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Perspectives in melanoma prevention: the case of sunbeds

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Abstract

The incidence of cutaneous malignant melanoma (melanoma) and of basal cell carcinoma is still increasing in most fair-skinned populations. The fashion of intermittent exposure to solar ultraviolet (UV) radiations is considered the main cause of this increase. In 20 years time, tan acquisition through exposure to artificial sources of UV radiations has become frequent among fair-skinned adolescents and young adults. Modern sunbeds are powerful sources of UV radiations that do not exist in the nature, and repeated exposures to high doses of UVA constitute a new phenomenon in humans. A large prospective cohort study on 106,379 Norwegian and Swedish women conducted between 1991 and 1999 has provided evidence for a significant, moderate increase in melanoma risk among regular sunbed users. Failure of past case-control studies to document with consistency the sunbed-melanoma association was probably due to a too short latency period between sunbed use and melanoma diagnosis, and to too few subjects with high total durations of sunbed use. Regulations of sunbed installation, operation and use should become standardised across the 25 European Union countries. Enforcement of regulations in tanning parlours remains inadequate. In contrast, the existence of regulations is presented by many tanning salon operators as a guarantee that sunbed use is safe. We stress the need for the control of information disseminated by the ''tanning industry'' on suppositions that sunbed use is safer than sun exposure, and on the hypothetical health benefits of tanning. New fluorescent UV lamps are proposed that have a spectrum similar to the midday sun. Given the known association between intermittent sun exposure and melanoma, public-health authorities should reconsider the soundness of the commercialisation of these lamps.

Keywords: Melanoma; Skin cancer; Ultraviolet radiation; Epidemiology; Prevention

1. Introduction

The incidence of cutaneous malignant melanoma (melanoma) has steeply increased in the past 50 years in most fair-skinned populations. For instance, from 1970 until 1997, a 2.5-fold increase in melanoma incidence was observed in Finland, and a 3.6-fold increase in White Americans [1,2]. From 1979 until 1998, a 2.4-fold increase was observed in Scotland [3], and from 1980 and 2000, a 2.8-fold increase was estimated for France [4]. Risk factors for the basal cell carcinoma (BCC) are similar to risk factors for melanoma [5]. The incidence of BCC is also increasing sharply in most fair-skinned communities, mainly in females [6].

The fashion of intermittent sun exposure that took place after 1950 is considered as the main cause of the increases in melanoma and in BCC. The depletion in ozone observed in the stratospheric layers of the atmosphere is not likely to contribute to the raising incidence of these skin cancers. The ultraviolet (UV) radiation is deemed to represent the part of the solar spectrum involved in the genesis of melanoma [7]. In spite of increasing knowledge on the association between sun exposure and the considerable rise in skin cancer incidence, exposure to artificial sources of UV radiation has become popular in all fair-skinned populations around the world. These artificial sources of UV radiation have various

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denominations, e.g., tanning machines, UVA-tanning devices, indoor tanning, sunbeds, and solarium. The sunbed fashion could contribute to the increase in skin cancer occurrence, in particular, of melanoma [8].

In this paper, we delineate the public-health issues involved in sunbed use in 2004, and we stress the need to promote actions going beyond the regulations of sunbed use, especially actions aiming at controlling the information disseminated by the "tanning industry" on supposed safety and hypothetical health benefits of sunbed use.

2. Sunbed use is an intentional sun exposure behaviour

The melanoma epidemic affects mainly skin areas usually covered by clothes, like the trunk, shoulders and limbs, while lower increases in melanoma incidence are observed on the more chronically sun exposed body sites, like the head and neck [3,9]. Likewise, the increase in BCC incidence is mainly observed on body sites that are not chronically exposed to sunlight [6]. This epidemiological feature points to the role attributed to the intermittent sun exposure in the genesis of most melanoma and BCCs. The most intense form of intermittent sun exposure is the intentional sun exposure (ISE) that is essentially motivated by the acquisition of a tan or by the possibility to go uncovered in the sun [10]. During ISE, significant portions of the trunk and of the limbs are generally uncovered. Sunbathing and sunbed use are the most typical ISE behaviours, and people attracted to sunbathing activities are also more attracted to indoor tanning [11].

In Europe, the sunbed fashion follows a strong South-to-North gradient. The sunbed fashion started in the 1980s in the Nordic countries and extended in more Southern countries in the 1990s. Surveys in Europe and North America indicate that between 15% and 35% of women, and between 5% and 10% of men 15–30 years old have used sunbeds [12–14]. In Sweden, after 1995, 70% of females and 50% of males 18–50 years old reported sunbed use [15,16]. In the late 1990s, the indoor tanning fashion rapidly extended to Mediterranean areas like the north of Italy [17,18]. In the State of Victoria, Australia – a sunny area with high records of skin cancers – 9% of subjects 14–29 years old reported sunbed use in the past years [19]. A substantial proportion of sunbeds are used in private facilities. In Germany or Nordic countries, home-made solaria are not uncommon.

3. The role of UVA and UVB in melanoma occurrence is still unknown

At present, there are no scientific data indicating that intentional exposure to UV radiations emitted by sunbeds is less harmful than intentional exposure to sunlight.

The UV radiation reaching the earth's surface comprises UVB (280–319 nm) and UVA (320–400 nm) radiations. During a sunny day on the Mediterranean coast, the solar UV spectrum at noon contains approximately 5% of UVB and approximately 95% of UVA. UVB is far more efficient than UVA at inducing the synthesis of melanin, and producing a deep, persistent tan. UVB is also 1000 times more potent than UVA at inducing skin erythema (painless skin reddening) or sunburn (painful skin reddening, sometimes with blisters).

Until end of the 1980s, UVB was considered as the carcinogenic part of the solar spectrum, and a shift in usage occurred towards low pressure fluorescent tubes emitting essentially in the UVA range, yielding the so-called "UVA-tanning".

At the end of the 1980s, UVA was also suspected of having carcinogenic potential. In 1992, the International Agency for Research of Cancer classified UVB and UVA radiations, as well as sunbeds, as "agents that are probably carcinogenic to humans" (group 2A of the IARC classification of carcinogenic agents) [7].

Biological mechanisms by which chronic sun exposure causes squamous cell cancer (SCC) of the skin are better known (e.g., the UVB-induced mutations found in the *p53* gene). In contrast, we still have a poor knowledge of the biological mechanisms by which solar radiations are involved in the genesis of melanoma and BCC in humans.

3.1. Long-term health effects of high UVA doses are unknown

In large powerful tanning units, the UVA irradiation intensity may be 10–15 times higher than that of the midday sun [20]. When UV output is calculated in terms of biological activity, as estimated by the erythema-effective irradiance, the emission of many sunbeds is equivalent or surpasses the emission of the midday sun on the Mediterranean Sea [20,21]. Such powerful sources of UVA radiations do not exist in nature, and repeated exposures to high doses of UVA constitute a new phenomenon in humans. If the role of UVA in melanoma occurrence is uncertain, the UVA doses per unit of time received by the skin during a typical sunbed session are far higher than what is experienced during daily life or during sunbathing. We have little idea of the likely long-term medical consequences of such exposure. Worries are further reinforced by knowledge that UVA penetrates deeper than UVB into the skin. A recent study discovered DNA lesions typical of UVA action in the basal epithelial layer of the human skin, the skin region where most melanocytes are situated [22].

3.2. The questionable concept of "UVA-tanning"

The term "UVA-tanning" is misleading, as the output of a sunbed equipped with low pressure fluorescent lamps always contains some UVB, which is critical for the induction of a deep, persistent tan. In addition, most of the DNA damage observed in the skin of sunbed users is due to the fraction of UVB emitted by the fluorescent lamps [23].

In the 1990s, regulations in some countries (e.g., Sweden, France) limited the maximum proportion of UVB in the total UV energy output of sunbeds to 1.5%. However, in the real world, the UV output and spectral characteristics of sunbeds vary considerably. The proportion of UVB in UV energy output could vary from 0.5% to 4% [24,25], and may attain an emission spectrum similar to the sun spectrum in the UVB range [20]. These differences are due to sunbed design (e.g., the numbers and type of fluorescent tubes, the presence of high-pressure UV lamps, the materials of the filters, the distance from the canopy to the skin), to sunbed power, and to tube aging.

3.3. Sunbed-induced sunburns

Sunburn experience during childhood or during adulthood is a risk factor for melanoma, and the risk increases with increasing numbers of sunburns [26]. Skin erythema or burns are reported by 18–55% of sunbed users [12,13,16,27]. Although UVB is more potent than UVA for triggering sunburn, high fluxes of UVA are capable of inducing skin erythemal reactions after 10–20 min in a subject who is naturally susceptible to sunburns and having moderate tanning ability (i.e., Fitzpatrick skin phototype 2). The same subject engaging in unprotected sunbathing in the midday sun would incur an erythemal reaction after 20 min.

The high frequency of sunburn experience by sunbed users shows that sunbed use is very close in nature to sunbathing, and there is no reason to believe that sunburns experienced during sunbed sessions would convey less melanoma risk than sunburns experienced during sun exposure.

4. Epidemiological data on sunbed use and melanoma

As there is no valid animal model for human melanoma, and because we are still ignorant about the effects of UV radiation(s) and melanoma occurrence, the study of any eventual link between sunbed use and melanoma left to epidemiological investigations.

Seven epidemiological case-control studies specifically addressed the possible association between increasing amounts of sunbed use and melanoma [12,15,28–32]. Two reviews concerning six studies [33,34] concluded that some data raised the possibility of a moderate positive association between sunbed use and melanoma. However, overall, the results lacked consistency and no conclusive evidence could be drawn from these six studies on the influence of sunbed use on melanoma occurrence. A seventh case-control study conducted in the UK explored sunbed use before 1989 [32]. It showed no dose-response relationship between amounts of sunbed use and melanoma.

In 2003, MB Veierød and co-workers published the results of a prospective cohort study of 106,379 women in Norway and Sweden who were followed for an average of 8.1 years from 1991 until 1999 [26]. During the follow-up, 187 cases of melanoma were diagnosed. After adjustment for intermittent sun exposure and host characteristics, the study found a 55% increase in melanoma risk (95% Confidence Interval: 4–132%) among the 18% of women aged 10–39 years old who reported having used sunbed at least once a month when they were 10–19, 20–29 or 30–39 years old. An increase in melanoma risk was observed for all age groups, from 20 to 49 years old. Twelve sunbed sessions per year correspond to the 12-session tanning programme proposed by many commercial tanning facilities. Hence, the results of the Norwegian–Swedish study were consistent with the existence of a moderate association between regular sunbed use at least once a month and melanoma occurrence.

5. What are the differences between the Norway–Sweden and case-control studies?

5.1. Methodological limitations of case-control studies

In the seven case-control studies, exposure to sunbeds was assessed retrospectively, and compared between patients with melanoma (i.e., the cases) to subjects without melanoma (i.e., the controls). These case-control studies could suffer from three limitations:

1. Case-control studies are not optimal designs for demonstrating an increase in Relative Risk when additive risks are small, i.e., an estimated Relative Risk of between 1.00 and 1.99.
2. The answers of melanoma patients on their past sunbed use could be biased because, at the moment of the interview, they knew they had a melanoma (interview bias).
3. The selection of controls may have included subjects more inclined to have had more sunbed use than average (selection bias).

The Norwegian–Swedish study was a longitudinal cohort design. Sunbed use was assessed retrospectively, but before any diagnosis of melanoma. So, the

Norwegian–Swedish study was less prone to interview and selection biases at the inception of the cohort. In addition, prospective cohort studies on large numbers of subjects are more powerful designs than case-control studies, and are thus more appropriate to reveal the existence of moderately elevated risks.

5.2. Changing emission spectrum, latency period and accumulated UV doses

Apart from methodological issues, the negative results of the case-control studies could be due to the following factors:

1. The UV lamps changed over time. Up to the mid-1980s, arc mercury lamps having an emission spectrum rich in UVB (and even UVC) radiations were commonly used as a substitute to the absence of sunshine, e.g., for the synthesis of vitamin D in children. Hence, eventual carcinogenic effects could be attributable to exposure of children to these arc mercury UV lamps, and not to modern tanning devices.
2. The latency period between exposure to artificial UV sources and melanoma occurrence is probably several decades [11]. Five of the seven case-control studies examined sunbed use before 1990, and were conducted in countries where the indoor tanning fashion was still in its early phase. The latency period may be the main reason why case-control studies yielded inconsistent results, since sunbed use was not frequent before 1985.
3. Only a few subjects included in the case-control studies had more than 20 h of cumulative sunbed exposure.

How the Norway–Sweden study addressed these factors?

1. In 1983, commercialisation of arc mercury lamps was banned in Norway and Sweden. A further analysis of the Norway–Sweden study showed that the increased melanoma risk associated with sunbed use was not due to the use of UV lamps before 1983 [35].
2. Women who participated in the Norway–Sweden study were 30 years old or more at cohort inception. The highest melanoma risk was found in women who used sunbeds at least once per month when they were 20–29 years old [increase of 158% (95% CI: 48–350%)]. Lower melanoma risks were found for sunbed use at least once a month during the third or fourth decade of life. This result supports the hypothesis that there is a latency period. In the Nordic countries, the sunbed fashion is popular since the late 1970s, and rates of sunbed use in those countries are the highest in the world. Furthermore, women are approximately two times more inclined than men to utilise sunbeds. Hence, it is probable that the risk of melanoma associated with sunbed use started to become apparent in the Norway–Sweden study in women.
3. The Norway–Sweden study showed that before 1992 18% of the study women used sunbeds at least once a month over 10 years, what is equivalent to at least 40 h of cumulative sunbed use, if one assumes a duration of 20 min for a typical sunbed session.

In conclusion, the results of the Norway–Sweden study are consistent with the existence of a 55% (95% CI: 4–132%) increase in melanoma risk associated with 40 h or more of sunbed use. Further follow-up of the cohort will inform us about the trends in melanoma risk according to amounts of sunbed exposure.

5.3. Are 40 h of sunbed use equivalent to 40 h of sunbathing?

Over a 10-year period, the duration of sunbathing activities may exceed 400 h in suntan enthusiasts. So, how significant are 40 h of sunbed use, compared with 400 h of sunbathing? In fact, durations of sunbed use and of sunbathing are not readily comparable because:

- We do not know if sun exposure or sunbed use would influence melanoma occurrence by acting through the same biological mechanisms.
- If the UVA dose is the key element, then 20 min of sunbed exposure represents a UVA dose equivalent to 2–3 h of sun exposure in the summer midday sun, but the dose rate of UVA received per unit of time by skin cells is 5–10 times higher than that in the sun.
- The erythemal effectiveness of sunbed use is approximately two times that of the midday sun. If sunburns are key indicators of biological events implicated in the genesis of melanoma, then 20 min spent under a sunbed could have the biological significance of 40 min of sunbathing in the summer midday sun.
- Sunscreens are often used during sunbathing, with the net result for suntan worshippers that sunburn occurrence is delayed, and time spent in the sun is longer [36].
- Sunbathing may take place when the sun is less bright, for instance at the end of the afternoon.

So, with our current state of knowledge about the relationship between UV radiations and melanoma, one should be cautious when comparing durations of sunbathing with durations of sunbed use.

6. Skin cancers other than melanoma

Two case-control studies examined past exposure to sunbeds in patients with non-melanoma skin cancer.

One found no association [37]. Another found positive associations between sunbed use and SCC and BCC [38]. In the latter study, the estimated Relative Risk associated with sunbed use was 2.5 (95% CI: 1.7–3.8) for SCC and 1.5 (95% CI: 1.1–2.1) for BCC. These findings are in line with data on non-melanoma skin cancers in patients affected by severe psoriasis and treated with PUVA therapy (a combination of UVA irradiation and oral psoralen).

7. Regulations of commercialisation, installation, operation and use of artificial tanning devices

Since 1990, many countries have issued specific rules for sunbed installation, operation and utilisation. There is a wide variation in the content of these rules. In the European Union, there is no standardisation of regulations on sunbed commercialisation and use. In some countries (e.g., in the UK, Canada and the Netherlands), recommendations are formulated by, or in association with the sunbed industry, or organisations of professional sunbed operators. In the US, the Food and Drug Administration provides standards only for the manufacturing of tanning devices, and regulations for operation and utilisation vary considerably across the States.

An important achievement of regulations is the requirement for better information for consumers, as well as the wearing of protective eyewear to protect the eyes. Table 1 presents a list of criteria that should prevent individuals to use sunbeds. In some countries (e.g., in France), training of commercial tanning facilities is mandatory, and tanning machine operators are instructed to refuse access to the sunbed to the consumer meeting at least one criteria listed in Table 1. The need to have trained operators has prevented the multiplication of automated tanning parlours, working without the surveillance of an operator.

However, regulations and recommendations to consumers are not a panacea because:

1. Their enforcement remains a challenge.
2. They do not apply to the private use of sunbeds.
3. They do not reflect the numerous uncertainties we have on the association between UV exposure and skin cancers, or other UV-induced lesions like the premature skin aging and eye lesions.
4. Their potential impact on hazards associated with sunbed use is probably marginal because after all, they do not prevent individuals from receiving high doses of UV radiation.
5. Indoor tanning operators take advantage of the existence of regulations for asserting that sunbed use is secure.

8. The tanning industry and the concept of "safe tan acquisition"

8.1. The tanning industry

The "tanning industry" can be understood as all commercial activities developed around the behaviours of intentional sun exposure, for tan acquisition or for other reasons like the search of well-being. Products promoted and sold by the tanning industry comprise sunscreens, a variety of oral preparations deemed to increase the resistance to UV aggressions or to facilitate tan acquisition, swim suits permeable to UV radiations, and the use of non-solar sources of UV presented as safe

Table 1
Criteria that should prevent sunbed use*

1. To be less than 18 years of age.
2. To be pregnant.
3. To suffer from a febrile episode.
4. To suffer from significant eye vision impairment.
5. To have red hair.
6. To have melano-compromised skin, i.e., when the skin always sunburns with no ability to tan or has a high susceptibility to sunburn with a poor ability to develop a tan.
7. To have a family history of eye or cutaneous melanoma.
8. To have large numbers of naevus (mole), in the order of more than 30 moles $\geqslant$ 2 mm on the whole body, or one or more naevi larger than 5 mm.
9. To have a tendency to have freckling developing on the face when going in the sun.
10. To have a history of frequent sunburn during childhood or during adulthood.
11. To have pre-malignant (e.g., solar keratosis) or a history of malignant skin lesions.
12. To have a sun damaged skin (wrinkles on the face, or irregular pigmented skin areas on the face and arms).
13. To wear cosmetics. Cosmetics may enhance sensitivity to UV exposure.
14. To be taking medications. Medications may increase sensitivity to UV, and may sometimes lead to severe health complications (e.g., extensive skin burns). Individuals should seek advice from their physician to determine if the medication will make them UV-sensitive.

* After World Health Organisation (WHO) 2003 (60) and International Commission on Non-Ionizing Radiation Protection (ICNIRP) 2003 (8).

alternatives to sunlight. The tanning industry has elaborated a large part of its marketing strategies around the concept of "safe tan acquisition", that is the acquisition of a tan without incurring (or with incurring less) detrimental effects of UV exposure, mainly sunburns, skin cancers, and skin aging.

8.2. The dubious concept of "regulated" or "controlled" tan acquisition

For promoting the idea of the possibility of "safe (or safer) tan acquisition", the sunbed industry has invented the concept of "regulated" or "controlled tanning", as opposed to beach tanning that would be "unregulated" or "uncontrolled" [39,40]. "Controlled" tan acquisition would be safer than sunbathing because of the constancy of several UV-exposure criteria, like, for instance, a constant UV intensity in wavelength and in time. In hot countries, like Italy and Australia, the "controlled tan acquisition" concept is used for convincing consumers that sunbed use represents a good substitute to beach sunbathing.

But the perilous assertion that "controlled" tan acquisition would be less aggressive than 'uncontrolled' tan acquisition is not supported by laboratory experiments, it contradicts recent findings in basic science, and denies epidemiological and behavioural data:

1. Subjects attracted by indoor tanning are also attracted by sunbathing [11]. Hence, for most sunbed users, amounts of indoor UV add to amounts of outdoor UV, with possible interactive processes that could further increase the melanoma risk. In addition, the weak photoprotection against sunburns afforded by a sunbed-induced tan may encourage longer stays in the sun [41].
2. Surveys continually show the ignorance of tanning parlours operators and the lack of enforcement of basic utilisation rules [42–45].
3. DNA damage that is detectable after sunbed exposure is comparable to DNA damage induced by exposure to natural sunlight [46].
4. Tan induction is rather an indicator of skin aggression with DNA damage than a marker of skin photoprotection [47,48].
5. The recurring induction of melanin synthesis could be involved in skin carcinogenesis [49,50].
6. Sunbed use causes sunburns in 18–55% of users, and these acute skin reactions are associated with melanoma and BCC occurrence.
7. The UVB fraction present in the sunbed emission spectrum may still have detrimental effects on the skin.
8. We have no knowledge about the long-term effects of repeated exposures to high UVA doses mixed with some UVB.

8.3. The questionable photoprotection properties of "pre-vacation tan"

The tanning industry and many sun-enthusiasts allege that a "pre-vacation tan" acquired through sunbed use would confer protection against sunburns and other deleterious effects of the sun. But photoprotection against sunburns and DNA photodamage afforded by the facultative pigmentation induced by tanning under the sun is very low, just equivalent to a sun protection factor (SPF) 3 sunscreen [51]. The tan induced by UVA-tanning provides practically no photoprotection [52]. The moderate skin thickening induced by sunbed use would afford even less photoprotection than tanning [53]. Increasing numbers of laboratory data show that a pre-vacation tan offers only little protection against sun-induced DNA damage [41,54,55].

9. New threats on the horizon

9.1. The UV-lamps rich in UVB radiation

Recently, new fluorescent lamps that have an emission spectrum resembling the emission spectrum of the midday sun have been introduced into the market. Exposure to these lamps enables a faster acquisition of a deep tan. Exposure to UVB-rich lamps is similar to intentional sun exposure in the midday sun, and is thus likely to convey the same risk of skin cancer. Given the known association between intermittent sun exposure and melanoma, public-health authorities should reconsider the soundness of the commercialisation of these lamps.

9.2. Age of sunbed users

Age of sunbed users is a new concern: in Sweden, sunbed use is popular among adolescents 14–17 years old [56]. A large survey in 2004 in the schools of Lanarkshire (UK) showed that 7% of children 8–11 years old had used a sunbed [57]. This phenomenon is also observed in Australia [58]. Most countries do not have regulation on a minimal age for indoor tanning [59]. Childhood and adolescence are periods of greater biological vulnerability to UV radiations, and thus prohibition of the use of tanning devices before 18 years old seems wise [8,60].

9.3. The hypothetical health benefits of UV radiations

The subtlest position for the defence of indoor tanning is the recognition of good and bad effects of indoor tanning, but that finally, good effects would outweigh bad effects. The good health effects attributed by the tan-

ning industry to UV radiation are numerous, from the healing of seasonal depression to the prevention of breast, colon and prostate cancers. Advocacy texts issued by the tanning industry seems to come to the conclusion that everything being considered, finally, ''controlled skin damage'' is somehow good for health [61].

The generation of vitamin D is the main known benefit of UV radiation. Vitamin D synthesis is activated by UVB radiation, not by UVA radiation. In fair-skinned European subjects, if dietary intakes of vitamin D are inadequate, brief periods of exposure to summer sunlight in everyday life on hands and face is all that is needed to initiate vitamin D synthesis. Longer exposures provide no additional benefit in this respect.

UV radiations are used for treating various skin conditions such as psoriasis and dermatitis. Psoriasis patients treated over long periods of time with a combination of UVA and oral psoralen have an increased incidence in non-melanoma skin cancers [62,63], and a significant increase in melanoma incidence was found in one cohort of PUVA-treated psoriasis patients [64,65].

The role that UV radiation would have in the prevention of cancerous diseases is largely based on ecological data and on speculations on as yet unproven biological mechanisms. At present, there is no sound scientific data showing a protective effect of intentional exposure to UV radiation on any cancer in humans.

In North European countries, and in Canada, advertisements recommend sunbed use from November to March to combat the ''winter depression'' or ''seasonal depression'', attributed to the absence of days with bright sunshine and to long periods of obscurity. However, light therapy using white fluorescent lights is as effective for the treatment of seasonal depression [66]. Thus there is no reason to promote exposure to potentially harmful UV radiation to treat that condition.

10. How credible is the precautionary principle?

The precautionary principle is frequently evoked in the shaping of health or of environmental policies. In brief, that principle consists of regulating the general public use or the diffusion in the environment of a substance or of a device whose safety remains open to question. In Europe, the precautionary principle is frequently put forward to oppose the development of innovations, even though there is no evidence for a detrimental impact on health or on the environment.

In spite of the scientifically established association between the intermittent exposure to solar UV radiation and melanoma, and of the evidence that melanoma incidence is doubling every 10 or 20 years in many fair-skinned populations, the indoor tanning fashion has undergone a considerable growth in the past 20 years. Hence, although there was far more scientific evidence for possible harmful health effects due to sunbed use than for many other products, the precautionary principle has never been applied for protecting consumers against the many health uncertainties regarding the safety of artificial UV sources, and against the many unverified beliefs utilised for the marketing of the sunbed fashion.

11. The need to control information disseminated by the tanning industry

For most people, information and advertisements disseminated by the tanning industry are the main source of information regarding tan acquisition and sun protection. Behavioural studies in Europe [17,67,68] show that people know about skin cancer and the damaging affect of sunbathing, and about possible dangers associated with sunbed use, but that knowledge does not alter their tanning behaviours in general. In Europe and the USA, recommendations on sunbed

Table 2
Steps to be taken in the regulation of sunbed use and of information given to the general public*

1. Devise regulations for the installation, operation and utilisation, independently of those set by the tanning industry.
2. To prohibit sunbed use before 18 years old.
3. Rendering the use of protective eyewear (goggles) mandatory during sunbed sessions.
4. Use of and speculations on concepts such as ''safe'', or ''controlled'', or ''regulated'' tan acquisition'' should not be authorised.
5. Reference to hypothetical health benefits of outdoor or indoor ultraviolet (UV) exposures must be prohibited. The mention of preventive effects on cancers and other major health conditions should not be authorised.
6. The existence of legal regulations on indoor tanning should not be used for advertising purposes, or for issuing claims on the safety of indoor tanning.
7. Requirement to inform consumers visiting tanning parlours on the dangers associated with sunbed use and sun exposure, including, among other things:
   (a) Increased risk of skin cancer, especially melanoma and basal cell carcinoma (BCC).
   (b) Risk of sunburns and skin erythema.
   (c) Risk of premature wrinkles.
   (d) Risk of unpleasant and disgraceful pigmented skin lesions.

* The list should be included in information packages accompanying tanning devices that are acquired for private use.

use and regulations restricting indoor tanning do not make sunbed users more cautious, especially adolescents and young adults [67–71].

The most relevant strategy for curbing sunbed use is to obtain a change in attitudes toward sunbathing and having a tan. In that respect, the principal public health target should be to draw up regulations, independently of those set by the tanning industry, and the control of information and advertisements (Table 2). The tanning industry should no longer have the possibility to have recourse to claims on health benefits of outdoor or indoor tanning in order to convince consumers to use sunbeds.

Indeed, this strategy would concern other segments of the tanning industry, such as sunscreen companies that base their marketing strategy on the possibility of acquiring a healthy and safe tan, thanks to the use of their product.

12. Conclusions

The Norway–Sweden study [26] has provided epidemiological evidence that regular sunbed use is associated with a moderate increase in the risk of melanoma. Large numbers of people use sunbeds on a regular basis, and sunbed use often starts during adolescence. So, in 2004, UV doses accumulated by many people though sunbed use may be far higher than observed in the Norway–Sweden study.

Public-health efforts should continue to disseminate information on the dangers of UV radiations, and to discourage sunbed use.

Regulation of sunbed installation, operation and use is desirable, but enforcement of rules is by far the most difficult challenge. In addition, regulations should become harmonised in the European Union.

Advertisements and information disseminated by the tanning industry to the general public should be controlled. The sunbed manufacturers and operators should no longer be able to claim health benefits of any sort attributable to sunbed use, and to other forms of intentional sun exposure.

Close monitoring of sunbed use and of its immediate consequences (e.g., skin erythema and sunburns) is now well established in Sweden. There are signs of decreasing trends in sunbed use among adolescents and young adults in Sweden [68]. Is the sunbed fashion be levelling off in Sweden? Similar surveys should be conducted in other countries to monitor global exposure to privately owned or commercially operated tanning devises. Boldeman et al. [68] have proposed an international harmonisation of survey tools for the monitoring of sunbed use and sunburn experience. Such an instrument is highly desirable for comparing sunbed use habits and consequences across countries and to follow the impact of policies intended to discourage sunbed use or to combat the ''safe tan'' concept. The survey tool could also include the monitoring of sun exposure and sun protection habits.

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