Artificial Tanning in Québec

Review of knowledge and recommendations

Joint Committee on Exposure to Ultraviolet Rays

and Artificial Tanning

Québec

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Joint Committee on Exposure to Ultraviolet Rays

and Artificial Tanning

Gouvernement du Québec
Ministère de la Santé
et des Services sociaux

ARTIFICIAL TANNING IN QUÉBEC
Review of knowledge, and recommendations

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EXECUTIVE SUMMARY

In October 1995, the Minister of Health and Social Services set up a committee to reach a scientific consensus on the health risks of exposure to ultraviolet rays and to formulate appropriate recommendations for the use of tanning salons.

Health impact of exposure to ultraviolet rays

Ultraviolet rays (UV) have few known beneficial effects on health apart from the vitamin D synthesis in the skin. Many types of skin reactions can occur as the result of acute exposure to UVA and UVB rays, such as tanning, erythemas, burns, photodermatosis, phototoxicity and photoallergies. Acute reactions of the eye mainly occur in the anterior chamber (photokeratitis, photokeratoconjunctivitis).

UVA and UVB rays are carcinogenics and their effects include initiatation and promotion of cancer. Ultraviolet rays can induce damage to the genetic material of cells (DNA) and thereby induce mutations that cause the development of skin cancer. Epidemiological studies have shown that skin cancer (basal-cell and squamous-cell carcinomas, and melanomas) in humans is associated with exposure to the sun. The relationship between exposure to tanning devices and skin cancer is not as clearly demonstrated by epidemiological studies, but studies in which exposure is well documented suggest a possible association between melanoma and artificial tanning devices.

Moreover, experimental studies have shown that animals exposed to UVA radiation have a greater propensity to develop squamous-cell carcinoma. In humans, the treatment of psoriasis with PUVA therapy (a combination of UVA radiation and psoralen) is associated with a higher risk of developing squamous-cell carcinoma. A more recent study also suggests a possible association between PUVA therapy and melanoma.

Long-term exposure to ultraviolet rays has also been shown to have effects other than skin cancer, such as premature aging of the skin, cataracts and a weakening of the immune system.

Artificial tanning in Québec

A survey conducted in Québec in 1996 involving 1003 individuals indicated that 19% of the population had used a commercial tanning devices during the last five years prior to the survey. During the last twelve months before the survey, the rate was 11%. The highest prevalence rate of use was observed among 18 to 34-year-olds. In this age group, one person in three had used a tanning devices during the last five years prior to the survey. Those who use tanning salons most are 18 to 34 years of age and are women. The main reasons given for using a tanning device are to improve their appearance by a tan and to get a protective tan before going on vacation. According to the survey, 26% of users have had one or more acute adverse health problems with artificial tanning. A total of 68% of the undesirable effects reported were skin burns.

A study of tanning salon owners showed a number of shortcomings, particularly in the customer selection process, advertising, information and warnings for customers, maintenance and safety of devices, and knowledge of device operators concerning various subjects related to ultraviolet radiation. According to the study, many tanning salons use tubes that produce a high proportion of UVB radiation.

It has been estimated, on the basis of measurements taken on various models of tanning beds, that the ultraviolet radiation dose received in a tanning salon is an average of four times higher than that received by natural exposure to the sun. For some users, the cumulative annual dose of UVA radiation could exceed the level corresponding to a significant increasing risk to develop skin cancer with PUVA therapy.

Artificial tanning regulations

Regulations are in force in Canada and the United States for ultraviolet sunlamps and tanning devices. These regulations are based on standards aimed at protecting the public from the acute adverse effects of ultraviolet radiation, such as burns to the skin and eyes. A number of states in the US and two Canadian provinces have adopted various regulations specific to tanning salons. A comparative analysis has shown major differences between regulations, particularly in regard to requirements concerning operator training, the admission of young people, equipment inspection and maintenance, and penalties in the case of non-compliance.

Regulatory agencies do not consider artificial tanning harmless and, accordingly, have adopted a number of measures to protect public health, such as the requirement that the risks involved be posted, the prohibition on claiming that an operating permit constitutes approval by the health authorities, and the prohibition on referring in advertising to the beneficial effects of artificial tanning on health. However, the regulatory approach does not provide adequate protection against long-term effects of ultraviolet rays exposure (skin cancer, photoaging of the skin and so on).

Public education

Various awareness programs have been implemented in Australia and the United States on the dangers of ultraviolet rays and the ways to provide protection from them. A variety of clienteles, such as day care centres, schools and the adult public in general have been met by these programs. The results show that knowledge improved through the programs but that retention diminished over time. In addition, the duration of exposure seems to have changed little through this intervention. Recurrent information campaigns by a variety of parties could, however, have a positive impact on behaviour in regard to exposure to ultraviolet radiation.

Conclusion

Natural or artificial ultraviolet ray exposure has a detrimental impact on public health. Current scientific knowledge suggests that repeated exposures to ultraviolet rays in order to get a tan provide little protection and involves health risks. Several groups of experts in Canada, France and the United States have reached a consensus and advise the public against any form of tanning. The work of the Joint Committee has highlighted a number of elements in favour of tighter control of the tanning industry in Québec. However, concerns have been raised about the potential of provincial regulations to correct the various shortcomings found in the industry. In the current situation, the most effective strategies in protecting public health include public education regarding the harmful effects of tanning and reduction of the ultraviolet emissions of tanning devices through tougher federal regulations.

Recommendations

For the Committee's recommendations, please see Page 67 of this report.

INTRODUCTION

Since the early 1970s, tanning salons have grown steadily in popularity in Europe and North America, particularly among young people. The main factors that contributed to the expansion of the tanning industry are the social desirability of a tanned skin and consumer trust in tanning devices. In fact, many people consider “tanned skin” as an expression of “healthy skin”. Public are also encouraged to acquire a “safe tan” by tanning industry. Many false or misleading informations such as “artificial tanning is safer than the sun” or “artificial UVA rays have no detrimental effect on health” have contributed to increase consumer trust in tanning salons. However, regardless of the claims of operators, UVA rays exposure have been shown for a number of years to play an evident role in the development of skin cancer, premature aging of the skin, photodermatosis and impairment of immune function.

In the wake of repeated demands by the Association of Dermatologists of Québec, Health and Social Services Minister Jean Rochon set up a joint committee in October of 1995 to reach a scientific consensus on the health risks of exposure to ultraviolet rays, especially the risks of artificial tanning. The Joint Committee is composed of representatives of the ministère de la Santé, and of the public health network, the Association of Dermatologists of Québec and the Association of Ophthalmologists of Québec, and medical researchers studying ultraviolet rays. The mandate of the committee is to :

(1) Evaluate recent scientific data on the risks of exposure to UVA and UVB rays such as those used in tanning salons;

(2) Review the regulatory or other means used in the other Canadian provinces or in other countries to protect the public from natural or artificial ultraviolet radiation;

(3) Assess the appropriateness of imposing regulations in Québec governing ultraviolet rays;

(4) Analyse the economic impact of the issue, taking into consideration the viewpoint of the tanning industry representatives consulted.

(5) Evaluate other possible options than the regulatory, including public information and education.

The purpose of this report is to provide a response to each of these mandates, followed by a discussion and the recommendations of the Joint Committee. The contributions of the members of the Joint Committee are given in their original format at the end of the report.

1. OVERVIEW OF ULTRAVIOLET RADIATION

Wavelengths between 100 and 400 nanometres (nm) correspond to a region of the electromagnetic spectrum called ultraviolet radiation. Ultraviolet rays are subdivided into three distinct regions on the basis of their biological absorption properties. The most commonly used division is that of the International Commission on Illumination (IARC, 1992), which defines the spectral bands for ultraviolet C (UVC) radiation, 100-290 nm; for ultraviolet B (UVB) radiation, 290-320 nm, and for ultraviolet A (UVA) radiation, 320-400 nm.

For most humans, the sun is the main source of exposure to ultraviolet radiation. About 5% of the radiation from the sun is emitted in the form of ultraviolet rays. UVC rays do not reach the Earth since they are completely absorbed by the ozone layer. Only UVA and UVB rays are detected on the Earth's surface. Hence, terrestrial ultraviolet radiation consists of 95% UVA rays and 5% UVB rays. In contrast to UVA rays, the quantity of UVB radiation that reaches the Earth's surface depends on many environmental factors. The effects of which are summarized in Table 1.

Table 1

Factors that determine the terrestrial UVB radiation levels*

Factor	Comment	UVB radiation intensity
Stratospheric ozone	↓	↑
Time of day	9 a.m. to 3 p.m.	↑
Season	Summer	↑
Geographic latitude	↓	↑
Cloud cover	↑	↓
Altitude	↑	↑
Reflecting surfaces	Water, sand, concrete, snow	↑
Air pollution	↑	↓

* From Rhainds (1997), *Pollution atmosphérique et champs électromagnétiques.*

Tanning salons are the main source of exposure to artificial ultraviolet rays for the general population (IARC, 1992). For the same duration of exposure, a tanning bed can deliver a UVA radiation dose that is three or more times greater than that of the sun (advisory of the Conseil supérieur d'hygiène publique de France, 1996; Diffey, 1986; Nachtwey, 1981). The other artificial sources of ultraviolet radiation are limited especially to the workplace (dental and medical applications, sterilization and disinfection processes, arc welding, lasers, printing and so on).

The biological effects of UVA and UVB rays on the skin range from a simple erythema to the induction of damage to the DNA of skin cells. The radiation intensity required to produce an erythema with UVA rays is 500 to 1000 times greater than for UVB rays. However, the sun emits 100 times more UVA than UVB rays at the Earth's surface. The best known effect of exposure to ultraviolet rays is tanning. The pigmentation of the skin resulting from exposure to ultraviolet rays is produced by two types of reactions, i.e. immediate pigment darkening and delayed tanning. UVA rays induce pigmentation that begins in the minutes following exposure and reaches its highest level at the end of the radiation period. The pigmentation is the result of photo-oxidation reaction of the melanin already present in the skin and involves no production of new melanin. The tanning produced with UVA rays provides no degree of protection from future erythemas. The pigmentation induced by UVA rays generally does not last for more than 36 hours.

Delayed tanning appears 48 to 72 hours after exposure to ultraviolet rays. Pigmentation reaches its maximum level seven to ten days following exposure and lasts for several weeks. This type of tanning is caused by the action of UVB rays, which stimulate the production of new melanin within melanocytes. UVA rays have also been associated with delayed tanning, but in real exposure conditions, the doses of UVA radiation needed are never high enough to induce the formation of new melanin. The pigmentation resulting from the production of melanin provides a degree of protection against cutaneous erythema and sunburn, which is a function of the skin type of the subject. For most people, tanning is a normal defensive reaction by the skin when it is exposed to ultraviolet rays. However, tanning also involves the induction of damage to

the skin, particularly to the DNA of the epidermal cells (CSA, 1989; Nachtwey, 1981), which, over the long term, may have a more serious impact on health.

2. EVALUATION OF SCIENTIFIC DATA ON THE HEALTH EFFECTS OF EXPOSURE TO UVA AND UVB RAYS

2.1 Evaluation of the carcinogenic effects of ultraviolet rays

2.1.1 Molecular and genetic effects

Additional information on the role of ultraviolet rays in inducing skin cancer is provided in Appendix 1. Ultraviolet rays play a major part in the development of skin cancer. Since genetic, animal and epidemiological studies have provided sufficient proof that the sun is a carcinogen for humans, the International Agency for Research on Cancer (IARC, 1992) classified sun radiation as a Group 1 carcinogen. UVA and UVB rays were classified as probably carcinogenic to humans (Group 2A).

Figure 1 summarizes the main mechanisms involved in the induction of skin cancer. Ultraviolet rays cause several types of damage to the genetic material (DNA) of skin cells. Cell death occurs when the frequency of DNA damage is too high; it is then said that the cell goes into apoptosis. However, if the frequency of damage is low, the cell can repair its DNA and regain its integrity. Mutations may occur when the cell is being repaired because of base misincorporation in the DNA sequence. Mutations alter the operation of normal genes in the cell that suppress the development of cancer. Hence, cancerous cells are those that have been transformed and have lost the usual mechanisms that control multiplication. Therefore, utraviolet rays may initiate the development of skin cancer by damaging the DNA. They may also promote skin cancer by suppressing the immune system, which is required to eliminate transformed cells.

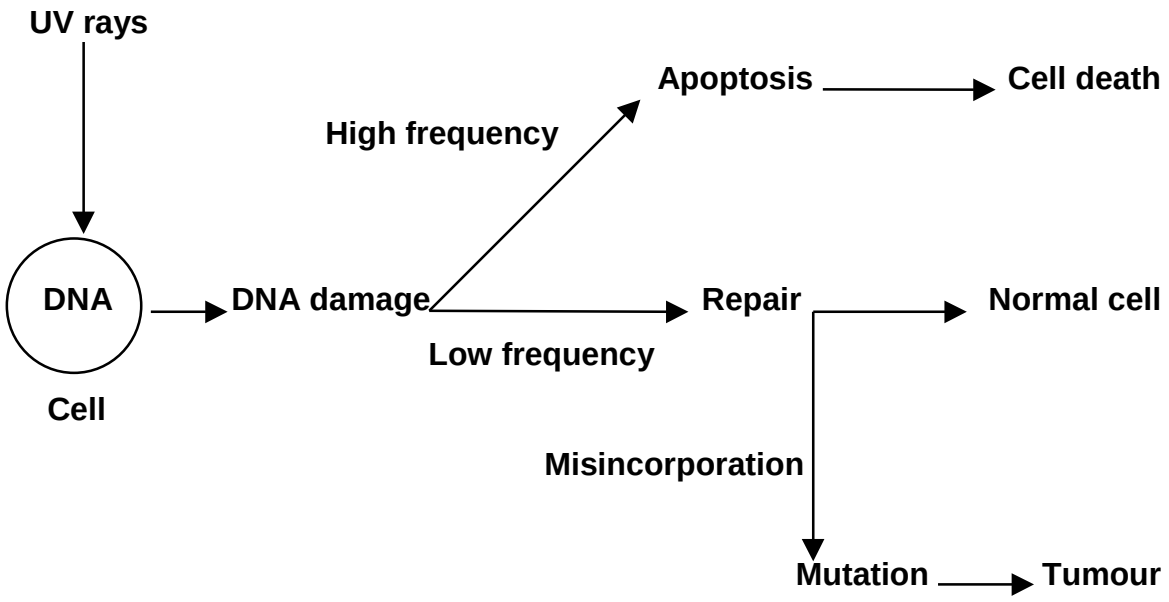

Figure 1. Effects of ultraviolet rays on the DNA sequence of a cell

Various types of damage may occur in the DNA. The three main categories of damage are : (1) cyclobutane pyrimidine dimers (CPDs); (2) (6-4) photoproducts; (3) minor photoproducts or photo-oxidative damage. The type of damage and the relative quantity produced depend on wavelength (see Table 2). For example, UVB rays produce more CPDs and (6-4) photoproducts, while UVA rays are involved particularly in photo-oxidative damage.

Table 2

Relative quantity of photoproducts induced according to type of ultraviolet (UV) rays

Type of UV rays	Type of damage to DNA		
	CPDs[†] (%)	(6-4) photoproducts (%)	Photo-oxidatives (%)
UVA	1.5	0.5	80
UVB	75	17	7.8
UVC	75	20	4.9

[†] Cyclobutane pyrimidine dimers.

All groups of photoproducts have mutagenic potential. The relative contribution of each type of DNA damage to the mutational spectrum is, however, unknown. A recent study of the frequency of mutations according to the different types of ultraviolet rays sheds light on the possible role of each type of damage in the process of inducing mutations (Drobetsky, 1995). Drobetsky *et al.* demonstrated that the mutational spectrum is specific to the type of ultraviolet rays. Findings have shown that UVB and UVC rays mainly induce C to T transitions on DNA, as well as CC to TT tandem transitions. UVA rays specifically produce T to G transitions.

The probability that damage of specific DNA sequence will induce a mutation depends on three factors : (1) the mutagenicity or mutagenic potential of the damage; (2) the frequency of damage to the site; (3) the rate of repair of the damage to the site. It has been shown that the higher the frequency of damage to the site, the higher the probability that a mutation will occur. It has also been documented that mutations occur more frequently on damage sites where the speed of repair is slow. In fact, eight of the most frequent mutations sites in human skin tumours correspond to a very high frequency of CPD damage and a very slow speed of repair.

2.1.2 Epidemiological studies on the relationship between skin cancer and exposure to the sun

This section of the report reviews the main findings of epidemiological studies, which establish a causative link between skin cancer and sun radiation. A detailed review of the subject is provided in appendices 2a and 2b.

2.1.2.1 Overview of skin cancer

There are three histological forms of cutaneous melanoma : superficial spreading melanoma, nodular melanoma and lentigo malignant melanoma or Hutchinson's melanotic freckle (IARC, 1992). Cutaneous melanomas account for approximately 5% of total cases of skin cancer. The average survival rate at five years is 81%, but it varies considerably according to the stage of the disease (Koh, 1991). The anatomical sites most often affected are the back and the face among males, and the legs among

females. Non melanoma skin cancer (NMSC) is classified into two histological types : basal-cell carcinoma and squamous-cell carcinoma (IARC, 1992). Carcinomas account for 95% of all skin cancer. The anatomical sites most often affected are the face, head and neck (Preston, 1992). The prognosis for carcinomas is generally good. The survival rate for BCC is almost 100 % while the 5-year SCC survival is 88 % in men and 84 % in women (Koh, 1995).

Melanomas and NMSC mainly affect white people, particularly light-skinned populations. This is the most common form of cancer in all countries where cancer data are recorded. The highest incidence is found in Australia among people of British descent (Giles, 1988; IARC, 1992). The risk of developing skin cancer is highest among people with light skin who burn easily, or tan little or not at all (Armstrong, 1996; IARC, 1992). People with *xeroderma pigmentosum* (the inability to repair DNA damaged by ultraviolet rays) are also at very high risk for developing skin cancer (Armstrong, 1995; IARC, 1992).

2.1.2.2 Relationship with the ambient solar radiation

The incidence rates of melanomas, basal-cell carcinoma (BCC) and squamous-cell carcinoma (SCC) in the White population increases according to the North-South gradient. The rates increase with increasing proximity to the equator and with increasing measured ambiant solar ultraviolet irradiance (IARC, 1992; Armstrong, 1995). Indirect proof of the link between the place of residence (level of exposure to solar radiation) and the development of skin cancer has been provided by studies of the role of immigration. The findings show that the melanoma incidence rates in Australia are two-fold higher in British descent born in this country than in British immigrants (IARC, 1992). This relationship was also observed for BCC (Kricker, 1991a). The risk of developing melanoma or BCC in a person who migrates during childhood to a region of high solar radiation level is similar to that of a person born in that region (Armstrong, 1996).

2.1.2.3 Relationship with benign skin lesions caused by the sun

Some benign skin lesions are considered indicators of skin damage linked to chronic exposure to the sun. Solar elastosis, solar telangiectasia and solar lentigo are associated with skin cancer (melanomas and carcinomas) in a number of case-control studies (Armstrong, 1995 and 1996; Green, 1988; Kricker, 1991a). Certain benign sun related conditions are associated more specifically with a given type of skin cancer, such as freckles and cutaneous melanocytic naevi with melanoma (Armstrong, 1995), and solar keratosis of the face with carcinoma (Green, 1988; Kricker, 1991b).

Many epidemiological studies have reported an association between severe sunburn (indicator of episodes of intense sun exposure), particularly in childhood and adolescence, and the risk of developing melanoma or NMSC (Gallagher, 1995a and 1995b; Hogan, 1989; IARC, 1992). Sunburn is defined as severe, painful burning of the skin over a period of at least two days, accompanied by blisters.

2.1.2.4 Relationship with sun exposure

From 1970 to 1990, a number of cross-sectional and case-control studies conducted in various countries established a linear dose-response relationship between NMSC and cumulative exposure to the sun (O'Beirn, 1970; Vitasa, 1990; Urbach, 1974). More recent studies suggest, however, that for BCC, the dose-response relationship is non-linear, with risk rising to peak at 35 000 hours of cumulative exposure to the sun followed by a fall (Kricker, 1995a and 1995b). This relationship was particularly observed among individuals who have difficulty tanning. The authors of these studies do not believe there is an actual reduction in the risk of developing BCC. They believe the drop in the risk is attributable to a reduction in sun exposure by people at very high risk, i.e. those who have already been treated for skin cancer or for such benign lesions as solar keratosis. Hence, people who have not had skin cancer or warning signs of it and who are therefore less likely to develop skin cancer continue to accumulate hours of exposure to the sun (Armstrong, personal communication, 1996).

Intermittent exposure to the sun between the ages of 15 and 20 has been associated with an increase in risk of developing BCC. In the age groups of 15 to 19 years and 20 to 24 years, the risk of BCC adjusted according to individual capacity to tan increases considerably for those who tan little or not at all, compared with people who tan easily (Kricker, 1995a and 1995b). The risk of developing SCC related to sun exposure to the sun is still linear according to recent studies on the subject (Armstrong, 1996; Gallagher, 1995b). In the case of melanoma, the findings of studies conducted in Western Canada (Elwood, 1985), Denmark (Osterlind, 1988), Sweden (Beitner, 1990) and Italy (Zanetti, 1988) suggest a significant relationship with intermittent and intense exposure to the sun. Intermittent exposure is usually measured on the basis of such activities as excursions to the beach, sun-bathing, swimming and vacations in sunny climes.

2.1.2.5 Relationship with occupational exposure

People who work outside, particularly farmers, have higher mortality rates for NMSC (Atkin, 1949; Beral, 1981; Lancaster, 1957; Marks, 1989; Whitaker, 1979). A higher risk of SCC among people who work outdoors (Aubry, 1985) and of BCC among farmers (Hogan, 1989) has been reported. In contrast to NMSC, cutaneous melanomas are more frequent among people who work inside. This relationship between melanoma and work could be explained by a selection bias introduced by people with lightly pigmented skin, who are less likely to work outside (Green, 1996). Furthermore, a higher frequency of intermittent exposure to the sun (seasonal jobs resulting in short-term exposure to the sun) among individuals working inside could be also an explanation (Elwood, 1985; Paffenberger, 1978).

In summary, epidemiological studies have established a link between skin cancer and exposure to sun radiation. This association is supported by the following elements : (1) skins cancers develop mainly on sun exposed body areas; (2) are more frequent in regions where the ambient level of sun radiation is high; (3) among people with high sun exposure; (4) among people with sensitive skin who burn easily or tan little or not at all in the sun; and (5) people with benign skin lesions caused by the sun. Furthermore, studies indicate that the pattern of exposure to the sun (intermittent versus cumulative) plays a role in the development of the various forms of skin cancer.

2.1.3 Epidemiological studies of the relationship between exposure to sunlamps and tanning beds, and skin cancer

A detailed review of the main epidemiological studies on the subject is given in Appendix 3 of this report. The objectives of the authors of this report were to review the epidemiological studies dealing with the relation between skin cancer and exposure to sunlamps and tanning beds, and to evaluate, on the basis of these studies, all the elements that may support a cause-and-effect relationship between exposure to artificial ultraviolet rays and skin cancer.

From 1979 to 1995, 15 case-control studies have been conducted to evaluate the association between exposure to sunlamps and tanning beds, and cutaneous melanoma (See Table 3). On the basis of the review, it was noted that the main objective of nine of these studies was not to evaluate the risk of developing melanoma related to artificial tanning (Adam, 1981; Elwood, 1986; Gallagher, 1986; Garbe, 1993; Holman, 1986; Klepp, 1979; Osterlind, 1988; Sorahan, 1985; Zanetti, 1988). These studies were eliminated from the analysis particularly because of the many shortcomings in the characterization of the exposure to artificial tanning and in the methodology generally.

Table 3

Summary of case-control studies of exposure to sunlamps and tanning beds and cutaneous melanoma

Author	Period of diagnosis	Number of cases/controls	Exposure
Klepp (1979)	1974-1975	78/131	UV lamps
Adam (1981)	1971-1976	111/342	Sunlamps
Sorahan (1985)	1980-1982	58/333	Sunlamps
Elwood (1986)	1981-1984	83/83	Sunlamps at home
Holman (1986)	1980-1982	511/511	Sunlamps
Gallagher (1986)	1979-1981	595/595	Sunlamps
Osterlind (1988)	1982-1985	474/926	Sunlamps
Zanetti (1988)	1984-1986	208/416	UVA lamps
Swerdlow (1988)	1979-1984	180/120	Sunlamps and tanning beds
MacKie (1989)	1987	280/280	Artificial UV and tanning beds
Walter (1990)	1984-1986	583/608	Sunlamps and tanning beds
Garbe (1993)	1984-1987	856/705	Tanning beds
Westerdahl (1994)	1988-1990	400/640	Sunlamps and tanning beds
Autier (1994)	$\geq$ 1991	420/447	Sunlamps and tanning beds
Holly (1995)	1981-1986	452/930	Sunlamps

The most recent studies on the subject better describe the exposure to artificial ultraviolet rays by adding duration and intensity (Autier, 1994; Holly, 1995; MacKie, 1989; Swerdlow, 1988; Walter, 1990; Westerdahl, 1994). In five of these studies, the risk of developing melanoma was statistically significant in the highest exposure categories as expressed in minutes, hours, months or number of sessions per year (see Table 4). A dose-response relationship between the use of sunlamps and tanning beds, and cutaneous melanoma was observed in these five studies, as shown in Table 4 (Autier, 1994; MacKie, 1989; Swerdlow, 1988; Walter, 1990; Westerdahl, 1994). The association observed was, however, statistically significant in three studies, i.e. those of Swerdlow, Walter and Westerdahl. Furthermore, the subgroups analyzed are characterized by very small numbers of cases and controls as shown by very wide confidence intervals around risk estimates (Table 4).

Table 4

Relationship between cumulative artificial tanning exposure indicators and cutaneous melanoma

Author	Cumulative exposure indicator	OR (CI 95%)[†]	Comments
Swerdlow[‡]	> 5 years before diagnosis	9.1 (2.0-40.6)	Trend significant with cumulative number of hours
	≤ 5 years before diagnosis	1.9 (0.6-5.6)	
MacKie	Tanning beds > 3 months ♂+♀	4.7 (1.89-11.54)	
	Tanning beds > 3 months ♂	8.6 (1.06-70.24)	
	Tanning beds > 3 months ♀	3.9 (1.41-10.71)	
Walter	Cumulative duration in months		
	< 12 months ♂	1.74 (1.03-2.97)	⇑ risk with duration, trend significant in ♂+♀
	≥ 12 months ♂	2.12 (0.90-5.28)	
	< 12 months ♀	1.22 (0.80-1.87)	
	≥ 12 months ♀	2.99 (1.08-9.57)	
	Cumulative duration in minutes		
	< 180 minutes ♂	1.44 (0.75-2.82)	⇑ risk with duration, significant trend in ♂ only
	≥ 180 minutes ♂	2.50 (1.34-4.80)	
	< 180 minutes ♀	1.17 (0.70-1.95)	
	≥ 180 minutes ♀	1.62 (0.91-2.89)	
	Last exposure more than 5 years ago ♂	2.00 (1.21-3.34)	
Westerdahl	> 10 times/y	1.8 (1.0-3.2)	
	> 10 times/y, melanoma on trunk	4.2 (1.6-11.0)	Significant trend
	> 10 times/y and < 30 y	7.7 (1.0-63.6)	Significant trend
Autier	≥ 10 hours, to tan, skin burn	7.35 (1.67-32.3)	
	≥ 10 hours, all reasons, skin burn	3.81 (1.21-12.0)	
Holly	Low use	0.91	
	High use	1.10	

† Odds ratio with confidence interval at 95%
‡ Relative risk (RR) rather than odds ratio
♂ Men
♀ Women

Certain variables associated with artificial tanning, such as skin burns, age of the subject, histological type and tumour location, were also looked at in some studies in order to evaluate their effects on the risk of developing melanoma (see appendix 3, and tables 4 and 5 of the study report).

These studies show that there was a trend of increasing risk only when they are associated with the duration of exposure. Furthermore, the review of the studies highlighted that exposure to the sun, which is the main confounding variable in the relation between melanoma and artificial tanning, is not always adequately controlled. Hence, part of the effects observed with sunlamps and tanning beds could be attributable to exposure to the sun. Despite these reservations in terms of methodology, it has been estimated that about 15% of melanomas may be linked to the use of sunlamps and tanning beds (Marrett, 1994).

The association between non melanoma skin cancer and exposure to sunlamps and tanning beds have been evaluated in four studies (Aubry, 1985; Herity, 1989; Hogan, 1991; O'Loughlin, 1985). Their detailed findings are given in Appendix 3. None of these studies had as its main objective to evaluate the risk of NMSC associated with artificial tanning devices use. Furthermore, the many methodological shortcomings found in these studies limit the interpretation of their findings.

In conclusion, the most recent epidemiological studies do not establish at the moment a causative link but suggest the possibility of a dose-response relationship between cutaneous melanoma and artificial tanning. Moreover, no negative findings in studies that were methodologically well constructed were found in the literature. Future studies on the subject should be improved in particular with respect to evaluation of exposure to artificial ultraviolet rays and control of the confounding effect of sun exposure. In addition, the relation between skin cancer other than melanoma and artificial tanning should be studied more carefully in the coming years.

2.1.4 Experimental studies on the induction of skin cancer in animals through UVA rays

The carcinogenic properties of UVA rays received little attention before tanning devices were introduced on the market. Since then, many experimental studies have evaluated the association between exposure to sunlamps and the inducing of skin cancer in animals. This section contains a summary of the main studies in which the exclusion of UVB rays was well documented (IARC, 1992).

The effects of exposure to UVA rays from sunlamps (Phillips TL 40W/09) used in the tanning industry were evaluated on male and female mice by van Weelden *et al.* (1986a, 1986b, 1988). The mice were irradiated for 12 hours a day, 7 days a week for about a year. The dose of UVA radiation delivered was 220 kJ/m^2 per day. By comparison, a 20-minute session in a tanning bed with UVA irradiance of 250 W/m^2 corresponds to a dose of 300 kJ/m^2 (Diffey, 1987). The study showed that most of the animals developed one or more skin cancers after an average of 265 days of exposure. Sixty percent (60%) of the skin cancers were squamous-cell carcinomas. Sterenborg and van der Leun (1990) also evaluated the induction of skin cancer in mice with a UVA radiation source (UVA SUN 5000, > 340 nm). The duration of exposure was two hours a day, seven days a week for 400 days. The daily UVA irradiation dose was 220 kJ/m^2. Most of the animals irradiated developed squamous-cell carcinoma of the skin following the experiment.

Kligman *et al.* (1990, 1992) evaluated the effects of UVA exposure in female mice with wavelengths above 340 nanometres. The animals were irradiated several times a week for 60 weeks. The daily dose of UVA radiation was 360 kJ/m^2. After 100 weeks of observation, the 22 surviving mice developed a total of 40 squamous-cell carcinomas of the skin. The authors concluded that short-wavelength UVA rays (320 to 340 nm) are approximately five times more effective in inducing skin cancer than long-wave length UVA rays (340-400 nm).

Fish strains (*platyfish xiphophorus*) susceptible to melanocytic neoplasm have been studied to estimate the sensitivity for melanoma induction as a function of exposure and wavelength (Setlow, 1993). The animals were irradiated with a mercury lamp (500 W). The wavelengths used were 302, 313, 365, 405, 436 nm. There was an increase in melanoma prevalence in animals with exposure at all wavelengths. This study suggests that wavelengths in UVA range are effective in induction of malignant melanoma in this animal model.

Many authors, including those already cited, have observed a phenomenon of photoaugmentation of the carcinogenic effects of UVB rays by UVA rays. On average,

the dose of UVB rays required to induce a carcinogenic effect was reduced by 16% by UVA rays (IARC, 1992).

2.1.5 Medical photochemotherapy (PUVA) and skin cancer

Photochemotherapy or PUVA therapy is used to treat certain pathologies of the skin, mainly psoriasis. PUVA therapy involves the combination of UVA radiation source and a photo-active medication, psoralen (8-methoxypsoralen), which forms unstable complexes with the DNA molecule of skin cells. Strict medical control is required in using photochemotherapy because of the use of UVA radiation in high concentrations and in conjunction with a strong photosensitizer. The average cumulative UVA dose used to treat a case of psoriasis varies from one country to another and is within an interval of 700 to 1500 J/cm^2 (Studniberg, 1993).

Since the introduction of PUVA therapy in 1974, its carcinogenic potential has aroused much interest. Many prospective and retrospective studies have evaluated the association between PUVA therapy and the development of skin cancer. Despite a number of methodological shortcomings, many of these studies establish an independent link between PUVA therapy and the development of squamous-cell carcinoma (SCC). PUVA therapy can induce and promote the development of SCC regardless of the skin type. The findings show that the risk is significant for cumulative PUVA exposure above 1000 to 1500 J/cm^2 (Studniberg, 1993). It is recommended that these patients be screened annually to detect precancerous lesions (solar keratosis) or skin cancer. A recent study also suggests an association between PUVA therapy and cutaneous melanoma (Stern, 1997). To date, the link between basal-cell carcinoma and PUVA therapy has not been demonstrated.

2.1.6 Uveal melanoma and exposure to sunlamps

See Appendix 4 for a detailed review of the epidemiological studies on the relation between uveal melanoma and exposure to sunlamps.

Uveal melanoma is a rare disease in the population (6 per 10^6 person-years). It is more frequent in men than in women and mainly affects individuals in their 60s. Three authors studied the possible link between exposure to artificial ultraviolet rays and uveal melanoma (Holly, 1990; Seddon, 1990; Tucker, 1985). The three case-control studies show an increasing risk of developing uveal melanoma that varies from 1.4 to 3.7. However, in the study conducted by Tucker *et al.* (1985), the risk was not statistically significant. Seddon *et al.* (1990) found a relative risk of 3.4 (CI 95% : 1.1-10.3) in subjects exposed to sunlamps, whereas Holly *et al.* (1990) found a risk of 3.7 (CI 95% : 1.6-8.7) in individuals exposed to ultraviolet rays other than the sun, without specifying whether sunlamps were the source. None of the studies clearly demonstrated a dose-response relationship between exposure to artificial ultraviolet rays and uveal melanoma.

Various methodological problems have been found in these studies. Among them are the following : (1) the objective of these studies was to document a number of etiological factors, not specifically exposure to artificial ultraviolet rays; (2) the case diagnosis period (1974-1987) was a time when the prevalence of exposure to sunlamps was low; (3) the debatable choice of control cases in Tucker's study, where 50% of them had a cataract, which is a pathology of the eye associated with exposure to the sun; and (4) a too short latency period between the beginning of exposure and the diagnosis of eye cancer to adequately evaluate a dose-response relationship. It seems obvious that the three studies now available do not provide support for a causal association between exposure to artificial ultraviolet rays and uveal melanoma. Furthermore, a comparison between cutaneous melanoma and uveal melanoma in terms of their respective risk factors does not add any relevant information about this association.

The number of studies now available with their many methodological shortcomings make it impossible to state whether or not there is an association between uveal melanoma and exposure to sunlamps or other artificial sources of ultraviolet radiation. Additional studies are required to resolve the question.

2.2 Ultraviolet radiation effects on immunologic function

The skin is one of the organs that has an active participation in the immunologic reactions. This role is mainly played by Langerhans cells, located in the suprabasilar layer of the skin (CSA, 1989). Langerhans cell are bone marrow-derived cells which are responsible of antigen presentation to T lymphocytes. Keratinocytes of the skin also take part in the process of immune reaction by producing different types of cytokines. Cytokines play a particular role in the proliferation of B and T lymphocytes (Nozaki, 1991).

It has been demonstrated in *in vivo* and *in vitro* studies that UVA and UVB rays alter the morphology and the function of Langerhans cells, suppress the hypersensitivity of contact and promote the release of immunosuppressors (CSA, 1989). Ultraviolet rays therefore induce local and systemic immunosuppression. An experimental study showed that humans exposed to the sun for one hour a day on 12 consecutive days had a reduced immune response with high levels of T lymphocyte suppressors (Hersey, 1983). Similar results have been observed in experimental studies on animals and humans irradiated under sunlamps (CSA, 1989; Rivers, 1989). The effects of ultraviolet rays on the immune system can promote the development of skin cancer and other types of cancer or infectious diseases by inducing a general state of immunosuppression. However, whether the changes in immune function are of clinical and public health significance remain unclear.

2.3 Cutaneous effects other than cancer of ultraviolet rays exposure

The effects on the skin other than cancer associated with exposure to ultraviolet rays are given in detail in Appendix 5 of this report.

2.3.1 Acute effects

Exposure to ultraviolet rays from natural or artificial sources causes vasodilatation and an increase in the volume of blood in the dermis that is perceived visually as redness. A more severe reaction takes the form of sunburn. UVB rays are very effective in inducing

erythema or sunburn. UVA rays also cause erythemas, but the radiation dose required, depending on the wavelength, is 500 to 1000 times greater than the UVB dose. UVA rays penetrate more deeply into the skin than UVB rays and may also cause damage to the dermis. The extent of the acute reaction is affected by the intensity of the radiation, but also by such individual factors as skin phototype, skin thickness and the quantity of melanin.

2.3.2 Skin photoaging

Skin aging induced by ultraviolet rays is distinct from physiological aging. The manifestations of photoaging include dry, thick, leathery or yellow-brown appearance of the skin with wrinkles, telangiectasias and atrophy. The appearance of surface and deep wrinkles is due to a changes in the quantity and integrity of dermal elastic tissue (elastosis). The cutaneous changes are usually observed in areas of the body exposed to the sun such as the face, neck, back, arms and hands. Solar keratosis, considered as premalignant tumour that can lead to non melanoma skin cancer, is also a manifestation of photoaging. UVB and UVA rays are responsible for premature aging of the skin.

2.3.3 Photodermatosis

UVA and UVB rays play a significant role in the development of photodermatosis. An interaction between ultraviolet rays and a chromophore is required for the development of photodermatosis. Photodermatosis can take the form of exacerbated skin diseases and diseases induced by ultraviolet rays, as well as hereditary pathologies. Some of these pathologies can be induced by infrared rays.

Diseases of the skin exacerbated by ultraviolet rays are numerous and include dermatomyositis, lupus erythematosus, pellagra, porphyria of the skin and psoriasis vulgaris. Some infections, for example herpes simplex, shingles, plantar warts, *molluscum contagiosum* and *pityriasis versicolor*, may also be aggravated by exposure to UVA and UVB rays. Certain skin pathologies are induced directly by ultraviolet rays, such as polymorphous light eruption, solar urticaria and actinic prurigo.

A group of hereditary diseases is characterized by high photosensitivity accompanied sometimes by an inability to repair the DNA of skin cells damaged by ultraviolet rays. The best known of these hereditary diseases is *xeroderma pigmentosum*. People with this pathology develop signs of photoaging of the skin and skin cancers at a very young age.

2.3.4 Phototoxicity and photoallergy

Phototoxic reactions are frequent in the population. Most individuals are at risk for such reactions since they do not require prior immunization. A phototoxic reaction develops when a person is exposed to a considerable quantity of an antigen, for example medications, and a sufficient dose of ultraviolet rays. The onset of clinical manifestations occurs a few minutes to a few hours after exposure to ultraviolet rays and presents in the form of an erythema or sunburn solely on the exposed areas of the body. Phototoxic reactions occur mainly in the UVA radiation spectrum, but include wavelengths between 300 and 400 nm.

Photoallergic reactions are less common, and initial contact with an antigen is required beforehand for the allergic reaction to develop. Subsequently, a low concentration of an antigen or of a medication is sufficient to trigger the allergy. The reaction usually occurs 24 to 48 hours after exposure to ultraviolet rays and presents in the form of eczematous lesions accompanied by papular eruptions or urticaria. UVA rays, UVB rays and visible light can induce photoallergic reactions.

2.4 Eye injuries related to ultraviolet rays exposure

The acute effects of ultraviolet radiation on the eye are discussed in detail in Appendix 6.

2.4.1 Cornea and conjunctiva

The cornea absorbs wavelengths of 280 to 315 nm, which correspond to the UVB and UVC rays emission spectrum. Acute exposure to ultraviolet radiation (mainly UVB rays)

can cause photokeratoconjunctivitis and photokeratitis (corneal burns). Although photokeratitis can result in temporary blindness (6-24 hours) and intense pain, it is a reversible lesion with generally no sequelae when adequately treated. However, repeated exposure to ultraviolet rays produces a thickening and hypervascularity of the conjunctiva (Spencer, 1995). Chronic exposure to UVB rays can cause three types of corneal-conjunctival pathologies : climatic droplet keratopathy, pinguecula and pterygium.

The use of tanning salons has been associated with corneal burns (MMWR, 1989; Walters and Kelly, 1987). A study of ophthalmologists in Wisconsin showed that, over a 12-month period, 152 patients had consulted these physicians for eye burns caused by the use of tanning devices (MMWR, 1989). It was also observed that the eye surface exposed to ultraviolet rays could be up to two-fold greater in a tanning bed than outdoors in sunlight. Corneal burns related to artificial tanning usually occur in people who do not use protective eyewear.

2.4.2 Lens

The lens absorption spectrum encompasses wavelengths between 315 and 400 nm. Long-term exposure of the lens to ultraviolet rays is associated with increased risk of developing cataracts. A cataract is present when there is a len opacitie that interfered with the passage of light through the len. Approximately 85% are senile cataracts and they are subdivided into three morphological types : nuclear, cortical and posterior subcapsular cataracts. The cataractogenic properties of ultraviolet radiation have been evaluated in *in vitro* (biochemical, photochemical, histological) studies. The opacity mechanism reportedly consists in a change in the structural proteins of the lens. The photo-oxidation of aromatic amino acids, particularly tryptophane, is one of the mechanisms suggested.

A number of epidemiological studies have also highlighted an association between cataracts and exposure to ultraviolet radiation (Seidman-Ripley, 1993). Ecological studies have shown that the prevalence of cataracts is higher in regions near the Equator, where UVB radiation is more intense. Taylor *et al.* (1988) also observed a

dose-response relation between exposure to UVB rays and cortical cataracts among Maryland fisherman.

2.4.3 Posterior eye

The retina is protected from ultraviolet rays by anterior structures of the eye that absorb wavelengths below 400 nm. Usually, only visible and close infrared radiation can reach the vitreous humour and the retina (400-1400 nm). Ultraviolet rays can damage the retina in people who have undergone surgical excision of the lens.

2.5 Vitamin D synthesis

A detailed review of vitamin D, including the role of the sun, diet and its protective effect for certain cancers, is provided in Appendix 7. Vitamin D has the properties of a vitamin, but also those of a hormone. Its role consists in maintaining calcium and phosphorus in blood serum at concentrations that ensure the mineralization of the bones, neuromuscular functioning and various cellular activities. The circulating concentration of 25-hydroxyvitamin D_3 (25-OH-D_3) is the best biochemical marker of vitamin D status. The serum level of 25-OH-D_3 varies from one country to another according to climate and food enrichment practices. For example, comparative studies have shown that the mean concentration of 25-OH-D_3 in the blood in young adults living in Canada and the United States (25 ng/ml; Chesney, 1981) was higher than that observed in Great Britain (12 ng/ml; Lester, 1980).

The normal range for concentrations of vitamin D also varies according to the age and physiological condition of the subject. Although there is no clearly defined critical level, the organism is considered to be lacking in vitamin D at concentrations below 10 ng/ml. Vitamin D deficiency causes rickets in children, whereas in adults, it causes a defect in mineralization of the bones called osteomalacia. Increased secretion of the parathyroid hormone is also associated with vitamin D deficiency. This results in an increase in the porosity of the bones through the mobilization of calcium and, eventually, an exacerbation of osteoporosis.

Sunlight is the main source of active vitamin D. Vitamin D_3 is synthesized by UVB rays through the 7-dehydrocholesterol in the skin. Vitamin D_3 is carried by the bloodstream and undergoes an initial transformation in the liver (25-OH-D_3). Further hydroxylation in the kidneys (1,25-$(OH)_2$ D) produces the physiologically active molecule. It has been estimated that exposure of the cheeks to the sun at noon for 10-15 minutes is sufficient to provide the organism with the required dose of vitamin D. During prolonged exposure to the sun, the production of vitamin D is self-regulated by vitamin D_3 photodegradation mechanisms. Certain factors may alter the vitamine D synthesis in the skin. The increase in the skin's pigmentation through tanning reduces the capacity of the epidermis to synthesize vitamin D_3. Reduced production of vitamin D by the skin as age increases has also been observed.

Generally, exposure to the sun provides for all vitamin D needs. However, it is estimated that an average of 12.5 mg (500 IU) of vitamin D per day is needed in the diet to keep blood concentrations of 25-OH-D_3 within normal limits for individuals who are not exposed to the sun. Despite that, the elderly are usually more likely to have a vitamin D deficiency. The causes of this deficiency are reduced synthesis of vitamin D by the skin, an insufficient dietary intake of vitamin D and less exposure to the sun. A supplement is recommended for this age group.

Enriched milk is the main dietary source of vitamin D. Milk, margarine and eggs provide about 80% of dietary vitamin D. The addition of vitamin D to milk has been mandatory in Canada since 1975 under the *Food and Drug Regulations*. According to the regulations in force, milk must contain between 8.8 and 11.7 mg/L (350-470 IU) of vitamin D. Health Canada inspects all dairies at least once every 12 to 18 months. If the result of an analysis is not satisfactory, the dairy is subjected to other, more frequent inspections. According to recent analyses of milk samples conducted by the Canadian Food Inspection Agency, dairy products sold in Québec contain sufficient amounts of vitamin D. In 1986, the Nutrition Research Division of Health Canada analysed vitamin D concentrations in margarine. Among the brands assessed, 16 are sold in Québec and account for 90% of the volume of sales. The analyses showed that all of the products had some vitamin D, whereas only two samples contained less than the minimum required under the regulations. Thompson and Verdier, of Health Canada's Bureau of

Nutritional Sciences, evaluated overall vitamin D dietary intake, on the basis of the findings of the 1971-1972 Nutrition Canada survey (see Appendix 7). The daily vitamin D intake from all food sources is an average of 4 mg (160 IU) for women and 7 mg (280 IU) for men. The authors concluded that, according to their estimates, Canadians have an adequate daily vitamin D intake from dietary sources.

In conclusion, vitamin D is essential to maintaining homeostasis. Short-term exposure to the sun with no erythema or tanning is enough to maintain a normal vitamin D serum level. The daily vitamin D intake appears to be adequate for everyone in Québec, apart from the elderly.

3. PROFILE OF ARTIFICIAL TANNING IN QUÉBEC

3.1 Québec survey of use of artificial tanning devices

In March 1996, the Direction de la santé publique of the ministère de la Santé ordered a survey of tanning salon use by people in the Montréal and Québec City metropolitan regions. The objectives of the survey were to estimate the prevalence of use of tanning equipment during the last five years and during the last 12 months prior to the survey, to characterize people who reported using tanning equipment, to estimate the prevalence of acute adverse health effects in tanning equipment users and to assess attitudes and beliefs related to tanning equipment use. The survey was conducted through telephone interviews of 1003 respondents aged 18 to 60. The interviewers used a standardized questionnaire to query people about their exposure to artificial sources of ultraviolet radiation and about their motivations, perception of risk and health problems related to the use of tanning devices. The detailed findings of the survey are given in Appendix 8.

3.1.1 Prevalence of use of artificial tanning devices

The characteristics of the participants as a whole and those of individuals who went to a tanning salon in the five years prior to the survey are given in Table 5. The study revealed that less than 1% of the population had a tanning device at home. In all, 19.3% of the people questioned went to a tanning salon during the last five years prior to the survey. The prevalence of use of tanning devices during the last 12 months prior to the survey was 10.8%. More than half (56.2%) of the people who had gone to a tanning salon during the last five years prior to the survey had also gone to this type of establishment during the last 12 months prior to the survey. Seventy-nine percent (79%) of those who visited a tanning salon during the last 12 months prior to the survey used 24 tanning sessions or fewer a year. However, 13.4% of users went regularly to a tanning salon, that is, more than 50 times a year. Most of those who went to tanning salons were women (68%) and were 18 to 34 years of age (61%). More than half of users (54%) had 12 or more years of schooling. A higher proportion of single people (39.4%) were found among those who used tanning salons.

Table 5

Characteristics of sample and tanning salons users

Variable	Total sample (N = 1003) %	Users ≤ 5 years (N = 203) %
Sex (% women)	58.4	68.5
Age (years)		
18-24	13.8	22.2
25-34	24.5	37.9
35-44	28.5	26.1
45-54	22.9	10.8
55-60	10.2	2.9
Schooling (% ≤ 12 years)	43.5	46.3
Marital status (% single)	30.4	39.4

The findings of the survey show that the prevalence rate of use of tanning salons is higher among women than among men (see Table 6). The highest rate of use was found among people 18 to 24 years of age and 25 to 34 years of age (see Table 6). In these age groups, one person in three had used an artificial tanning devices in the last five years prior to the survey. The prevalence rate of use of those 18 to 34 years of age was high during the last 12 months prior to the survey, i.e. nearly 20%.

Table 6

Prevalence rate of use of commercial tanning devices during the last five years and during the last 12 months prior to the survey, according to sex and age (N = 1003)

Variable		N	Users (%)	
			≤ 5 years	≤ 12 months
Sex	M	417	15.3	8.6
	F	586	23.7	12.8
Age (years)	18-24	138	32.6	19.5
	25-34	246	31.3	17.1
	34-44	286	18.5	8.3
	45-54	230	9.5	6.1
	55-60	102	5.9	3.9

More than half (53.9%) of those who used tanning salons during the last five years prior to the survey intended to return in the next 12 months. The anticipated rate of use for the following year would then be 10% of the population as a whole. The intention was clearly greater among those who used tanning devices during the last 12 months prior to the survey (79.6%) compared to those who used during the 1 to 5 year period prior to the survey (23.9%).

The prevalence rates of use of tanning salons in Québec at five years and at 12 months are comparable to the rates reported in other countries. In the early 1980s, Anon *et al.* (1987) reported that, in the two years previous their survey, 9% of the population of the United Kingdom had used a tanning bed. In a more recent study, also conducted in the United Kingdom, the prevalence rate of use of tanning salons was 10% during the previous year and 19% in the past (IARC, 1992). In 1984, a survey conducted in Holland showed that 14.7% of individuals had used a tanning device during the last 12 months (Bruggers, 1987). A survey conducted in 1990 in New York State showed that 21.5% of the population had used a tanning device in the past (Lillquist, 1994). In 1994, an omnibus survey carried out in London showed a rate of tanning bed use comparable to that in Québec, i.e. 10% during the last year. Among people 16 to 24 years of age, the prevalence rate of use in the previous year was 24% (Bulman, 1995).

3.1.2 Prevalence of acute adverse health effects with artificial tanning as reported by users

The ministère de la Santé survey showed that 26.1% (53/203) of tanning salon users had experienced one or more acute adverse health effects following a tanning session. The results show that 17.7% of the users had skin burns (“sunburn”) from artificial tanning. In addition, 14.8% of users reported skin dryness after tanning sessions. The prevalence of eye problems (itching or burning sensation) in this population was 3%. A total of 1.5% of users reported nausea. The intention to use a tanning salon in the following year was little affected by adverse health effects associated with artificial tanning use. Among users who had experienced one or more acute health problems, 49% intended to return to a tanning salon the following year, compared with 54.6% among those who did not report any health problems.

Few prior studies are available to compare Québec's prevalence data on the reported health impact of artificial tanning. As part of an experimental study of human volunteers exposed to ultraviolet rays from tanning beds, Rivers *et al.* (1989) observed that 22% of the subjects had developed an erythema, 27%, itching, 15%, dry skin and 4%, nausea. The omnibus survey carried out in London in 1994 showed that 3% of the men and 7% of the women had developed a painful erythema after using a tanning device (Bulman, 1995). The Dutch study by Bruggers *et al.* (1987) reported a prevalence of acute negative effects related to artificial tanning among 15% of users. The symptoms reported included skin burns, itching and dry skin.

3.1.3 Risk perception regarding artificial tanning use

In the survey conducted by the ministère de la Santé, the population was asked about its perception of the danger of exposure to artificial ultraviolet rays like those used in tanning salons. Artificial tanning is perceived as highly or moderately dangerous to health by 76.2% of non-users, while this perception is shared by only 41.4% of those who used a tanning salon in the five years preceding the survey (See Table 7). The percentage of users who consider artificial tanning to be low or none dangerous to health is higher among those who used tanning salons during the last 12 months prior to the survey (61.3%) than among those who used tanning salons during the last five years (55.7%).

Table 7

Risk perception related to artificial tanning

Level of danger perceived	**Users† (%)**		**Non-users (%)**
	≤ 5 years (N = 203)	**≤ 12 years (N = 111)**	**(N = 800)**
High-moderate	41.4	36.9	76.2
Low	46.3	51.4	14.8
None	9.4	9.9	2.4

† According to the reference period of use prior to the survey.

Only one study was found whose findings could be compared with this survey. It was a survey conducted in a shopping centre in North Carolina using a self-administered questionnaire (Mawn and Fleischer, 1993). The findings showed that 76.3% of people who do not use tanning salons perceive tanning beds as worse than the sun, whereas only 49.2% of users have this perception. The great majority (50.8%) of users believe that tanning beds are as safe as, if not safer than, the sun.

3.1.4 Determining factors in use of artificial tanning devices

Users during the last five years prior to the survey were asked about motivations to visit a commercial tanning salons. Most of them, i.e. 56.7%, said they used this type of devices “to improve their appearance by a tan”. A high proportion of users also indicated that they wanted “to get a protective tan before going on vacation” (27.6%). The other reasons given for using a tanning device were “to relax” (11.8%) and “for the general health of the skin” (10.8%).

Survey findings on the motivation for using an artificial tanning device are comparable to those reported in previous studies on the subject (Anon, 1987; Bruggers, 1987; Bulman, 1995; Diffey, 1986; Dougherty, 1988; IARC, 1992; Lillquist, 1994). The cosmetic aspects of tanning, such as looking good and obtaining a year-round tan, are the motivation factor most frequently reported by people who use tanning devices. Other reasons often invoked by users include improvement of health and the desire to acquire a tan before vacation in order to protect the skin from the sun. A factor more rarely reported in the literature was wanting to use a tanning device to reduce stress or to treat a skin disease (eczema, psoriasis, acne).

3.2 Survey of tanning salon owners

A survey of tanning salon owners in the Québec City region was conducted between December 1995 and January 1996. The report on the study is given in Appendix 9. The main objectives of the study were : (1) to evaluate the practices of tanning salon owners; (2) to evaluate the knowledge of tanning salon owners and employees concerning various subjects related to exposure to ultraviolet rays; and (3) to identify the

information given the public in tanning salons. In all, 18 establishments offering artificial tanning services were selected by random sampling. Of this number, 12 owners agreed to meet with pollster. The meeting consisted of a visit of the premises, a focused interview with a questionnaire, and a self-administered questionnaire about knowledge, to be completed by the owner and his or her employees.

The survey revealed that tanning beds are found in businesses that offer artificial tanning services exclusively or in other types of services grouped under the heading of “health and beauty centres” (offering hairstyling, cosmetology services, massages, seaweed baths and so on). In the case of the other establishments, tanning was an incidental service (fitness centres and drugstores, for example). According to the survey, more than 80% (10/12) of the owners had no experience in the artificial tanning field before opening their business. Owners and employees were self-trained and their sources of information consisted of material provided by tanning bed distributors or cosmetic companies. The training material consulted often contained erroneous information on the health benefits of tanning, such as “ultraviolet radiation decreases blood pressure and cholesterol levels” (See Appendix 9, and Appendix 4 of the study report). These false messages are actually used by some tanning salons in their advertising. The advertisements evidently could draw in consumers to use artificial tanning to treat health problems or to try to get unattainable cosmetic results.

Customers are not systematically asked their age when they first go to the tanning salon. The owner may, however, ask for the written or oral authorization of parents if a doubt subsists regarding the age of the customer (under 18). Each new customer must fill out a registration form, which is often the sole source of information about the risks of tanning. The content of the form varied little from one salon to another, and included such information as skin type, medications taken, diseases and mandatory protective eyewear (see Appendix 9, and Appendix 5 of the study report). No information was given to the customer concerning the risks of chronic exposure to ultraviolet rays in terms of photoaging and skin cancer. The dearth of information for customers when they register implies that they know little or nothing about the risks to which they are exposing themselves or the ways to reduce them. In fact, it was noted that many customers sign the registration form without ever reading it. The criteria for refusing a

customer were virtually non-existent, with the exception of a second visit to the same salon in fewer than 24 hours. The information collected in subsequent visits was administrative (date, length of session, type of bed and so on) and did not deal with the health of the customer.

Warning signs are usually posted at the reception desk and in the tanning booths. The information on these signs focuses on the dangers related to the use of make-up and perfume and the wearing of jewelry during tanning sessions. In a few locations, other information was given, particularly the need for protective eyewear and the dangers related to medications taken. It was noted that protective eyewear was not really mandatory, even though this was indicated on the registration form. Customers were not reminded to wear eye protection devices. The survey of the ministère de la Santé confirmed these observations, given that 25.3% of users admitted that they did not put on protective eyewear during their tanning sessions (see Appendix 8). From the standpoint of safety and hygiene, many shortcomings were noted at the time of the visits. Among them were the absence in many cases of switches to turn off the tanning beds in the event of an emergency, the ways of cleaning tanning beds and eyewear and the maintenance of the devices. However, in most salons, the length of the tanning sessions was monitored by an employee and was not allowed to exceed 30 minutes.

The proportion of UVB rays emitted by the tubes used in tanning beds varied from 0.5% to 5%. According to the owners, the use of tubes with a higher proportion of UVB rays would give better tanning results. This is definitely a subject for concern in regard to the risks of burns during artificial tanning. Only low intensity UVB rays are needed to induce an erythema. Furthermore, the carcinogenic potential of UVB rays has been well established. The marketing of these fluorescent tubes is, however, controlled by distributors, who promote their use by salon owners.

The knowledge of 18 tanning salon owners and employees was assessed. In all, 11 categories of knowledge were evaluated in the questionnaire (See Appendix 9, and Appendix 3 of the study report). Table 8 summarizes this information. The overall success for the questionnaire varied from 19% to 94%, with an average rate of 73% for all personnel participating. Although the score was generally satisfactory, the validity of

the study specifically concerning the evaluation of knowledge was challenged because of a possible selection bias. The decision to participate in the survey may have been affected, since the owners were informed, when their participation was solicited, that their knowledge would be evaluated. Hence, better basic knowledge about ultraviolet rays may have had an impact on the decision to participate.

Despite these reservations, certain types of knowledge are lacking among tanning salon personnel (See Appendix 9, and Appendix 6 of the study report), for example, the physiology of tanning, which was understood by less than 50% of employees. In addition, only 56% of employees believe that repeated exposure to ultraviolet rays increases the risk of developing skin cancer. One staff member in three failed to adequately answer questions about the acute adverse health effects that overexposure to ultraviolet rays may have and about what to do in such circumstances. The other question categories where knowledge was lacking concerned reactions to ultraviolet rays depending on skin type, and possible contraindications for artificial tanning if the customer has certain diseases.

Table 8

Summary of knowledge of tanning salon owners and employees (N = 18)

Category of knowledge	Overall success (%)
Types of ultraviolet (UV) rays	65
Reactions to UV rays and skin type	47
UV rays and health risks	
Minor side effects	61
Interactions with some medications	cancelled
Contraindications with some medications	20.5
Photosensitivity	81
Effects of repeated exposure	77
Effective means of protecting the eyes	89
Physiology of tanning	59
Sun protection factor	50
Sun protection provided by UV rays	36

On the basis of the information collected in the survey, we were able to define three main categories of tanning salon : (1) tanning businesses run by owners who are concerned with giving impeccable service that is not detrimental to health. These businesses have adopted practices likely to protect health. The owners have adequate minimum knowledge and are interested in improving their training; (2) tanning businesses run by owners who, although they want to do what is right, have adopted practices that could be detrimental to health. The knowledge of this group is insufficient, but most are receptive to the idea of improving their training; and (3) tanning businesses where minimal hygiene and safety rules are not complied with and which therefore are a threat to health (communicable diseases, acute adverse effects on the skin and eyes from overexposure to ultraviolet rays). Most of the owners of these salons are opposed to any training to improve their practices.

Lastly, it was noted, incidental to this survey, that there is very wide accessibility to tanning services from the standpoints of geographic distribution of businesses in Québec, the prices charged for a session and business hours. If public demand for tanning is partly determined by accessibility-related factors, action affecting one or more of these factors can reduce the business of salons or the number of sessions per customer.

3.3 Survey of Québec dermatologists

The Association of Dermatologists of Québec conducted a survey of 170 of its members in February 1996. The objective of the survey was to evaluate whether people consulted dermatologists for health problems related to the use of tanning devices. A total of 111 dermatologists participated in the survey, a rate of participation of 65%.

Most of the dermatologists questioned (97.3%) advised their patients not to use artificial tanning devices. When a dermatologist recommended that his patient undergo a tanning session, it was in a very special situation such as for the treatment of certain cases of psoriasis or acne. The results of the survey showed that, in their practices, 82% of dermatologists were consulted for health problems associated with the use of a

tanning device. Seventeen percent (17%) of them had more than 25 consultations related to artificial tanning.

The skin diseases observed included phototoxicity and photoallergic reactions, polymorphous light eruptions, lupus, cases of irregular pigmentation, melasma, sun lentigo and itching. Certain infections were also reported, such as *pityriasis versicolor*, herpes, warts and *molluscum contagiosum*.

3.4 Evaluation of ultraviolet radiation irradiance in artificial tanning devices and estimate of exposure dose

The dose of ultraviolet radiation received when using an artificial tanning device has been studied very little until now. According to certain authors, the UVA radiation dose in tanning beds is at least three-fold higher than that received naturally from the sun (Diffey, 1986; Nachtwey, 1981). Irradiance from UVA tubes (Philips TL 10R) like those used in tanning beds was measured by Diffey (1987). The tubes evaluated emitted an average of 250 W/m^2 of UVA radiation. With these tubes, a 30-minute tanning session corresponds to a UVA dose of 450 000 J/m^2 (45 J/cm^2).

At the Second Symposium on Ultraviolet Radiation-Related Diseases, held in Vancouver in May 1996, Dr. Yvon Deslauriers, of the Medical Devices Bureau of Health Canada, presented findings concerning irradiance measurements carried out on a tanning bed. The bed evaluated was a Sunvision® (41/4F Wolfsystem), fitted with 41 Wolfsystem DFF 71-T12 100W tubes (Deslauriers, personal paper, 1996). The average irradiance for UVA rays was 200 W/m^2 and for UVB, 5 W/m^2. The UVB/UVA ratio corresponding to these measurements is about 2.1% (0.021). The time required to reach a minimum erythema dose (MED) was 18 minutes.

As part of the work of the Joint Committee of the ministère de la Santé, UVA and UVB radiation was measured in a tanning salon with the owner's authorization. The radiometer used was a UVX model of the UVP company (San Gabriel, CA, USA), fitted with a UVX-36 (360 nm) probe for UVA rays and a UVX-31 (310 nm) probe for UVB rays. Measurements taken on various models of tanning bed. The average irradiance in

tanning beds fitted with tubes emitting mainly UVA rays varied from 150 to 200 W/m^2 for UVA rays and from 1.1 to 1.5 W/m^2 for UVB rays. The UVB/UVA ratio for these types of bed is 0.007. In the case of tanning beds using tubes with a higher proportion of UVB rays, the average irradiance was 80 W/m^2 for UVA rays and 50 W/m^2 for UVB rays, which corresponds to a UVB/UVA ratio of 0.62.

The irradiance levels measured in tanning beds were compared with those of the sun and are given in Table 9. The intensity of solar radiation in Québec measured at its zenith is 50 to 55 W/m^2 for UVA rays and 1 to 2 W/m^2 for UVB rays (Boulet, 1993). The measurements of solar radiation intensity at various regions of the globe yield values comparable to those in Québec. For UVA rays, the average irradiance is 56 W/m^2 (46-68 W/m^2), while for UVB rays it is 1.6 W/m^2 (1-2.2 W/m^2) (Jeanmougin, 1987; Wilkinson, 1983). Comparison of the data on irradiance shows that the intensity (W/m^2) of the UVA radiation in a tanning bed is four times higher than that of the radiation of the sun measured at its zenith. Furthermore, for an identical exposure period, the UVA radiation dose received in a tanning salon is higher than that received from natural exposure to the sun, since the skin over almost the entire body is irradiated in a tanning bed.

On the basis of the UVA radiation dose needed to induce an erythema (30 J/cm^2), a 20-minute session in a tanning bed is equal to one or two MEDs, according to the type of device used (Diffey, 1987; Pathak, 1985). According to frequency of use, an individual can receive a cumulative annual dose of 360 to 3500 J/cm^2 of UVA rays with artificial tanning, which is equal to 15 to 300 MEDs. Diffey (1996) estimated that the maximum annual dose of UVA radiation received from the sun is an average of 1500 J/cm^2 (50 MEDs). Hence, tanning salons can contribute a sizable share of the cumulative annual dose of UVA rays. In addition, for some individuals, the cumulative UVA ray dose with a tanning device may exceed 1000 J/cm^2, the level of radiation at which the risk of developing skin cancer with PUVA therapy is significant.

Table 9

Mean levels of ultraviolet radiation irradiance emitted by the sun and tanning tubes

Source of ultraviolet radiation	Irradiance in W/m^2		UVB/UVA ratio
	UVA	UVB	
Sun (measured at its zenith)			
Average	55	1.6	0.03
Range	46-68	1.0 -2.2	–
Tanning device			
UVA tubes	150-200	1.1-5.0	0.005-0.03
UVB tubes	80	50	0.62

The intensity of UVB radiation measured in certain tanning bed models is very high compared with solar radiation. It is not possible, however, to accurately assess whether this type of device is widely used in Québec tanning salons. The survey of tanning salon owners also highlighted the use of tanning bed tubes with a proportion of UVB radiation of up to 5%. Evidently, the higher the UVB radiation intensity in a tanning bed, the greater the risk of skin burns. The survey of the ministère de la Santé also suggests that UVB radiation doses in tanning salons are probably too high, since 18% of users have suffered skin burns after tanning sessions.

3.5 Evaluation of the economic impact of the tanning industry

The Joint Committee's work showed that no economic data on tanning businesses have been compiled at the ministère de l'Industrie et du Commerce. The Association des salons de bronzage du Québec (ASBQ) submitted a brief to the Joint Committee in which it provided data on the economic impact of the Québec tanning industry. The ASBQ's economic data were obtained by extrapolation from results of the survey of the ministère de la Santé on exposure to artificial tanning. According to the ASBQ, the Québec tanning industry generates over $100 million a year. The validity of the ASBQ's estimate of the industry's economic impact is relative because of the sources of the data, and the estimate therefore cannot be used as a reference in comparing the economic activity of this industry with other types of businesses in Québec. In the

United States, suggested figures for the economic impact of tanning salons vary from $1 billion to $2 billion a year depending on the author (Anonymous, 1995; Spencer, 1995).

4. REVIEW OF THE REGULATORY MEANS TO REDUCE ULTRAVIOLET EXPOSURE AND PROTECT PUBLIC HEALTH

Appendices 10, 11 and 12 contain a detailed review of the standards and regulations now in force for ultraviolet rays.

4.1 International standards on maximal limits of exposure to ultraviolet radiation

The International Radiation Protection Association (IRPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) issued recommendations for workers and the public concerning exposure to ultraviolet rays of 180 to 400 nm (Rhainds, 1996). The acceptable levels determined by these bodies are aimed at protecting the skin and eyes from the acute effects of exposure to ultraviolet rays, particularly cutaneous erythema and photokeratoconjunctivitis. However, it is specified that the recommendations do not protect photosensitive individuals, subjects exposed to photosensitizing agents or people with no lenses.

The acceptable skin exposure limits depend on the minimal erythema dose (MED). The threshold for inducing an erythema depends on wavelength, irradiance of the source, type of skin and duration of exposure. The maximum intensity of an erythema occurs between 290 and 300 nm, i.e. in the UVB ray emission spectrum. The radiation dose required to induce an erythema on untanned, lightly pigmented skin in the interval of its wavelengths varies from 6 to 30 mJ/cm^2. UVA rays (315-400 nm) are also capable of inducing an erythema. However, the radiation dose required is much higher (> 1000 mJ/cm^2). As regards the effect on the eyes, the recommendations are based on the minimum dose that induces photokeratitis. The maximum sensitivity of the human eye for developing photokeratitis occurs at 270 nm. The radiation dose capable of inducing an erythema varies from 4 to 14 mJ/cm^2.

For each wavelength on the ultraviolet spectrum (180 to 400 nm), the IRPA and the ACGIH recommend exposure limits for an eight-hour period. These are given in Appendix 10. The exposure standards in force offer little protection from the long-term effects of ultraviolet rays such as skin cancer, photoaging and immunosuppression.

Cumulative ultraviolet ray exposure over a subject's entire life is a risk factor associated with skin cancer (IARC, 1992; Preston, 1992). The cumulative ultraviolet ray dose is the sum of all exposure including work, regular and recreational activities, vacations and tanning. Table 10 gives the average annual cumulative dose of ultraviolet rays according to type of activity expressed in MED. According to Table 10, an individual can accumulate a high dose of radiation annually even if he or she complies with the IRPA and the ACGIH recommendations.

Table 10
Cumulative annual dose of ultraviolet radiation expressed in MED

Type of activity	MED
Recreational exposure (excluding vacation)	20-100
Vacation outside, "sun" destination (two weeks)	30-60
Office workers	40-160
Outdoor workers	250
Ambient solar UVA radiation level (150×10^5 J/m^2)	50
Exposure to artificial sources of ultraviolet light in the workplace with ACGIH recommendations	
270 nm (30 J/m^2)†	36
365 nm (2.7×10^5 J/m^2)†	324
Tanning beds (2.4×10^5 J/m^2 per session of 20 minutes)	30-300

Source : IARC, 1992; Rhainds, 1996; Diffey, 1996.

† Acceptable limit for eight hours of exposure.

In 1983, the Standards Association of Australia (SAA) recommended ultraviolet radiation exposure limits for the use of tanning equipment (Wilkinson, 1983). The SAA based its recommendations on UVA and UVB sunlight irradiance measures. The average irradiance from the sun is 50 W/m^2 (46-68 W/m^2) for UVA rays and 1.5 W/m^2 (1-2.2 W/m^2) for UVB rays, which corresponds to a UVB/UVA ratio of 0.03. The SAA's recommendations are also based on a minimal UVA dose that induces erythema. The UVB/UVA ratio was set at 0.01 with maximum irradiance of 200 W/m^2 for UVA rays. The maximum UVA radiation dose allowed is 200 000 J/m^2, which corresponds to 20 minutes of exposure. The Australian standard for tanning equipment is the same as that of the IRPA or the ACGIH. In fact, the acceptable level of UVA exposure rests solely on

the minimal dose that induces erythema without considering the chronic effects of UVA radiation on health. However, the mandatory UVB/UVA ratio is an interesting component of the SAA's recommendations for controlling UVB radiation emissions in tubes for tanning salons.

4.2 Canadian federal regulations governing radiation emitting devices

In Canada, there have been regulations governing sunlamps since 1994 (under the *Radiation Emitting Devices Act*, chapter R-1, Revised Statutes of Canada, 1985) (see Appendix 11). The regulations lay down the standards for the design, construction and operation of ultraviolet lamps to be used as sunlamps, and specifications for the posting of warnings for users.

4.2.1 Design and construction standards

The outside surface of a sunlamp (tanning bed) must bear information that is perfectly legible and visible to the user before an exposure session. A summary of this information is given in Table 11. The sunlamp must be equipped with a control through which the exposed person can easily extinguish the lamp without disconnecting it or removing the ultraviolet lamp or lamps. The lamp must also be fitted with a timer that meets operating standards; in particular, it must be adjustable to preset times and have a maximum timer interval not exceeding the maximum exposure time (see Appendix 11, Regulation 4.2).

Table 11
Information required on the outside surface of a sunlamp

Name and address of manufacturer
Model, serial number, and month and year of manufacture
Recommended exposure positions
A warning that other positions may result in overexposure
Minimum interval between consecutive exposures
Type and model of each ultraviolet lamp to be used in the sunlamp
Electro-optical radiation warning sign

4.2.2 Standards of functioning

Ultraviolet lamps used in sunlamps must operate so that the irradiance within wavelengths from 200 to 260 nm does not exceed 0.003 of that produced by wavelengths from 260 to 320 nm, regardless of the distance or position of the lamp.

The sunlamp must be sold with protective eyewear. Eye protection devices must have a spectral transmittance not exceeding a value of 0.001 for wavelengths of 200 to 320 nm and a value of 0.01 for wavelengths from 320 to 400 nm.

4.2.3 Warning sign specifications

The electro-optical radiation warning sign must be clearly visible and identifiable by the user during exposure. Its contents are given in Table 12.

Table 12

Electro-optical radiation warning sign

Warning :
"Warning - Ultraviolet radiation - Follow instructions - Failure to use protective eyewear may result in severe burns or other eye injury - If discomfort develops, discontinue use and consult a physician."
Declaration :
That, as with natural sunlight, overexposure can cause eye injury and sunburn,
That repeated exposure may cause premature aging of the skin and skin cancer,
That medications or cosmetics applied to the skin may increase sensitivity to ultraviolet light,
That a person who does not tan in the sun most likely will not tan from the use of this device,
That a person having a history of skin problems or having a skin that is specially sensitive to sunlight should consult a physician before use, and
That overexposure should be avoided.

4.3 Federal regulations in the US governing radiation emitting devices

In the United States, the regulations governing radiation emitting devices are administered by the Food and Drug Administration (FDA), under the *Electronic Product* Radiation Control Chapter of the *Federal Food, Drug and Cosmetic Act*. The federal regulations in the United States governing sunlamps are very similar to those of Health Canada (standards for construction and manufacturing, and for the posting of warnings). The sole difference resides in the extent of the liability of a tanning salon, which, by law, is treated like a manufacturer if it makes changes in its equipment (lamps, timer and so on).

4.4 Regulations for the use and operation of commercial tanning devices

Details concerning each of the specific regulations governing tanning salons are provided in Appendix 12. In this section, only the elements dealt with in the regulations and the differences between them are given. In Canada, two provinces, Alberta and New Brunswick, have adopted regulations for tanning salons. In the United States, a number of states have adopted regulations for tanning salons, but they have only been in force for a short period of time, since 1990 in most cases. Table 13 lists the different categories of provisions found in regulations governing tanning salons.

Table 13

Categories of provisions found in regulations governing tanning salons

Sale and distribution of tanning devices
Registration
Safety of devices
Training of operators
Warning sign
Selection of customers
Information for customers on the risks of ultraviolet rays
Operators responsabilities
Protective eyewear
Disinfection of devices before use
Records
Advertising
Inspection and penalties

4.4.1 Sale and distribution of tanning devices

Only Oregon, in addition to the FDA, regulates the sale and distribution of tanning devices. According to its regulations, it is mandatory for a vendor of tanning devices, lamps, UV ray measurement instruments and other products and services related to artificial tanning to hold a government licence. The licence is issued by the Radiation Protection Services of the Oregon Health Division.

4.4.2 Registration

In all regulations except New Brunswick's, an operating permit is a prerequisite for the opening and operating of a tanning salon. The permit is issued if the salon meets the requirements of the regulations, which deal with such matters as the safety of facilities and equipment, the training of operators and the warning sign. The fee for the issuing of a permit varies widely from one regulation to the next, from a minimum of US$15 up to a maximum of US$350. The fee is a way of covering the administration and inspection costs of the regulatory agencies. In some states in the US, before a permit is issued, an

initial inspection must be made, and the permit is renewed every year or every two years.

4.4.3 Safety of devices

The owner must ensure that his tanning devices are in compliance with Canadian or American federal regulations, as the case may be. Oregon's regulations provide for other safety standards for the design of the salon, such as the capacity of the ventilation system and the maximum temperature in a tanning booth, as well as the construction of booths so as to prevent any exposure of staff to ultraviolet rays.

4.4.4 Training of operators

The regulations in Alberta seem to be the most comprehensive in regard to the training of operators. According to the content of the courses, which is also regulated, a qualified operator must have basic knowledge about ultraviolet rays, the acute and chronic adverse health effects of exposure to ultraviolet rays and the synergic effects of ultraviolet rays with medications, and must know how to recognize overexposure of the skin or the eyes. Inspectors may check the knowledge of operators by having them take a detailed test. In New Brunswick, the regulations have no provision concerning the training of operators. In Oregon, the courses are given either by vendors of tanning devices or operator training services. The courses must, however, be approved beforehand by the government agency.

4.4.5 Warning sign

Most of the regulations provide detailed instructions on the type of warning and its content. The warning must be posted in the tanning booths in such a way that the consumer can see it easily. The various types of information found on the warnings are summarized in Table 14.

Table 14

Types of information found on warning signs

The effects on health of ultraviolet rays : eye burns and injuries, skin burns, allergic reactions, premature aging of the skin, skin cancer
That protective eyewear is required
That medications and cosmetics may increase sensitivity to ultraviolet rays
That consumers should consult a physician if skin problems arise, if they are sensitive to sun radiation or if they take medication
That people who do not tan in the sun will probably not tan using a tanning device
That consumers should declare any injury caused by ultraviolet rays

4.4.6 Selection of customers

Only New Brunswick's regulations prohibit access to tanning salons to people under 18. The exclusion age in other regulations varies from 14 to 16 years of age. In some states in the US, access by those under 18 is allowed provided they have the written consent of their parents.

4.4.7 Information for customers on the risk of ultraviolet rays

In general, the regulations stipulate that customers must, when they first come to the salon, read and sign a declaration that they understand the risks related to ultraviolet rays, that they agree to use protective eyewear and that they will comply with instructions for the safe use of the devices. In some states in the US, tanning salon operators are given a list of foods, cosmetics or drugs that may increase skin photosensitivity.

4.4.8 Operators responsabilities

An operator must offer a customer a safe tanning schedule, the content of which differs according to the regulations. A tanning plan may have the following components : (1) the maximum exposure time, as recommended by the manufacturer, depending on skin type; (2) the frequency of tanning sessions; (3) appropriate positions; (4) the proper use of protective eyewear; (5) the location of the emergency switch; (6) prohibition of the use of tanning devices by people who have or report signs of skin irritation or burns; and (7) the keeping of a record of the date and length of exposure for each customer.

4.4.9 Protective eyewear

All the regulations governing tanning salons stipulate that protective devices for the eyes must be worn by the consumer and that they must be in compliance with federal Canadian or American regulations in force concerning radiation emitting devices.

4.4.10 Disinfection of devices before use

The regulations vary the most in this regard. In some regulations, the operator must sterilize the eye protection devices and the tanning devices with a disinfectant that meets USEPA standards, while in others, nothing is specified.

4.4.11 Records

Most regulations stipulate that an operator must keep a record, for verification purposes, of the customers' tanning sessions. The record must indicate, among other things, the number of sessions, and the dates and the length of exposure. In Oregon, the record is more detailed and includes a declaration signed by each customer, the written consent of the parents of customers who are minors, the results of the testing of timers, the training of operators, a report on any injuries for which medical care was requested, as well as information on the inspection and maintenance of tanning devices and changes made to them.

4.4.12 Advertising

With the exception of those of New Brunswick, Alberta and Ohio, the regulations stipulate that the issuing of an operating permit in no way means approval of a tanning

salon by the health authorities. The owner of the salon is not authorized to indicate in his advertising that he holds a permit from the health authorities or to promote artificial tanning as safe, without risk or even beneficial to health.

4.4.13 Inspection and penalties

The power to inspect tanning salons is found in all regulations, with the exception of New Brunswick's. Penalties such as permit suspension and revocation, and fines of up to $1000 a day are provided for a serious offence that threatens public health or safety.

4.5 Limitations of the regulatory approach to protect public health

The Canadian federal regulations are applied only to the manufacturing and sale of tanning devices. Control and use of these devices is the responsibility of the provinces. The Canadian federal regulations have other limitations from the standpoint of the protection of public health. The main shortcomings noted are as follows : (1) the absence of a maximum limit of irradiance for wavelengths corresponding to UVA, UVB and UVC rays in tubes for the tanning salon market; (2) the absence of a limit for the proportion of UVB rays compared with UVA rays in tubes distributed to tanning salons; (3) the maximum duration of exposure determined on the basis of the minimal dose that induces a cutaneous erythema. No consideration is given to the carcinogenic potential of UVA and UVB rays and other long-term effects such as skin photoaging and immunosuppression; (4) the absence of criteria for defining the term "overexposure" in the regulations; and (5) the ineffectiveness of the means of enforcing the regulations. The Standards Association of Australia, in contrast to the Canadian federal legislation, controls UVB radiation emissions by setting a UVB/UVA ratio and a maximum irradiance limit for UVA rays.

At the provincial level, regulatory agencies governing tanning salons have adopted a number of measures to protect public health, such as the requirement that risks involved be posted, the prohibition on referring in advertising to the beneficial effects of artificial tanning on health. However, these regulations do not provide adequate protection against long-term effects of ultraviolet rays exposure. Finally, there are no standards for the general public in Canada, as there are in the United States, for sunglasses sold without a prescription.

5. REVIEW OF PUBLIC EDUCATION CAMPAIGNS ON ULTRAVIOLET RAYS

A detailed review of studies of the action taken to make the public aware of the risks of exposure to ultraviolet rays is given in Appendix 13 of this report. In this section, only a brief description of these campaigns is given, with an analysis of their potential impact on behaviour in regard to artificial tanning.

A number of programs were set up in various states in the US for pre-school children. These programs aimed at improving the knowledge of parents and day care staff about the dangers of the sun and the means to protect children. The education programs used a variety of tools, particularly audiovisual presentations, pamphlets and mailings. As a general rule, the results show an improvement in participants' knowledge, with a rather modest impact on the exposure of children to the sun. In addition, it was noted that very few of the studies were randomized with a control group.

Experiments to make young people in elementary and secondary schools more aware of the dangers are also numerous and varied. The pedagogical tools used in these programs include puppet shows, cartoons and interactive games. The programs are usually evaluated before and after the educational intervention, using a questionnaire dealing with the knowledge, attitudes and behaviour of the children in regard to exposure to the sun. Some evaluations included a reference group. The results of the evaluations showed that knowledge improved significantly in post-testing, with a gradual reduction over time. The authors also observed that a single education program had little impact on children's preventive attitudes and behaviour. The programs often improved the use of sunscreens but they appear to have had little effect on the duration of exposure to ultraviolet rays.

Activities aimed at the early detection of skin cancer constitute the main tool in making adults aware of the dangers of the sun. Rigorous assessments of these programs from a methodological standpoint are rare and tend to show that adult behaviour does not change even if the level of knowledge and awareness improves.

The incidence of skin cancer is closely tied to exposure of the population to ultraviolet rays from solar and artificial sources. To reduce the incidence, the behaviour that determines individual exposure must be modified, in addition to reinforcing the use of protective measures. The studies described above suggest that awareness campaigns have little effect on behaviour related to exposure to ultraviolet radiation. However, some authors insist on the need to strengthen the messages, for example with recurrent information campaigns from a variety of sources. The impact of these awareness campaigns and educational programs on the use of tanning salons has not been studied, whereas for young people artificial tanning may account for a sizable proportion of total exposure to ultraviolet rays.

Despite the limitations of the action described above, information campaign and education program aimed at reducing the exposure to ultraviolet rays must remain at the top of the list of public health efforts. To change attitudes towards tanning and to promote healthy behaviour, it is important to intervene starting at birth and to develop a critical mass of individuals who can serve as role models for young people. The mothers of infants and the family certainly constitute role models which action must target initially. For example, mothers could be made aware, through perinatal programs, of the dangers of exposure to ultraviolet rays. They would then be able to promote their children's preventive behaviour in regard to the sun at an early age. Intervention in day care centres and in the schools should also be geared toward the family model in order to reinforce educational messages about the dangers of the sun and the protective means to be taken.

The first step consists in the province-wide coordination of specific intervention by various organizations and in the selection of the action that provides the best cost-benefit ratio in reducing exposure to ultraviolet rays. Improvement in the reporting and monitoring of skin cancer, and the development of ultraviolet exposure indicators based on behaviour will also be required to evaluate the impact of this preventive action. These supplementary approaches are prerequisites for intervention to change the habits of the public in regard to tanning and to prevent diseases related to ultraviolet radiation.

6. DISCUSSION

Exposure to ultraviolet rays, whether solar or artificial sources, has adverse effects for public health. Among the effects of most concern are skin cancer, cataracts, skin photoaging and immunosuppression. Current scientific data from experimental cytogenetic and molecular genetic studies, experimental studies on animals and epidemiological studies provide convergent proof of the relationship between these pathologies and exposure to UVA and UVB rays.

Although in the past they were believed to be harmless, it is increasingly accepted that UVA rays from solar or artificial sources are complete carcinogens that can act as both inducers and promoters of skin cancer. The work of the Joint Committee has shown that exposure to ultraviolet rays in order to tan involves health risks. Tanning is associated with molecular damage to the DNA of skin cells. The frequency of this damage to genetic material is closely tied to the process of cell mutation and induction involved in skin cancer.

At the Second Symposium on Ultraviolet Radiation-Related Diseases, held in Vancouver in May 1996, the group of experts brought together by Health Canada reaffirmed their position that exposure to the sun or the use of sunlamps or tanning beds in order to tan is not recommended (Mills, 1997). The Conseil supérieur d'hygiène publique de France also issued a public advisory against tanning using ultraviolet radiation emitting devices (advisory issued by the Conseil supérieur d'hygiène publique de France, 1996). A number of factors were taken into consideration by the Conseil in support of its opinion; the main factors are as follows : (1) artificial UVA rays constitute a risk factor for skin cancer; (2) exposure to low dose of UVA rays can potentiate cancer experimentally induced by UVB rays; (3) it has been found that UVA rays have a mutagenic effect on human cells; (4) exposure to UVA rays may cause an acceleration of skin aging, and certain skin diseases may be exacerbated by artificial tanning. A number of associations of dermatologists in North America advise against tanning in the sun or the use of artificial tanning devices. These are the American Academy of Dermatology, the Canadian Dermatology Association and the Association of Dermatologists of Québec.

Tanning is reportedly being touted as a means of counteracting vitamin D deficiency. However, according to the advertising, the devices used in tanning salons emit only UVA radiation, whereas the synthesis of vitamin D requires exposure to UVB radiation. The work done by the Joint Committee seems to indicate that the intensity of the UVB rays used in tanning salons is on the rise. Given this, vitamin D could be used in the marketing strategy of the tanning industry to justify the use of UVB rays to achieve a positive effect on health. But the use of tanning salons to meet vitamin D needs is not supported by any scientific data. Vitamin D is present in sufficient quantities in food. Furthermore, regular, short-term exposure to sunlight without tanning or an erythema, along with a balanced diet, is enough to meet the organism's physiological vitamin D needs.

If outdoor or artificial tanning is of no benefit to health, should tanning salons be regulated or even banished? The work of the Joint Committee highlighted a number of factors in favour of tighter control of the tanning industry. First, we noted that tanning salons are little affected by current federal regulations, which only cover the manufacture and sale of tanning devices. A probable consequence of this weak regulation is the use in tanning salons of increasingly high UVB radiation levels in order to obtain better cosmetic results. The high prevalence of skin burns reported by users of tanning beds confirms this impression. This is an element of great concern, since UVB rays have a high carcinogenic potential and skin burns is also a risk factor associated with malignant melanoma and skin cancer generally (Autier, 1994; Koh, 1995). Furthermore, these injuries generate costs for the health care system because they must be assessed and treated. The survey also revealed a high rate of use of tanning salons by 18 to 34-year-olds, i.e. one person in five. Tanning beds provide this age group with another opportunity to be exposed to ultraviolet radiation in addition the sun.

The following points were also noted as arguments in favour of regulation of the tanning industry : (1) the tanning services offered the public are very accessible in terms of price and geographic distribution; (2) because of the way that customers are selected, it is not impossible for people under 18 to use tanning salons; (3) advertising by the tanning industry seems to go way beyond cosmetic aspects; (4) the clientele is poorly informed

about the health risks of exposure to ultraviolet rays through the use of tanning devices; (5) tanning salon operators are poorly trained and their knowledge of various subjects related to ultraviolet radiation is probably insufficient to inform customers and ensure their safety.

Despite all these observations, the members of the Joint Committee harbour doubts about the ability of provincial regulations to correct the shortcomings found in the tanning industry. A number of surveys conducted in states in the US where such regulations have existed for many years showed a high rate of non-compliance by tanning salons with many aspects, such as safety of premises, advertising, customer information, hygiene and changes to tanning devices (Bruyneel-Rapp, 1988; Fleischer, 1993; Spencer, 1995). These studies clearly illustrate the gaps between regulations and their application. The development of regulations may, in some cases, give government authorities and the public a false sense of security. Furthermore, the high cost of introducing and enforcing regulations on tanning salons is an obstacle, given Québec's current economic situation. The members of the Joint Committee also wondered whether regulations might have an unintended effect in that they may be perceived by the tanning industry and the public as a stamp of approval by the Québec health authorities of artificial tanning.

Given the scientific evidence that tanning is of no benefit to health, the members of the Joint Committee felt that the closing of tanning salons would be an option that is desirable but difficult to implement in the current context. However, in the short term, it is nonetheless important to try to reduce the health risks associated with artificial tanning. A change in the federal regulations is one strategy now envisaged to reduce ultraviolet radiation exposure at its source. The regulations should be amended to set a UVB/UVA ratio and to limit the UVA irradiance of tubes for the tanning salon market. Changes in these two parameters would reduce the UVB rays in tanning salons, thereby minimizing the possible deleterious health effects, such as skin burns. The federal regulations should also provide for mechanisms to control the sale and distribution of tubes for tanning salons. Such restrictions now exist on the sale of sunlamps for medical and greenhouse uses.

In the long term, it would appear to be more effective to continue to educate the public and make it more aware of the risks of both outdoor and indoor tanning. The creation of a provincial prevention program for diseases related to ultraviolet radiation is a possibility to be explored that would have an effective impact on the determinants of sun exposure and artificial tanning for the Québec public.

7. RECOMMENDATIONS

CONSIDERING the documented effects of UVA and UVB rays on health, such as skin cancer, skin photoaging, suppression of the immune system, corneal diseases and cataracts;

CONSIDERING that UVA and UVB rays cause damage to the genetic code of cells;

CONSIDERING that UVA and UVB rays have been found to have a mutagenic effect;

CONSIDERING that UVA rays are a factor in initiating and promoting skin cancer;

CONSIDERING that exposure to UVA rays has the potential to reduce the effective dose of UVB to induce erythemas and skin cancer;

CONSIDERING that exposure to artificial UVA and UVB rays can cause skin burns and photosensitivity reactions that are aggravated by the use of certain common products and medications;

CONSIDERING that exposure to artificial UVA rays is a suspected risk factor in skin cancer;

CONSIDERING that the body's vitamin D needs are met by the sun and a balanced diet;

CONSIDERING the shortcomings of Canada's federal legislation in limiting exposure to UVB radiation in tanning devices;

CONSIDERING that it is impossible, for the time being, to close establishments that offer tanning services;

1) the Joint Committee advises the public against tanning outdoors and by means of an ultraviolet radiation emitting device;

2) the Joint Committee recommends that the ministère de la Santé evaluate the feasibility of prohibiting all advertising by tanning salons claiming that artificial tanning is beneficial to health, that it carries no risk, and that the skin should be tanned before vacationing in the sun and before exposure to the sun;

3) the Joint Committee recommends, to ensure that exposure to ultraviolet rays is as low as possible, that the ministère de la Santé approach Health Canada with a view to amending the federal regulations on radiation emitting devices ("Sunlamp" section) in order to :

   - impose a UVB/UVA ratio of 0.005;
   - impose a maximum UVA ray irradiance level of 100 W/m^2;
   - control the distribution and sale of tubes for the tanning salon market and other users;

4) the Joint Committee recommends that the ministère de la Santé et des Services sociaux set up a provincial coordinating committee for ultraviolet radiation prevention activities whose principal mandates will be to :

   - see that the reporting and monitoring of skin cancer in Québec are improved;
   - improve knowledge about the attitudes, beliefs and behaviour of the Québec public in regard to tanning and sun exposure;
   - inventory ultraviolet radiation prevention activities in Québec;
   - standardize the messages conveyed to the public about sun protection and the ways to achieve it;
   - plan and introduce new ultraviolet radiation prevention activities;
   - evaluate the effectiveness of the various ultraviolet radiation prevention activities in terms of modification of the behaviour of the public and the reduction of the incidence of skin cancer;

5) the Joint Committee recommends that the Office de protection du consommateur evaluate the feasibility of making it mandatory to obtain a permit in order to open a tanning salon, so that the authorities can keep track of activities in this sector.

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