Superior
Health Council

RECOMMENDATIONS ON THE USE OF ARTIFICIAL UV DEVICES IN BELGIUM.

JUNE 2017
SHC № 9216

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Superior Health Council

ADVISORY REPORT OF THE SUPERIOR HEALTH COUNCIL no. 9216

Recommendations on the use of artificial UV devices in Belgium

In this scientific advisory report on public health policy, the Superior Health Council of Belgium provides recommendations for the Belgian population on the exposure to artificial UV radiation (sunbeds)

This version was validated by the Board on June - 2017[1]

I INTRODUCTION AND ISSUE

In 2000, the Superior Health Council (SHC) issued an advisory report on sunbeds (SHC 5783, 2000).

The data that pertain to this issue are still valid today, though they are no longer up-to-date. Recent publications highlight the various problems and especially the significant increase in cancers that are associated with the exposure to ultraviolet radiation (UVR), including UVR emitted by sunbeds.

The general public and especially the young people with high UVR exposure for cosmetic reasons, should be informed about these risks.

Moreover, the government needs up to date information about the current situation and about possible measures to further reduce health risks related to UVR in general and UVR emitted by sunbeds, more in particular.

Therefore, the SHC decided to revise the advisory report taking into account the most recent scientific evidence and the current (international) recommendations.

[1] The Council reserves the right to make minor typographical amendments to this document at any time. On the other hand, amendments that alter its content are automatically included in an erratum. In this case, a new version of the advisory report is issued.

II RECOMMENDATIONS

The SHC reviewed recent evidence to update the advisory report on sunbeds (SHC 5783, 2000).
An ad hoc working group with experts in risk analysis, dermatology, psychology, ophthalmology and biophysics reviewed the literature concerning the effects of UVR relevant to health, with particular reference to sunbeds for cosmetic purposes.

There is longstanding evidence that UVR exposition induces the production of vitamin D. Limited UVR exposure however is sufficient to generate the necessary vitamin D levels and alternative sources of vitamin D (oral vitamin D supplements) are available if needed.
But in recent decades there is also increasing evidence that UVR, including UVR emitted by sunbeds, acts both as an initiator and a promoter of skin cancer. More concrete, there is strong evidence that exposure to UVR, including UVR emitted by sunbeds, increases the risk for cutaneous melanoma and squamous cell carcinoma at all ages and that the risk for these types of cancer (especially melanoma) is even higher in case of exposure during childhood and adolescence. There is also moderate evidence that exposure to UVR, including UVR emitted by sunbeds, also increases the risk of basal cell carcinoma and ocular melanoma.

Based on the well-established evidence that UVR, including UVR emitted by sunbeds, induces skin cancer and other cutaneous and ocular diseases, and taking into account that:

- There is no threshold level of UVR for the induction of skin cancer and hence no safe limit for exposure to UV radiation;
- The risks of UVR exposure outweigh the benefits such as the induction of vitamin D;
- Minimal exposure to natural UVR is in general sufficient to induce sufficient amounts of vitamin D;
- Sunbed use is not the way to replenish vitamin D deficiencies;
- Sunbed use is continuously available and invites for repetitive and excessive use. Exposure to natural UVR can be limited by protective measures but cannot be excluded completely.

The SHC recommends to ban the sunbeds and all artificial UVR devices that are available to the public, with the aim of reducing the risk for skin cancer.

In the interim period to the effective ban of sunbeds, and also afterwards, in order to avoid a shift towards an increased exposure to natural UVR, the SHC further recommends to inform the general public in an objective and transparent way about the risks linked to UVR in general (and including the risks of UVR emitted by sunbeds), and about the rationale to ban the sunbeds. Moreover, it is also important to include objective information about the beneficial effects of casual exposure to the sun e.g. vitamin D production, in this information campaign.

Keywords and MeSH *descriptor terms*[2]

MeSH terms*	Keywords	Sleutelwoorden	Mots clés	Schlüsselwörter
Sunbed	Sunbed	Zonnebank	Banc solaire	
Ultraviolet radiation	Ultraviolet radiation	Ultraviolette straling	Rayonnement ultraviolet	
Skin Cancer	Skin cancer	Huidkanker	Cancer de la peau	

MeSH (Medical Subject Headings) is the NLM (National Library of Medicine) controlled vocabulary thesaurus used for indexing articles for PubMed http://www.ncbi.nlm.nih.gov/mesh.

[2] The Council wishes to clarify that the MeSH terms and keywords are used for referencing purposes as well as to provide an easy definition of the scope of the advisory report. For more information, see the section entitled "methodology".

III METHODOLOGY

After determining the scope of the project, the Board and the Chair of the permanent working group “Cosmetology and cosmetic devices, including cosmetic surgery” identified the necessary fields of expertise. An *ad hoc* working group was then set up which included experts in risk analysis, dermatology, psychology, ophthalmology and biophysics. The experts of this working group provided a general and an *ad hoc* declaration of interests and the Committee on Deontology assessed the potential risk of conflicts of interest.

This advisory report is based on a review of the scientific literature published in both scientific journals and reports from national and international organisations competent in this field (peer-reviewed), as well as on the opinion of the experts.

Once the advisory report was endorsed by the *ad hoc* working group and by the standing working groups “Cosmetology and cosmetic devices, including cosmetic surgery” and “Non-ionising radiation” it was ultimately validated by the Board.

IV ELABORATION AND ARGUMENTATION

List of abbreviations used

ACGIH	American Conference of Governmental and Industrial Hygienists
FPS	Federal Public Service
GPSD	General Product Safety Directive
ICNIRP	International Commission on Non-Ionizing Radiation Protection
MC1R	melanocortin receptor 1
MSH	melanocyte-stimulating hormone
NMSC	non-melanoma skin cancer
POMC	pro-opiomelanocortin
SED	Standard Erythema Dose
SHC	Superior Health Council
SPF	sun protection factor
UV	ultraviolet
WMO	World Meteorological Organisation
WHO	World Health Organisation

1 Sources of UV radiation

Ultraviolet (UV)-radiation is a form of electromagnetic radiation, with wavelengths shorter than light (visible electromagnetic radiation), but longer than X-rays. UV radiation is usually classified as UV-A, UV-B and UV-C radiation (Table 1) (*Commission Internationale de l'Éclairage, 2009*).

Table 1: Classification of ultraviolet radiation (Commission Internationale de l'Éclairage 2009).[3]

Name	Wavelength range (nm)
UV-A	400-315
UV-B	315-280
UV-C	280-200

1.1 Natural source (sunlight)

The sun emits radiation across a very wide spectrum and is the only natural source of UV radiation. The Earth's atmosphere filters out a large part of the shortwave radiation. Therefore, almost no radiation with wavelengths shorter than 280 nm (UV-C) reaches the surface of the Earth. The absorption of radiation between 280 and 315 nm (UV-B) is strongly affected by the thickness of the ozone layer, whereas a large part of the UV-A radiation (315 – 400 nm) passes through the atmosphere.

[3]Sometime the wavelength boundaries are listed as 320 and 290 nm (Diffey, 2002).

The intensity of the UV radiation that reaches the surface of the Earth is influenced by many factors:

- The time of day and year. The height of the sun determines the distance the radiation has to travel through the atmosphere; the longer the distance, the more radiation is absorbed, and the lower its intensity. The intensity of UV radiation peaks in the hours around noon during the summer.
- Geographic latitude. In low-latitude locations, the sun is higher in the sky, and the distance the radiation has to travel through the atmosphere is shorter.
- The altitude of a given location. At higher altitudes, the path through the atmosphere is shorter, and more radiation reaches the surface.
- Clouds. Clouds tend to attenuate the radiation. But in some cases, i.e. broken clouds, the intensity of the radiation reaching the surface is actually enhanced.
- Ozone. Ozone is the main absorber of UV-B radiation in the atmosphere. Therefore the intensity of the radiation that reaches the surface is modulated by the thickness of the ozone layer (at approximately 20-25 km altitude). The mean values vary according to location and season, but are also affected by the actual atmospheric conditions.
- Albedo. The amount of radiation that is reflected at the surface (for example by snow or water) also influences its intensity.
- Aerosol. Any aerosol particles present in the atmosphere scatter and absorb radiation, thereby lowering the latter's intensity.

The World Meteorological Organisation (WMO) and the World Health Organisation (WHO) (WHO, 2002) jointly developed the UV index as a tool to inform the general public about the intensity of solar radiation at a given location. (A definition of the UV index as well as additional information on its interpretation are provided in appendix 1). The higher the index, the more UV radiation reaches the surface, and the greater the attendant risk.

KEY MESSAGES

The UV Index is a scale that relates the intensity of solar radiation to the effects on unprotected skin. The actual effects depend on the type of skin but it is generally acknowledged that protection is needed when the index exceeds 3. In many countries the current and/or expected UV index is provided with the weather forecast.

1.2 Artificial sources

1.2.1 Sunbeds and other tanning equipment

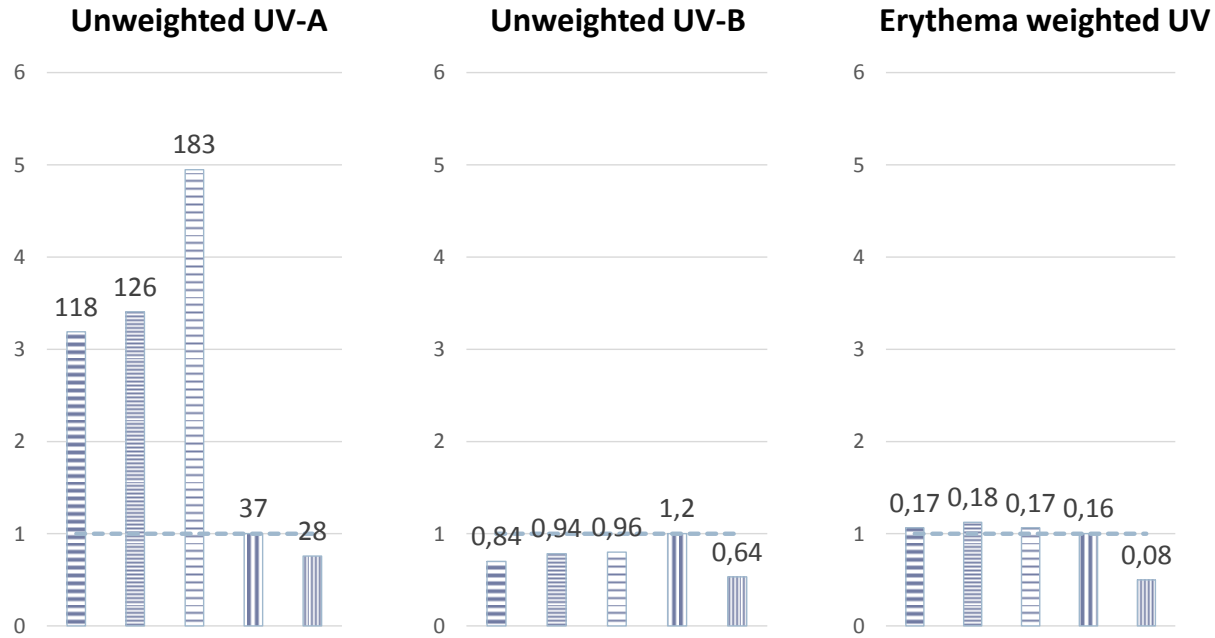
Over a century ago, Caucasians looked upon a fair skin as a token of beauty and social achievement (Carter, 2007). As physical activity and outdoor living became increasingly fashionable in the early 20th century, so did the tanned skin that was believed to reflect such a lifestyle.

Sunlight was thought to exert a wholesome impact, which was certainly true with regard to the bone disease known as rickets (Hess & Unger, 1921). When there was not enough exposure to sunlight, light sources imitating the solar spectrum were used (Albert & Ostheimer, 2002). Even in the 1980s, many households owned sun lamps (Health Council of the Netherlands: Committee on UV-appliances, 1986). But from the 1970s, tanning became the primary purpose of exposure to artificial UV sources (Bruggers et al*.,* 1987; Diffey, 1987). This was accompanied by a shift to radiation sources in which the ratio of UV-A/UV-B radiation is relatively greater than that of midday solar radiation. Underpinning this development was the argument that this allowed to build up a tan without the risk of 'sunburn' (erythema) (1987). It also boosted a 'tanning industry', and with it, commercial tanning salons and tanning devices in wellness centres.

Technical aspects

Modern sunbeds and other tanning lamps available for the general public emit a variety of spectra and intensities. A Norwegian study measured the emissions of 191 sunbeds in 78 tanning facilities. The results are presented in Figure 1. These data demonstrate, as mentioned above, that UV-A radiation is an important part of sunbed emissions and accounts for roughly half of the erythema effective exposure (Nilsen et al., 2012).

Figure 1 Normalized results of the average emission of a sample of Norwegian sunbeds. From left to right in each of the three diagrams: bench, canopy, facial, sun at 35ºN (maximum), sun at 60ºN (maximum). Normalization to sun exposure at 35ºN. The numbers at the top of bars are the 10 minutes



exposure in kJ/m². Derived from (Nilsen, 2012).[4]

The European standard EN-60335-2-27 limits the erythemal effective irradiance to 0.3 W/m². In actual practice many appliances exceed this recommended irradiance (Tierney *et al.,* 2013).

[4] Gibraltar and Cyprus are situated at about 35ºN, Oslo, Stockholm and Helsinki are situated at about 60ºN.

Legal aspects

There is no harmonised European legislation for tanning salons. In Belgium, the competent authority for regulations concerning the operation of tanning salons and the placing on the market of sunbeds in the FPS Economy, SMEs, Self-Employed and Energy:

- Directorate General (DG) Energy is the market surveillance authority responsible for the LVD (Low Voltage Directive);
- DG Quality and Security is the market surveillance authority responsible for the GPSD (General Product Safety Directive);
- DG Economic Inspection is the market surveillance authority responsible for the inspections of tanning salons.

A tanning salon may only be operated if it meets the general safety requirements laid down in the Code of Economic Law (*Code de droit économique*), Book IX on the safety of products and services. The requirements of this Code are supplemented by the specific requirements of the Royal Decree (RD) of 20 June 2002 on conditions regarding the operation of tanning salons, last amended by the Royal Decree of 22 October 2010.
In no area of the sunbeds shall the overall erythema effective irradiance (maximum radiation density) exceed 0.3 W/m^2.
People with type I skin and those aged under 18 are banned from using sunbeds.
Detailed information on the conditions relating to the commercial operation of tanning salons as well as information booklets written by the FPS Economy are available on the internet[5].

Sunbeds for private use fall under the "low voltage" regulations, i.e. the Royal Decree of 21 April 2016 regarding the placing on the market of electrical equipment). The sunbeds that are placed on the market shall be safe and their overall erythema effective irradiance (maximum radiation density) shall not exceed 0.3 W/m^2.
Detailed information on these regulations is available on the internet[6].

Advertising is regulated by Book VI *Pratiques du marché et protection du consommateur* ("Market Practices and Consumer Protection") of the Code of Economic Law.
Information on these regulations is available on the internet[7].

[5] http://economie.fgov.be/fr > Entreprises & Indépendants > Sécurité des produits et des services > Sécurité des centres de bronzage (http://economie.fgov.be/fr/entreprises/securite_produits_et_services/Zonnecentra/)
[6] http://economie.fgov.be/fr > Entreprises & Indépendants > Sécurité des produits et des services > Sécurité des appareils électriques
(http://economie.fgov.be/fr/entreprises/securite_produits_et_services/Securite_des_appareils_electriques/Basse_tension/
http://economie.fgov.be/fr/entreprises/securite_produits_et_services/Securite_des_appareils_electriques/#.VkyJ7tlvdpg)
[7] http://economie.fgov.be/fr > Protection des consommateurs > Pratiques du marché > Publicités et pratiques déloyales (http://economie.fgov.be/fr/consommateurs/Pratiques_commerce/Publicite_pratiques_deloyales/)

The tanning salon sector is continuously monitored by the Economic Inspectorate. During inspections, all the administrative and technical requirements laid down in the Royal Decree on tanning salons are verified. In the event of non-compliance, depending on the severity of the infringement and according to the requirements laid down in Book XV of the Code of Economic Law, the measures taken may range from a warning or a settlement submission to temporary seizure of the non-compliant sunbeds or the salon as a whole until all infringements have been removed. When the tanning salon does not meet the given deadline, the case is taken to the public prosecutor's office.

Practice of sunbeds in Belgium

At a national level, the inspection reports from the FPS Economy show that the current legislation is poorly abided by:

- In 2015, 65 tanning salons were inspected. Only 2 salons were managed according to requirements of the Royal Decree, which only amounts to 3.1 % of the inspected premises.
- In 2014, 58 tanning salons and 236 sunbeds were inspected. Only 3 salons were managed in accordance with the requirements of the Royal Decree, i.e. no more than 5.2 %. Of the 236 sunbeds, 12.7 % emitted a radiation intensity in excess of the legal limit of 0.3 W/m². One in four inspected tanning salons accepted individuals under 18 or with skin type I.
- In 2013, 96 tanning salons were inspected. Only seven of them were operated in accordance with the law. Likewise, in 2012 (7.5 %) and 2011 (10.9 %), a minority of salons were run in accordance with the law.
- The most prevalent infringements are:
    - Lack of information on the risks of artificial tanning;
    - Lack of control and registration of exposure times;
    - Missing customer files;
    - Allowing minors or people with skin type I to expose themselves;
    - The radiation intensity emitted by the lamps.

Given the fact that tanning salons are regulated by national legislation, it is difficult to compare the degree of compliance to the national laws by member state across the EU.

In 2008-2009, a joint action was set up in several Member States by PROSAFE, a non-profit professional organisation active in market surveillance. A follow-up action was launched in 2010-2011. Belgium participated in these actions.

The results of the first action, called "Sunbeds I" (2008-2009), mainly focused on measuring the erythema effective irradiance (radiation intensity). The participating market surveillance authorities inspected over 300 premises and tested over 500 sunbeds.

Most inspections were carried out at service providers (tanning salons, wellness centres, etc.), and were concerned with safety warnings and advice to consumers, sunbed labelling, the availability of protective eyewear and the measuring of the UV radiation emitted by the sunbeds. The general conclusions drawn from the outcome of the inspections conducted during this first action were the following:

- Tanning salons often failed to provide customer advice, a fact that is difficult for an inspector to verify;
- Sunbed labelling was not up to standard in at least 20 % of cases;
- Of the 84 sunbeds measured, 83.3 % emitted radiation in excess of the 0.3 W/m² limit. It should be noted, however, that these measurements were not performed at random, but targeted sunbeds suspected of exceeding the limit. Across the market as a whole, the percentage of offending sunbeds ranged from less than 3 % in one Member State to over 80 % in several other Member States. Inspections conducted as part of the second action, viz. "Sunbeds II" (2010-2011), were based on the same criteria as the "Sunbeds I" action, but included compliance with the minimum age requirement.

The 12 participating market surveillance authorities inspected over 1,150 premises with sunbeds, most of which were tanning salons and wellness centres. The overall conclusions drawn from this second action were the following:

- Tanning salons failed to provide customer information and advice on a regular basis, a fact that is difficult for an inspector to verify;
- In many tanning salons, the minimum age requirement, viz. no under 18-year-olds, was not abided by;
- Sunbed labelling was not up to standard in at least 20 % of cases. In some participating countries, the labelling failed to meet the requirements in up to 20 %, or even 45 % of cases;
- Over half of the sunbeds in tanning salons emitted a radiation intensity that exceeded the maximum allowed. The radiation emitted by 1.072 sunbeds in total was measured as part of the action. As it turned out, 688 (64 %) of these sunbeds (sometimes significantly) exceeded the limit.

Other considerations

As pointed out above, advertising and the promotion of sunbeds claim that the latter are a good source of vitamin D as well as being useful for pre-tanning before leaving on holiday. Furthermore the sector has also been making a number of health claims (preventive action on diseases such as cancer, diabetes, multiple sclerosis, Alzheimer, etc.) in its advertising (websites, social media).

Prevalence of sunbed use in Belgium

According to data from the Belgian Cancer Foundation (2015a), in 2015, the overall prevalence of sunbed use in Belgium was 14 % (at least 1 tanning session during the past 12 months). 62 % of sunbed users have at least 10 sunbed sessions per year, and 23 % more than 20 sessions per year. This amounts to a total of over 1 million people aged between 15 and 65 having used sunbeds during the past year.

52 % of the Belgian population aged between 15 and 65 have used sunbeds at least once in their lives. This amounts to ± 3 750 000 individuals aged between 15 and 65. On average, first-time sunbed users are 25 years old, with 38 % starting to use sunbeds before the age of 18. In 2015, 20 % of those aged < 35 had used sunbeds at least once during that year.

6 % of families privately owned a sunbed in 2015. Sunbeds at home are typically used by several members of the family, in 6 % of the cases this involved family members aged under 18 (table 2).

Table 2 Use of privately owned sunbeds by family members (Belgian Cancer foundation, 2015a).

Which family members make use of your sunbed at home? (n = 73)					
	Yourself	*Your partner*	*Children (< 18 years of age)*	*Children (> 18 years of age)*	*Other adult family members*
Yes	*71 (97%)*	*35 (48%)*	*4 (6%)*	*14 (19%)*	*15 (20%)*
No	*2 (3%)*	*19 (26%)*	*35 (48%)*	*27(36%)*	*26 (36%)*
Not applicable	*0 (0%)*	*19 (27%)*	*34 (46%)*	*33 (45%)*	*32 (44%)*

The percentage of sunbed users is declining slightly. The percentage of sunbed owners at home has remained stable over the past years.

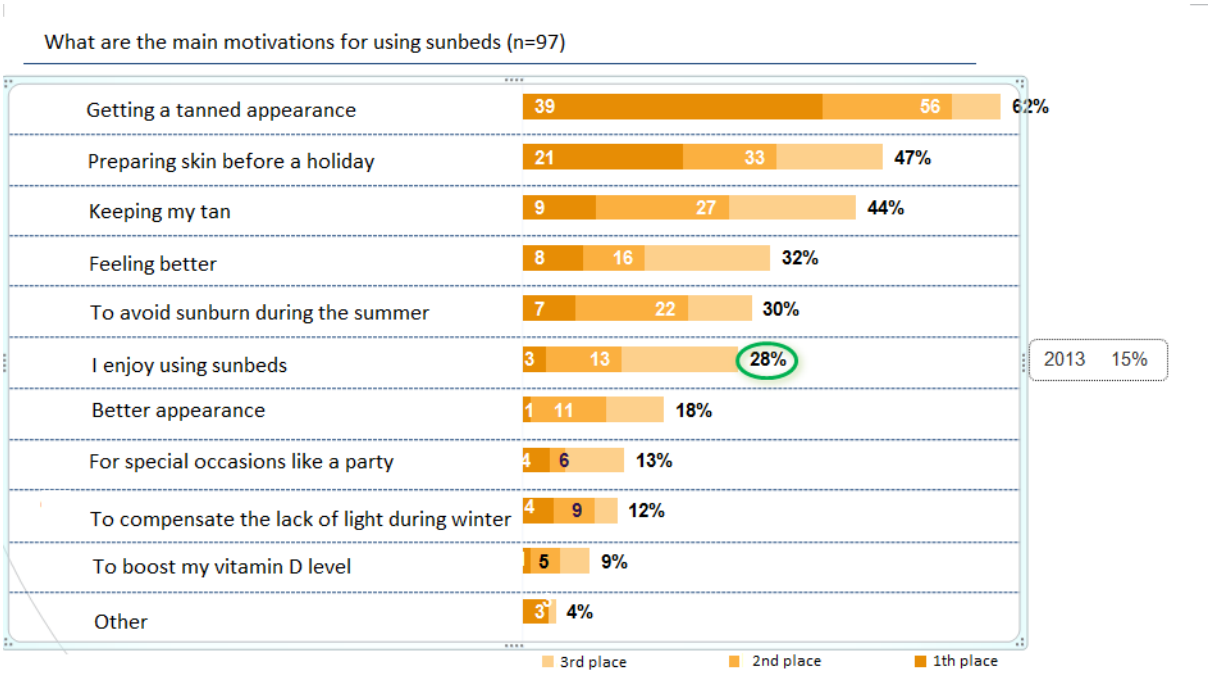
During a Euromelanoma screening campaign conducted in Europe between 2009 and 2012 (appendix 2) and during which 38 484 people were screened, it was found that the overall average sunbed use in 31 European countries was 8.6 % (all ages, both genders). Belgium turned out to have an above average (15 % on average, gender and age confounded) prevalence of use, i.e. 23 % within the screened population. Focussing on the female population aged under 35, Belgium appears to have the highest rate of sunbed use, viz. around 30 % (less than 20 sessions per year). On average, sunbeds had been used for 8.35 years (median 6). From 2009 to 2014, 18 000 Belgians were screened, and among the total population screened (aged between 15 and 35, both males and females) 25.6 % had used sunbeds at least once, 90 % for less than 20 sessions per year and 10 % for more. These data are not representative for the general population, but the number and the reproducibility of these data made then reliable.

Characteristics and behaviour of sunbed users in Belgium

Positive determinants of sunbed use are: female gender, skin type II, being single (widow or divorced). The positive correlation with other risk factors such as smoking and sunny holiday destinations were measured. There was no overall positive or negative correlation with social class. Still, as it turns out, with 15 % of sunbed users coming from the lowest social class (10.6 % in the Belgian population), the latter is overrepresented (Belgian Cancer Foundation, 2015b).

Reasons for using sunbeds

The main motivation for using sunbeds is a desire for a tanned appearance (getting a tan 62 %, keeping one's tan 44 %) or preparing the skin before a holiday (47 %). 32 % of users indicate that it makes them feel better, 9 % use sunbeds to boost their vitamin D levels.



Knowledge and misconceptions

Though the population is generally well aware that sunbed use is carcinogenic (94 % agree), misconceptions continue to exist. The main misconceptions are:

- Pre-tanning on sunbeds helps to avoid sunburn from the sun: 40 % mistakenly believe this to be the case (44 % believe a tanned skin protects them from the sun).
- A larger percentage of sunbed owners underestimate the risks of sunbeds compared to non-owners. They also have a more positive attitude towards sunbeds:

- 18 % of non-owners think using sunbeds is safer than sun-tanning, compared to 47 % of sunbed owners;
- 36 % of owners versus 55 % of non-owners think sunbeds should be banned.

KEY MESSAGES

The prevalence of sunbed use in Belgium is high compared to other European countries.

The main reason for using sunbeds is to get a tan (for purely cosmetic purposes).

Sunbed users are predominantly female and young (< 35 years).

1.2.2 Other sources of UV radiation

UV sources other than the sun and tanning lamps are also used for both medical and non-medical purposes. Phototherapy has a one-century-long history (Albert & Ostheimer, 2002, 2003a, b). It started with the idea that using lamps as a means to provide 'sunlight' prevented the occurrence of a variety of common diseases (the so-called Finsen-therapy). Although various treatments have now become obsolete, phototherapy with or without photosensitisers is used to treat a range of skin diseases (Ceburkov & Gollnick, 2000; Diffey, 2002; Choudhary et al*.,* 2009). Both broadband sources and more monochromatic sources are used to induce exposure in the UV and visible spectral region.

In occupational settings a variety of sources are used. An overview is presented in Table 3 (2009). Protection standards in the form of occupational exposure limits have been published by the ICNIRP[8] (2010) and the ACGIH[9] (2010).

A more detailed discussion of these sources and exposures would go beyond the scope of this report.

8 International Commission on Non-Ionizing Radiation Protection.

9 American Conference of Governmental and Industrial Hygienists.

Table 3 Common UV sources in the workplace. Derived from Ontario Government (2009).

Source	Potential for Overexposure	Hazard Description
The sun†	Very high	UV from the sun is highest in spring and summer from 11 to 16 hours. UV guidelines can be exceeded in 15 minutes on a clear summer day. Clouds may do little to reduce UV levels.
Electric Welding Arcs	Very high	Welding arcs can exceed the UV guidelines in seconds within a few meters of the arc. Besides workers, bystanders and passers-by are often overexposed to UV from the arcs.
UV Curing Lamps	Medium	Lamps are usually inside cabinets, but substantial UV radiation can escape through openings.
Black Lights	Medium to Low	Low-power UV-A lamps used in non-destructive testing (NDT), insect control, and entertainment.
Germicidal Lamps	High	UV-B- and UV-C-emitting lamps used to sterilise work areas in hospitals and laboratories.
UV Lasers	High	Source of intense UV radiation at a single wavelength, with no visible light.
Lighting	Low	Most lamps used for lighting are made to emit little or no UV radiation.

† The sun has been included for completeness as it is an important source of occupational UV exposure.

2 Effects and health risks of UV

2.1 Intentional effects

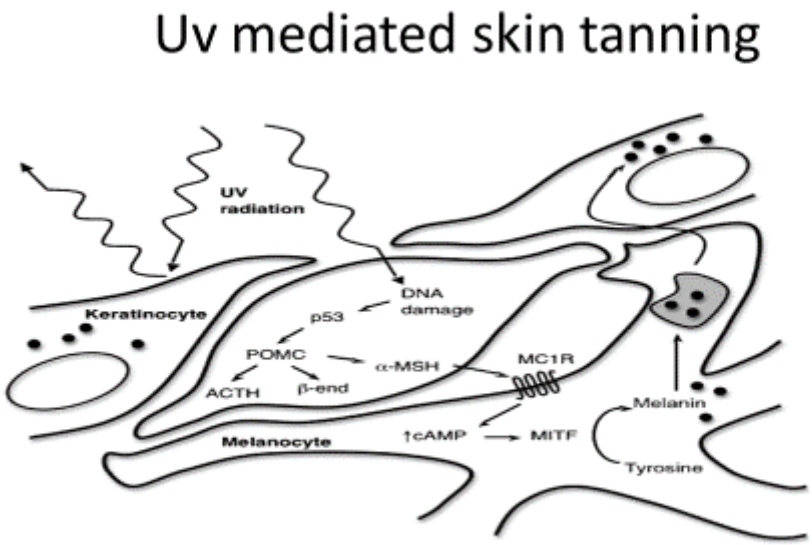
2.1.1 Photo-protection effects

The degree of natural pigmentation in the skin rises from phototype II to VI and as the synthesis of eumelanin in the skin increases, so does the protection conferred. The purpose of tanning is to induce facultative non-permanent tanning, which is poorly efficient in providing protection against UV-induced damage. In contrast, the constitutive melanin present in naturally pigmented skin (phototypes IV to VI) has a great ability to protect against skin cancer. There are 6 skin phototypes. People with phototype 1 skin tend to have ginger hair or be albinos. They never tan but always burn when exposed to sunlight. People with phototype 2 skin tend to have blond hair, tan slightly and always burn when exposed. People with phototype 3 skin tend to have blond or light brown hair, get a moderate tan and sometimes burn. People with phototype 4 skin tend to have a Mediterranean appearance with olive skin; they burn very little and build up a deep tan. People with phototype 5 skin exhibit significant pigmentation; they build up a deep tan and burning is rare. They have a Mediterranean, Latin-American or North-African appearance. People with phototype 6 skin are black individuals of Central- or South-African descent; they tan slightly and never burn (Fitzpatrick's Dermatology in General Medicine. McGraw-Hill Professional; 5th edition).

The process that induces pigmentation following UV radiation has been identified. As previously shown, UV radiation triggers the formation of pyrimidine dimers (thus directly resulting in DNA damage). More recently, it has been found that, as a corollary, the dimers generate an intracellular (keratinocyte) increase and activation of the p53 protein. p53 will transactivate the transcription of different genes, pro-opiomelanocortin (POMC), endotheline 1, and many others that are related to the process of UV irradiation (inflammation, pigmentation, etc.) (Chen et al., 2014).

The fact that pyrimidine dimers are the direct inducers of pigmentation is proof that skin pigmentation is only related to DNA damage.

When POMC is synthesised, posttranslational cleavage of POMC produces β-endorphin and α-MSH (melanocyte-stimulating hormone). Beta-endorphin synthesis may be responsible for tanning addictions.
Once the MSH-receptor (MCR1) is activated by its ligand (MSH), the synthesis of eumelanin (black and brown melanin) is favoured instead of pheomelanin (red). Eumelanin provides protection against UV damage because it is mainly a free radical scavenger and acts as a chromophore. In contrast, UV radiation causes pheomelanin to be a potential source of free radicals that are also responsible for oxidative DNA damage.
Both types of melanin are synthesised inside specific organelles, called melanosomes. Melanosomes are transferred from the melanocytes to the keratinocytes and confer a pigmentation to the epidermis. Skin pigmentation is related to the amount and the type of melanin synthesised (pheomelanin (red) and eumelanin (brown to black)).



- *Tran T-N et al , Pigm Cell Melanoma Res, 2008*

Given the fact that UV-induced pigmentation provides low photoprotection (equivalent to a sunscreen with an SPF-level of 2), UV protection is mandatory, especially for children and fair-skinned individuals (even lower photoprotection) (Miyamura et al., 2011). Additionally, these authors were able to confirm that UV-A tanning does not confer any photoprotection but does induce DNA damage, just as is the case for UV-B rays. Many people mistakenly believe that a few artificial UV sessions prior to sunny holidays may protect them against sunburns whilst in fact, the low level of photoprotection induced by UV tanning does not prevent the occurrence of sunburns and UV-induced DNA-damage (Brenner & Hearing, 2008).

KEY MESSAGES

UV-induced skin pigmentation is only obtained as a result of the formation of pyrimidine dimers (i.e.: DNA damage).

Constitutional skin pigmentation (phototypes IV to VI) provides protection against skin cancer but UV-induced pigmentation will only provide protection to the skin in the range of an SPF-level of 2-4 (equivalent to sunscreens with an SPF of 2).

UV-induced pigmentation confers low photoprotection. Artificial UV exposure prior to sun exposure should be avoided. There is therefore no good reason to make use of artificial UV-exposure as a means to prevent sunburns.

2.1.2 Sociological and psychological effects

Sociological aspects

Mankind has always had a special and privileged relationship with the Sun. Both worshipped and feared, many supernatural powers have been attributed to this celestial body, which has always had a prominent place in our civilisations.

It should be noted, however, that depending on the time and/or place, it has triggered quite different types of behaviour.

A few examples give a good account of sociological data grounded in habits and customs that may fluctuate according to fashion trends.

In this part of the world, a fair skin used to be associated with a form of nobility, whereas a darker skin tone hinted at peasantry. This has been a thing of the past for several decades now.

The history of sun tanning reveals that attitudes started to change around 1920-1930. When paid leave became a reality in 1936, workers started to travel and seek destinations with plenty of sunshine. After World War II, as the bikini became fashionable, exposure to the sun became all the more popular. Thus, it took no more than a fashion trend to allow these bodies to tan in the sun.
A tanned appearance has become indicator of "good health" (cf. "a healthy tan"), whereas a white or even pallid skin has clearly grown to be interpreted as a sign of illness. Advertising has been eager to shape consumer behaviour accordingly.

After sunscreens, self-tanners appeared on the market. Next came sunbeds as a means to extend this pursuit of sunshine, regardless of the weather and the location.

Psychological aspects

Besides this sociological aspect, the psychological factors involved in the decision to use a sunbed also need to be mentioned. What is the basis for the desire to go to a tanning salon or the irresistible urge to return frequently? Are some people more vulnerable than others? When does a type of addiction, i.e. dependence, set in?

Psychologically, the starting point is self-image. This self-image is linked to one's "outer persona". It is a "calling card" that is shaped during the first years of life and allows one to position oneself in the eyes of others as in our own.
This self-image tends towards a certain search for an ideal, whilst being moulded by the cultural and social context. This self-image goes beyond our earthly bodies in the sense that it also involves psychological components that may or may not be consistent with the representation of the body. This is why everyone has a physical and psychological image of themselves that may fluctuate in response to the events of life. Moreover, this self-image faces the dictates of fashion. Over the last few decades, fashion has imposed its laws, bringing in its wake conformism and anti-conformism. Tanning is an adornment, just as clothing is. This reflects the growing importance of the representation of the body in our societies. Despite some reactions to tanning, as was the case in the 1990s when Calvin Klein and Kate Moss advocated pale complexions, a fashionably tanned skin remains synonymous with good health and, for some, a high social standing.

Behind the fashion trends there looms, at the psychological level, a whole narcissistic dynamic. The culture we live in is admittedly increasingly narcissistic and great value is attached to surpassing oneself (e.g. sporting competitions), whereas illness and death, if not simply ignored, give rise to a great deal of fear.
It follows that, within such a cultural context, displaying some degree of narcissism is normal. Still, calling someone narcissistic remains pejorative. Most notably, such a person’s behaviour is characterised by a lack of psychological depth as well as superficiality in their interaction with other people. This accounts for the fact that there is still an ambiguous and ambivalent connotation to narcissism.

There does not seem to be any real at-risk type of personality, but some types are clearly more vulnerable to narcissistic injuries.
Thus, when the personality traits grow rigid, inadequate, persistent and significantly impair functioning or cause subjective suffering, this will be consistent with a personality disorder, i.e. a predisposition.
Thus, according to the DSM-IV, a "narcissistic personality disorder" is characterised by a pervasive pattern of grandiosity, need for admiration and lack of empathy.

Recently, Fell et al. (2014) emphasised how dangerous exposure to the sun can be, not only as regards the risk of cancer, but also the risk of addiction. Chronic exposure to UV radiation releases endorphins in the body that elicit the same chemical response as opiates, e.g. heroin or morphine. These are the same receptors that could cause symptoms that are typical of intoxication, which is consistent with the findings of laboratory research with mice (Petit et al., 2014). This compulsive desire to build up a tan, regardless of the proven negative consequences, is suggestive of a behavioural complex similar to addictive disorders (Warthan et al., 2005; Kourosh et al., 2010; Robinson et al., 2010; Harrington et al., 2011; Hillhouse et al., 2012).

It is believed that such an addiction most frequently affects adolescents (Petit et al., 2011, 2013, 2014). Depending on the parameters used, various studies take the view that 5 % to 15 % of sunbed users can be considered to have a tanning addiction (Heckman et al., 2014). This addiction mainly affects young girls, but is also found in the least-favoured social classes. The label "tan-addict" has been proposed to describe an irrepressible urge to expose oneself to UV radiation, bringing about a sense of lack when this activity cannot be engaged in and a feeling of euphoria and an enhanced mood when it can, as well as a relaxing and anxiolytic effect. Moreover, knowing what the adverse health effects of this type of behaviour are does not prevent it from continuing.

This diagnosis of "tan-addict" has led to various debatable translations in French, viz. "*tanorexie, tanoholisme* or *bronzomanie*" (WIKIPEDIA), i.e. many neologisms to describe the pathological addiction to tanning. Indeed, it is necessary to understand the nature of the addiction and pathological need to have a tanned skin underlying all these pseudo-diagnoses. The quest for an aesthetic appearance and social desirability has been described as the main factor that accounts for the fact that health concerns fade in the background.

This addiction may occur in combination with other psychiatric disorders. Thus, an American study (Mosher & Danoff-Burg, 2010) showed that out of a total of 229 students, 70 (30.6 %) of those who had a pathological addiction to tanning based on the diagnostic criteria of DSM-IV-TR and CAGE, also reported anxiety symptoms and an excessive use of alcohol, marijuana and other substances. In another study (Ashrafioun & Bonar, 2014) involving a sample of 533 students, 31 % had a tanning addiction. This tanning addiction was predominantly found in females, and there was a significant association with an obsessive-compulsive disorder as well as a body dysmorphic disorder.

KEY MESSAGES

The sociological data account for changes in habits and customs as regards the relationship mankind has had with the sun, which varies from one period in time to another, and from one continent to another, and is significantly affected by the dictates of fashion.
In this part of the world, tanning started to become fashionable in the 1920s-1930s, a trend that gained momentum as paid leave and lengthier holidays became a reality, with a tanned appearance becoming synonymous with "good health". Fed by the media, this quest for sunshine naturally resulted in the emergence of sunbeds.
On a more psychological level, this desire for a tanned appearance is grounded in the image of oneself one wishes to convey to others, and which is linked to one's "outer persona" and the search for a certain ideal. Whilst this drive to attract and seduce typically finds its roots in the narcissistic aspects of our personalities. It can, however, result in a form of addiction in some more vulnerable individuals. Based on the release of endorphins during chronic UV exposure, this pathological addiction to tanning, known as tanorexia, is mainly found in adolescents, mainly female, often in association with other psychiatric disorders such as anxiety disorders, obsessive-compulsive disorders, body dysmorphic disorders and addictive disorders.

2.1.3 Vitamin D

In 2016, the SHC of Belgium issued the sixth edition of the "Nutritional recommendations for Belgium" (SHC 9285, 2016). For each nutrient including vitamin D, the new recommendations provide the following information:

- The nutritional properties and the impact on health,
- The recommended intake for different age/gender groups,
- The risks related to an excessive intake and the estimated upper tolerable intake,
- The alimentary sources and the average intake by the Belgian population,
- Practical recommendations (incl. dietary supplements),
- References.

Synthesis

Vitamin D is an essential hormone that has a considerable influence on the calcium balance and bone development.

Humans acquire vitamin D through endogenous or exogenous synthesis. Endogenous synthesis of vitamin D3 occurs in the skin upon exposure to UV-B radiation. Exogenous vitamin D2 or D3 is supplied through dietary intake, mainly through oily fish (e.g., salmon), dairy products, mushrooms and eggs. Many food products are nowadays also enriched with vitamin D3.

Vitamin D on its own has no physiological action. To be physiologically active, vitamin D must undergo two chemical transformations. The first transformation occurs in the liver, which yields 25-hydroxyvitamin D. The second takes place in the kidneys, yielding 1alpha, 25-dihydoxyvitamin D. It is under this form that vitamin D is physiologically active. Because serum 25-hydroxyvitamin D levels are affected by the intake of vitamin D as well as the exposure to UV-B rays, measuring serum 25-hydroxyvitamin D levels is commonly used as a marker of the "individual vitamin D status".

In the early 2000s, it was discovered that many tissues other than the kidney could locally produce 1aplha, 25-dihydoxyvitamin D. This discovery gave rise to the hypothesis that active vitamin D produced at tissue level could play a role in the healthy functioning of organs.

UV-lamps and endogenous vitamin D synthesis

Vitamin D is only synthesised to a limited extent in the skin, and only during the initial exposures to UV radiation. Moreover, this process is largely dependent upon the intensity of the UV-B radiation emitted by the lamps (Davies et al., 1980; Sallander et al., 2013).

Two controlled interventional studies have been conducted on the influence of typical sunbed exposures on serum 25-hydroxyvitamin D levels.

A Danish group performed a randomised trial that involved Caucasian females aged 50 years and over, assigned to:

(a) A control group (21 women),

(b) A group (n=20) undergoing 4 UV-A-tanning sessions for 6 to 12 minutes on machines emitting 0.4 % UV-B rays,

(c) And a group (n=15) undergoing 4 UV-A-tanning sessions on machines emitting 1.4 % UV-B rays.

As it turned out, 37 to 64 % of sunbed sessions induced side effects such as erythema and polymorphic light eruption. The average baseline serum 25-hydroxyvitamin D level was 19 ng/mL. 25-hydroxyvitamin D levels did not change in the control group. After 4 sunbed sessions, they significantly increased by an average of 12.5 nmol/L and by 27.5 nmol/L in the 0.4 % and 1.4 % UV-B groups, respectively. After 4 more sessions, these increases became non-significant, viz. only 3 and 0.5 nmol/L, respectively. Thus, a plateau was rapidly reached after only a few sessions as regards the circulating 25-hydroxyvitamin D levels (Thieden et al., 2008).

Another Danish group randomised 20 healthy volunteers to one 10-16 minute whole-body exposure using either a commercial sunbed with UV-B emissions (UV-B/UV-A ratio 1.8 – 2.0 %) or an identical placebo sunbed that did not emit UV-B rays (Langdahl et al., 2012). After seven days, the mean increase in 25-hydroxyvitamin D levels in the UV-B group was 4.5 nmol/l (SD 7 nmol/l) compared to a decline of -1.2 nmol/l (SD 7 nmol/l) in the placebo group ($p = 0.1$).

Two trials have tested the influence of extensive (10 minutes or more) sunbed exposure sessions over a short period of time on the vitamin D status.

In the Netherlands, a trial was conducted with 105 young adults (aged between 18–30 years; 91 % female) during the winter months. 35 of these adults were randomly assigned to a group receiving 6-to-12 minute exposures to sunbeds in commercial indoor tanning salons 3 times a week for a period of 8 weeks. Hence these subjects were exposed to a total of 24 tanning sessions (de Gruijl et al., 2012). Another thirty-seven subjects received 25 µg per day of vitamin D supplementation, and the remaining 33 subjects were assigned to a control group who received neither vitamin D supplementation nor sunbed sessions. After 8 weeks, the mean serum 25-hydroxyvitamin D levels dropped from 62 to 55 nmol/L (-7, SD:11) in the control group. They rose from 62 to 109 (+47, SD: 23) and from 58 to 93 nmol/L (+35, SD: 19) in the sunbed and in the supplementation groups, respectively. The statistical difference between the sunbed and the supplementation groups was not reported.

A Norwegian randomised cross-over trial involved 31 healthy volunteers (8 men and 23 women) aged 21 to 61 who, during a 2-week period, either underwent a series of ten commercial sunbed sessions for 7 to 15 minutes (equivalent to a mean of 12.6 SED) or received a daily dose of 50 µg vitamin D (Lagunova et al., 2013).
Nine subjects withdrew from the trial, leaving 11 subjects in each group. A similar increase in 25-hydroxyvitamin D levels was observed in both groups, i.e., 19•8 (SD: 5•4) nmol/L after the sunbed sessions and 25•3 (SD: 5•4) nmol/L after supplementation (Lagunova et al., 2013).

Hence, in fair-skinned people, short sessions (a few minutes) of UV-B irradiation of the skin can trigger a significant increase in 25-hydroxyvitamin D levels and longer exposure times do not enhance endogenous vitamin D production. Sunbed sessions slightly increase these rum 25-hydroxyvitamin D levels, but only during the first sessions. The trials that involved more sunbed sessions suggest that in healthy adults, a large number of sunbed sessions with short intervals (2-3 days) in between does not boost the vitamin D status to levels beyond what daily supplementation with oral vitamin D would achieve.

Health effects of vitamin D

It has been known for about a century that the physiologically active form of vitamin D is necessary for the digestive absorption of calcium and phosphorus in the gut and its incorporation in bone tissues. Childhood and pregnancy are two periods of life during which vitamin D requirements are higher.

Ecological, cross-sectional and observational studies have documented the association between a low vitamin D status and a greater risk of being diagnosed with a myriad of diseases, including minor ailments and rare conditions (Harvey et al., 2012). Many have concluded from these non-interventional studies that a low vitamin D status could be a cause of illness/disease, and that preserving a high vitamin D status could provide an easy way to prevent diseases and increase life expectancy. In the same spirit, it was believed that maintaining high serum levels of circulating 25-hydroxyvitamin D would allow the optimal local production of physiologically active vitamin D at tissue level.

A more recent study looked into the different beneficial health outcomes initiated by UV radiation through Vitamin D-dependent and independent pathways such as the beneficial effects on infectious diseases, inflammatory skin diseases (e.g. psoriasis), asthma, cardiovascular diseases, obesity and diabetes and all-cause mortality (Hart et al., 2017).

Vitamin D is in fact a naturally occurring hormonal drug. As for any drug, the most robust way to evaluate the health effects of increasing vitamin D levels is to examine how increases in circulating 25-hydroxyvitamin D impact on the incidence and mortality associated with conditions deemed to be vitamin D-preventable.

To date, the over 400 randomised trials that have been conducted on vitamin D supplementation and their meta-analyses have been unable to confirm the health benefits supposedly associated with increased 25(OH)D levels, even when high doses of supplementation (i.e., ≥50 µg per day) were used in subjects with a low vitamin D status before randomisation, and even on skeletal or postural endpoints (i.e., osteoporosis, fractures and falls) (Autier et al., 2014; Bolland et al., 2014a; Bolland et al., 2014b; Bolland et al., 2014c; Meyer et al., 2015; Theodoratou et al., 2014). The risk of all-cause death among elderly subjects is the only outcome for which a significant risk reduction of 11 % has been observed with ordinary doses (5 to 20 µg or 100 to 800 IU per day) of vitamin D3 supplementation tested in 14 trials (Chowdhury et al., 2014). This effect is not observed with vitamin D2 supplementation.

However, a more careful reading of the literature shows that if the analysis is restricted to the 10 trials that actually tested vitamin D3 (cholecalciferol) on its own (and not another vitamin D compound [e.g., calcitriol or 1α,25-dihydroxyvitamin D3]), the risk of death was reduced by 8 %, which was no longer statistically significant (Bolland et al., 2014). In any case, these results are not relevant to the issue of artificial UV tanning by adolescents and young adults.

Extensive randomised trials are being conducted on vitamin D supplementation (Manson et al., 2015), but the first results that have been released so far do not differ from those of earlier, smaller trials (Amrein et al., 2014). So, the fact that administering vitamin D does not have any impact on virtually any outcomes strongly indicates that low 25(OH)D should be looked upon as a marker rather than a cause of impaired health. The main working hypothesis for explaining the low vitamin D status associated with so many conditions is based on acute and low-grade chronic inflammatory processes that are part of many physiological phenomena involved in deteriorating health and diseases (Autier et al, 2014).

Vitamin D recommended intake

The recommended intake of vitamin D is actually still debated amongst scientists. However, there is at present no firm evidence in support of advising healthy subjects to increase their vitamin D status (Meyer et al., 2015).

The SHC of Belgium recommends a daily intake of 10 µg Vitamin D3 for children (0 - 10 years), 10-15 µg for adolescents and adults (11-70 years), 20 µg for pregnant and breastfeeding woman and 20 µg for the elderly (> 70 years) (SHC 9285, 2016).

Because of the numerous health hazards associated with exposure to artificial UV radiation (e.g., increased risk of skin and eye cancer, skin rashes, sunburn, skin ageing), individuals who wish to increase their vitamin D status may turn to oral vitamin D supplementation. There is some debate as to the tolerable upper intake level of vitamin D. The SHC of Belgium has set the upper limit at 25 µg vitamin D3/day for children 1-10 years old and at 50 µg/day for subjects aged 11 years and older. The cost of vitamin D supplements is generally lower than that of a series of UV tanning sessions and does not trigger the undesirable effects of exposure to artificial UV radiation.

KEY MESSAGES

There is currently no evidence that increasing the vitamin D status of healthy subjects with a normal diet is associated with any health benefits in terms of preventing diseases or improving their outcome.

Exposure to artificial UV radiation as a means to increase the vitamin D status is no more efficient than taking oral supplements of vitamin D, but it is associated with an increased risk of several health conditions, including skin and eye cancer.

People who wish to increase their vitamin D status can do so by consuming oral vitamin D supplements. Oral supplementation with ordinary doses as recommended by the SHC (10 to 20 µg/day) is safe.

2.1.4 Other uses

The use of UV radiation for therapeutic purposes goes beyond the scope of this advisory report.

2.2 Non-intentional effects

2.2.1 Carcinogenicity

Genotoxicity

Different wavelengths of UV light induce different types of DNA damage (SCHEER, 2016). UV-C and UV-B, but much less so UV-A, are capable of exciting the DNA molecule directly and subsequently generating DNA photoproducts. Indeed, DNA is regarded as a major chromophore for most of the biological effects of UV-B and UV-C, including erythema, tanning, immunosuppression, mutagenesis and carcinogenesis. But other chromophores have also been shown to be involved. Thus, double stranded snRNA (through LTR3), and tryptophan (through AhR), lipids and receptors in the cell membrane contribute to the appearance of erythema, pigmentation and/or immunosuppression. Also, urocanic acid plays a part in immunosuppression, whilst a UV-A-sensitive opsin in melanocytes is involved in immediate pigment darkening. The main UV-induced DNA photoproducts are dimers, which are formed by the covalent binding of two adjacent pyrimidines in the same polynucleotide chain. The two major types of pyrimidine dimers are cyclobutane dimers and 6.4-photoproducts.

While UV-B-induced pyrimidine dimer formation results from the direct absorption of photons by DNA bases, UV radiation (and violet/blue light) can also damage DNA indirectly. As a consequence of photon absorption by non-DNA chromophores, energy can be transferred either to DNA (type I photosensitised reaction) or to molecular oxygen, with reactive oxygen species in turn being able to damage DNA (type II photosensitized reaction).
It is noteworthy that much of the biological impact of UV-A, including its cell toxicity, is largely dependent upon the presence of molecular oxygen, which is indicative of the prominent role played by reactive oxygen species. Although these reactive oxygen species are also formed by UV-B, UV-A has been shown to be largely responsible for the oxidative DNA damage that occurs after the exposure of cells to natural sunlight. UV-A-induced pyrimidine dimer formation may involve a type I photosensitised reaction, unlike direct UV-B induced pyrimidine dimer formation.

UV-induced reactive oxygen species include singlet oxygen and probably other non-radical and radical reactive oxygen species, such as hydrogen peroxide and the superoxide radical. This oxidative stress affects not only DNA, but also membranes and proteins. The relative contribution of each (oxidative membrane damage, oxidative protein damage, oxidative DNA damage) to the different biological effects of UV irradiation has not been well established.

Mutagenesis and carcinogenesis

The wavelength dependencies (the 'action spectra') of pyrimidine dimer formation, cell killing, mutation, and cell transformation are highly similar and resemble the DNA absorption spectrum (at least over the UV-C and UV-B ranges, but also up to 330 nm into the UV-A range). Both cyclobutane pyrimidine dimers and (6-4) photoproducts have been shown to be mutagenic, causing typical 'UV-signature' mutations, i.e. C→T transitions at neighbouring pyrimidines in the same DNA strand (sometimes even tandem CC→TT mutations). Skin carcinomas show these UV-signature mutations abound in the p53 tumour suppressor gene, which constitutes classical evidence that UV radiation plays a part in triggering these skin cancers (SCHEER, 2016).

Next Generation Sequencing techniques have revealed that - despite efficient DNA repair mechanisms - sun-exposed middle-aged skin is littered with mutations, with 15 % of the epidermal cells carrying a p53-mutation, most of which bear the UV signature. A recent study conducted on 74 cancer genes found that there were over 100 mutated cell clones per cm^2 of eyelid skin from people over 55 who had undergone eyelid surgery, and again most of these mutations bore the UV signature.

Given these findings, it is not surprising that skin cancers rank among the absolute top in terms of the number of mutations they carry (10 000 to over 100 000 per genome, with hundreds in coding regions). And again UV-signature mutations predominate. Due to this wealth of mutations it is difficult separate the 'driver' mutations from the 'passenger' mutations, i.e. determine which mutations really drive tumour development and which mutations are just hitchhiking.

But before NGS was available, driver mutations had already been identified by studying familial/hereditary skin cancers (e.g., p16Ink4A loss in FAMMM melanomas, and defective PTCH activating the Hedgehog pathway in BCC in Gorlin syndrome) and recurrent mutations (e.g. in mutated p53 in skin carcinomas).
Although UV-signature mutations appear to abound in skin cancers, this is not always clearly the case in prominent driver mutations (e.g. PTCH or SMO in BCC, or N-RAS of B-RAF in melanomas), with the exception of P53 in skin carcinomas and Notch1- 4 in squamous cell carcinomas of the skin.

Experiments with transgenic mice carrying one of the prominent driver mutations show however, that UV irradiation can greatly enhance the development of the corresponding skin cancer (Noonan et al, 2001; Noonan et al. 2010; Wolnicka-Glubisz A et al., 2006; Berking et al. 2002)

KEY MESSAGE

Experiments with transgenic mice carrying one of the prominent driver mutations show that UV irradiation can greatly enhance the development of the corresponding skin cancer.

Epidemiological studies (sunbed-related)

After World War II, the incidence of cutaneous melanoma increased sharply in most fair-skinned populations and in the 2000s, the rise in incidence is still a fact in most fair-skinned communities (Erdmann et al., 2013).

A vast body of epidemiological data indicate that the increased incidence of melanoma is mostly attributable to the fact that sun exposure became fashionable and spread during the second half of the twentieth century (IARC, 1992). That the ultraviolet (UV) radiation component of the sun spectrum reaching the earth's surface is the carcinogenic agent was formally recognised more recently (IARC working group, 2006; "Radiation", 2012). Intermittent exposure to UV-sources is believed to be the real culprit in the occurrence of melanoma, intermittency being defined as the brisk exposure of skin areas that are never exposed to sunlight most of the year. Experiments in animals and epidemiological studies (e.g., in migrants) have provided ample evidence that susceptibility to UV is greater at a younger age (mainly in childhood) than later in life (Autier et al., 1998; Noonan et al., 2001; Noonan et al., 2012; Whiteman et al., 2001).

In twenty years' time, sunbed use has become widespread in fair-skinned populations, mainly among young (i.e., under the age of 25) adults, especially women. Sunbed use is a typical intermittent sun exposure pattern.

In large powerful tanning units, the UV intensity may be 10 to 15 times higher than that of the midday sun (Gerber et al., 2002), and the UV-A doses per unit of time received by the skin during a typical sunbed session are well above those experienced during daily activities or sunbathing.
The annual UV-A doses received by frequent indoor tanners may be 1.2 to 4.7 times those received from the sun, and these doses add to those received from the sun (Miller et al., 1998). However, the UV emission spectra of sunbeds have special characteristics and are different from the solar spectrum: sunbed emission spectra are similar to the sun spectrum in the UV-B (280-320 nm) range but reach values 10 to 15 times higher in the UV-A (320-400 nm) range (Gerber et al., 2002). The average UV output of sunbeds corresponds to a UV index of 13, which is what vacationers encounter on Mediterranean beaches in the summer. In sunbeds, the trunk is the most exposed area of the body, whilst the head and feet are the least exposed, though there are sunbeds that are fitted with high-pressure lamps specially designed for the face. Natural sources of UV-A are probably never this powerful and repeated exposures to high doses of UV-A constitute a new phenomenon in human beings.

For obvious ethical and practical reasons, there are no direct experimental human data available (e.g., a randomised trial) showing that exposure to sunbeds causes melanoma or other skin cancers. Despite this, in 2009, an international group of experts convened by the IARC classified exposure to "UV-A-lamps" or "UV-emitting tanning devices as carcinogenic to humans" (El Ghissassi et al., 2009). This classification is based on the accumulation of compelling evidence that sunbed use can be a cause of melanoma and not just a proxy for sun exposure for the following reasons:

- Basic animal and human studies have demonstrated that the UV-A and UV-B regions of the radiation spectrum emitted by sunbeds are carcinogenic agents to humans (El Ghissassi et al., 2009; "Radiation," 2012);
- Meta-analyses of case-control and prospective studies have revealed the following:
  - Based on dose-response calculations, 35 studies provide evidence of a 1.8 % (95 % confidence interval 0 % to 3.8 %) increase in the risk of melanoma for each additional session of sunbed use per year (Boniol et al., 2012).
  - Three studies show that sunbed use may be involved in the occurrence of eye melanoma (El Ghissassi et al., 2009; "Radiation", 2012), a type of cancer that occurs more rarely than cutaneous melanoma, but is much more fatal.
  - In 13 studies, first use of sunbeds before the age of 30 is associated with the occurrence of cutaneous melanoma, eye melanoma, basal cell carcinoma and squamous cell carcinoma (Boniol et al., 2012; "Radiation", 2012; Wehner et al., 2012). This relationship has been consistently found in all observational studies.
- Most epidemiological studies on sunbed use and skin cancer have adjusted for sun exposure and natural susceptibility to UV.
- The investigation of a melanoma epidemic in Iceland (a country located between 64 ° and 66 ° N and where sunny days are uncommon) revealed that after 1990, the incidence of melanoma increased sharply, mainly in young women, with preferential occurrence on the trunk. The incidence tended to decline after 2000, when public health authorities imposed more stringent controls over sunbed facilities and their use. Although this was an ecological study, the exposure of Icelandic youngsters after 1985 seemed to be the most likely cause for that epidemic (Alberg, 2011; Autier, 2010).
- Before 1990, the increased incidence of melanoma in women mainly concerned the lower limbs, whereas since 1990, this increase has been more marked on the trunk than on other body parts, which is believed to be the consequence of artificial UV tanning.

The relationship between sunbed use and melanoma that has been observed both in the laboratory and in epidemiological studies is consistent with the data linking sun exposure to melanoma, notably the greater susceptibility to the carcinogenic action of UV radiation at younger ages (Autier et al., 2008; "UV radiation & skin cancer. The science behind age restrictions for tanning beds", 2012). Moreover, epidemiological data on sunscreens, sunbeds and other factors support the findings from basic scientific research that has revealed the carcinogenic properties of UV-A radiation (Agar et al., 2004; Autier et al., 2011; Mouret et al., 2006; Noonan et al., 2012).

The high levels of sunbed exposure in fair-skinned communities will contribute to the continuing upward trend in the incidence of cutaneous melanoma and of other skin cancers (Boniol et al., 2012; Tierney et al., 2015).

Health risks

In 2012, a meta-analysis and review based on 13 informative studies led to the conclusion that first-ever use of sunbeds before the age of 35 was associated with a significant increase in the relative risk of melanoma of 1.87.

By using prevalence data from surveys and data from Globocan (2008) (for 18 EU countries), an estimated 3 438 cases of melanoma could be attributed to sunbed use, most of which affected women (n=2.341) (Boniol et al., 2012).

A similar meta-analysis has been performed on NMSC and included 12 studies with 9 328 cases of NMSC. As regards people who reported ever using indoor tanning compared with those who had never done so, the summary relative risk for squamous cell carcinoma was 1.67 and that for basal cell carcinoma was 1.29, though the latter was not significant.
In the US, the population attributable risk fraction was estimated to be 8.2 % for squamous cell carcinoma and 3.7 % for basal cell carcinoma: this corresponds to more than 170 000 cases of NMSC each year that can be ascribed to indoor tanning. This risk is higher if sunbed use occurred early in life (< 25 years) (Wehner et al., 2012).

KEY MESSAGES

UV-A and UV-B are both carcinogenic.

Recent reviews of biological data, animal experiments and meta-analyses of the risks involved in UVR exposure (including sunbed use) confirm that there is an association between exposure to natural and sunbed UVR on the one hand and the risk of skin cancer, especially melanoma, as well as squamous cell carcinoma.

Economic burden of skin cancer in Belgium

A bottom-up cost-of-illness study was performed for skin cancer in 2015 by the University Ghent (Pil et al., 2016). The total annual cost that is currently induced by skin cancer in Belgium is estimated to be € 103 million (for a population of 8.8 million adults), of which almost € 64 million are borne by the healthcare system (government), which amounts to about 0.15 % of the total healthcare budget in Belgium. Projections to 2034 showed an estimated annual discounted cost of € 153 million, and a total cumulative cost of € 3.2 billion.
A Markov model simulation over 50 years estimated that an average € 227.7 million (0.57 %) of the healthcare budget could be redirected to other diseases by implementing a skin cancer prevention campaign and a total of € 238 million could be redirected by banning sunbeds in Belgium (cumulative costs over 50 years). When calculating the cost-effectiveness of both interventions, they are cost-saving on the long term and thus to be preferred. Over a period of 50 years, 5 944 deaths could be avoided by means of an annual UV prevention campaign (2 368 in males and 3 576 in females) and 5 692 by means of a ban on public sunbed use (2 198 in males and 3 494 in females). Although the fact that over this 50 years period, other factors might also influence the incidence of melanoma in Belgium, this study of Pil et al indicates that a nation-wide population-based strategy promoting UV protective behaviour combined with a national ban on the use of sunbeds can have a positive effect on both public health and public finances (Pil et al., 2016).

KEY MESSAGE

Estimates of the effects of a skin cancer prevention campaign combined with a total ban on sunbed use predict that this would result in the prevention of nearly 6 000 melanoma deaths over 50 years and that € 227.7 million could be saved by a sensitisation campaign and € 238 million by a total ban on sunbeds in Belgium.

2.2.2 Ageing (heliodermy)

Intrinsic skin ageing is a natural process that is determined by genetic and chronological factors that are affected by external factors such as the sun or sunbeds.
Also, the genetic material of the cells is altered, especially the structure of DNA, under the influence of UV-A radiation in particular. In addition, UV radiation triggers the formation of aggressive free radicals, which also modify the structure of DNA.
There are physiological DNA repair mechanisms, but these processes are overwhelmed in the event of significant repeated and cumulative doses of UV radiation, causing the skin to change slowly over the years, a process known as "**actinic elastosis**" (Calderone DC et al., 1995).

Excessive sunlight on the neck and cleavage causes the skin to become less supple and atrophic, with increased and decreased pigmentations producing an irreversible appearance called **poikiloderma**.
With brown spots, **solar lentigines**, or depigmented spots called **guttate hypomelanosis** (Nakamura et al., 2015; Ortonne et al., 1990).

Actinic keratoses are precancerous lesions, some of which progress into squamous cell carcinoma, viz. between 0.1 and 0.53 % per year or 5 to 20 % within 10 to 20 years (Trakatelle M et al., 2016; Green AC et al., 2015)

KEY MESSAGES

Heliodermy is the extrinsic ageing of the skin induced by intense and/or frequent and cumulative exposure to the sun and is linked to the harmful effects of ultraviolet radiation, including sunbeds.

There are physiological cellular DNA repair mechanisms, but these repair processes are overwhelmed in the event of significant repeated and cumulative doses of UV radiation, causing the skin to change slowly over the years to progress towards a precancerous state called a **"dysplastic state**".

Actinic keratoses are UV-induced precancerous lesions that can progress into a squamous cell carcinoma within 10 to 20 years in about 5 to 20 % of cases.

2.2.3 Other issues

Ocular problems linked to UV radiation

Exposure to sunbeds could also increase the risk of eye (intra-ocular) melanoma, a rare tumour that is deadlier than skin melanoma. Four case-control studies conducted so far on artificial UV and intraocular melanoma have all obtained results that are highly consistent with a raised risk: in the US, Tucker et al. 1985 found a 1.4-fold increased risk (95 % CI: 0.9; 2.2, Holly et al. 1990 a 3.6-fold increased risk (95 % CI: 1.6-8.7), and Seddon et al. 1990 a 3.4-fold increased risk (95 % CI: 1.1-10.3) whereas in Australia, Vajdic et al. 2004 found a 1.7-fold increased risk (95 % CI: 1.0-2.8) (Holly et al., 1990; Seddon et al., 1990; Tucker et al., 1986; Vajdic et al., 2002).

Photoallergic reactions

Photoallergic reactions are abnormal reactions induced by an allergy to one or more types of solar radiation – UV-B and/or UV-A and/or visible light - and take on different shapes (Onoue S. et al., 2017).

These reactions are rare and occur in predisposed individuals with a history of allergy. They appear after a certain time of exposure and affect exposed areas of the skin, but may spread to unexposed areas. A short enumeration of the different types of photoallergic reactions is mentioned below. A more detailed description of these diseases goes beyond the scope of this report.

a) Seasonal episodes of light eruption (Gruber-Wackernagel et al., 2014; Lava et al., 2013):

   - Benign summer light eruption.
   - Juvenile spring eruption.
   - Benign winter light eruption.
   - Polymorphic light eruption.

b) Chronic actinic dermatitis (Rodríguez-Carreón et al., 2015).

c) Solar urticaria (Goetze et al., 2015).

Photoinduced disorders

Some intrinsic skin diseases may worsen under the influence of UV radiation. Examples are Lupus erythematosus (Kuhn et al., 2005) and Porphyrias (Palma-Carlos et al., 2005).

Photosensitisation reactions

Photosensitisation reactions are common and can affect anyone from the first exposure to UV radiation, both natural and artificial. They are triggered by the interaction between UV radiation and a toxic substance found in the skin to a greater or lesser extent.
Endogenous photosensitisation occurs when this substance has been ingested. Exogenous photosensitisation occurs when it has been applied to the skin. In this case, the disorder may be either due to a phototoxic or a photoallergic reaction.
These photosensitising substances are oral medicines or topical drugs formulated as gels or creams, cosmetics, perfumes, plants or vegetables.

a) Phytophotodermatitis (Sasseville, 2009):
   This phototoxic reaction is caused by contact of the skin with photosensitising plants, which may or may not have been ingested.
   - Plants that induce phytophotodermatitis (non-exhaustive list):
     Umbelliferae
     Rutaceae
     Moraceae
     Cruciferae
     Ranunculaceae
   - Food that induces phytophotodermatitis (non-exhaustive list):
     Fennel, carrots, parsley, dill, celery, angelica
     Lime, lemon
     Figs
     Mustards

b) Berloque dermatitis:
   This is induced by contact of the skin with photosensitising cosmetics such as perfumes or certain types of make-up.

c) Drug-induced phototoxicity (Kutlubay et al., 2014; Scheinfeld et al., 2014; Dawe et al., 2014)

Certain drugs sensitise to UV rays following oral or topical administration. This is known as endogenous photosensitisation of the phototoxicity type.
The nails may display pigmentation, or the nail plate may separate from the nail bed, with or without bleeding.

Many drugs may be sensitising, without inducing any actual toxicity, but may, as a result of their effects on the skin, enhance the absorption of UV radiation and thus trigger an increased hypersensitivity to UV radiation. This is looked upon as a case of endogenous photosensitisation of the photoallergy-type, either to UV-A and UV-B radiation.

- Photosensitising drugs inducing phototoxicity-type reactions (non-exhaustive list):
    Oral:
    Antibiotics (cyclins, quinolones)
    Anti-inflammatory drugs (piroxicam, ketoprofen,…)
    Anti-epileptic drugs
    Psoralens
    Etc.
    Topical:
    Antibiotics (sulfonamides, ...)
    Psoralens
    Anti-acne medication (tretinoin, benzoyl peroxide ...)
    Anti-inflammatory drugs (naproxen, piroxicam...)
    Etc.

- Photosensitising drugs inducing photoallergy-type reactions (non-exhaustive list):
    Oral:
    Anti-tumoral drugs (methotrexate, dacarbazine, ...)
    Diuretics (Lasix)
    Antianginal drugs (amiodarone,furosemide, ...)
    Anti-diabetic drugs
    Etc.
    Topical:
    Antiseptics (chlorhexidine, triclosan,...)
    Anti-inflammatory drugs (naproxen, piroxicam...)
    Etc.

KEY MESSAGES

The World Health Organization believes that 20 % of cataracts (clouding of the lens), viz. 3 million cases each year, could be due to exposure to UV radiation.

It is strongly advised to regularly wear sunglasses that block UV-A and UV-B radiation.

Photoallergic reactions are abnormal reactions that are triggered by an allergy to one or more types of solar radiation (UV-B and/or UV-A radiation and/or visible light) and take on different shapes.
Some conditions may worsen under the influence of UV radiation.

Photosensitisation reactions can affect anyone from the first exposure to UV radiation, both natural and artificial.
Photosensitising substances are oral medicines or topical drugs formulated as gels or creams, cosmetics, perfumes, plants or vegetables.

V CONCLUSION AND RECOMMENDATIONS

1 Conclusions

The SHC reviewed recent evidence to update the advisory report on sunbeds (SHC 5783, 2000).
An ad hoc working group with experts in risk analysis, dermatology, psychology, ophthalmology and biophysics reviewed the literature concerning the effects of UVR relevant to health, with particular reference to sunbeds for cosmetic purposes.

From the literature, the following conclusions can be drawn:

- The UV Index is a scale that relates the intensity of solar radiation to the effects on unprotected skin. The actual effects depend on the type of skin but it is generally acknowledged that protection is needed when the index exceeds 3. In many countries the current and/or expected UV index is provided with the weather forecast.

- The prevalence of sunbed use in Belgium is high compared to other European countries.
  The main reason for using sunbeds is to get a tan (for purely cosmetic purposes).
  Sunbed users are predominantly female and young (< 35 years old).

- UV-induced skin pigmentation is only obtained as a result of the formation of pyrimidine dimers (i.e.: DNA damage).

  Constitutional skin pigmentation (phototypes IV to VI) provides protection against skin cancer but UV-induced pigmentation will only provide protection to the skin in the range of an SPF-level of 2-4 (equivalent to sunscreens with an SPF of 2).

  UV-induced pigmentation confers low photoprotection. Artificial UV exposure prior to sun exposure should be avoided. There is therefore no good reason to make use of artificial UV exposure as a means to prevent sunburns.

- The sociological data account for changes in habits and customs as regards the relationship mankind has had with the sun, which varies from one period in time to another, and from one continent to another, and is significantly affected by the dictates of fashion. In this part of the world, tanning started to become fashionable in the 1920s-1930s, a trend that gained momentum as paid leave and lengthier holidays became a reality, with a tanned appearance becoming synonymous with "good health". Fed by the media, this quest for sunshine naturally resulted in the emergence of sunbeds.
  On a more psychological level, this desire for a tanned appearance is grounded in the image of oneself one wishes to convey to others, and which is linked to one's "outer persona" and the search for a certain ideal. Whilst this drive to attract and seduce typically finds its roots in the narcissistic aspects of our personalities, it can, however, result in a form of addiction in some more vulnerable individuals. Based on the release of endorphins during chronic UV exposure, this pathological addiction to tanning, known as tanorexia, is mainly found in adolescents, mainly female, often in association with other psychiatric disorders such as anxiety disorders, obsessive-compulsive disorders, body dysmorphic disorders and addictive disorders.

- There is currently no evidence that increasing the vitamin D status of healthy subjects with a normal diet is associated with health benefits in terms of preventing diseases or improving their outcome.
  Exposure to artificial UV radiation as a means to increase the vitamin D status is not more efficient than taking oral supplements of vitamin D, but it is associated with an increased risk of several health conditions, including skin and eye cancer.
  Oral supplementation with ordinary doses as recommended by the SHC (i.e., 10 to 20 µg per/day) is safe.

- Experiments with transgenic mice carrying one of the prominent driver mutations show that UV irradiation can greatly enhance the development of the corresponding skin cancer.

  UV-A and UV-B are both carcinogenic.

  Recent reviews of biological data, animal experiments and meta-analyses of the risks involved in UVR exposure (including sunbed use) confirm that there is an association between exposure to natural and sunbed UVR on the one hand and the risk of skin cancer, especially melanoma, as well as squamous cell carcinoma.

- Estimates of the effects a skin cancer prevention campaign and of total ban on sunbed use predict that this would result in the prevention of nearly 6 000 melanoma deaths over 50 years and reduce public healthcare costs by € 227.7 million could be saved by a sensitisation campaign and € 238 million by a total ban of sunbeds in Belgium.

- Heliodermy is the extrinsic ageing of the skin induced by intense and/or frequent and cumulative exposure to the sun and is linked to the harmful effects of ultraviolet radiation, including sunbeds.
  There are physiological cellular DNA repair mechanisms, but these repair processes are overwhelmed in the event of significant repeated and cumulative doses of UV radiation, causing the skin to change slowly over the years to progress towards a precancerous state called a “dysplastic state”.
  Actinic keratoses are UV-induced precancerous lesions that can progress into a squamous cell carcinoma within 10 to 20 years in about 5 to 20 % of cases.

- The World Health Organization believes that 20 % of cataracts (clouding of the lens), viz. 3 million cases each year, could be due to exposure to UV radiation.
  It is strongly advised to regularly wear sunglasses that block UV-A and UV-B radiation.
  Photoallergic reactions are abnormal reactions that are triggered by an allergy to one or more types of solar radiation (UV-B and/or UV-A radiation and/or visible light) and take on different shapes .
  Some conditions may worsen under the influence of UV radiation.
  Photosensitisation reactions can affect anyone from the first exposure to UV radiation, both natural and artificial.
  Photosensitising substances are oral medicines or topical drugs formulated as gels or creams, cosmetics, perfumes, plants or vegetables.

- Some individuals may develop a pathological addiction to tanning, called tanorexia.

2 Recommendations

Based on the well-established evidence that UVR, including UVR emitted by sunbeds, induces skin cancer and other cutaneous and ocular diseases, and taking into account that:

- There is no threshold level of UVR for the induction of skin cancer and hence no safe limit for exposure to UV radiation;
- The risks of UVR exposure outweigh the benefits such as the induction of vitamin D;
- Minimal exposure to natural UVR is in general sufficient to induce sufficient amounts of vitamin D;
- Sunbed use is not the way to replenish vitamin D deficiencies;
- Sunbed use is continuously available and invites for repetitive and excessive use. Exposure to natural UVR can be limited by protective measures but cannot be excluded completely.

The SHC recommends to ban the sunbeds and all artificial UVR devices that are available to the public, with the aim of reducing the risk for skin cancer.

In the interim period to the effective ban of sunbeds, and also afterwards, in order to avoid a shift towards an increased exposure to natural UVR, the SHC further recommends to inform the general public in an objective and transparent way about the risks linked to UVR in general (and including the risks of UVR emitted by sunbeds), and about the rationale to ban the sunbeds. Moreover, it is also important to include objective information about the beneficial effects of casual exposure to the sun e.g. vitamin D production, in this information campaign.

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VII COMPOSITION OF THE WORKING GROUP

The composition of the Committee and that of the Board as well as the list of experts appointed by Royal Decree are available on the following website: composition and mode of operation.

All experts joined the working group ***in a private capacity***. Their general declarations of interests as well as those of the members of the Committee and the Board can be viewed on the SHC website (site: conflicts of interest).

The following experts were involved in drawing up and endorsing this advisory report. The working group was chaired by **Olivier VANHOOTEGHEM**; the scientific secretary was Veerle MERTENS.

ADANG Dirk	Health and environment	UCL
AUTIER Philippe	Skin cancer, epidemiology	IPRI
BOONEN Brigitte	Skin cancer prevention	Belgian Cancer Foundation
BROCHEZ Lieve	Skin cancer	UGent
DE BACKER Hugo	Weather instruments	Royal Meteorological Institute of Belgium
DE MOL Jacques	Psychology	
DEL MARMOL Véronique	Skin cancer, epidemiology	ULB
KOPPEN Carina	Ophthalmology, visual optics and visual revalidation	UAntwerpen
VANHOOTEGHEM Olivier	Surgical dermatology	CHU UCL Namur

The following experts were heard:

VAN RONGEN Eric	Radiation expert	Health Council Netherlands
DE GRUIJL Frank	Photobiology/physics	Leiden University
PASSCHIER Wim	Health risk analysis	Maastricht University

The following administrations and/or ministerial cabinets were heard:

MEUNIER Joëlle	Head of the cell Cosmetics	SPF SPSCAE
JACQUES Sarah	Regulation expert	FPS Economy
PASTEELS Karine	Technical expert	SPF SPSC
VERCKENS Bram	Regulation expert	FPS Economy

The following firms/associations/etc. were heard:

BOECKX John	Chair	BESKO
DELGOFFE Daniel	Technical advisor	UNEB
GYS-BEHETS Francine	Honorary chair	BESKO
SALEMBIER Nadine	Chair	UNEB

The standing working group Cosmetics has endorsed the advisory report. The standing working group was chaired by **Albert DE MEY**; the scientific secretary was Veerle MERTENS.

The standing working group of Non-Ionising Radiation has endorsed the advisory report. The standing working group was chaired by **Luc VERSCHAEVE**; the scientific secretary was Eric JADOUL.

VIII APPENDIXES

1 Appendix 1: Definition and interpretation of the UV index

Figure a explains how the UV-index is calculated. The yellow line shows the intensity of the solar radiation on a horizontal surface on a typical summer day in Belgium as a function of wavelengths in the UV-B and UV-A range (mind the logarithmic scale). The blue line shows a typical spectrum reaching the surface at a mid-latitudinal location at noon during summer. The cyan line shows the action spectrum for erythema in human skin (http://www.cie.co.at/publ/abst/s007.html). Multiplying this with the measured spectrum gives the red line. The UV-index is obtained by integrating this curve between 280 and 400 nm and multiplying it by 40.

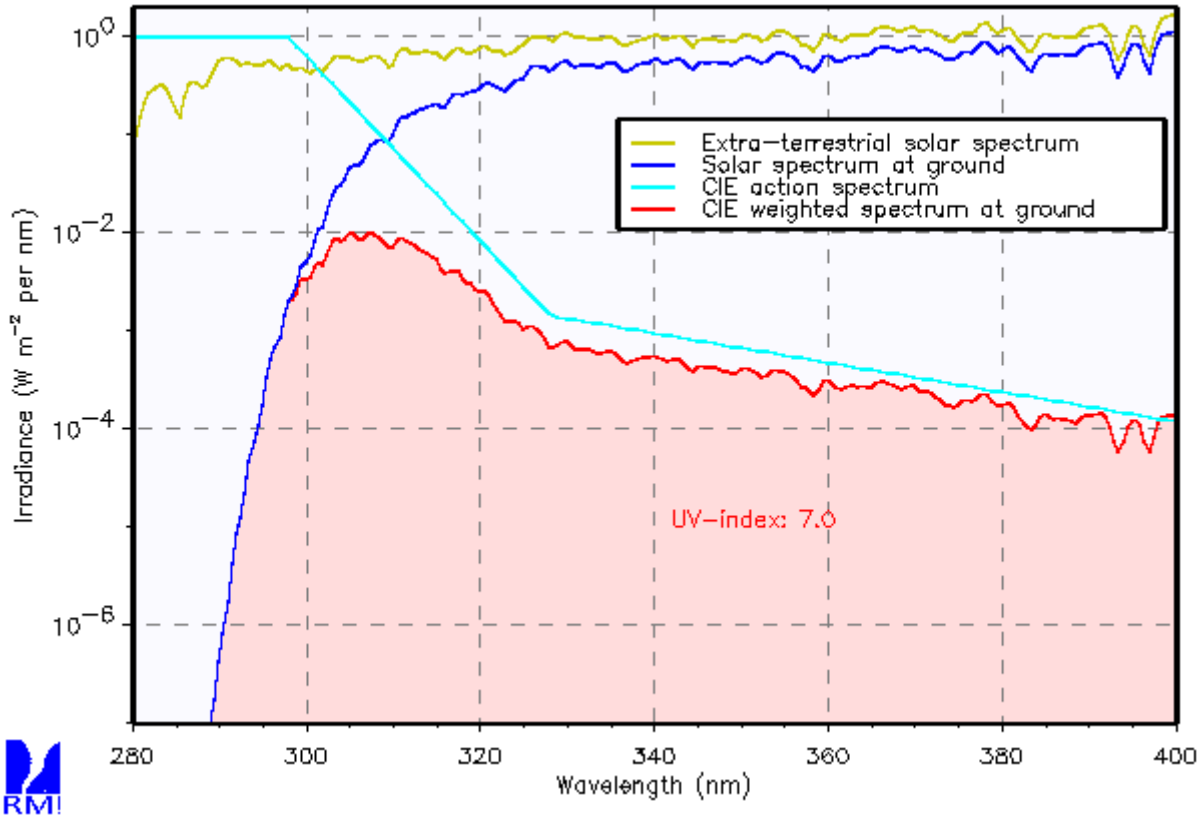


Figure a: Definition of the UV-index

The meaning of the index (for typical European skin) is explained in table a.

Table a Relationship between UV-index, UV-intensity and (European) skin burning[10]

UV-Index	UV-Intensity	Skin burns
0-2	low	almost not
2-4	moderate	slowly
4-6	moderately high	easily
6-8	high	fast
8-10	very high	very fast
a>10	extreme	almost immediately

This index can also be forecasted[11] for clear sky conditions using radiative transfer models. Measurements of the UV index are also available[12 and 13].

In Belgium the UV index reaches values of 7-8 in early summer at solar noon (corresponding to approximately 13:45 local time). On the Canary Islands, for example, the maximum value can go up to 12 and even higher. In high-mountain regions (e.g. Himalaya in Nepal), where UV radiation reflected from the snow, values of 20 or higher are sometimes observed. As mentioned in section 1.2, sunbeds may expose users to effective erythemal intensities of maximum 0.3 W/m². Following the WMO/WHO definition, this corresponds to a UV-index of 12.

[10] Classification according to the Royal Meteorological Institute of Belgium (adapted from WHO, 2002).
[11] These forecasts are distributed together with the weather forecasts (*http://www.meteo.be/meteo/view/nl/123504-Uv-index.html*)
[12] *http://www.meteo.be/meteo/view/nl/123504-Uv-index.htm*

2 Appendix 2: Results of Euromelanoma survey (31 countries)

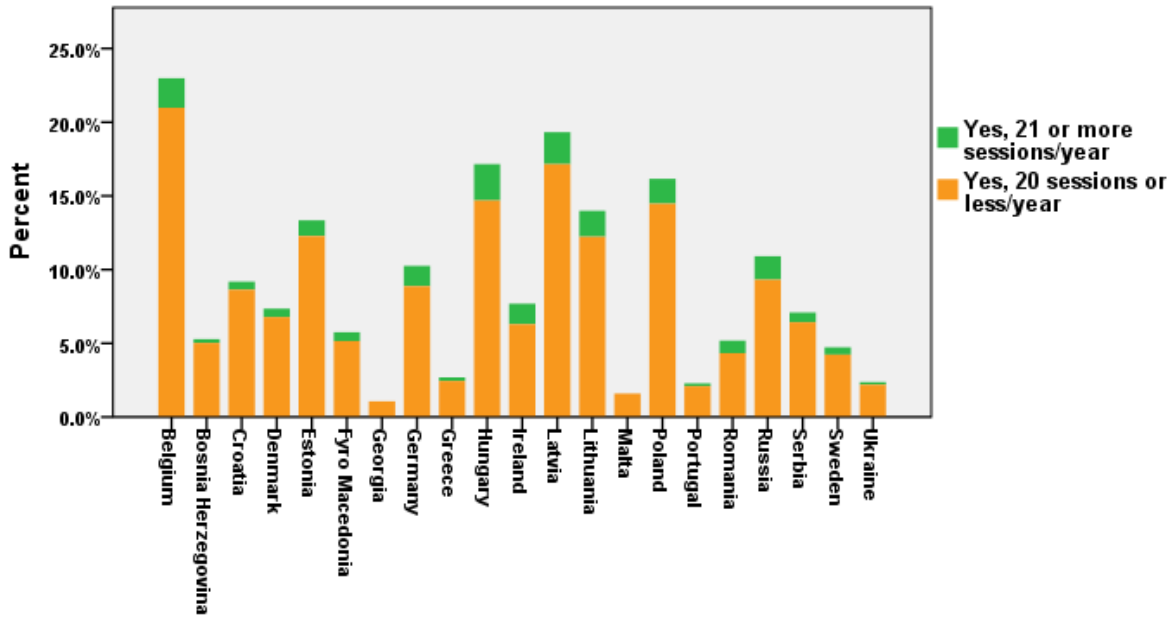
2.1.1 EU population

2.1.2 Sunbed use

	Valid N	N	%
Period 2009-2014	218,433	19,467	8.9%
2015	44,212	4,416	10.0%

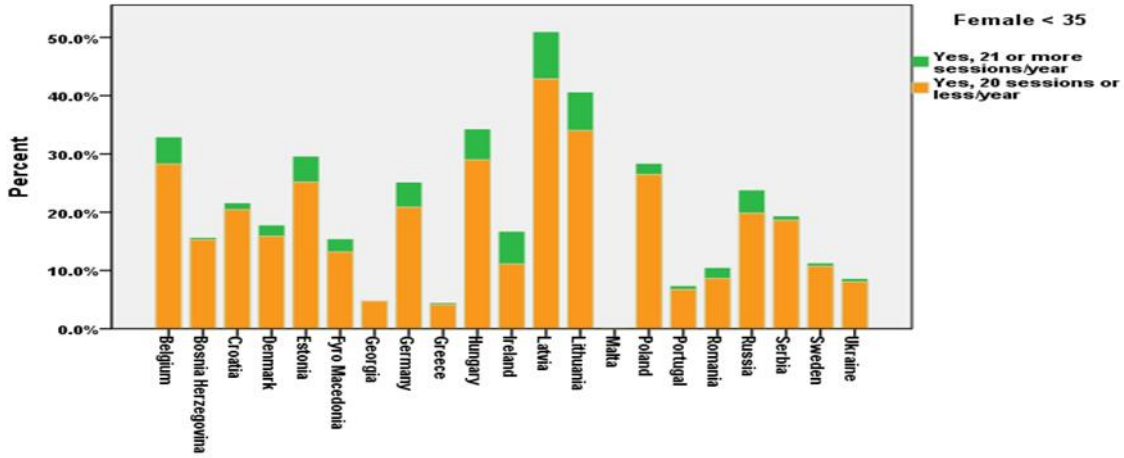
	Screenees	Percentage
No	33,775	87,8%
Yes	3,303	8,6%
Unknown	1,406	3,7%
Total	38,484	100%

	Mean	Standard Deviation	Median	Percentile 25	Percentile 75
Belgium	8.35	6.79	6.00	3.00	10.00
Bosnia H	3.32	2.62	3.00	1.00	4.00
Croatia	4.97	3.67	4.00	3.00	5.50
Denmark	10.23	9.21	9.00	3.00	17.50
Estonia	4.33	3.30	3.00	2.00	5.00
Fyro Macedonia	3.88	4.51	3.00	1.50	4.00
Georgia					
Germany	9.21	6.69	9.50	4.00	11.00
Greece	2.85	2.40	2.00	1.00	3.00
Hungary	7.23	4.95	6.00	3.00	10.00
Ireland	9.20	9.88	3.00	2.00	20.00
Latvia	6.18	4.66	5.00	3.00	8.00
Lithuania	4.15	3.44	3.00	2.00	5.00
Malta	1.00	.	1.00	1.00	1.00
Poland	7.45	5.06	6.00	3.00	10.00
Portugal	4.65	4.58	3.50	2.00	5.50
Romania	2.84	2.49	2.00	1.00	3.00
Russia	4.07	3.32	3.00	2.00	5.00
Serbia	3.23	2.66	2.00	2.00	4.00
Sweden	9.11	7.93	7.00	3.00	11.00
Ukraine	3.04	2.21	2.00	1.00	4.00



> 15%: Belgium, Hungary, Latvia, Lithuania, Poland

2.1.3 Sunbed use (females < 35y)



> 20 %: Belgium, Croatia, Denmark, Fyro, Macedonia, Estonia, Germany, Hungary, Latvia, Lithuania, Poland

< 10 %: Georgia, Greece, Malta, Portugal, Romania

2.2 Belgian population

2.2.1 Sunbed use (2015)

	Valid N	N	%	< 20 sessions	≥ 21 sessions
15 - 65 years of age	1427	233	16.3%	93.6%	6.4%
18 – 35 years of age	404	66	16.3%	92.4%	7.6%

	Women	Men				
	%	< 20 sessions	≥ 21 sessions	%	< 20 sessions	≥ 21 sessions
15 - 65 years of age	21.7%	20.4%	1.3%	8.7%	8.0%	0.7%
18 – 35 years of age	20.8%	19.7%	1.1%	6.4%	4.8%	1.6%

2.2.2 Number of years of use (2015)

	Mean	Standard Deviation	Median	Percentile 25	Percentile 75
15 - 65 years of age	7.4	7.2	5	2	10
18 – 35 years of age	5.4	4.1	5	2	10

2.2.3 Evolution of sunbed use (2009 – 2015)

		Valid N	N	%	< 20 sessions	≥ 21 sessions
Total	**Period 2009-2014**	9,901	2,207	22.3%	90.0%	10.0%
	2009	2,605	658	25.3%	89.4%	10.6%
	2010	1,131	237	21.0%	86.1%	13.9%
	2011	1,711	389	22.7%	89.7%	10.3%
	2012	1,652	388	23.5%	91.2%	8.8%
	2013	1,136	217	19.1%	89.4%	10.6%
	2014	1,666	318	19.1%	93.7%	6.3%
	2015	1,723	248	14.4%	93.5%	6.5%
15 - 65 years of age	**Period 2009-2014**	8,763	2,102	24.0%	90.0%	10.0%
	2009	2,181	619	28.4%	89.0%	11.0%
	2010	1,012	232	22.9%	85.8%	14.2%
	2011	1,592	377	23.7%	89.7%	10.3%

	2012	1,471	372	25.3%	91.1%	8.9%
	2013	1,036	203	19.6%	90.1%	9.9%
	2014	1,471	299	20.3%	94.0%	6.0%
	2015	1,427	233	16.3%	93.6%	6.4%
18 – 35 years of age	**Period 2009-2014**	2,888	775	26.8%	89.0%	11.0%
	2009	632	202	32.0%	89.1%	10.9%
	2010	397	115	29.0%	82.6%	17.4%
	2011	624	161	25.8%	87.0%	13.0%
	2012	440	122	27.7%	88.5%	11.5%
	2013	302	61	20.2%	91.8%	8.2%
	2014	493	114	23.1%	97.4%	2.6%
	2015	404	66	16.3%	92.4%	7.6%

2.2.4 Evolution of number of years of use

	Mean	**Standard Deviation**	**Median**	**Percentile 25**	**Percentile 75**
Period 2009-2014	7.5	6.6	5	3	10
2009	6.6	6.4	5	2	10
2010	7.4	6.8	5	3	10
2011	7.9	6.1	5	3	10
2012	8.4	6.8	6	3	10
2013	8.4	7.2	6	3	10
2014	7.8	6.9	5	3	10
2015	7.3	7.1	5	2	10

About the Superior Health Council (SHC)

The Superior Health Council is a federal advisory body. Its secretariat is provided by the Federal Public Service Health, Food Chain Safety and Environment. It was founded in 1849 and provides scientific advisory reports on public health issues to the Ministers of Public Health and the Environment, their administration, and a few agencies. These advisory reports are drawn up on request or on the SHC's own initiative. The SHC aims at giving guidance to political decision-makers on public health matters. It does this on the basis of the most recent scientific knowledge.

Apart from its 25-member internal secretariat, the Council draws upon a vast network of over 500 experts (university professors, staff members of scientific institutions, stakeholders in the field, etc.), 300 of whom are appointed experts of the Council by Royal Decree. These experts meet in multidisciplinary working groups in order to write the advisory reports.

As an official body, the Superior Health Council takes the view that it is of key importance to guarantee that the scientific advisory reports it issues are neutral and impartial. In order to do so, it has provided itself with a structure, rules and procedures with which these requirements can be met efficiently at each stage of the coming into being of the advisory reports. The key stages in the latter process are: 1) the preliminary analysis of the request, 2) the appointing of the experts within the working groups, 3) the implementation of the procedures for managing potential conflicts of interest (based on the declaration of interest, the analysis of possible conflicts of interest, and a Committee on Professional Conduct) as well as the final endorsement of the advisory reports by the Board (ultimate decision-making body of the SHC, which consists of 40 members from the pool of appointed experts). This coherent set of procedures aims at allowing the SHC to issue advisory reports that are based on the highest level of scientific expertise available whilst maintaining all possible impartiality.

Once they have been endorsed by the Board, the advisory reports are sent to those who requested them as well as to the Minister of Public Health and are subsequently published on the SHC website (www.shc-belgium.be). Some of them are also communicated to the press and to specific target groups (healthcare professionals, universities, politicians, consumer organisations, etc.).

In order to receive notification about the activities and publications of the SHC, please contact: info.hgr-css@health.belgium.be.

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