peak hours apparently increase knowledge among youngsters; they do not, however, promote any changes in behavior. In the study conducted by Hillhouse et al⁴⁹ (1997), most youngsters practiced sunbathing, despite the high level of knowledge of risk and forms of protection detected among these subjects.

Those responsible for forming the opinions of youngsters and for divulging behavior patterns among this public, when overrating tanned skin and presenting sunbathing – be it on the beach or swimming pool – as something pleasurable, no matter the time of the day or the total period of exposure, stimulate exposure to the sun and discourage practices aimed at protecting the skin from the sun.

In Australia, one of the countries with highest incidence of cutaneous melanoma, there has been a reduction in the exposure of individuals to the sun. However, this reduction is the result of many years of campaigns and effective actions aimed at increasing protection against the sun. In schools, recreation areas are covered by trees or buildings and the use of clothing and hats is encouraged. In fashion magazines, there is a greater frequency of models with natural skin color.

In the same way as there are campaigns aimed at discouraging smoking, due to the health hazards related to this behavior, there should also be similar campaigns addressing excessive exposure to the sun. Divulgation of the concept that tanned skin is not healthy – since it is skin that has been damaged by solar ultraviolet radiation – and the implementation of campaigns capable of effectively modifying people's behaviors and the motivations behind them, may yield profits for the generations to come.

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