A Pilot Study on the Use of Sunlamps and Tanning Beds

by

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A thesis submitted in conformity with the requirements for the degree of Master of Science
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ABSTRACT

Detailed data on the use of non-solar ultraviolet radiation (UVR) sources and the emissions from these devices are not currently available. We conducted a pilot study to describe the pattern of use of non-solar UV devices in young women in Metropolitan Toronto (Metro) between 1985-1995.

The age adjusted prevalence of use in 1985-1995 by Metro women aged 20-44 was 20.7% (95% CI, 15.5-25.8). Tanning beds were the most popular tanning devices in Metro. The most commonly reported length of tanning sessions were 20 and 30 minutes. The percentage of ultraviolet B (UVB) to ultraviolet A, (UVB/UVA)%, of the tanning lamps in Metro varied from 0.7% to 8.5%.

We found that it was feasible to gather data on the use of non-solar tanning devices by using our questionnaires. In addition, it was possible to estimate general non-solar UVA and UVB exposure from tanning sources where use was reported.
ACKNOWLEDGEMENT

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On a personal note, I would like to dedicate this thesis to my son, Cyrus, and especially my supportive wife, Lorraine Tenzif. Her unconditional love and understanding over the years has assisted me greatly. Last but not least, I would like to thank my parents Mr. and Mrs. Siavash and Saltenat Tenzif for their loving support and encouragement throughout my life.
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CHAPTER 1

INTRODUCTION

The health effects of ultraviolet radiation (UVR) exposure have been studied in many settings. Classical studies of UVR have linked solar ultraviolet (UV) to a number of negative health effects including: erythema, skin aging, photokeratitis, skin cancer (including melanoma) and others. More recently, use of non-solar sources of UV for cosmetic purposes has been studied. But only a few of these studies have collected detailed information on amount of non-solar UV exposure and almost no information on type(s) of non-solar devices, and type(s) of tanning lamps has been collected. Therefore, it has been difficult to reach consensus about the health effects of non-solar UVR used for tanning.

The need for a pilot study in this area was brought to my attention after a discussion with my supervisor Dr. L. D. Marrett. We agreed to design and to carry out this study as part of the requirement for completion of my Masters of Science degree at University of Toronto.

We decided to undertake a small study, in order to examine the feasibility of gathering data to estimate exposure to ultraviolet A (UVA) and ultraviolet B (UVB) from tanning equipment by using data collection instruments (“questionnaires”) and manufacturers' information. We designed two questionnaires: one to administer to tanning salons and one for a sample of the general population, and examined the utility of data collected by these instruments.
CHAPTER 2

BACKGROUND AND LITERATURE REVIEW

2.1 Ultraviolet radiation

Ultraviolet radiation (UVR) is an invisible form of non-ionizing radiation with wavelength between 100 and 400 nm. While sunlight is the main source of UVR out of doors, there are also many UV tanning lamps.

UVR is generally divided in three categories according to wavelength. The notion to divide the UV spectrum into different spectral regions was initiated in 1932 at the Second International Congress of Light in Copenhagen (Diffey et al. 1983). The three major wavelength bands of the UVR spectrum are: UVA (400-315 nm); which is the closest to the visible spectrum, passes through window glass and is least harmful; UVB (315-280 nm), which is primarily responsible for most biological effects of sunlight on human skin; and UVC (280-100 nm), which is the most biologically effective, but is not present in sunlight reaching the earth. Although the definition of the bands may vary slightly, the above scheme has been adopted by many agencies, groups and authorities, and is used in the context of the present study.

The solar UV that reaches the earth’s surface is restricted to UVA and UVB. No solar UVC or UVB less than 290 nm is transmitted through the ozone layer. The ratio of solar UVB/UVA at the earth’s surface varies from 3 to 5% (Wilkinson, 1983), determined by latitude, temperature, altitude, season, time of day, and cloud coverage. This ratio has changed over the years and it is believed that due to depletion of ozone layer the UVB/UVA% has
increased, but the precise magnitude of the increase is not readily available (Personal communication, Environment Canada, 1997).

The most common sources of non-solar UVR are various kinds of fluorescent lamps and electric arcs. Ultraviolet radiation-emitting lamps can generate almost any wavelength, depending on pressure within the lamp, rare gas and phosphor used, type of metal or metal halide incorporated, housing, and whether filters are being used. Some UV lamps generate greater than 5 times more UVA per unit time than the solar UVA radiation reaching the earth's surface at the Equator (National Institute of Health, 1989).

In order to estimate the biological effects of UV exposure on humans (e.g., tanning), several measurements are done. These include the spectral output of the source, the effective irradiance, the susceptibility of the individual, and the exposure duration (Philips, 1987).

The biological processes (e.g., tanning) at specific wavelengths are examined by studying the action spectrum of the UV sources, since not all wavelengths are equally effective in producing biological effects. Effective dose is a function of the action spectrum and a correction factor for different skin types. A unit of effective dose commonly used in cutaneous photobiology is the "minimal erythema dose" (MED). One MED has been defined as the lowest radiant exposure to UVR that is sufficient to produce erythema with sharp margins 24 hours after exposure (Morrison, 1983), in unacclimatized white skin (Diffey, 1990b).

There is approximately a four fold range in MED of exposure to UVB radiation in untanned white skinned populations according to skin type. According to Urbach (1987) the
calculated effective dose of UVR for individuals with skin type II (moderately sensitive to tanning) was 200 joules per square metre (J/m²).

2.2 Health effects of UVR exposure

The health effects of UVR (positive or negative) to a large extent depend on the effective dose and on the specific wavelengths of the radiation.

On the positive side, UVR exposure is a contributor to the production of vitamin D (Devgun et al. 1982), and lack of UVR has been linked to symptoms of seasonal affective disorder (SAD) (The Task Force Report of American Psychiatric Association, 1989). Also, UVR exposure and tanning may have some positive psychological effects (Dougherty et al. 1987, and Council on Scientific Affairs, 1989).

However, there are many known negative outcomes associated with UVR exposure. There have been numerous studies in this area and there is consensus about some of the negative health effects, but considerable controversy remains concerning the specific effects of various wavelengths of UVR and the magnitude of adverse effects (National Institute of Health, 1989).

UV radiation can cause acute and chronic inflammatory changes, can burn the skin, injure the eyes, produce actinic changes, increase the risk of skin cancer and cause photoaging and various photodermatoses (Health and Welfare Canada, 1981 and Margolis et al., 1989).

The International Agency for Research on Cancer (IARC, 1992) concluded that there is
sufficient evidence in humans for carcinogenicity of solar radiation, particularly in those who do not tan or tan poorly.

Experimental animal studies have shown evidence of damaging effects of UVR exposure. These effects vary from skin sagging in albino mice to vascular damage, an increase in glycosan, collagen damage, and elastosis in experimental hairless mice (Kligman et al., 1991 and Bech-Thomsen et al., 1991).

Morrison (1989) states that UVB alters immune functions and suppresses normal immune responses. She further concluded that immune suppression is important in the development of non-melanoma skin cancer, and may influence the development and course of infectious diseases.

Van Weelden et al. (1988) compared the doses of UVA and UVB required for the induction of tumours and for acute reactions of the skin in an animal model. They further concluded that since experience has proven that the doses for acute affects in mouse are at least proportional to human tanning doses, therefore, the carcinogenic risks of tanning by UVA and of tanning by UVB are in the same order of magnitude.

2.2.1 Acute effects

Sunburn is the most common acute effect of UVR exposure. In its mildest form, sunburn involves erythema (reddening of skin) that appears 6 to 24 hours after exposure to UVR and disappears after a few days. Severe cases of sunburn involve inflammation, blistering
and peeling of skin. Not all wavelengths are effective in producing erythema or other photobiological effects.

The relative erythemal effectiveness is highly variable and depends on an individual's skin type and other factors such as skin thickness and intensity and spectral distribution of irradiation. The relative erythemal effectiveness (and some other effects) by wavelength are shown in Figure 1.

Figure 1: Relative biological effectiveness versus wavelength for induction of minimal erythema in untanned Caucasian skin and for DNA damage with and without skin transmission (From Nachtwey et al., 1981).
As is evident from Figure 1, UVB (315-280 nm) contributes significantly to development of erythema, while short wavelength UVA (335-315 nm) contributes much less and longer wavelength UVA not at all. In the range of solar UVB that reaches the earth ( >290 nm) effectiveness drops off quickly with increased wavelength.

Figure 2 shows the classical, and two other known action spectra that display the relative biologic response for erythema at different UVB wavelengths compared to that at 297 nm along with the spectrum for the solar UV radiation that reaches the earth.

Figure 2: Comparison of classical erythema, McKinlay-Diffey, and Robertson-Berger action spectrums, with solar UV that reaches the earth (from Scotto et al, 1996).

Figure 3 depicts the irradiance weighted for erythemal effectiveness (i.e. effective irradiance) of various wavelengths for the noontime sun at 30 degrees North at the summer solstice and for four different sunlamps of the type in use in the 1970's.
In addition to erythema, UVR exposure can produce photosensitive and phototoxic reactions that are exacerbated if any photosensitizing medication has been taken. Eye irritation and photokeratitis may also be caused by exposure to UVR. The most common acute harmful effect of excessive exposure of the eyes to UVR are conjunctivitis and photokeratitis or snowblindness (Health Canada, 1981 and Taylor, 1989). It also appears that longer (300-315 nm) UVB wavelength and higher chronic UVA are effective at inducing cataracts (Health Canada, 1981).

In a study of UVA tanning sunbeds, the effect on vitamin D formation, and protection against sunburn (Devgun et al., 1982), it was shown that sunbeds had limited value with regard to prevention of vitamin D deficiency, and side-effects (like skin irritation and dryness) were caused.

Figure 3: Irradiance weighted for erythema effectiveness versus wavelength (from Nachtway et al., 1981)
2.2.2 Cellular level effects

Researchers in a study of a few non-melanoma skin tumours in the sun exposed areas of xeroderma pigmentosum patients concluded that since these patients are extremely sensitive to UV, the solar UV must have caused the mutations in the p53 gene and the mutations must have played a significant role in UV tumorigenesis (Sato, 1993).

Results of a study by Kligman and colleagues on the effects of UVA in an animal model showed that the longer wavelengths of UVA (340-400 nm), with a spectral distribution similar to solar UVA, can damage the skin of hairless mice when given in large doses. They also concluded that one needs to be concerned about the deleterious effects of UVA in lower doses because it is present in sunlight all day, year around and it penetrates the skin more deeply than UVB; 40-50% of UVA is transmitted through Caucasian epidermis compared to 10-30% of UVB (Kligman et al., 1991). In another animal study Kligman and Gebre found that chronic UVA radiation may increase cross-linking of dermal collagen (Kligman and Gebre, 1991).

The interaction between the environment and host factors has been considered as an essential contributor to development of skin tumours. From the environmental standpoint, UVB irradiation can alter DNA molecular structures; if DNA is not repaired correctly, the irradiated cells could die or acquire the potential for malignant transformation (Larcome et al, 1991).

A study of the effects of tanning salon exposure on DNA repair capacity by Larcom et al., (1991) showed that tanning exposure could: (a) pose a significant hazard for individuals who are already immuno-suppressed (e.g., cancer patients, transplant patients, AIDS patients or carriers of
latent HIV) and; (b) increase the carcinogenic effects of environmental mutagens, since, tanning exposure produced significant inhibition of phytohemaglutinin-induced mitogen or of the ability to repair DNA lesions by unscheduled DNA synthesis in human subjects.

Exposure to UVA was shown to suppress activities of the natural killer cells in humans (Hersey et al, 1988), and has an impact on weakening the immune system.

2.2.3 Skin cancer and other chronic health effects

The incidence rates of both malignant melanoma and non-melanoma skin cancers are increasing. It is estimated that 92,000 new cases of melanoma and 2,750,000 cases of non-melanocytic skin cancer occur worldwide each year (Armstrong, 1995). Sun exposure is the main risk factor for skin cancer (Autier 1994, IARC, 1992).

Exposure to UV tanning lamps has only recently been considered as a possible risk factor for malignant melanoma skin cancer. There is increasing evidence that UV tanning lamps, in particular sunlamps and sunbeds, increase the risk of melanoma (Table 1).
<table>
<thead>
<tr>
<th>First Author Reference</th>
<th>Year</th>
<th>Place</th>
<th>Measurement of Exposure</th>
<th>RR (CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gallagher et al.</td>
<td>1985</td>
<td>Canada</td>
<td>Frequency and duration of use</td>
<td>&lt;1 non-significant</td>
</tr>
<tr>
<td>Osterlind et al.</td>
<td>1988</td>
<td>Denmark</td>
<td>Ever use of sunbeds</td>
<td>0.7 (0.5-1.0)</td>
</tr>
<tr>
<td>Swerdlow et al.</td>
<td>1988</td>
<td>Scotland</td>
<td>Ever use of UV sunlamps or sunbeds</td>
<td>2.9 (1.3-6.4)</td>
</tr>
<tr>
<td>MacKie et al.</td>
<td>1989</td>
<td>Scotland</td>
<td>Sunbeds use for &gt;= 3 months</td>
<td>1.3 (M)* (0.2-7.9)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.2 (F)** (0.5-3.0)</td>
</tr>
<tr>
<td>Walter et al.</td>
<td>1990</td>
<td>Ontario</td>
<td>Sunlamps/sunbeds use for &gt;= 1 yr, location, duration, frequency of use</td>
<td>2.1 (M)* (0.9-5.3)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3.0 (F)** (1.1-9.6)</td>
</tr>
<tr>
<td>Autier</td>
<td>1991</td>
<td>Belgium</td>
<td>Use of sunlamps/sunbeds at least one time before study</td>
<td>N/A</td>
</tr>
<tr>
<td>Autier</td>
<td>1994</td>
<td>Europe</td>
<td>Sunbed use prior to 1980, hours of use</td>
<td>2.1 (0.84-5.4)</td>
</tr>
<tr>
<td>Westerdahl et al.</td>
<td>1994</td>
<td>Sweden</td>
<td>Use of sunbeds/sunlamps &gt; 10 times/yr</td>
<td>1.8 (1.0-3.2)</td>
</tr>
<tr>
<td>Holly et al.</td>
<td>1995</td>
<td>U.S.A.</td>
<td>Ever use of sunlamps</td>
<td>0.94 (0.74-1.2)</td>
</tr>
</tbody>
</table>

N/A = Not applicable to this study, * Males  ** Females

Several studies of melanoma and non-solar UVR exposure have shown non-significant, yet consistent, positive associations between exposure and development of melanoma.

A recent European multi-centre case-control study showed that exposure to sunlamps and sunbeds may increase the risk of cutaneous malignant melanoma (RR=2.12, 95% CI (0.84-5.37)). These researchers concluded that public health authorities should have a cautious approach towards the rapidly developing fashion of tanning under sunlamps or sunbeds (Autier, 1994). However, the non-significant estimates of risk from this study remains a concern.

Westerdahl et al. (1994) in a population-based, matched case-control study of melanoma in
the South Swedish Health Care Region found that ever having used sunbeds or sunlamps significantly increased the risk of developing melanoma (RR=1.8, 95% CI (1.0-3.2)). These researchers also discovered a dose-response relation between the number of exposure times (use) and development of melanoma.

In a descriptive study by Autier et al. (1991) the usage pattern of sunlamps and sunbeds of melanoma patients was compared with that for the general population in Belgium. These researchers provided evidence that melanoma patients were greater users of non-solar UVR sources for tanning than the general population. They also discovered that in Belgium the incidence of melanoma in different geographical areas was positively associated with the proportion of people using tanning devices.

In a large comprehensive case-control study of the cutaneous melanoma and use of sunlamps and tanning beds by Walter et al. (1990) in the Southern Ontario region it was shown that use of non-solar tanning sources was a risk factor for melanoma (RR males=2.12, 95% CI (0.9-5.28), RR females=2.99, 95% CI (1.08-9.57)).

MacKie et al. (1989) in a Scottish study of the personal risk-factors for cutaneous melanoma discovered that some use of non-solar UV sources was associated with an increased risk of melanoma in both males and females (RR females=1.3, 95% CI (0.2-7.9), RR males=1.2, 95% CI (0.5-3.0)), but wide confidence interval estimates point out to non-significance of these results.

In another Scottish study by Swerdlow et al. (1988) the risks of cutaneous melanoma was examined in association with exposure to non-solar UV sources. In this case-control study the use
of UV sunlamps and sunbeds may be associated with a significant risk of cutaneous melanoma (RR=2.9, 95% CI (1.3-6.4)).

On the other hand some studies have shown different results. Osterlind et al. (1988) reported that in a population-based case-control study cutaneous malignant melanoma in East Denmark, no association was found between the risk of cutaneous melanoma and exposure to non-solar UV sources (fluorescent light, sunlamps, or sun beds) (RR=0.7, 95% CI (0.5-1.0)). However, in this study data were collected only on the "use" or "not use" of the non-solar UV sources for tanning and no other detailed information (i.e., number of visits, duration) was collected.

In a recent population-based case-control study of females ages 25-59 conducted in five San Francisco Bay area counties, no association was found with use of fluorescent lights or exposure to sunlamps for all types of cutaneous malignant melanoma (RR=0.94, 95% CI (0.74-1.2), superficial spreading melanoma, or nodular melanoma (Holly et al., 1995).

In the Western Canada study of melanoma (Gallagher, 1986), no association was found between exposure to sunlamps and risk of melanoma (Chi-sq = 6.1, 5 d.f., P = not significant).

One of the problems with these studies is inadequate control, in general, of solar exposure as a potential confounder.

As is evident there still remains controversy on the cancer causing potential of non-solar UVR exposure and specific wavelengths contribution to these health effects.

Some studies have shown a consistent dose-dependent association between ocular UVB exposure and two common types of cataract (cortical and posterior subcapsular). It appears that the
longer (300-315 nm) UVB wavelengths and higher chronic UVA exposure levels are effective at inducing cataracts (Health Canada, 1981).

Data on non-solar UV exposure and risks of non-melanoma skin cancer are also indicative of the harmful effects of the UV rays: Diffey (1986) reported that UVA radiation used for tanning purposes is capable of inducing non-melanoma skin cancer.

Fluorescent lights used for general purposes have also been examined as sources of non-solar UV and according to Stone (1991) risks of skin cancer from conventional interior fluorescent lights is extremely small.

2.2.4 Medical use of non-solar UV sources

Ultraviolet radiation has been used to treat psoriasis and eczema. Various types of UV lamps are used for medical purposes including mercury or metal halide lamps. The primary output of these lamps is in the UVB range (IARC 1992).

The psoralen photochemotherapy clinically known as PUVA involves combination of photoactive drugs, psoralens (P), with UVA radiation. During a general course of treatment (25 treatments, over a 6-12 week period) (Wolff, 1997), an estimated 100-250 J/cm² (1,000-2,500 kJ/m²) dose of UVA is required to clear lesions (IARC, 1992).

The possible association between PUVA and development of non-melanoma skin cancers (NMSC) and malignant melanoma has been studied for several years. Stern and his colleagues recently showed that 15 years after the first treatment with PUVA, the risk of malignant melanoma
increases, particularly in those who had received more than 250 treatments (Stern, R.S., Khanh, MD., et al., 1997). The risks of non-cutaneous cancer did not increase after PUVA treatment (Stern, R.S., Vakea, L.H., 1997).

Several studies have also demonstrated the role of PUVA in combination with other risk factors (e.g., history of skin cancer, skin type) in development of NMSC (Stern et al., 1994; Maier et al., 1996; Henseler et al., 1987).

However, weighing the risks and benefits of PUVA and considering the other options for treating severe psoriasis we can not discontinue PUVA (Wolff, 1997).

2.3 Tanning
2.3.1 Tanning mechanisms

Tanning is a result of one of two processes: a) immediate pigment darkening (IPD), and b) delayed pigment darkening (DPD). IPD is a result of exposure to UVA (solar or non-solar), and it normally lasts for few days. IPD begins immediately on exposure to UVR and is caused by the darkening of the pigment melanin that is already present in the skin. DPD is a direct result of UVB (solar or non-solar) absorption; it involves melanogenesis. The produced melanin is transported to the upper layer of skin, especially the stratum corneum, within 4 to 6 days, and the resulting pigmentation is long-lived (Osterlind, 1988).

The increased production of melanin in the skin is actually the skin’s protection against any further radiation-induced injury. Individuals with different skin types have different tanning
capabilities (Table 2).

Table 2: Classification of skin types on the basis of ability to tan (from IRPA/INIRC Guidelines 1991)

<table>
<thead>
<tr>
<th>Skin Type</th>
<th>Tanning ability</th>
<th>Sunburn susceptibility</th>
<th>Minimal Erythemal Dose (MED)* J/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td>I Very sensitive</td>
<td>Never tans</td>
<td>Always sunburns</td>
<td>&lt; 200</td>
</tr>
<tr>
<td>II Moderately sensitive</td>
<td>Moderate</td>
<td>High</td>
<td>200-250</td>
</tr>
<tr>
<td>III Moderately insensitive</td>
<td>Good</td>
<td>Moderate</td>
<td>250-400</td>
</tr>
<tr>
<td>IV Insensitive</td>
<td>Very good</td>
<td>Low</td>
<td>400+</td>
</tr>
</tbody>
</table>

* These are ranges of reported MED values from several studies. For Skin type II, the generally adopted value is MED = 200 J/m²

2.3.2 Indoor tanning equipment and facilities

Tanning equipment have been in use for many years. Over the years devices have evolved from being small and relatively inexpensive, such as sunlamps, to more sophisticated such as tanning beds. This evolution of tanning devices has been in conjunction with an emergence of commercial facilities offering use of tanning devices. In addition, extensive advertisement through the media has boosted popularity of these devices (Juergen et al., 1987).

There are a variety of types of equipment that induce a tan. The most common types that are currently used include: tanning beds, tanning canopies, and facial units. Tanning beds, which are also known as 'sunbeds', are equipped with fluorescent UV lamps in both the lower and upper parts of the device. There are usually between 18 and 36 tanning lamps in a tanning bed. Some tanning beds may also include a special facial tanning portion on the mobile (upper) part of the bed. While bed lamps are usually fluorescent UV tubes, the facial lamp components
are more often mercury vapor lamps. In general, newer fluorescent tubes emit mainly UVA with a small amount of UVB, where high pressure mercury lamps are of the high UVB emission type. Thus, expected emissions from fluorescent lamps and facial lamps in a tanning bed generally differ. For photos of some tanning beds refer to Appendix A Photo #’s 1-5.

Tanning canopies or ‘sunlamps’ are a simpler form of tanning beds. Here lamps are only mounted of the upper part on the device (Appendix A, photo #’s 6 & 7). Therefore, stronger lamps, such as the medium or high pressure mercury arcs, are mounted in canopies to produce similar and often stronger results than tanning beds.

A ‘facial tanning unit’ is a device that is used to tan one’s face. This device normally has one to three panels on a stand that will radiate a person’s face while she/he is sitting in front of it. Older facial units consisted of one strong tanning lamp mounted in a small portable fixture (Appendix A, photo # 9). In a typical modern facial unit, 3 to 6 bulbs of the quartz or high pressure mercury lamps are mounted (Appendix A, photo # 8).

Although not as popular as other forms, the tanning booth is also in use. Here tanning lamps are mounted vertically on walls in a booth. Subjects stand in the middle of the tanning device during tanning sessions.

Tanning equipment is found in private homes, in medical facilities and in a variety of commercial outlets that vary in size, function and nature of their business such as: tanning salons, fitness spas, beauty-salons, and health clubs. Tanning salons are by far the most popular commercial tanning establishments with the greatest number of clients (Holly et al., 1995,)

In contradiction to what has been projected (Taylor, 1989), namely that in the long term the poor cost-to-benefit ratio to customers in terms of both money and time would reduce the popularity of sunbeds within the next few years, sunbeds and sunlamps have become more popular over the years (Gies et al., 1986), and their popularity continues to increase.

According to recent trade publications, the estimated annual revenue from indoor tanning in the United States exceeds $1 billion (Looking Fit, 1992). An estimated one million Americans visit tanning salons in a year (Spencer, 1995). Other studies (Armstrong, 1994 and DeLeo, 1992) have indicated an increase in popularity of tanning equipment in other industrialized countries.

Tanning salons are proliferating in Ontario, particularly in urban areas, where young women are the most frequent users (Vessel et al., 1996).

2.3.3 Reasons to use tanning equipment

There are a variety of reasons why some people like to use tanning equipment. Dougherty et al. (1987) found that some of the most frequently cited reasons included: a) "tanning is accomplished in less time", b) "a tan is appealing", c) "salons have a pleasant atmosphere", d) "burning is avoided". Words frequently associated with tanning equipment use in salon setting as reported by these investigators included "relaxation", "easy", "nice", and
"friendly".

According to the American Academy of Dermatology (1991), there are no health benefits from tanning. Despite warnings from the dermatologists and other physicians, indoor tanning has remained popular.

The Council on Scientific Affairs of the National Institutes of Health has reported that there are no known medical benefits from cosmetic tanning except for the possibility that a tanned skin may have positive psychological value by creating an enhanced image of personal worth (Council on Scientific Affairs, 1989).

Some researchers believe that tanning may provide protection against further adverse effects. Rivers et al. (1987) in a small study showed that UVA sunbeds produced mild tanning protection against acute problems due to subsequent frequent exposure. However, the small sample size for this study remains a concern.

Margolis et al. (1989) demonstrated that a UVA tan provides photo-protection against acute UVA exposure. They mentioned that UVA and UVB can render skin more resistant to the insult of primary irritants. This positive effect may explain the benefits of UV irradiation in some dermatoses (Lehman et al., 1991).

2.3.4 UVR emissions from tanning lamp

The UVR exposure from tanning equipment is a function of wavelength and intensity of emitted UVR, distance, number of lamps, exposure time, type(s) of tanning lamps and
distance from the lamps.

In addition, filters that are used to cover the surface of tanning beds (surface area between lamps and subjects) have a direct impact on transmitted UV bands from the lamps. In a study by Gies et al., (1986) the acrylic material that was used transmitted close to 80% of the UVB emitted from the lamps.

The total UVR received from a tanning lamp can be measured; this is called irradiance, and is expressed in the number of watts per metre squared. When the values of irradiance are multiplied by the number of seconds that the radiation lasted, the dose in Joules meter squared is obtained.

**Exposure Index 1**

\[
\text{Dose} = \text{Irradiance} \times \text{Time}, \text{ expressed as J/m}^2
\]
\[
\text{Where J/m}^2 = \text{Watt per square meter} \times \text{Time (second)}
\]

The effective irradiance of a tanning source is the summation over wavelengths of the products of spectral irradiance and the relative biological effectiveness of radiation for each wavelength. When the effective irradiance is integrated over time the effective dose obtained expressed in J/m² (IARC, 1992).

The tanning process is strongly enhanced by UVB; the effectiveness of tanning with only UVA is lower than tanning when UVB is present. However, since UVB is also directly toxic to cells of the epidermis, especially Langerhan cells (American Academy of
Dermatology, 1991), it is inadvisable to permit large doses of this sort of radiation. This is an extremely important consideration in choosing the lamp types to be applied (Philips Lighting, 1987). As a consequence, pure UVA has to be administered at a higher irradiance level than radiation where some UVB is present in order to effectively induce a tan. Lamp manufacturers are largely able to determine the ratio of UVA and UVB in relation to the total radiated UV (Sterilein, 1994).

The ratio of solar UVB/UVA that reaches the earth was reported by Wilkinson to be between 3 to 5% (Wilkinson, 1983). This ratio is believed to have increased over the years (Personal communication, Environment Canada, 1997). The non-solar UVB/UVA ratio from tanning lamps can vary according to type of gas, housing, pressure within the lamps and other factors (Diffey and McKinlay 1983).

Tanning lamps that emit mostly UVA and a small amount of UVB are known as UVA lamps. Diffey and Langely (1986) discovered that so-called UVB fluorescent lamps emitted approximately 55% of their total UV output in the UVB range.

Tanning lamps before the 1970's had high UVB and even some UVC emissions. Modern lamps emit primarily UVA with a small percentage emission of short-wave UVB (280-300 nm). A letter from the Alberta Workers' Health, Safety and Compensation to establishments with sun tanning equipment in Alberta (1980) indicated that there has been a recent trend to the installation of European-type tanning equipment (sunbeds/tanning beds, with mainly UVA outputs) in commercial establishments. Therefore, it is anticipated to see
more UVA exposure than before.

Kligman (1987) believes that the means now exist for humans to be exposed to more UVA radiation than is normally possible by sun exposure alone. This is because of the increased use of UVA emitting lamps. In addition, long exposure times associated with the use of tanning equipment that employ mainly UVA tanning lamps (UVA tanning equipment) (typically 30 minutes) can result in a significant accumulated UVB exposure, which may cause sunburn and eye irritation.

Diffey believes that despite the sales talk, UVA radiation is not normally effective in producing a tan. UVA sunbeds generally produce a tan in people who tan well in sunlight (sun reactive skin types III and over, Table 2), but those who tan poorly (skin types I and II) are likely to be disappointed with the UVA beds. In addition, minor annoying cutaneous effects such as redness, itching, and dryness were prevalent (Diffey, 1987b).

The UV output of a tanning lamp decreases as the age of the lamp increases. This decline in the UV output is more pronounced in UVB emissions than UVA. Gies and colleagues (1986) reported that the UVB output of their lamps dropped to 86% of initial values after 10 hours, while the UVA irradiance of the same lamps fell to 94% during the same period. They also reported that UVB continued to decrease more rapidly (0.1% per hour) than did the UVA output (0.04% per hour), though both rates were much slower than that during the initial 10 hour period.

Lamp aging may have a direct impact on duration of use of a tanning device. Subjects
who are using devices with lamps that are relatively old may not obtain the same results as using newer lamps and hence may want to extend their exposure time, or increase the frequency of their use.

2.4 Reports from previous studies and actual measurements of UVR

Previous studies (Diffey, 1987a, 1990a; Gies et al., 1986; Bowker et al., 1987; Bruyneel-Rapp, 1988) have carried out measurements of the total UVR output of tanning devices.

Figure 4: Emission spectra of output of UVR lamps that were used in Gies' study (from Gies, 1986)

Gies et al. (1986) used a spectroradiometer to measure the spectral irradiance of UVR lamps used in sunbeds and tanning booths in solaria in Melbourne (Australia) in 1985. As is evident from Figure 4, the reported UVA lamp has more than 95% of its emission in the 315-
400 nm range (UVA) with a peak at 350 nm, while the UVB lamp has more than 90% of its emission in the 280-350 nm range with a peak at approximately 310 nm. The third type of lamp, the least popular lamp in Gies’ survey, was the sunlamp with its emission lines consisting solely of mercury emission lines covering the wavelength range from 250 nm into the visible region.

Diffey (1987a, 1990a) provided spectral emissions from three types of tanning lamps used in tanning canopies and sunbeds in England in the 1970's. He defined Type I UVA lamps where UVB content of the lamps as a percentage of the total UVR was about 1%; Type II UVA lamps were defined as having UVB% of close to 0.05% of the total UVR. The typical spectral irradiances of Type I, Type II and an optically-filtered metal halide high pressure mercury arc lamp are provided in Figure 5.

![Figure 5: Typical spectral irradiance in the UV range from tanning devices using (a) Type I UVA lamps; (b) Type II UVA lamps; (c) optically filtered metal halide high-pressure mercury arc lamps (from Diffey, 1987a).](image)
According to Diffey (1987a, 1990a) the typical total UVA irradiance at the skin surface from a sunbed containing Type I UVA lamps is around 80 W/m², and 250 W/m² for Type II UVA lamps.

Other researchers (Bowker and Langford, 1987) carried measurements of tanning lamps in eight commercial tanning facilities in Oxford (England) area. Bruyneel-Rapp et al. (1988) visited tanning salons in Arkansas (U.S.A.) area and measured irradiance of the lamps that were used in tanning salons in the mid 80's. The total UVA irradiances for UVA I lamp types as reported by Bowker and Langford (1987) and Bruyneel-Rapp (1987) was between 50-150 W/m². This variation in reported irradiance may be attributed partly to: a) different age of the lamps used in these studies; b) different number of the total lamps used in devices and; c) other factors such as distance from the lamps and use of filter.

As discussed, there has been a trend to manufacture and employ lamps with a major UV output in the UVA range more than before (Alberta Occupational Health and Safety Bulletin, 1980 and Bowker, 1987). The modern tanning devices employ tanning lamps with mainly UVA output (Spencer, 1996).

2.4.1 Tanning industry's knowledge level

In a survey of 37 tanning salon operators' knowledge about tanning in lower mainland British Columbia, Ross and his colleagues (1994) found substantial knowledge deficiencies in the definition of UVA and UVB, and the biological roles of the UV bands. Other studies have reported
similar results (Bruyneel-Rapp et al., 1988 and Beyth et al., 1991).

In another survey of the tanning salons operators' knowledge and safety information that they provide to their clients in New York City from 1988 to 1989, researchers discovered that there was a disparity between known/postulated health risks of UVR exposure and safety information provided to tanning salon customers. These researchers call for a greater regulation of the tanning salon industry and for education of tanning salon operators in the risks associated with the use of non-solar tanning devices (Fairchild et al., 1992).

2.4.2 Regulatory measures

The general knowledge that the biological effectiveness of UVA is less relative to UVB, and that tanning with UVA is safer than tanning with UVB is reflected in the regulations and advice concerning the manufacture and design of sunbeds given by many national agencies. Recommendations and regulations on the spectral quality of the radiation from tanning sources have been in place, but in most instances they cannot be enforced since they have not been adopted by the appropriate level(s) of governments.

According to the Canadian Radiation Emitting Devices Act (RED Act, 1986), "sunlamps shall function in such a manner that, at any distance in any direction from the sunlamp, the irradiance within the wavelength range from 200 nm to not more than 260 nm does not exceed 0.003 of the irradiance within the wavelength range from 260 nm to not more than 320 nm". In other words the ratio of UVC/UVB shall not exceed 0.003.
Identical regulations are in place in the United States and many of the present manufacturers of the tanning devices refer to the U.S. Federal Standard Number CFR 1040.20 (Federal Standard 21 CFR 1040.20) in the technical brochures of their tanning lamps as the standard.

As seen there are no mention of absolute limits for UVA and UVB in the above standards. The RED Act and the U.S. CFR 1040.20 were designed to limit the UVC output of tanning lamps, but today we need more comprehensive regulations. These new standards are needed to regulate the use of new types of tanning lamps and devices.

One of the more comprehensive recommendations for UV exposure limits for tanning equipment was suggested by Wilkinson (Wilkinson, 1983). His recommendations were based on the spectral quality of the radiation in terms of maximum limits on the ratios of the energy in selected wavelength bands of the actinic UV (200-320 nm) region to the energy in the UVA region (or the total UV). His recommended limits were:

for wavelengths between 315 and 300 nm (longer UVB) - 1% of the UVA irradiance

for wavelengths between 300 and 280 nm (shorter UVB) - 0.1% of the UVA irradiance

for wavelengths between 280 and 100 nm (UVC) - 0.01% of the UVA irradiance

The most comprehensive guidelines for the use of sunlamps and sunbeds in cosmetic tanning are those published by the International Electrochemical Commission (1987, 1989). The guidelines classify tanning appliances into one of four types according to the effective irradiance at short (≤ 320 nm) and long wavelength (320 to 400 nm, UVA). The guidelines recommend that the annual exposure to sunlamps and sunbeds should not exceed an effective dose of 25 kJ/m².
Although there are regulations governing provision and use of timers, protective eyewear, posting of warning labels, lamp replacement, and maintenance and operation of tanning equipment, there are no standards regulating the operation and practices of tanning facilities.

As discussed, tanning salons are proliferating in Ontario (Vessel et al., 1996). However, there are no detailed data available about the types of equipment that have been in use in the past several years and their use. Therefore, it was essential to conduct a study to have a better understanding of the tanning equipment and its use in Ontario. For logistical reasons, the study was further focussed on a large urban setting, namely Metropolitan Toronto.
CHAPTER 3

MATERIALS and METHODS

3.1 Rationale

As was discussed in previous sections, there still remains controversy on some of the health effects of non-solar UVR exposure. This difference in views may be partially due to lack of detailed data on emissions and actual exposure.

Armstrong (1994) discussed a detailed strategy for assessment of exposure to non-solar sources of UVR in relation to malignant melanoma. He proposed that, in order to examine the UVR action spectrum for melanoma induction, future studies should not only examine the pattern of exposure in some detail, but they should also attempt to identify the devices used. He suggested that identification of devices might "best be done by the use of photographs of all types of devices that had been in use in the populations in question over the relevant period of time". Furthermore, information on the spectral output of the lamps used in these devices would be necessary; this might be measured as part of a field study.

In reviewing data from several studies of melanoma and exposure to non-solar UVR tanning devices (Table 1), it is evident that measurement of exposure mostly relied on questions about ever use and, in some instances, the frequency of use of these devices. Walter et al. (1990) collected more detailed information, including location of use of tanning devices (home, commercial facility or medical facility), duration of use (in minutes), and actual calendar year of use. However, none of these previous studies collected detailed data on types of equipment and their tanning lamps.
In response to the need for a comprehensive study of non-solar UVR, and as a prerequisite for future detailed studies, we were motivated to undertake a small study to develop and test instruments to collect the types of information recommended by Armstrong.

### 3.2 Objectives

The primary objectives of this study were:

1. to assess the feasibility of gathering detailed data on the use of tanning equipment (including facilities, devices, etc.) in young female residents of metropolitan Toronto; and
2. to ascertain whether it was possible to estimate general non-solar UVB and UVA exposure levels from tanning sources where use was reported by the study population.
3. A secondary objective was to describe the overall pattern of use of tanning devices in the study population in a recent time period.

### 3.3 Overall study design

We used a cross-sectional design for our study in order to obtain data from a representative sample of the female residents of Metro Toronto ages 20-44 and all tanning salons listed in our study area.

As suggested by Armstrong (1994), it is essential to identify specific devices used so as to facilitate estimation of UVR exposure. Therefore, two questionnaires were designed: one was administered to tanning salons to determine what types of equipment were available and one was
administered to the population to determine types of equipment that had actually been used. Additionally, in order to estimate UVR exposure, attempts were made to secure information from manufacturers of tanning lamps and tanning devices.

The salon questionnaire was administered first and the population questionnaire was developed based on salon data. The salon and population phases of data collection are described in the sections that follow.

3.4 Data collection

As discussed, the UVR emissions associated with a particular piece of tanning equipment are a function of the equipment itself and, more importantly, of the type and number of the lamps (tubes) employed in the device. In order to estimate a person's UVR exposure from tanning equipment, information is required both about the equipment and about the individual's use of that equipment.

3.4.1 Salon questionnaire

For the purposes of this study we limited our survey of available equipment to tanning salons, since previous studies (Diffey, 1987c; Mawn et al., 1993) had indicated that most exposure had occurred in these facilities. Although other commercial facilities (health clubs, hair salons) offer tanning services, it was not easy to identify those which have tanning equipment and those which do not.
The questionnaire of equipment available in tanning salons was developed in collaboration with one of the major distributors of tanning equipment in Ontario. The questionnaire was presented to a few salons as a pre-test and was modified as required.

Salon questionnaires were mailed out to all salons listed under the heading "Tanning" in the 1994 Yellow Pages of the Metropolitan Toronto (Metro) telephone book (Bell Canada, 1994). A study summary and an invitation to participate along with a questionnaire was sent to each tanning salon in Metro (Appendix B). The purpose of our study was clearly indicated to salon owners in the cover letter.

Descriptive questions about the tanning salon's year of establishment and number of years of operation were included in the salon questionnaire. Detailed questions about the tanning equipment name(s), model(s), type(s), and year(s) of use, in addition to name(s), type(s), model(s), code(s), wattage, and number of tanning lamps in each piece of equipment used during the previous 10 years were asked.

Some questionnaires were completed and returned after initial contact. A series of follow up phone calls were made to non-respondents two weeks after the initial mail-out. A second questionnaire was mailed when required, followed by a telephone reminder to the non-respondents. A few salons were personally visited by the study staff and questionnaires were completed in cooperation with salon owners.

Salons who were still non-respondents after follow up attempts were contacted by one of the study staff who introduced himself as a potential client. Basic information (e.g., years of
operation, number of devices and types) was collected.

Information provided by the salons was evaluated to determine its completeness, and value. Details of answers were used as criteria to assess the value of salons' information. Usefulness of salons' data was assessed when compiling summary tables.

Salons' information was used to compose a photo sheet of the tanning equipment most commonly used in the salons. Some of the actual photos of these devices came from technical brochures provided by manufacturers or salons. This photo sheet was used as a memory aid for users of tanning equipment (See Section 3.4.2).

In the salon questionnaire, there were no questions about the UVA and UVB emissions of the lamps. We used information from lamp manufacturers to determine the UVB/UVA percentage for each reported lamp. In recent years, some manufacturers have adopted time in minutes for erythema to occur (Te) and time in minutes for melanogenesis to occur (Tm) as measures of the strength of a lamp. Detailed lamp information obtained from manufacturers included either UVB output as a percentage of UVA and UVB, or the Te and Tm.

3.4.2 Subject questionnaire

A subject questionnaire was developed and administered to a random sample of young women, ages 20-44, living in Metro. This group was chosen because previous studies have indicated relatively high use of tanning devices (Autier, 1991 and Walter et al., 1990). The questionnaire requested, in addition to demographics, information about subjects' tanning habits.
(years of visits, number of visits, duration of visits) in the previous decade at commercial tanning facilities (i.e., tanning salons, health clubs, hair salons) and at home and about the name/address of the facility and the name(s), model(s), and type(s) of tanning equipment used. Although we believed it was unlikely that subjects would recall the type(s) of lamps that they had used, it was reasonable to assume that they would be able to recall the type(s) of equipment (e.g., tanning bed, facial lamp, booth). The photo sheet developed from salon data was used to assist subjects in recalling specific pieces of equipment.

A random sample of households was generated from the 1995 Metro Toronto telephone book (Bell Canada, 1995). In order to identify households with potential subjects (women ages 20-44), a screening call was placed to each selected household (although, in the early stages of the study the target population was women ages 25-44, it was later expanded to include 20-24 year olds also, to increase the yield per telephone call). During the screening call the interviewers requested a census of the household.

From the census, one subject per household was selected. In the case that there were two or more eligible subjects in one household, all potential subjects were randomly assigned a number between 1-5, the one to be included was identified by using a list of random choices stating one of the numbers between 1-5.

Four telephone attempts were made to each household in cases of no response to screeners' telephone calls, or to contact an eligible subject not available at time of screening call before exclusion.
Telephone scripts were developed for use when contacting subjects for both screening and follow up; this ensured a uniform approach. Study staff were trained to deal sensitively with subjects who may have had specific concerns. In addition, a trouble shooting sheet was generated to answer some of the anticipated subjects' objections.

In the early phases of the study, permission to send a questionnaire was obtained from the potential subject at the time of screening or at a later time as required. Questionnaires were then sent to all who agreed. However, a couple of months into the study procedures were changed to increase response rate and reduce workload. From this point on, the five key questions that pertained to everyone (demographics and whether tanning equipment had been used) (Appendix C, questions 1-5) were asked of all selected eligible subjects who agreed during the screening call (or at a later telephone call if required), in order to identify the 'tanners' (i.e., users of tanning devices) right away. Then a complete questionnaire (Appendix C) requesting details of tanning equipment use was mailed to the tanners only.

Subjects/tanners received an introductory letter and the questionnaire (Appendix C), which required less than 10 minutes to complete, along with a stamped envelope addressed to the study office at University of Toronto for return of the completed questionnaire. A copy of a brochure entitled "Enjoying the sun safely" prepared by Health Canada was also included. This contains educational material about UVR and its effects (Appendix C).

A telephone reminder was made to subjects whose completed questionnaires had not been received within two to three weeks of mailing. A second questionnaire was mailed out to those who
indicated that they had not received or had misplaced the first questionnaire. In the early phases of study, study staff attempted a telephone interview at four to six weeks after the initial mailing, with those who were still non-respondents. In later phases of the study (after changing recruitment strategy), identified non-responding "tanners" were telephoned and reminded to return their full questionnaires; at this time if they had decided not to participate their decline was accepted.

A random sample of Metro area residents was chosen as the study population for reasons of feasibility, accessibility and convenience. It was not feasible to obtain a list of the tanning salons' clients as the study population because most salons do not keep a comprehensive list of their clients, and would not likely be willing to release such information. In addition, a random sample of the general population would provide data that are representative of the general pattern of use.

Subjects' information was used to calculate the number of years of use, the average number of sessions and total exposure time. All reported uses after 1995 were excluded from calculations. For single reported years of use (e.g., 1989, 1995) the raw information about the average number of sessions was used, and a value of 0.5 was assigned to the number of years (as in occupational epidemiology studies to account for uncertainties in reported years of use/exposure). Where reports of visits consisted of multiple years, the total number of years of use was calculated and the actual number of sessions based on it. Here the first and the last years contributed one half year each and intermediate years each contributed a whole year (value 1.0 each). For instance, if the reported years of visit were "1987-1989", both 1987 and 1989 were counted as a half year of use (0.5 value), while the intermediate year 1988 was counted as one full year of use (1.0 value). Number of years were
then cumulated across for each subject (2.0 for this example).

This system of assigning values had a direct impact on the calculation of the average number of sessions and consequently the total exposure time. Thus, if the reported average numbers of visits per year were 10, 5, 6, 10, and 7 respectively for the period 1985-1989, the calculated numbers of visits for each of the years were 5, 5, 6, 10 and 4 (3.5 was rounded to 4) for a total of 30 sessions over four years (for the period 1985-1989), or an average of 7.5 sessions per year.

The total exposure time was defined as:

**Exposure Index 2**

\[
\text{Total exposure time} = \sum \text{over reported periods of use of (average number of visits/year)} \times \text{(duration of visits)} \times \text{(assigned value(s) to the year(s) of use)}
\]

In the final example given above, if the duration for these visits was reported to be 20 minutes and there were no other periods of use, the total exposure time would be 600 minutes (7.5 \times 20 \times 4.0).

### 3.5 Sample size

Sample size calculation relied on the information from two major studies of the use of tanning lamps and sunbeds. Walter et al. (1990) showed that, in 1984-1986, females aged 25-44 had the highest percentage of ever using tanning beds or sunlamps in Southern Ontario. A secondary look at their data showed that among this age group 18% had ever used such equipment.
in a commercial facility.

A Belgian study by Autier et al. (1991) indicated that in 1988, 13.8% of the females in the general population of Belgium were exposed to sunlamps and sunbeds. The age-specific data showed that females 25-34 had the highest percentage of exposure (20%) to these devices. According to the same study, the proportion of Belgian people (males and females) exposed to sunlamps or sunbeds rose from 7.2% in 1986 to 8.4% in 1988.

Based on the above studies, about 20% of women ages 20-44 in Toronto were expected to have had some exposure over the study period. This estimate was realistic, and it was plausible to anticipate a higher rate of use among the subjects in this study, since we were examining not only commercial use, but also the home use of tanning devices.

To estimate expected prevalence (P), of 20%, for various sample sizes (N), the expected 95% CI are as follow:

<table>
<thead>
<tr>
<th>N</th>
<th>95% CI* for prevalence of use (P)</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>12.5-27.8</td>
</tr>
<tr>
<td>150</td>
<td>13.6-26.8</td>
</tr>
<tr>
<td>200</td>
<td>14.5-25.6</td>
</tr>
<tr>
<td>250</td>
<td>15.0-24.6</td>
</tr>
<tr>
<td>300</td>
<td>15.5-24.5</td>
</tr>
</tbody>
</table>

It was decided that a sample size of 200-250 respondents would give satisfactory precision,
given the relatively small gain in precision with increasing number of respondents (N) and given
the fact that this was only a pilot study (See Table 3). Given an anticipated response rate of 60%,
we needed to contact about 333-416 eligible women. Of course, many more telephone numbers
were needed to be selected.

A sample of 200-250 women with a 20% prevalence would result in 40-50 tanners which
would be expected to be adequate to characterize tanning equipment use as a pilot study.

3.6 Ethics

This study was approved by the University of Toronto Human Subjects Review Committee
(Appendix D). Verbal permission to send a questionnaire was obtained from screened subjects. A
cover letter was mailed with the questionnaire to each subject to inform her of the intention of study
(Appendix C). Subjects were informed that this study did not bring them any harm and that their
information would be used for the purposes of this study only. Completion of the subject
questionnaire was indicative of their consent to participate.

Salons' and subjects' questionnaires were numbered, so that no identifying information was
present in the questionnaire; no names were included in questionnaires, and results will be
published as aggregate data. Subjects' names and salons' names were recorded in a log book, and on
a computer disk that was kept in a locked cabinet accessible only by the study staff, and were
stored separately from the questionnaires. Similarly, paper files were stored in a secure cabinet.
accessible by study staff only. All nominal records will be destroyed as soon as study is completed and reviewed.

The risk to subjects was minimal. There was no chance of physical harm. Findings from this study have important implications in determining feasibility of estimating UVA and UVB from tanning equipment by using the designed instruments.

In addition, subjects were asked to indicate if they would like to receive a copy of the final results of the study. A summary of the reports will be sent to those interested.

Salons information was kept confidential and there was no chance of harm (physical, or financial). For the time they spent, participating salons will receive a summary report, which will have valuable information about Metro salons.

3.7 Data entry and statistical analysis

We used the Statistical Analysis System (SAS) to create two data bases: one for the salons and one for the subjects. Data entry was done by one of the study staff and data checking procedures were put in place to ensure accuracy. Descriptive analysis using SAS was done. Univariate analysis were carried out to produce descriptive information. Chi-square values were calculated and their significance was examined (alpha= 0.05) in order to examine the possible associations between subjects' characteristics and some of their tanning habits. Confidence intervals were calculated where appropriate.
Correspondence between years of use of tanning devices, and years of operation of salons, and also reported sketch numbers by subjects and reported devices in salons were examined. The estimates of UVR were calculated based on the overall exposure time (number of sessions), the most popular types of devices and their tanning lamps, and estimates of UVR per session.

From salons’ and manufacturers’ data we determined the highest and lowest, and the intermediate UVB/UVA% levels from lamps used in tanning beds in Metro salons from the manufacturers’ data. By using total UVA irradiance values from other studies that had employed lamps with similar UVB/UVA%, total power consumption, similar UV peaks in the total irradiance graphs, to those used in our study we estimated the absolute UVA and UVB irradiance of the tanning devices reported in this study. Then we carried out a sensitivity analysis to examine variation in the UVA and UVB over the study period. Using reported lengths of tanning sessions we estimated the UVA and UVB doses per session use.

3.8 Determining UVA and UVB from exposure to tanning devices

To estimate the UVA and UVB outputs of a tanning device we needed information about the equipment design, number of lamps and UVA and UVB irradiance per lamp and/or total UVA and UVB irradiance per device.

Manufacturers are often able to provide UVB/UVA% data for their lamps, but this must be complemented by information on actual spectral output or total UV irradiance of lamps and devices.
in order to estimate actual UVA and UVB irradiances.

Since data on spectral output and UVA and UVB irradiance are not generally available for tanning lamps and tanning devices, because manufacturers do not produce them or do not have them readily available, some other way of estimating actual UVA and UVB outputs of lamps was required.

Ideally measurement of the total UV irradiance of various lamp types and devices would be the most appropriate method. However, we did not carry out these measurements and had to use results of other studies as surrogates. Details of the procedures used to estimate UVA and UVB dose are discussed below.

We used data provided by our salons and subjects combined with information from other sources to make estimates of the UVB and UVA exposure levels between 1985-1995 in Metro. We have restricted our estimates to tanning bed use only, since they are the most popular tanning devices (Mawn, 1993; Diffey, 1987c).

An indirect method of estimating the total irradiance of the lamps in our study was to identify lamps with similar characteristics which had documented UV irradiance values. The following criteria were used to assess similarity between our lamps and those reported in literature:

a) identical types of lamps (i.e., fluorescent, high pressure, etc.)

b) similar total irradiance spectral diagrams;

c) irradiance peaks at similar wavelengths and;
d) total power consumption in Watts (W).

Bowker and Langford (1987), Bruyneel-Rapp (1988) and Diffey (1987a, 1990a) have reported total irradiance and spectral irradiances for Type I UVA (UVB/UVR%=1.0), and Type II UVA (UVB/UVR%=0.05) lamps (see section 2.4). The anticipated total UVA irradiance from devices using these lamps is between 50 and 150 W/m² per session with a typical irradiance (as reported by Diffey, 1990a) of 80 W/m² for devices with Type I UVA lamps and 250 W/m² per session for devices containing Type II UVA lamps (See Figures 5a and 5b on page 48).

If our lamps' irradiances were similar to lamps used in devices reported by the above mentioned three studies in their spectral irradiance distribution, peaks and the total power consumption, then the reported irradiance of these devices could be used as surrogates for devices in our study.

To estimate an individual's exposure to UVA and UVB from tanning devices, we needed, in addition, information about her use of specific tanning devices, and exposure time (duration of each tanning session, number of tanning sessions/yr and number of years of use). Although other factors such as total exposed body area and age of the lamps are also important in estimating UV output and exposure, we did not include these factors in our study.

The exposure dose from the UVA tanning devices (mainly with lamps that emit 80% or more of their UV output in the UVA range) has been estimated/set to be 0.75 MED (150 J/m²)/session (Braggers et al, 1987, FDA). Since UVB is known to be more erythemally effective
than UVA (IARC, 1992), then it is obvious that UVA tanning devices with higher UVB/UVA%,
bu, similar total irradiance can produce the 0.75 MED/session limit in a shorter time than weaker
lamps (lower UVB/UVA%, but same total irradiance). Therefore, duration of a tanning session is
expected to be in inverse relation to UVB/UVA% of the lamps and the total irradiance of the
device. Hence, it is reasonable to anticipate shorter tanning sessions with stronger lamps (possibly
more total UV irradiance and higher UVB/UVA%) than those with weaker lamps and devices.

We carried out a sensitivity analysis to calculate a range of UVA and UVB values for
various scenarios of exposure: UVB/UVA% of the lamps and duration of tanning sessions.

For example, by using 80 W/m² as the total UVA irradiance of the tanning lamps with a
UVB/UVA% of 0.7% in our study area, and using 30 minutes as a typical tanning session for
devices with the above lamps the estimated dose per session would be:

**UV exposure dose calculation**

<table>
<thead>
<tr>
<th>UV Exposure Dose (J/m²)/session* = Irradiance (W/m²) x Time (Seconds)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Example:</td>
</tr>
<tr>
<td>UVA Exposure Dose = (80 W/m²) x (30 min) x (60 sec/min)</td>
</tr>
<tr>
<td>UVB¹ Exposure Dose = (144000) x (0.007)</td>
</tr>
<tr>
<td>Total UV Exposure Dose</td>
</tr>
</tbody>
</table>

144,000 J/m²  
1,008 J/m²   
145,008 J/m²

¹Not erythemally weighted
* 1 J/m² = 1 W/m² x sec
CHAPTER 4

RESULTS

4.1 Salons

4.1.1 Salons accrual

Initially, a total of 27 questionnaires were mailed to salons in Metro between December 1994 and February 1995. Results of salon participation are summarized in Table 4.

Table 4: Metro salons study participation profile

<table>
<thead>
<tr>
<th>Salon Code</th>
<th>Numbers</th>
<th>% Total Salons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Participated</td>
<td>12</td>
<td>44.4</td>
</tr>
<tr>
<td>Did not participate</td>
<td>11</td>
<td>40.7</td>
</tr>
<tr>
<td>Out of business</td>
<td>4</td>
<td>14.9</td>
</tr>
<tr>
<td>Total</td>
<td>27</td>
<td>100.0</td>
</tr>
</tbody>
</table>

The overall participation rate among operating salons was 52.2% (12/23).

Among the participating salons, descriptive information such as year of establishment, number of years in operation, name and phone number of a contact person were completely provided. According to our survey, the oldest tanning salon in our sample had been in operation for 14 years, and the newest for only 1 year. The majority of these salons had been in operation for the previous nine years. Since the salon participation rate was only 52.2%, it was important to know whether and in what ways the responding and non-responding salons differed.

The non-responding salons who were contacted “by the potential client” (a total of 9: one
was not cooperative and one had gone out of business) had been in business for slightly fewer years on average (5 compared to 7 in responding salons) but had a similar distribution of types of equipment when compared to responding salons (Table 5). No information about those salons which had gone out of business was available.

Table 5: Comparison of participating and non-participating salons with respect to types of tanning equipment and years of operation

<table>
<thead>
<tr>
<th>Equipment type</th>
<th>Participating (N=12)</th>
<th>Non-participating (N=9)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>N</td>
<td>%</td>
</tr>
<tr>
<td>Tanning Bed</td>
<td>88</td>
<td>81.5</td>
</tr>
<tr>
<td>Facial Unit</td>
<td>11</td>
<td>10.2</td>
</tr>
<tr>
<td>Canopy</td>
<td>9</td>
<td>8.3</td>
</tr>
<tr>
<td>Booth</td>
<td>0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>108</td>
<td>100</td>
</tr>
</tbody>
</table>

Average years of operation 7 years 5 years

On average participating salons had more equipment (9 pieces) than the non-participating salons (6 pieces).

Some of the reasons given for not participating were; a) "study will be used against us", b) "study does not make any sense", c) "our previous help has been taken advantage of". These objections were raised despite our clear indication of the neutrality and confidentiality of the study and the scientific nature of the supporting institution (University of Toronto).

One year after our survey only 18 tanning salons were listed in the yellow pages (Bell
Canada, 1995). Fifteen of these had been in operation in 1994 and had been sent a study questionnaire, and none of them were of the participating salons.

4.1.2 Salon results: overview

Responding salons provided some information on equipment for all of the years in the previous decade for which they had been in operation. Results of our salons' survey showed that in 1985-1994 there were primarily three different types of tanning devices in use in Metro salons: tanning beds, tanning canopies, and facial lamps. Beds were by far the most commonly reported devices followed by facial units and canopies (Table 5).

4.1.3 Salon results: tanning beds

There were many different models of tanning bed in use, although 6 tanning bed models accounted for nearly 60% of the beds (Table 6), most results will be restricted to these six beds.

Salons were able to report lamps used in their devices. It is important to note that even within a given device different lamps with different emission characteristics can be used.

We examined completeness of lamp information by considering the equipment type that this information was provided for. For all devices, information on type(s) (facial or non-facial), name(s), quantity, and wattage of lamps was fully provided. However, lamp-specific information (e.g., code, model number) was not as complete. Information on the UVB/UVA% of the lamps was not requested in our questionnaire. Therefore, lamps' data needed to be complemented by the
manufacturers' or other sources of information.

Table 6 presents detailed information on the most popular tanning beds in Metro salons, including the earliest year of use. Ultrasun 2500 was the bed with the earliest year of reported use. The most common tanning bed was Silver Solarium Super JT (N=13) which was found in two locations, although UWE Sunstream (N=10) was found in 3 locations. The most recent year of use was 1994 because that was when the questionnaire were completed.

Table 6: The most popular tanning beds in Metro salons

<table>
<thead>
<tr>
<th>Tanning Bed Name</th>
<th># of Locations</th>
<th>Total Quan.</th>
<th>Earliest Yr. in use</th>
<th>Yr. Last in use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silver Solarium Super JT</td>
<td>2</td>
<td>13</td>
<td>1985</td>
<td>1994</td>
</tr>
<tr>
<td>UWE Sunstream Bronzium</td>
<td>3</td>
<td>10</td>
<td>1986</td>
<td>1994</td>
</tr>
<tr>
<td>Ultrasun 2500</td>
<td>1</td>
<td>8</td>
<td>1984</td>
<td>1994</td>
</tr>
<tr>
<td>Ergoline</td>
<td>2</td>
<td>9</td>
<td>1990</td>
<td>1994</td>
</tr>
<tr>
<td>Maxima S32</td>
<td>1</td>
<td>6</td>
<td>1993</td>
<td>1994</td>
</tr>
<tr>
<td>Solarmobil</td>
<td>2</td>
<td>8</td>
<td>1985</td>
<td>1994</td>
</tr>
</tbody>
</table>

4.1.3.1 Variation in tanning beds design and number of lamps

We specifically looked at design and the numbers and types of facial and non-facial lamps in the most commonly reported tanning beds.

Five of the six most common beds were included in the photo sheet (Appendix A). As it is seen from photo # 1 (Silver Solarium Super JT) and photo # 5 (Solarmobil) are similar in design, and they could be distinguished from other beds because of the hydraulic device used to move their mobile upper part. These devices have been in use since 1985 in Metro.

Photo # 2 (UWE Sunstream Bronzium) presents a conventional design of the older types of
tanning beds. It has been in use since 1986. Photo #’s 3 and 4 (Ergoline and Maxima S32 respectively) are typical designs of the modern looking tanning beds. The earliest years of use of these devices were 1990 and 1993 respectively. We were not able to obtain a photo of the Ultrasun 2500 tanning bed.

Table 7 summarizes data on the types of lamps used in the 6 devices shown in Table 6.

Table 7: Characteristics of the most popular tanning beds in Metro salon sample

<table>
<thead>
<tr>
<th>Tanning Bed Name</th>
<th>NF* Lamp Quan.</th>
<th>NF* Lamp Names</th>
<th>F**Lamp Quan.</th>
<th>F**Lamp Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Silver Solarium</td>
<td>24</td>
<td>Philips Cleo, Philips Cleo Professional</td>
<td>1</td>
<td>Dr. Muller, Cosmotech</td>
</tr>
<tr>
<td>Super Jt</td>
<td>22</td>
<td>Goldarium S, Hitan, Philips RUVA,</td>
<td>none</td>
<td>N/A</td>
</tr>
<tr>
<td>UWE Sunstream</td>
<td>24</td>
<td>Belarium S, Goldarium S</td>
<td>none</td>
<td>N/A</td>
</tr>
<tr>
<td>Bronzium</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ultrasun 2500</td>
<td>24</td>
<td>Ergoline, Light Sources,</td>
<td>3</td>
<td>High pressure</td>
</tr>
<tr>
<td>Ergoline</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maxima S32</td>
<td>32</td>
<td>Cosmolux VHO</td>
<td>none</td>
<td>N/A</td>
</tr>
<tr>
<td>Solarmobil</td>
<td>24</td>
<td>Philips Professional, Philips RUVA</td>
<td>1</td>
<td>High pressure</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*NF: Non-facial **F: Facial N/A: Not applicable

The total number of non-facial lamps in the top six tanning beds varied from 22 for the UWE Sunstream to 32 for the Maxima S32 beds. There were only 3 models with facial lamps, the total number of these lamps was either 1 or 3. The average number of lamps per bed was 22.

In order to complement information from Table 7 we produced Tables 8 and 9 which provide more detailed and specific data about the non-facial and facial lamps used in tanning beds.
Table 8: Characteristics of the non-facial lamps used in the most popular tanning beds in Metro salon sample

<table>
<thead>
<tr>
<th>Tanning Lamp Name</th>
<th>Quantity (%) in Use in Metro Sample</th>
<th>Manufacturer</th>
<th>% UVB/UVA or Te, Tm*</th>
<th>Wattage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Philips Cleo Professional</td>
<td>391 (20.3)</td>
<td>Philips</td>
<td>1.4</td>
<td>100</td>
</tr>
<tr>
<td>Light Sources</td>
<td>276 (14.4)</td>
<td>Light Sources</td>
<td>1.3 to 4.4</td>
<td>100</td>
</tr>
<tr>
<td>Philips Professional</td>
<td>266 (13.9)</td>
<td>Philips</td>
<td>1.5</td>
<td>100</td>
</tr>
<tr>
<td>Cosmolux VHO</td>
<td>192 (10.0)</td>
<td>Cosmolux</td>
<td>1.5</td>
<td>100</td>
</tr>
<tr>
<td>Ergoline</td>
<td>182 (9.5)</td>
<td>Ergoline</td>
<td>Te=42 min Tm=100 min</td>
<td>100</td>
</tr>
<tr>
<td>Belarium S</td>
<td>168 (8.8)</td>
<td>Sun Industries</td>
<td>1.4</td>
<td>100</td>
</tr>
<tr>
<td>Goldarium S</td>
<td>134 (6.9)</td>
<td>Cosmedico</td>
<td>4.8</td>
<td>100</td>
</tr>
<tr>
<td>Hitan</td>
<td>86 (4.5)</td>
<td>Cosmedico</td>
<td>8.5</td>
<td>100</td>
</tr>
<tr>
<td>Philips RUVA</td>
<td>84 (4.4)</td>
<td>Philips</td>
<td>1.5</td>
<td>100</td>
</tr>
<tr>
<td>Philips Cleo</td>
<td>76 (4.0)</td>
<td>Philips</td>
<td>0.7</td>
<td>100</td>
</tr>
</tbody>
</table>

* Time to Erythema (Te) and Time to Melanogenesis (Tm) to occur, whichever information was provided by manufacturers

Most Metro salons provided enough data about the lamp names to enable us to extract the amount of the percentage UVB/UVA% from manufacturers' brochures. All of the reported lamps were 100 watt lamps. Based on this information we classified the reported most popular tanning beds in Metro as UVA. However, the UVB/UVA% varied from bed to bed.

The total quantity of lamps in use was determined by summing the results of multiplying number of devices by the total number of each lamp per device.

The frequency distribution of the highest, the lowest and the intermediate UVB/UVA% output of the lamps used in the most popular devices in tanning beds in our survey showed that Hitan (UVB/UVA%=8.5%) had the highest, Philips Cleo (UVB/UVA%=0.7%) the lowest, and
lamps with UVB/UVA% of 1.4-1.5%, and UVB/UVA% of 4.8% comprised the intermediate UV output level groups.

Only a small number of these lamps (6.2%) had a UVB/UVA% of less than 1% (Philips Cleo). Close to 76% of the tanning lamps had a UVB/UVA% of either 1.4% or 1.5%, 10.9% had UVB/UVA of 4.8% and lamps with a very high UVB (Hitan) comprised almost 7.0% of the lamps used in the most popular tanning beds in Metro salons.

We were able to obtain graphs of the relative UV irradiance for few of the most popular lamps in our study area (Figure 6).

Figure 6: Graphs of the relative irradiance of some of the tanning lamps used in tanning beds in Metro Toronto (a) Philips Cleo Professional (1.0% UVB); (b) Belarium S (1.4% UVB)

(Please note: The relative irradiance (the Y axis) was used by these researchers because absolute irradiance values are not available. Therefore, the above are only useful for demonstrating the distribution of specific wavelengths)
As seen from Figure 6, and information in Table 8 shows that most of the UV output of the above lamps is in the UVA range with a small portion of the output as UVB rays.

Characteristics of the facial lamps used in tanning beds are summarized in Table 9.

### Table 9: Characteristics of the facial tanning lamps used in all tanning beds in Metro salon sample

<table>
<thead>
<tr>
<th>Facial Tanning Lamp Name</th>
<th>Quantity in Use in Metro Sample</th>
<th>Manufacturer</th>
<th>Wattage (W)</th>
<th>%UVB/UVA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cosmedico</td>
<td>6</td>
<td>Cosmedico</td>
<td>400</td>
<td>N/A</td>
</tr>
<tr>
<td>Dr. Muller HPA400</td>
<td>10</td>
<td>Dr. Muller</td>
<td>400</td>
<td>6.0</td>
</tr>
<tr>
<td>Hellma</td>
<td>4</td>
<td>not available</td>
<td>400</td>
<td>N/A</td>
</tr>
<tr>
<td>Cosmotech</td>
<td>5</td>
<td>Cosmedico</td>
<td>400</td>
<td>N/A</td>
</tr>
<tr>
<td>Philips LA010</td>
<td>1</td>
<td>Philips</td>
<td>400</td>
<td>11.0</td>
</tr>
<tr>
<td>High Pressure Lamp</td>
<td>17</td>
<td>not available</td>
<td>400</td>
<td>N/A</td>
</tr>
</tbody>
</table>

All of the facial lamps had a wattage of 400. We could only find information about UVB/UVA% output of two of these lamps (Dr. Muller and Philips LA010); for the rest this information was either not available or salon information was not specific enough to enable us to identify these lamps (i.e., High Pressure Lamps).

### 4.1.4 Salon results: facial units

Table 10 presents our survey data on the facial tanning units. Our survey showed that all of the most popular facial lamps in use in facial units had a wattage of 1000. Most of these lamps have a high UVB/UVA%. However, detailed information about the actual values is not routinely available from the manufacturers.
Table 10: Characteristics of the most popular facial tanning units in Metro salon sample

<table>
<thead>
<tr>
<th>Facial Tanning Unit</th>
<th># of Locations</th>
<th>Total Quan.</th>
<th>Earliest Yr. in use</th>
<th>Yr. Last in use</th>
<th>Lamp Quan</th>
<th>Lamp Name</th>
<th>Lamp Wattage (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UWE Sunstream</td>
<td>4</td>
<td>7</td>
<td>1987</td>
<td>1994</td>
<td>2</td>
<td>Osram Quartz, Ultramed, Hellma</td>
<td>1000</td>
</tr>
<tr>
<td>Supernova</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ultrasun 2000</td>
<td>2</td>
<td>2</td>
<td>1987</td>
<td>1994</td>
<td>1</td>
<td>MH Straller BQ112824</td>
<td>1000</td>
</tr>
<tr>
<td>Philips Sunhealth HP4000C</td>
<td>1</td>
<td>1</td>
<td>1990</td>
<td>1994</td>
<td>1</td>
<td>Philips High Pressure</td>
<td>1000</td>
</tr>
<tr>
<td>Dr. Muller</td>
<td>1</td>
<td>1</td>
<td>1989</td>
<td>1994</td>
<td>3</td>
<td>High Pressure lamps</td>
<td>1000</td>
</tr>
</tbody>
</table>

4.1.5 Tanning salon results: canopies

Table 11 presents information about the most popular tanning canopies and their lamps. All of the lamps used in these devices had a power output of 1000 watts except one, device which had lamps of 2000 watts. The only lamp for which we could obtain UVB/UVA% information is the Dr. Muller lamp with a relatively high UVB/UVA% of 6.0%. The earliest year of use of these devices was 1984.

Table 11: Characteristics of the most popular tanning canopies in Metro salon sample

<table>
<thead>
<tr>
<th>Tanning Canopy</th>
<th># of Locations</th>
<th>Total Quan.</th>
<th>Earliest Yr. in use</th>
<th>Yr. last in use</th>
<th>Lamp Quan</th>
<th>Lamp Name</th>
<th>Lamp Wattage (W)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UWE Supernova 8000</td>
<td>4</td>
<td>7</td>
<td>1986</td>
<td>1994</td>
<td>6</td>
<td>Dr. Muller, Osram Quartz</td>
<td>1000</td>
</tr>
<tr>
<td>Ultrasun 12000</td>
<td>1</td>
<td>1</td>
<td>1984</td>
<td>1994</td>
<td>8</td>
<td>High pressure lamp</td>
<td>1000</td>
</tr>
<tr>
<td>Ultrasun 15000</td>
<td>1</td>
<td>1</td>
<td>1991</td>
<td>1994</td>
<td>8</td>
<td>Hannau</td>
<td>2000</td>
</tr>
</tbody>
</table>
4.1.6 Salon results: lamp replacement

Although manufacturers' guidelines suggest replacement of lamps with similar wattage and UVB/UVA%, our survey showed that it was possible to use lamps with different UV output as replacements. Our salons' and manufacturers' data showed that on average tanning lamps have a rated life time of 800-1000 hours; this approximately translates to replacing lamps every 4 to 6 months. However, lamp replacement is dependent on the tanning facilities' practices and operations.

As seen from Tables 7 and 8, lamps with different UV output have been employed in many of the reported tanning beds. Lamps that were reported for the UWE had a UVB/UVA% that varied from 1.5% to 8.5%. In the Silver Solarium Super JT, lamps with a UVB/UVA% range of 0.7% to 1.4% were used. Tanning lamps in Ergoline, Solarmobil and Maxima S32 had a range of relative UVB/UVA% output of 1.3% to 4.4%.

Similar to a British study by Bowker and Langford (1987), our salon data showed that in a few instances, lamps with different UVB/UVA% were mounted in a device at the same time. This interchange and mix and match of the lamps is possible as long as the tail-end contacts of the lamps are compatible with those of the tanning devices.

This observation makes the value of historic tanning lamp information questionable. Furthermore, this means that reports of use of tanning devices does not necessarily translate to information about their tanning lamps.
4.2 Subjects

4.2.1 Subjects accrual

A total of 1,750 phone numbers were dialled, 194 of which turned out to be invalid (125 were out of service and 69 represented fax machines, out-of-Metro residences, etc.) (See Figure 7). Of the remaining 1,556 numbers, a further 337 had to be excluded because there was either no answer after four attempts (n=224) or no English-speaking resident available at the time of call (n=113), resulting in 1,219 numbers where we could attempt to get a household census.

A household census was provided at 1,042 phone numbers (85.5% of 1219) but only about 42% of these included a female ages 20-44 (n=434). Eighty-eight percent (n=382) of the 434 women invited to participate in the study agreed to do so; of the 12% who did not agree, about half refused and others could never be directly invited to participate, despite repeated attempts by the study staff.

Of the subjects agreeing to participate (n=382), 26 (6.8%) received a questionnaire but did not return it (not even questions 1-5). Finally, of the 66 subjects identified by telephone administration of questions 1-5 as "tanners", 13 did not return the questionnaires about their use of tanning devices. The remaining 53 (80.3% of the "tanners") provided details of their tanning experiences. Accrual results are summarized in Figure 7.
Figure 7: Subject accrual flow chart

Phone numbers called (N=1750)

Useable phone numbers (N=1219) (after excluding numbers out of service (N=125), language problems (N=113), no answer (N=224), and others (N=69)

Households that provided a household census (N=1042)

Households with an eligible individual (N=434)

Individuals who agreed to participate (N=382)*

Individuals who completed questions 1-5 or full questionnaire (N=356)

Tanners identified (N=66)

Tanners who completed the full questionnaire (N=53)

* This meant either agreeing to receive a study questionnaire (early in the study) or to conduct a brief telephone interview followed by a questionnaire (for tanning equipment users)
The success of our telephone screening process can be summarized as a combination of the proportion of "valid" households contacted who provided a census (1,042/1,556=0.67) and the proportion of identified eligible subjects who agreed at the time of screening to either receive a mailed questionnaire (early study procedure) or answer questions 1 to 5 on the telephone (382/434=0.88):

\[ 0.67 \times 0.88 = 0.59 \]

This is a conservative rate, as we do not know how many of the 224 numbers where no answer was obtained were valid. Excluding non-English speaking households (n=113), as we have done, would be expected to increase our estimated rate of equipment use (because we would expect use to be lower in the non-English speaking population, because of language barriers); their inclusion by the same token would not likely have yielded many users for our primary objective. After excluding non-English speaking households and those where no contact was made after four telephone attempts, a less conservative rate of participation would be:

\[ 0.85 \times \frac{1,042}{1,219} \times 0.88 = 0.75 \]

Thus, screening was successful in 59% to 75% of households contacted.

The overall response rate must also include the rate of response to the questionnaire. Of those agreeing to participate, 93.2% (356 out of 382) completed at least part of the questionnaire. Thus, the overall rate is estimated to be:

\[ (0.59 \text{ or } 0.75) \times (0.93) = 0.55 \text{ or } 0.70 \]

The target of at least 40 users with detailed data on equipment used was achieved, as 53
women provided these data.

4.2.2 Prevalence of use

Sixty-six (66) of the 356 respondents answered question 5 ("During the past ten years have you used any tanning equipment {e.g., sunlamps, tanning canopies, tanning beds, etc.}?") affirmatively, for a crude prevalence of use of 19%. The 19% use rate is close to the 20% rate that we had expected, based on the literature.

Age-adjustment is normally performed to control confounding, but in our study we calculated the age adjusted prevalence of use, because we were interested to refer back our estimate of use to the Metro female population aged 20-44, but our study under-represented 20-24 year olds since we added this age group part way through the study.

The age adjusted prevalence of use, standardized to the age distribution among Metro women ages 20-44 according to the 1991 census (Statistics Canada, 1991), was 20.7% (95% CI, 15.6-25.8).

4.2.3 Characteristics of respondents and users

When we compared our subjects aged 25-44 (N=313) with the 1991 census data on female residents of Metro of the same ages (Table 12), women aged 25-29 were under-represented in our sample (22.4% versus 29.3% in census data), but women aged 30-34 were over-represented (29.4% versus 26.6% in the census data); 35-39 (25.2%) and 40-44 (23.0%) years-old were also slightly
over-represented in our sample (23.0% and 21.0% respectively). Women aged 20-24 were excluded from this comparison because they were added part way through the study, so are under-represented in the study population by the study design.

Table 12: Comparison of the age distribution our sample versus 1991 census data

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Sample</th>
<th>Census</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-29</td>
<td>70 (22.4)</td>
<td>120930 (29.3)</td>
</tr>
<tr>
<td>30-34</td>
<td>92 (29.4)</td>
<td>109710 (26.6)</td>
</tr>
<tr>
<td>35-39</td>
<td>79 (25.2)</td>
<td>94775 (23.0)</td>
</tr>
<tr>
<td>40-44</td>
<td>72 (23.0)</td>
<td>86725 (21.0)</td>
</tr>
</tbody>
</table>

Total 313 (100) 412120 (100)

Tables 13,I,II,III show both respondent characteristics and use rates according to age, educational attainment, and residence in Metro. The total number of respondents aged 20-24 (Table 13,I) is low because the study protocol originally included only those 25-44, with 20-24 year-olds being added part way through subject accrual.

Use was most prevalent in the 25-29 and 20-24 age groups, was low in those older than 40 years, and was intermediate in 30-34 and 35-39 age groups (Table 13,I). This trend may reflect a period effect (there are more commercial facilities now than when today's 30-34 years old were in their 20's which would be included in the time they were asked to report on), and an age effect (younger women are more likely to use than older women). The average age at completing the
questionnaire for users was 31, a slightly younger group than non-users with an average age of 34.

More than 66% of the respondents had some post-secondary education, while 9.3% had not completed secondary school (Table 13,II). When we compared our data with the 1991 census data for Metro (Statistics Canada, 1991) we found that according to the census 65% of the females aged 20-44 had some post-secondary education, so our sample was similar to the general population in this education category. However, census data showed that close to 20% of the females in the above age group had not completed secondary school. The difference between our sample and census data may be partially due to exclusion of non-English speaking subjects from our study.

Educational attainment (highest level completed) was associated with use of tanning equipment (Table 13,II), with Chi-sq=8.7, 3 d.f., P < 0.05. Use was very rare in those who had not completed secondary school (0 and 3.9% in the lowest educational groups), intermediate in those who had completed secondary school but who had no post-secondary education (13.1%) and highest in those with some post-secondary school education (22.4%). Age was significantly associated with use (Chi-sq= 22.4, 4 d.f., P <0.05).
Table 13: Use of tanning equipment in previous decade according to socio-demographic characteristics, Metro Toronto women aged 20-44 (1995-96)

<table>
<thead>
<tr>
<th>Use Reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at Interview&lt;sup&gt;1&lt;/sup&gt;</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>20-24</td>
</tr>
<tr>
<td>25-29</td>
</tr>
<tr>
<td>30-34</td>
</tr>
<tr>
<td>35-39</td>
</tr>
<tr>
<td>40-44</td>
</tr>
<tr>
<td><strong>All ages</strong></td>
</tr>
</tbody>
</table>

II. Highest level of education<sup>2</sup>

<table>
<thead>
<tr>
<th></th>
<th>Yes (n, %)</th>
<th>No (n, %)</th>
<th>Total (n, %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>no secondary school</td>
<td>0 (0)</td>
<td>7 (100)</td>
<td>7 (100)</td>
</tr>
<tr>
<td>some secondary school</td>
<td>1 (3.9)</td>
<td>25 (96.1)</td>
<td>26 (100)</td>
</tr>
<tr>
<td>completed secondary school</td>
<td>12 (14.1)</td>
<td>73 (85.9)</td>
<td>85 (100)</td>
</tr>
<tr>
<td>some post-secondary</td>
<td>53 (22.4)</td>
<td>184 (77.6)</td>
<td>237 (100)</td>
</tr>
</tbody>
</table>

III. Years of residence in Metro<sup>3</sup>

<table>
<thead>
<tr>
<th></th>
<th>Yes (n, %)</th>
<th>No (n, %)</th>
<th>Total (n, %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 10</td>
<td>25 (20.8)</td>
<td>95 (79.2)</td>
<td>120 (100)</td>
</tr>
<tr>
<td>10-19</td>
<td>12 (14.8)</td>
<td>69 (85.2)</td>
<td>81 (100)</td>
</tr>
<tr>
<td>20</td>
<td>29 (19.2)</td>
<td>122 (80.8)</td>
<td>151 (100)</td>
</tr>
</tbody>
</table>

<sup>1</sup> Excludes three subjects who did not report age precisely enough to categorize them; all were non-users of tanning equipment.

<sup>2</sup> Excludes one non-user who did not report education.

<sup>3</sup> Excludes four non-users who did not answer this question.

There was no association between age and education, with \( \chi^2 = 1.4, 4 \text{ d.f.}, P>0.05 \).

Over one-third of the respondents had lived in Metropolitan Toronto for fewer than ten years (Table 13,III). Use was greatest among this group (20.8%) followed by those who had lived in Metro more than 20 years (19.2%). Years of residency in Metro was not associated with use of tanning devices.
4.2.4 Characteristics of "tanners"

The results presented in the following subsections are based on data from the 53 users who completed the detailed portion of the questionnaire.

4.2.4.1 Location of use

All but one of the users had visited a commercial facility (n=52) (Table 14), four of whom had also used tanning equipment at home, and one respondent had used tanning equipment at home only.

The 52 commercial facility users reported 89 unique facility-equipment combinations (i.e., lines in response to question 7 in the questionnaire), representing 42 different facilities. For 31 of 89, the facility name or type was either not reported or could not be classified (as tanning salon, health club, etc.) on the basis of the information provided. Of the remaining 58, 40 (69.0%) were tanning salons, 9 (15.5%) were beauty salons, 6 (10.3%) were health clubs or spas, and 3 (5.2%) were medical facilities. Unfortunately, we had not asked people to identify the type of facility even if they could not remember the name. The fact that such a high proportion of reported facilities were tanning salons as opposed to other types of facilities lends some support to our decision to direct our equipment survey only to tanning salons.
<table>
<thead>
<tr>
<th>Type of facility</th>
<th>Subjects(^1) (N=52)</th>
<th>Equipment-facility combination (N=89)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanning Salon</td>
<td>22</td>
<td>40</td>
</tr>
<tr>
<td>Beauty Salon</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>Health Club/Spa</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Medical Facility(^2)</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Missing(^3)</td>
<td>12</td>
<td>31</td>
</tr>
</tbody>
</table>

1. People were counted for as many types of facilities as they had visited
2. These included a hospital, a massage therapy office and a chiropractors' office
3. Subjects in missing had no information about any of the facilities they used

In terms of the 52 users, 18 (34.6%) could not report the names of any of the facilities they used or else the facility could not be classified. Of the remaining 34, 22 (64.7%) reported visiting at least one tanning salon, 9 (26.5%) reported visiting a beauty salon, 6 (17.6%) a health club and 3 (8.8%) medical facilities. Only 3 of the subjects who reported visiting a tanning salon, also reported visits to another type of tanning facility (one a medical facility and two a beauty salon). Likewise, only 2 subjects reported visiting both a beauty salon and a health club/spa, and 1 a beauty salon and a medical facility.

Thirteen of the facility-equipment lines (8 subjects) named tanning salons which were part of our salon sampling frame, and for 10 of these (representing 7 different salons) information was available from completed salon questionnaires which allowed comparison of some of the subject-reported and salon-reported information.
4.2.4.2 Equipment used

In the 89 equipment-facility combination lines, the most common type of tanning equipment reported was the tanning bed (N=83, 93.2%). Other reported tanning devices were facial units (three reports), tanning booths (two reports) and tanning canopy (one report). Facial units were the only type of device used at home (five lines reported by five individuals).

Equipment-facility-specific data showed that tanning beds were the most prevalent type of devices in each type of commercial tanning facility. All three reports of facial unit use in commercial facilities were in tanning salons, tanning booths were used in a medical and one health club; the facility type was unknown for the canopy report. Of the 52 tanners, 50 reported using tanning beds, one used a booth only and one reported canopy use only.

The photo sheet seemed to be a useful memory aid for the subjects, since 79 of the 89 equipment-facility lines had a photo number. Photo #2 (UWE Sunstream Bronzium tanning bed) was most often selected (n=29), Photo #5 (Solarmobil tanning bed) was selected 17 times and, photo #3 (Ergoline tanning bed) 13 times. Silver Solarium tanning bed (photo #1) was reported 7 times and Maxima S32 (photo #4) was reported 9 times. In 10 instances a name for a tanning device was mentioned in addition to or instead of a photo number.

For all reported home use either a photo number was selected (Photo #9, Philips facial unit) or description of the device was given. In the one instance that a photo was selected equipment was also described.

Although equipment-specific information showed that most of the time a specific piece of
equipment was reported, we do not know whether subjects were selecting a photo of the actual piece of equipment they had used or of the most similar device. Where we had information from both salons and subjects we examined agreement between salon and subject information, and results are reported in section 4.5.

4.2.4.3 Years of use of devices/visits at commercial facilities

For commercial facility use, we excluded all the reports of use pertaining to visits in 1996. One subject did not report any years of use. Forty of the 51 (78.4%) who did report years indicated less than or equal to one year of use, 7(13.8%) indicated greater than one but less than or equal to 4 years, and the remaining 4 (7.8%) were greater than 4 years of use. The highest calculated years of use/visits was 8. The median number of years of use was one year.

We examined information on the years of use of tanning devices and the earliest year that they had been in use. We found that Photo #2 (UWE Sunstream Bronzium) was the most popular device both before and after 1990. Subjects reported that Photo #5 (the Solarmobil tanning bed) has been the second most popular device since 1990 in our study area.

4.2.4.4 Average number of visits per year to commercial facilities

When a subject reported only a single year, the number of visits per year reported was assumed to be the number of visits the subject made in that particular calendar year, even though the year was only assigned a value of 0.5 years (see methods Section 3.8). Because most of the
interviews were conducted in early 1996, "visits per year" for 1996 were excluded.

Table 15 presents distribution of visits. The maximum number of visits per year reported by anyone was 75 and the minimum was 1. The median number of visits/year was 6.

<table>
<thead>
<tr>
<th>Number of sessions/ year</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>19 (36.5)</td>
</tr>
<tr>
<td>5-9</td>
<td>17 (32.6)</td>
</tr>
<tr>
<td>10-20</td>
<td>14 (26.9)</td>
</tr>
<tr>
<td>&gt; 20</td>
<td>2 (3.8)</td>
</tr>
</tbody>
</table>

4.2.4.5 Duration of tanning sessions

The duration of tanning sessions as reported by our subjects varied from 7.5 minutes to one hour. The most frequently reported duration values were 20 minutes and 30 minutes. These were obviously common units of time offered/charged for by tanning facilities. Table 16 summarizes the frequency of the reported duration of tanning sessions.

Table 16: Distribution of the tanning session duration

<table>
<thead>
<tr>
<th>Duration of Tanning Sessions (minutes)</th>
<th>N (%)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20</td>
<td>12 (13.6)</td>
</tr>
<tr>
<td>20</td>
<td>36 (40.9)</td>
</tr>
<tr>
<td>21-29</td>
<td>7 (7.9)</td>
</tr>
<tr>
<td>30</td>
<td>28 (31.8)</td>
</tr>
<tr>
<td>&gt; 30</td>
<td>5 (5.7)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>88 (100)</strong></td>
</tr>
</tbody>
</table>

* From a total of 88 equipment facility combination, one did not have enough information
4.2.4.6 Total exposure time

Total exposure time was calculated based on information from the number of tanning sessions/year, duration of each tanning session, and number of years of use. The sum of annual exposure time provided the total exposure time. Our subjects' exposure time over the study period varied from 7.5 to a high of 6075 minutes, with a median of 150 minutes (2.5 hours). Table 17 shows the distribution of exposure time for the 49 subjects with complete information.

**Table 17: Distribution of total annual exposure times (hours*)**

<table>
<thead>
<tr>
<th>Hours of exposure</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;= 1 hour</td>
<td>12 (24.5)</td>
</tr>
<tr>
<td>1 &lt; hours &lt;= 2</td>
<td>9 (18.4)</td>
</tr>
<tr>
<td>2 &lt; hours &lt;= 4</td>
<td>11 (22.4)</td>
</tr>
<tr>
<td>4 &lt; hours &lt;= 10</td>
<td>8 (16.3)</td>
</tr>
<tr>
<td>&gt; 10 hours</td>
<td>9 (18.4)</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>49 (100)</strong></td>
</tr>
</tbody>
</table>

* For 3 subjects this could not be calculated due to missing information

4.2.5 Use of tanning beds

As discussed, because tanning beds were the most popular devices in Metro, we intend to restrict our exposure estimates to these devices. The following sections/tables provide details of our subjects' bed use.

The majority (44.9%) of reported annual number of tanning bed sessions were less than 5. The highest reported number of tanning bed session per year was 108 and the median was 5. Table 18 presents the annual tanning bed session data.
We determined the total number of sessions (cumulated over the decade) that were exclusive to tanning beds for the 50 subjects who had used them; one subject had not provided information about number of sessions, so was excluded, bringing the total to 49. Table 19 shows the distribution of the cumulative number of sessions.

**Table 18: Annual number of tanning bed session use in Metro**

<table>
<thead>
<tr>
<th>Number of session/year</th>
<th>N (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-4</td>
<td>22 (44.9)</td>
</tr>
<tr>
<td>5-9</td>
<td>15 (30.6)</td>
</tr>
<tr>
<td>10-20</td>
<td>10 (20.4)</td>
</tr>
<tr>
<td>20+</td>
<td>2 (4.1)</td>
</tr>
</tbody>
</table>

Most users of tanning beds in Metro are not regular tanners (median=6), but there is a wide variation in the total number of sessions, from a low of 1 to a high of 490 sessions over the study period.

The majority (81.9\%) of tanning bed sessions were 20-30 minutes long. Tanning sessions longer than 30 minutes comprised only a small portion (6.0\%), and sessions less than 20 minutes
were only 12.0% of the reported visits/use of beds.

Total exposure time to tanning beds (Exposure Index 3) was calculated in a similar way to the total exposure time only restricted to time spent using beds. For those subjects who had reported tanning bed use, the total bed exposure time varied from 7.5 to a high of 6075 minutes, with a median of 120 minutes (2.0 hours).

**Exposure Index 3**

\[
\text{Total bed exposure time} = \text{Sum of (average number of use of beds/year) x (duration of bed visits) x (assigned value(s) to the year(s) of bed use)}
\]

Photo numbers 2 and 5 were the most popular tanning beds reported by our subjects. Various types of tanning lamps were used in these beds, including Philips Professional, Hi Tan, and Goldarium S. The mean number of visits per year for these two beds was 8 visits/year. The median total exposure time for these beds was 150 minutes (2.5 hours).

### 4.3 Agreement between two reports of equipment

Where both photo number and name of a specific piece of equipment were reported by the subjects (N=10) we checked for agreement. Where we had reported visits to a salon that was part of our salon survey (N=10) we examined agreement between salon and subject reports. Of the total 10 observations where both photo number and name of device were reported, four did not have adequate information about the named devices to check agreement. In one instance Silver Solarium
was named followed by the correct photo number (#1). This was considered an exact match. In another instance this device was named, but photo number 2 that presents Solarmobil was reported. This was considered "report of a similar device", since Silver Solarium and Solarmobil are similar in design.

In four other instances photo number(s) and name(s) of devices did not match. In two of these, subjects had reported a different type of tanning device than that represented by the sketch they selected. The other two had reported devices that did not match the photos reported by them. Although the number is small (six), agreement between photo and reported devices appeared to be low.

We further examined agreement between reported photo numbers by the subjects and the information from surveyed salons in the 10 observations where use at one of the study salons was reported. In four instances subjects had reported photo numbers for equipment that was also reported in the corresponding salons survey. In 6 other instances reported photo numbers were not reported by salons. For these 10 observations we also examined agreement between the reported year of visit to a given tanning salon and the earliest reported year of operation for that facility. All of the reported years of visits were after the earliest year of operation of the corresponding salons.

From our observations we concluded that agreement between subjects' reported devices and that of what has been in use in salons is low.
4.4 Estimation of UV per session

Using our assumptions/criteria (see Section 3.8) we estimated the UVA and UVB outputs. When we compared the relative irradiance graphs of the most popular lamps in our study area (see Figure 6, page 49) with relative irradiance graphs provided by Diffey (1987a, 1990a) (see Figure 5, page 22), it was evident that the spectral irradiances from a few of our lamps were of similar shape to the Type I UVA (see Figure 5a, page 22) reported by Diffey (1987a, 1990a). Also, the major UV irradiance peak in our comparison seemed to occur at a similar wavelength (around 360 nm). Furthermore, we knew that the total power consumption of our lamps were identical (100 W) to those reported by Diffey (1987a, 1990a). Therefore, it was possible to classify our lamps with UVB/UVA% of 0.7 and 1.4-1.5% as Diffey's Type I UVA, with a total UVA irradiance of 50-150 (W/m²) (Bruyneel-Rapp, 1987; Bowker and Langford, 1987), and a typical irradiance of 80 W/m² (Diffey, 1987a, 1990a).

Using the above irradiance values for Type I UVA lamps, and combining this information with the UVB/UVA% data for our lamps and the reported session lengths, we estimated the UVB and UVA irradiance of our lamps.

We also used the reported total UVA irradiance of the above studies for lamps with UVB/UVA% of greater than 1.4% in order to present a variety of estimates and to carry out a sensitivity analysis (these are for demonstration purposes only and the most applicable values are for those lamps with UVB/UVA <= 1.4% only).

For example, by using 80 W/m² as a typical output for the total UVA irradiance the
estimated UVA and UVB for the four categories of UVB/UVA% in our study lamps are:

<table>
<thead>
<tr>
<th>UVB/UVA%</th>
<th>Calculated Irradiance (W/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.007</td>
<td>0.56*</td>
</tr>
<tr>
<td>0.014-0.015 (we chose 0.015 for the calculations)</td>
<td>1.2*</td>
</tr>
<tr>
<td>0.048</td>
<td>3.84*</td>
</tr>
<tr>
<td>0.085</td>
<td>6.8*</td>
</tr>
</tbody>
</table>

* UVB irradiances are not erythemally weighted

As discussed the length of tanning sessions is expected to be inversely related to the tanning capability of devices, which is a function of the total irradiance, and percentage of the UVB rays as well as the total UV output. Shorter sessions are associated with stronger devices (more UVB).

According to our results, 12.0% of the bed tanning sessions were less than 20 minutes (with most reported times close to 10 minutes). Our salon data also showed that close to 11% of the lamps used in beds had high UVB/UVA% (8.5%) outputs. Based on these two pieces of information, we used 10 minutes (600 seconds) as the typical session length for this group and estimated the UVB and UVA per sessions for these strong beds.

For devices with smallest UVB/UVA% (0.7 and 1.4-1.5) we used 30 minutes as the typical session length, and for lamps with the UVB/UVA% of 4.8% we chose an intermediate value, 20
minutes, for our calculations. Results of our calculations for various total UVA irradiances and the corresponding UVA and UVB doses per session are summarized in Table 21.

UV Exposure Dose (J/m²)/Session = Irradiance (W/m²) x Session Length (seconds)

**Tables 21: Estimates of UVA and UVB exposure per session (J/m²)**

I. Total UVA irradiance is 50 W/m² (lower limit)

<table>
<thead>
<tr>
<th>UVB/UVA%</th>
<th>UVA (W/m²)</th>
<th>UVB (W/m²)</th>
<th>Session length (sec.)</th>
<th>UVA/Session (J/m²)</th>
<th>UVB/Session (J/m²)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7</td>
<td>50</td>
<td>0.35</td>
<td>30 x 60</td>
<td>90000</td>
<td>630</td>
</tr>
<tr>
<td>1.4-1.5*</td>
<td>50</td>
<td>0.75</td>
<td>30 x 60</td>
<td>90000</td>
<td>1350</td>
</tr>
<tr>
<td>4.8</td>
<td>50</td>
<td>2.4</td>
<td>20 x 60</td>
<td>60000</td>
<td>2880</td>
</tr>
<tr>
<td>8.5</td>
<td>50</td>
<td>4.25</td>
<td>10 x 60</td>
<td>30000</td>
<td>2550</td>
</tr>
</tbody>
</table>

II. Total UVA irradiance is 80 W/m² (medium)

<table>
<thead>
<tr>
<th>UVB/UVA%</th>
<th>UVA (W/m²)</th>
<th>UVB (W/m²)</th>
<th>Session length (sec.)</th>
<th>UVA/Session (J/m²)</th>
<th>UVB/Session (J/m²)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7</td>
<td>80</td>
<td>0.56</td>
<td>30 x 60</td>
<td>144000</td>
<td>1008</td>
</tr>
<tr>
<td>1.4-1.5*</td>
<td>80</td>
<td>1.2</td>
<td>30 x 60</td>
<td>144000</td>
<td>2160</td>
</tr>
<tr>
<td>4.8</td>
<td>80</td>
<td>3.84</td>
<td>20 x 60</td>
<td>96000</td>
<td>4608</td>
</tr>
<tr>
<td>8.5</td>
<td>80</td>
<td>6.8</td>
<td>10 x 60</td>
<td>48000</td>
<td>4080</td>
</tr>
</tbody>
</table>

III. Total UVA irradiance is 150 W/m² (upper limit)

<table>
<thead>
<tr>
<th>UVB/UVA%</th>
<th>UVA (W/m²)</th>
<th>UVB (W/m²)</th>
<th>Session length (sec.)</th>
<th>UVA/Session (J/m²)</th>
<th>UVB/Session (J/m²)**</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.7</td>
<td>150</td>
<td>1.05</td>
<td>30 x 60</td>
<td>270000</td>
<td>1890</td>
</tr>
<tr>
<td>1.4-1.5*</td>
<td>150</td>
<td>2.25</td>
<td>30 x 60</td>
<td>270000</td>
<td>4050</td>
</tr>
<tr>
<td>4.8</td>
<td>150</td>
<td>7.2</td>
<td>20 x 60</td>
<td>180000</td>
<td>8640</td>
</tr>
<tr>
<td>8.5</td>
<td>150</td>
<td>12.75</td>
<td>10 x 60</td>
<td>90000</td>
<td>7650</td>
</tr>
</tbody>
</table>

*used the upper limit (1.5%) for our calculations; ** not erythemally weighted

As seen, the UVA dose per session varied from a low of 30,000 J/m² to a high of 270,000 J/m². The UVB per session was between 630 J/m² and 8,640 J/m² depending on the session length and strength of the lamps.
4.5 Estimates of the annual UV exposure from tanning beds

The annual UV exposure for our subjects during the study period is a function of UVB and UVA per session and the annual number of sessions. From section 4.2.5.1 we know that the lowest total annual number of tanning bed sessions was 1, the median was 5 and the highest reported number of visits per year was 108.

The estimated annual UVA and UVB for various lamp types and session lengths are summarized in the Tables 22, 23, and 24.
Annual UV Exposure = UV/Session (J/m²) x Total Number of Sessions/year

Table 22: Estimates of annual UVA and UVB exposure: total UVA irradiance/session = 50 W/m²

I. UVB/UVA% = 0.7 or 1.4-1.5

<table>
<thead>
<tr>
<th>UVA/Session (J/m²)</th>
<th>Number of sessions per year</th>
<th>UVA (J/m²)</th>
<th>UVB (J/m²)</th>
<th>UVB/UVA% = 0.7 UVB (J/m²)</th>
<th>UVB/UVA% = 1.4-1.5 UVB (J/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>90000</td>
<td>1 (mode)</td>
<td>90000</td>
<td>630</td>
<td></td>
<td>1350</td>
</tr>
<tr>
<td>90000</td>
<td>5 (median)</td>
<td>450000</td>
<td>3150</td>
<td></td>
<td>6750</td>
</tr>
<tr>
<td>90000</td>
<td>108 (maximum)</td>
<td>9720000</td>
<td>68040</td>
<td></td>
<td>145800</td>
</tr>
</tbody>
</table>

II. UVB/UVA% = 4.8

<table>
<thead>
<tr>
<th>UVA/Session (J/m²)</th>
<th>Number of sessions per year</th>
<th>UVA (J/m²)</th>
<th>UVB (J/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60000</td>
<td>1 (mode)</td>
<td>60000</td>
<td>2880</td>
</tr>
<tr>
<td>60000</td>
<td>5 (median)</td>
<td>300000</td>
<td>14400</td>
</tr>
<tr>
<td>60000</td>
<td>108 (maximum)</td>
<td>6480000</td>
<td>311040</td>
</tr>
</tbody>
</table>

III. UVB/UVA% = 8.5

<table>
<thead>
<tr>
<th>UVA/Session (J/m²)</th>
<th>Number of sessions per year</th>
<th>UVA (J/m²)</th>
<th>UVB (J/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30000</td>
<td>1 (mode)</td>
<td>30000</td>
<td>2550</td>
</tr>
<tr>
<td>30000</td>
<td>5 (median)</td>
<td>150000</td>
<td>12750</td>
</tr>
<tr>
<td>30000</td>
<td>108 (maximum)</td>
<td>3240000</td>
<td>275400</td>
</tr>
</tbody>
</table>
Table 23: Estimates of annual UVA and UVB exposure: total UVA irradiance/session = 80 W/m²

I. UVB/UVA% = 0.7 or 1.4-1.5

<table>
<thead>
<tr>
<th>UVA/Session (J/m²)</th>
<th>Number of sessions per year</th>
<th>UVA (J/m²)</th>
<th>UVB (J/m²)</th>
<th>UVB/UVA%=0.7</th>
<th>UVB/UVA%=1.4-1.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>144000</td>
<td>1 (mode)</td>
<td>144000</td>
<td>1008</td>
<td></td>
<td>2160</td>
</tr>
<tr>
<td>144000</td>
<td>5 (median)</td>
<td>720000</td>
<td>5040</td>
<td></td>
<td>10800</td>
</tr>
<tr>
<td>144000</td>
<td>108 (maximum)</td>
<td>15552000</td>
<td>108864</td>
<td></td>
<td>233280</td>
</tr>
</tbody>
</table>

II. UVB/UVA% = 4.8

<table>
<thead>
<tr>
<th>UVA/Session (J/m²)</th>
<th>Number of sessions per year</th>
<th>UVA (J/m²)</th>
<th>UVB (J/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>96000</td>
<td>1 (mode)</td>
<td>96000</td>
<td>4608</td>
</tr>
<tr>
<td>96000</td>
<td>5 (median)</td>
<td>480000</td>
<td>23040</td>
</tr>
<tr>
<td>96000</td>
<td>108 (maximum)</td>
<td>10368000</td>
<td>497664</td>
</tr>
</tbody>
</table>

III. UVB/UVA% = 8.5

<table>
<thead>
<tr>
<th>UVA/Session (J/m²)</th>
<th>Number of sessions per year</th>
<th>UVA (J/m²)</th>
<th>UVB (J/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>48000</td>
<td>1 (mode)</td>
<td>48000</td>
<td>4080</td>
</tr>
<tr>
<td>48000</td>
<td>5 (median)</td>
<td>240000</td>
<td>20400</td>
</tr>
<tr>
<td>48000</td>
<td>108 (maximum)</td>
<td>5184000</td>
<td>440640</td>
</tr>
</tbody>
</table>
Table 24: Estimates of annual UVA and UVB exposure: total UVA irradiance/session = 150 W/m²

I. UVB/UVA% = 0.7 or 1.4-1.5

<table>
<thead>
<tr>
<th>UVA/Session (J/m²)</th>
<th>Number of sessions per year</th>
<th>UVA (J/m²)</th>
<th>UVB (J/m²) UVB/UVA%=0.7</th>
<th>UVB (J/m²) UVB/UVA%=1.4-1.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>270000</td>
<td>1 (mode)</td>
<td>270000</td>
<td>1890</td>
<td>4050</td>
</tr>
<tr>
<td></td>
<td>5 (median)</td>
<td>1350000</td>
<td>9450</td>
<td>20250</td>
</tr>
<tr>
<td></td>
<td>108 (maximum)</td>
<td>29160000</td>
<td>204120</td>
<td>437400</td>
</tr>
</tbody>
</table>

II. UVB/UVA% = 4.8

<table>
<thead>
<tr>
<th>UVA/Session (J/m²)</th>
<th>Number of sessions per year</th>
<th>UVA (J/m²)</th>
<th>UVB (J/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>180000</td>
<td>1 (mode)</td>
<td>180000</td>
<td>8640</td>
</tr>
<tr>
<td></td>
<td>5 (median)</td>
<td>900000</td>
<td>43200</td>
</tr>
<tr>
<td></td>
<td>108 (maximum)</td>
<td>19440000</td>
<td>933120</td>
</tr>
</tbody>
</table>

III. UVB/UVA% = 8.5

<table>
<thead>
<tr>
<th>UVA/Session (J/m²)</th>
<th>Number of sessions per year</th>
<th>UVA (J/m²)</th>
<th>UVB (J/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>90000</td>
<td>1 (mode)</td>
<td>90000</td>
<td>7650</td>
</tr>
<tr>
<td></td>
<td>5 (median)</td>
<td>450000</td>
<td>38250</td>
</tr>
<tr>
<td></td>
<td>108 (maximum)</td>
<td>9720000</td>
<td>826200</td>
</tr>
</tbody>
</table>
As seen from above tables there is a wide range for the estimated annual UVA and UVB. In Table 22 the lowest estimated annual UVA is 30,000 J/m² (Table 22 III) and the highest estimated UVA is 9,720,000 J/m² (Table 22 I). The lowest and the highest estimated UVB in Table 22 are 630 J/m² (Table 22 I) and 311,040 J/m² (Table 22 II) respectively.

In Table 23 the lowest and highest estimated annual UVA are 48,000 J/m² (Table 23 III) and 15,552,000 (Table 23 I) respectively. The estimated UVB varied from a low of 1,008 J/m² (Table 23 I) to a high of 497,664 J/m² (Table 23 II).

The lowest estimated annual UVA in Table 24 was 90,000 J/m² (Table 24 III) and the highest value was seen in Table 24 I (29,160,000 J/m²). The UVB varied from a low of 1,890 J/m² to a high of 933,120 J/m².

Based on our information about the most prevalent type of tanning lamps (UVB/UVA%=1.4-1.5%), the median of the annual number of tanning bed sessions (median=5) and the above calculations, the calculated annual UVA dose is between (450,000 J/m² ,Table 22 I) and 1,350,000 J/m² (Table 24 I)) with the most likely (typical) UVA estimate of 720,000 J/m². Similarly, the UVB estimates vary between 6,750 J/m² (Table 22 I) and 20,250 J/m² (Table 24 II), and the most typical non-erythemally weighted UVB is 5,040 J/m².

Few actual measurements have been reported of personal exposures to UVR sources. According to IARC (1992) there are clearly uncertainties associated with estimates of population exposure doses to UVA and UVB.

The general advice is to avoid the use of UV tanning sources. However, for those who insist
on using these devices a series of maximum allowable doses are recommended. The recommendations for exposure limits to solar and non-solar UV sources are given in terms of the erythemally weighted MED values. As discussed the MED values are mainly representative of the UBV strength of the UV sources.

The recommended maximum annual limits for non-solar UV exposure vary from 75 MED/year (Threshold Limit Value (TLV)), to 125 MED/year (IARC, 1992). The set standard for the annual UV from tanning equipment in Netherlands is 100 MED (van Der Leun et al., 1987), the International Electrical Commission (IEC) also had adopted 125 MED/year.

It has been estimated that the annual exposure dose of solar UV to the face for indoor workers in mid latitudes (40-60 degrees North) is 40-160 MEDs depending on the personal outdoor activities of the workers. The annual solar exposure for the outdoor workers is about 250 MEDs (IARC, 1992).

As discussed, we classified our tanning devices (beds) as UVA, hence we were able to use the reported/recommended MED per session of 0.75 MED (Bruggers et al., 1987; FDA) for UVA devices as a surrogate estimate of MED per session for devices in our study. Then by multiplying the annual number of tanning bed sessions and the reported MED/session values we calculated the annual MEDs that were between 0.75 MED (one session per year) and 81 MEDs (108 session per year), with a mean of 3.75 MEDs (5 session/year).

A general comparison of our estimated erythemally weighted UBV values with the above UBV exposure limits and solar UBV shows that the UBV levels in our study were below the
recommended limits and solar values. Our calculated erythemally weighted UVB estimates were 0.6% to 66% times of the annual solar UVB levels. When compared to solar values, the heavy tanner (108 session per year, 81 MED) received a large amounts (66%) of their average exposure from tanning sources.

Unfortunately, we were not able to obtain reliable estimates of the annual solar UVA values for our study area and could not compare our estimates with solar UVA.

4.6 Estimates of the accumulated UV exposure

The accumulated UV exposure for our subjects during the study period is a function of UVB and UVA per session and the accumulated number of sessions. From section 4.2.5 we know that the lowest calculated total number of tanning bed sessions was 1, the median was 6 and the highest reported number of visits was 490.

Using calculations similar to Tables 22, 23 and 24, we estimated the cumulative UVA and UVB (see Appendix E). According to our calculations the most probable cumulative estimates of UVA varied from (540,000- 1,620,000 J/m²), with the most likely value of 864,000 J/m². The non-erythemally weighted UVB estimates were between (8,100 and 24,300 J/m²), and the most probable UVB value was 12,960 J/m².
CHAPTER 5

DISCUSSION

5.1 Summary of findings

Our pilot study was a helpful attempt at testing two data collection instruments to describe the pattern of use of non-solar tanning devices in young women in a large urban setting namely, Metro Toronto.

The salon and subject questionnaires were useful in collecting data on the use of tanning devices in a young female group of Metro residents. The prevalence of use of tanning devices in our study population was 20.7% (95% CI, 15.6-25.8), which is similar to previous reports in other study populations (Autier, 1991; Walter, 1990).

Results of our salons’ survey showed that there were three different types of tanning devices in use in Metro between 1985 and 1994. Tanning beds were the most commonly reported devices by both salons and subjects, but facial lamps, canopies and tanning booths were also reported. The UVB/UVA% of the lamps used in tanning devices varied from 0.7% to 8.5%. Tanning lamps with UVB/UVA% of 1.4-1.5% were the lamps most commonly used by tanning salons in Metro.

The most commonly reported tanning session lengths were 20 and 30 minutes. The annual number of tanning bed sessions varied from one to a high of 108, with a median number of 5.

Data from our questionnaires and other sources (Bowker and Langford, 1987; Diffey, 1987a, 1990a; Bruyneel-Rapp, 1988) and a set of assumptions/criteria about the tanning lamps and devices in our study area enabled us to compare our lamps with those reported in literature, and to estimate UVA and UVB exposure levels from tanning devices in Metro between 1985-1995 for
young female users of these devices.

The main assumptions in our calculations were: a) that our lamps were similar to those reported in literature (i.e., with respect to spectral distribution, power consumption, type(s) of lamps (fluorescent), total irradiance, and irradiance peak) and; b) that there was an expected inverse relationship between the length of tanning sessions and the strength of the tanning lamps/devices.

In our calculations, we examined a range of scenarios of exposure based on: a) number of reported sessions/year; b) UVB/UVA% output of the lamps and; c) the range and a typical total irradiance for devices using these lamps. It is essential to remember that our estimates are only reflective of the scenarios of exposures for the users of tanning devices, and can not be applied to the general female population of Metro Toronto.

The estimated UVA exposure for study subjects who reported having used tanning devices was 450,000-1,350,000 J/m² per year, with a “typical” value (as defined by Diffey, 1990a, 80 W/m² per session) value of 720,000 J/m², while UVB exposure was estimated to be 6,750-20,250 J/m² per year, with a “typical” value of 5,040 J/m². The erythemally weighted UVB exposure range was estimated to be between 0.75 and 81 MEDs per year with a median of 3.75 MEDs.

The above estimates are lower than the maximal recommended annual non-solar UV exposure limits (75-125 MEDs) (TLV; IARC, 1992; van Der Leun, 1987; IEC). However, In addition, the estimated annual solar UV exposure for the face of indoor workers in mid latitude (40-60 degrees North) of 40-160 MEDs are also higher than the exposures we estimated for non-solar tanning devices in Metro. According to our estimates, our users were exposed to an additional 3%
of erythemally weighted UVB (range, 0.6-66% (using 125 MED as the annual solar estimate)) from the use of tanning devices in Metro on top of typical annual solar UVB.

Although we could not compare our estimated UVA with the solar UVA values for our study area, but we know that exposure to any doses of UVA is not without harm. Especially in light of the new evidence of the serious long term health effects of chronic UVA exposure, including photoaging of skin (Lowe, et al., 1995), metagenesis (Drobetsky, et al., 1995) and long term actinic damage (Lavker et al., 1995).

5.2 Study Strengths

Our study is one of the first studies of its kind. We have been able to provide a recent estimate of tanning devices use and related UV exposures in young women in a large urban setting namely, Metro Toronto.

Our study sample was drawn randomly from the general population of Metro Toronto residents with listed telephone numbers. Our salon and subject questionnaires, although in need of further refinements, were useful data collection devices. Our pioneering data collection instruments could be used for future studies to facilitate a better estimation of the UV from non-solar sources.

One of the unique features of our study was inclusion in our subject questionnaire of photos of some of the reported (by salons) popular tanning devices in our study area.

Our estimated UVA and UVB doses (per session, per year and accumulated) are only general estimates. However they reflect exposure scenarios across a range of values for: a)
UVB/UVA ratio; b) number of sessions; c) session length; d) lamp irradiance and because of our sensitivity analysis we expect that the actual value lies somewhere within the calculated range of estimates.

In addition, our estimated UV values are useful general estimates of the non-solar UV from tanning devices (more specifically tanning beds) in Metro for the study period. Furthermore, since UV population exposure measurements are scarce (IARC 1992), our results are useful estimates of the general exposure levels.

5.3 Study limitations

A small sample size and the resultant lack of statistical power is one of the limitations of our pilot study. Our small sample size also limits the precision of our estimates.

Both salon and subject questionnaires were pre-tested and modified as needed, before they were administered. The quality of salon and subject data could not be adequately evaluated. Accuracy and consistency of data were considered in the few cases where comparison of the salon and subject information was possible. This comparison showed that in most cases salon and subject data did not agree.

Our experience showed that detailed equipment data (UV irradiance, UVB/UVA%) are not readily available. We contacted several manufacturers of tanning devices in Canada, U.S.A. and Europe, but had a poor response to our inquiries. Finally, we were able to gather some information from a major distributor of the tanning devices in Ontario. However, this information was limited
to the types of tanning devices which are distributed by this company.

Since data on spectral output and UV irradiance of the lamps in our study area were not available (manufacturers do not produce them or do not have them readily available), we had to use alternative ways of estimating UVA and UVB doses. Salons' data were used in conjunction with the manufactures' data to determine the UVB/UVA% of the lamps. However, this information was not available for all of the lamps. In addition, lamp data was not as historical as we had liked, since most of the salons have provided data on the most recent types of lamps that they had used.

Our reliance on UVA irradiance estimates from the literature is a major limitation of our study. We used the notion of similarity of our tanning lamps with those reported by others Diffey (1987a, 1990a), Bowker and Langford (1987), and Bruyneel-Rapp (1988) to estimate UVA irradiance values of our lamps. We assumed that the lamps with a UVB/UVA% of 0.7 and 1.4-1.5% to be similar to the Type I UVA lamps reported by the above studies. If the actual total irradiances of our lamps are not similar to those reported by literature, then we may have greatly under or over-estimated the UV outputs. However, since we have carried out a sensitivity analysis, we expect that the actual UV output lies somewhere within the calculated range. Furthermore, only a very few actual measurements of individuals' UV exposure have been reported (IARC, 1992).

We did not carry any actual measurements on the UV irradiance of the lamps in our study area, because of feasibility reasons. Actual field measurements would be advantageous, although they would be limited to the UV outputs of the types of lamps that are currently in use in tanning devices.
The lack of UV measurement also affected the assessment of validity of our results. Our calculation assumptions about tanning lamps, devices and their irradiances had a direct impact on the estimated UVA and UVB. Our sensitivity analysis was useful in providing a range for the possible UV values in our study area.

Lamp replacement practices of tanning salons that has a major impact on the UV irradiances of the lamps were not fully explored, but a question about the first use of lamps was included in salon questionnaire.

The lack of ability to recall fine details of use is a major limitation of our subjects’ data. We requested information about the use of tanning devices in the decade prior to the study from our subjects. As we discovered information about the name and model number of devices were poorly recalled. However, our subjects were able to recall the year(s) of use, number of sessions, and types of devices that they had used in most cases.

Armstrong (1993) previously recommended the inclusion of photos of tanning devices in subject questionnaires as a useful method in assisting subjects to identify some of the devices that they may have used. We provided a small photo sheet of a limited number of the tanning devices that have been in use in Metro Toronto. However, perhaps due to lack of a comprehensive photo set, this may have resulted in misidentification of reported devices by subjects.
5.3.1 Other limitations

The results of the salon data collection phase could improve if all salons were visited by a member of study staff and questionnaires were completed in collaboration with salon owners/managers. Furthermore, during the personal visits, equipment data and information brochures (such as photos and possibly the UV irradiance values) which may be available at the salons could be gathered, and any uncertainty about the questionnaire and study itself could be resolved. Due to feasibility reasons we were only able to visit and collect information from few of the Metro salons.

We did not include questions about the usual tanning session lengths for different pieces of equipment in the salon questionnaire. Therefore, for our calculation of UVA and UVB we had to use general categories of session length, namely 10, 20 and 30 minutes. If we had collected this information, we could have made better decisions about the tanning session lengths as related to the specific type(s) of tanning device(s).

In the salon questionnaire we had not requested any information on the UVB/UVA% or Te and Tm values of the lamps. Therefore, we had to check several sources to obtain this information. This was time consuming and in some instances not as precise as we would have liked (where we had to use a range for the UVB/UVA% or Te, Tm values).

We used the previously reported UVA and UVB irradiiances of devices with UVB/UVA lamps of 1.0% to estimate the UVA and UVB for devices with lamps that had higher than 1.0% UVB/UVA. This was not an accurate method, but was only used for providing a range of possible
values for the sensitivity analysis.

5.3.2 Bias

In any epidemiological study, systematic errors in collecting or interpreting data (biases) need to be identified and their possible effects ascertained and, if possible, excluded.

The two main categories of bias are defined as: a) selection bias and; b) information bias. Selection bias can result from a number of circumstances related to the way in which individuals, subjects, or groups are ascertained and selected for study. Information bias results from systematic differences in the way in which data on exposure or outcome are obtained from the various study groups. Some of the specific types of information bias include recall bias, interview bias, non-response bias and misclassification bias.

We examined our method of salon and subject recruitment in order to assess selection bias. We randomly selected our study participants, so as to minimize selection bias. We attempted to recruit all advertised tanning salons in the Yellow Pages section of the 1994 Metro Toronto telephone book. We do not know if there are major differences (in terms of devices and practices) between the advertised and non-advertised salons in our study area.

Our study sample was intended to be a random sample of the Metro Toronto women ages 20-44. However compared to Census 1991 data, women 30 years of age and older (30-44) were over-represented in our sample, and women younger than 30 years of age in our sample (25-29) were slightly under-represented. The youngest group of women (20-24) were not included in our
comparison with census data, since they were added part way through the study. However, age
adjusted use rates were calculated so that the estimate of use/prevalence should not be affected by
age imbalances.

When we compared the highest level of education of our subjects with the 1991's census
female population of Metro, we found that post-secondary education was similar between our
subjects census data. However, our sample had a higher proportion with high school education.
This difference may be attributed to exclusion of non-English speaking subjects from our study and
in addition may be partly attributed to a slightly different classification scheme for education
between our study and the census.

One source of information bias derives from response rates among various study groups.
The overall response rate among participating salons was 52.2% which is low. The low response
rate among the salons is a source of caution in interpreting salons’ data. However, when we
compared general characteristics of the responding and non-responding salons (types and number
of devices) we found that there were not major differences between the two groups, although
participating salons had been in operation slightly longer that the non-participating salons.

The overall subjects' response rate was defined as a function of the screening rate and the
rate of response to the questionnaire, and was 55% before exclusion of non-English speaking and
non-respondents (i.e., numbers out of service, no answer) and was 70% after exclusion. Excluding
non-English speaking women may have increased our estimated rate of equipment use.

We have no way of knowing if participating and non-participating subjects had differences
in use of tanning devices, but our calculated prevalence of use was similar to what was reported in previous studies (Walter et al., 1990 & Autier, 1994) and are valid.

In order to minimize interviewer bias (another type of information bias), the study interview staff were trained rigorously on data collection procedures. Formal written protocols, and interview scripts were provided and all interview staff’s work was monitored by the study coordinator.

Loss to follow-up can be another source of information bias in epidemiological studies, specifically in cohort studies. But, our cross-sectional study was not affected by this kind of bias.

5.3.2 Generalizability

We only chose tanning salons for our survey purposes and do not know much about other commercial facilities and their tanning devices. However, since tanning salons have been known (Diffey, 1987c; Mawn et al., 1993) as the most popular commercial tanning facilities with probably the greatest number of clients, it was feasible and logical for our study to limit our survey to these facilities. However, this means that we do not know whether our exposure estimates would apply to other exposure locations. In addition, we do not have information about tanning devices and lamps used in other commercial facilities that offer tanning services.

For our subject recruitment we randomly selected households from the 1995 Metro Toronto telephone book, and therefore our results are applicable only to a large urban setting like Metro Toronto. We selected young English speaking subjects for the study, and do not have any information about the tanning practices of other groups of people residing in Metro.
In summary, although our study results are not fully generalizable and any conclusion and inferences drawn from them are limited, they are good indicators of the use of non-solar UV sources in English speaking women ages 20-44, who had used tanning devices in Metro between 1985-1995.

5.4 Recommendations for future studies of exposure from tanning devices

The main recommendation for future studies of non-solar UVR exposure from tanning devices would be to refine our data collection instruments and to include collection of specific data to facilitate valid exposure assessment.

One useful method of collecting historical equipment and lamp information would be to contact the manufacturers and distributors of tanning devices to request general sales data on various type(s) of equipment and lamps. In order to make this possible, a joint effort from several related federal, and provincial government agencies (such as Health Canada and Radiation Protection Branch) are needed to entice the manufacturers and distributors to release their data.

For the subject recruitment phase of future studies, we strongly recommend identifying tanners during the initial screening calls. This would reduce time and resource consumption. In the subject questionnaires, questions about the commercial facility type(s) must be included. This type of information is likely to be recalled by the subjects and would facilitate a better classification of the commercial facilities.

If resources are available and arrangements could be made, one study staff member should
visit commercial facilities of interest and assist the owners to complete the questionnaire. The end result of this data collection method should be better data, since study staff could ensure that detailed and specific information on items such as: equipment model numbers, lamp-specific data, and age of the lamps were provided whenever possible.

Since the age of tanning lamps has a direct impact on its emissions, for future studies we strongly recommend collecting detailed information about the age of the lamps or the frequency of their replacement, and types of replacement used. In addition, comprehensive lamp data should include historical sales data about the lamps manufactured and used in the study region. This information should also to be complemented with technical lamp data (specific model number, spectral output, total radiance).

We also recommend that questions about the UVA and UVB percentages, Te, or Tm of lamps in use be included in future salon questionnaires. This information could then be used where manufacturers' information was unattainable. In addition, data on the total irradiance of the lamps and spectral output of lamps should be secured, as well as information about filter(s) that are used in each tanning device.

Future studies also should try to compose a comprehensive photo booklet of the most common tanning devices that have been in use in their study area. Finally, actual field measurements of the output of the lamps would be advantageous.
5.5 Health implications of our findings

Armstrong (1995) has suggested that melanoma and non-malignant skin cancer incidence and mortality rates are likely to increase in the next few decades. Most of these increases would be attributed to solar UV radiation, but non-solar sources could enhance the harmful effects of the sun’s UV rays.

Lytle (1987) reported that the possible implication of 100 MED per year are five to six percent increases in non-melanoma skin cancer incidence rates. Van Der Leun (1987) estimated that if a population of 1 million people between 15 to 55 years of age is exposed year after year to an erythemally effective radiant exposure of 30 MEDs from non-solar sources, the skin cancer incidence in the Dutch population would increase by a few percent.

Our estimates UVB exposure levels in Metro between 1985-1995 are trivial for most users. However, for frequent users (more than 20 sessions per year), these trivial levels could have serious long term effects. In addition, we must remember that in most cases non-solar UV exposures are in addition to solar UV exposures, and that the cumulative UV (solar and non-solar) could have serious harmful effects such as those described above.

In addition, as we discovered, most of the use of tanning devices in Metro was after 1990's and if use of tanning devices continues to increase, we may expect more serious health problems in the next decade.
5.6 Conclusions

The feasibility of gathering data on tanning equipment in Metro (objective 1) was evaluated in terms of availability, accessibility, completeness and quality of the data. The most likely sources of these data are; a) manufacturers, b) distributors and c) tanning facilities.

Salons' tanning lamp information was not available with precise details. In addition, since tanning lamps were (are) replaced frequently, and that replacement information was not adequate, our estimates of UV were based on the most recent lamps. This meant that older types of lamps (possibly) with higher UVB are not included in our survey.

Our study showed that a useful exposure value is the total UVR irradiance from the lamps and tanning devices. This information, in conjunction with UVB/UVA ratios, could be used to estimate UVA and UVB exposure levels.

It was possible to estimate general non-solar UVB and UVA exposure from tanning sources where use was reported by the study population (objective 2). However, we were not able to directly secure either meaningful UV output data for surveyed lamps nor spectral irradiance graphs for the reported lamps in Metro. The combination of our salon data and reports from Diffey (1987a, 1990a), Bowker and Langford (1987), and Bruyneel-Rapp (1988), enabled us to estimate UVA and UVB outputs.

According to our results it was feasible to gather detailed data on the use of tanning equipment in young females of Metropolitan Toronto. Subjects' data were available and accessible. We had an overall response rate of 55% to 70%, which is a reasonable rate for a survey of this type.
Subjects' information was complete enough to provide a general profile of their tanning history in the past several years. Our evaluation of salons' information showed that their data were useful in establishing a profile of the tanning equipment in the past several years in Metro (objective 3).

Our subjects' UVB exposure estimates are lower than the recommended maximal annual UVB levels from tanning devices and are also lower than estimated average solar UV exposure. However, we must remember that exposure to non-solar UV sources may in fact exacerbate the solar UV effects by increasing the overall exposure for both UVA and UVB, especially since recent evidence indicates that UVA as well as UVB could have harmful effects in humans (van Weelden et al., 1988; Lowe et al., 1995; Drobetsky et al., 1995; Lavker et al., 1995).

New standards are needed to reflect the present state of the tanning industry and tanning devices manufacturing. The RED Act and U.S. Federal Standard, CFR 1040.20 are not comprehensive in their approach, since they do not limit the UVB and UVA, but only UVC.

Finally, a regulatory body should be set up to oversee the operation of the tanning salons and their practices in a given region. The mandate of such an agency could also include inspection of the tanning facilities. Few of the salons in Metro have indicated support for this idea, recognizing that it would be both beneficial to them and also their clients.
REFERENCES


Bell Canada (1994). Metropolitan Toronto Telephone Book, Yellow Pages Section.


Looking fit (1992). The $1,000,000,000 industry, 7(5):56-70.


APPENDIX A

A Photo Sheet of Some Common Tanning Equipment in Metropolitan Toronto (1985-1994)
Sketches of Tanning Equipment

Tanning Beds

Sketch #1

Sketch #2

Sketch #3

Sketch #4
Tanning Canopies

Facial Lamps
APPENDIX B

Salons’ Letter, Study Summary, Salons’ Questionnaire
Dear Salon Owner,

I am writing to request your cooperation in a Pilot Study of the Use of Sunlamps and Tanning Beds, which we are conducting through the Department of Preventive Medicine and Biostatistics at the University of Toronto. A summary of the study is attached.

We would greatly appreciate your completion of the attached questionnaire regarding equipment in use at your establishment. The information you provide will be confidential, used only for the purposes described on the attached, and available only to study staff. Since the first sheet of each questionnaire will be removed as soon as it is received, no information identifying your salon will remain with the description of equipment. For analysis and reporting your anonymous data will be put together with that provided by other salons. If you wish, a summary of the results of our study can be forwarded to you.

While completing the questionnaire, please follow the instructions and answer the questions as thoroughly as you can and return it in the enclosed stamped self-addressed envelope. If you would prefer, we can record the information over the phone, or send one of our staff members to visit your establishment.

If you have any questions or concerns regarding this study please contact the study coordinator, Mr Siamak Tenzif at (416) 217-2238.

Yours sincerely

Lorarine D. Marrett, Ph.D. 
Associate Professor
Pilot Study of the Use of Sunlamps and Tanning Beds

Study Summary

Many researchers are interested in knowing more about the health effects (both positive and negative) of various parts of the ultraviolet (UV) region of the spectrum. Although most UV exposure will come from the sun, this is difficult to assess, and we may be able to learn more by studying exposure to non-solar sources of UV such as comes from tanning equipment. However, accurate information on individuals' use of tanning equipment is required for scientific study; for some health effects this may involve an individual recalling exposure that occurred over the several previous years.

We plan to undertake a small study to determine if people can recall equipment used sufficiently accurately to permit estimation of their UV exposure. In order to do this we would like to provide a small random population sample with pictures or descriptions of the equipment they are most likely to have encountered in commercial establishments such as yours over the past ten years. We are therefore conducting a survey of such establishments to ascertain what equipment has been in use during the past decade, so we can design an appropriate study questionnaire.

The information you provide will be confidential, used only for the purposes described above, and available only to study staff. Since the questionnaire cover sheet that contains salons' identifying information will be removed and stored separately, and will not be used for analysis and reporting purposes, complete integrity and confidentiality of salons' information will be maintained.

Collaborating Institutions:

Department of Preventive Medicine and Biostatistics, University of Toronto

Public Health Branch, Ontario Ministry of Health

Radiation Protection Service Occupational Health and Safety Branch, Ontario Ministry of Labour

Thank you for your cooperation
Pilot Study of the Use of Sunlamps and Tanning Beds

please correct this information if necessary

Contact Person: (if further clarification is required)

Name: ___________________________  Telephone No.: (___)___-____

Year salon established: _______  Number of years in operation: _______

Comments: (please use this space for any comments you may have after completing the attached tables)

This questionnaire is part of a research study being conducted through the Department of Preventive Medicine and Biostatistics at the University of Toronto.

Thanks you for your cooperation. This page will be detached and filed separately.
Pilot Study of the Use of Sunlamps and Tanning Beds

Please complete the following table for all pieces of equipment used at any time during the past ten years. For each piece of equipment please provide details on the two or three most common lamps used in it.

<table>
<thead>
<tr>
<th>Tanning Equipment</th>
<th>Lamp Specifications (Note: Use F for Facial &amp; N for Non-facial lamps)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name and Manufacturer</td>
<td>Model</td>
</tr>
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</tbody>
</table>

* Currently in use=NOW
Pilot Study of the Use of Sunlamps and Tanning Beds

Please complete the following table for all pieces of equipment used at any time during the past ten years. For each piece of equipment please provide details on the two or three most common lamps used in it.

<table>
<thead>
<tr>
<th>Tanning Equipment</th>
<th>Lamp Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Name and Manufacturer</td>
<td>Model</td>
</tr>
<tr>
<td>Sunquest Wolff Pro by Wolff System</td>
<td>26 SX 2F</td>
</tr>
<tr>
<td>(This is an Example)</td>
<td></td>
</tr>
</tbody>
</table>

* Currently in use = NOW

Please continue on reverse
APPENDIX C

Subjects’ Letter, Study Summary, Subjects’ Questionnaire, Information Brochure
Date:

Title first-name surname  
Address 1  
Address 2  
Postal code  

Dear title surname:  

I am enclosing a questionnaire for the "Pilot Study of the Use of Sunlamps and Tanning Beds", as arranged during your recent telephone conversation with Ms. Gibson in our study office. Thank you for agreeing that we could send you a questionnaire. This study is being conducted through the Department of Preventive Medicine and Biostatistics at the University of Toronto with the collaboration of a number of other institutions; these are as listed at the end of the study summary which you will find on the reverse of this letter.

I would very much appreciate if you could take a few minutes to complete the questionnaire and return it to the study office in the enclosed stamped, addressed envelope. Please do not pass the questionnaire to another household member (or to anyone else): in order for our results to be scientifically valid it is important that the questionnaire be completed by the person selected at the time of the original telephone call. The questionnaire is very brief and should require no more than 5 to 10 minutes to complete.

Please be assured that all information you provide will be treated as confidential, used only for the study described on the reverse, and available only to study staff. Names will be stored separately from the questionnaires and will be destroyed as soon as the study analysis is complete. For analysis and reporting, your anonymous data will be put together with that provided by others.

I am enclosing, for your information, a brochure which describes ultraviolet radiation, from both the sun and other sources, and discusses what we know about its effects on health. This brochure was prepared by Health Canada to be used as an insert to a Reader’s Digest publication. Health Canada kindly provided me with copies to send to those participating in this study.

If you have any questions, please contact Ms. Gini Hunter, the study coordinator, at 217-1234.

Thank you for your help.

Yours sincerely

Loraine D. Marrett, Ph D. 
Associate Professor
There is much controversy concerning the health effects of exposure to ultraviolet radiation (UVR). To complicate matters, there are different types of UVR (for example, UVA and UVB) whose biological properties differ.

Although most UVR exposure comes from the sun, this is difficult to quantify and describe. Studying non-solar sources of UVR, such as tanning equipment, may help us learn more about the effects of different types of UVR. In order to study this scientifically, detailed information on people's use of tanning equipment is required; for study of some health effects it may be necessary for individuals to recall their experiences over the past several years.

We are currently conducting a small survey to determine if people can tell us about the tanning equipment they have used during the past decade in sufficient detail to permit further study of health effects. Thus we are asking a small random sample of the population of Metropolitan Toronto to complete a brief questionnaire.

The results of this survey will help us determine whether we can study the health effects of UVR emanating from tanning equipment using such a questionnaire.

Collaborating Institutions:
Department of Preventive Medicine and Biostatistics, University of Toronto
Public Health Branch, Ontario Ministry of Health
Radiation Protection Service Branch, Ontario Ministry of Labour
The Ontario Cancer Treatment and Research Foundation
Health Protection Branch, Health Canada

Thank you for your cooperation
A Pilot Study of the Use of Sunlamps and Tanning Beds

This questionnaire is part of a research study being conducted by the University of Toronto. Thank you for your help.

4th Floor, McMurrich Building
Department of Preventive Medicine and Biostatistics
Faculty of Medicine, University of Toronto
Toronto, Ontario M5S 1A8
1. What is your age? _______ years

2. What is your sex?
   _____ male    _____ female

3. What is the highest level of education you have completed? (please check one)
   _____ some post secondary (college, university)
   _____ completed secondary or high school
   _____ some secondary or high school
   _____ some or all elementary or grade school

4. How long have you lived in Metropolitan Toronto (i.e. the cities of Toronto, Etobicoke, North York, York and Scarborough and the Borough of East York)?
   _____ years

5. During the past ten years have you used any tanning equipment (e.g. sun lamps, tanning canopies, tanning beds etc.)?
   _____ yes    _____ no  (If no: please go to page 5)

If yes:

6. Did you use this equipment in a commercial tanning facility (e.g. tanning salon, health club, beauty salon etc.)?
   _____ yes    _____ no  (If no: please go to question 8 on page 4)
We are interested in the tanning equipment you have used and your tanning habits at commercial facilities. Some sketches are enclosed to assist you.

7. Please complete the chart below for each commercial facility (e.g. tanning salon, health club, beauty salon etc.) where you have used tanning equipment during the past ten years; please specify each different piece of equipment. If the equipment you used is not included in the sketches, please describe it as clearly as possible. Please start a new line for each tanning facility or piece of equipment.

<table>
<thead>
<tr>
<th>Commercial facility (Name and location, including city &amp; country, if appropriate)</th>
<th>Type of equipment used</th>
<th>Name of machine</th>
<th>**Sketch # or description if no sketch is provided</th>
<th>Year(s) used</th>
<th>Number of visits/year</th>
<th>Average duration of each session (in minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Example:</strong> ABCD Tan Club 1234 Smith St. Toronto</td>
<td>Bed</td>
<td>Silver Solarium</td>
<td>1</td>
<td>1987 &amp; 1988</td>
<td>2</td>
<td>20 minutes</td>
</tr>
<tr>
<td><strong>Example:</strong> DEFG Tanning Studio 5678 Jones Ave. Toronto</td>
<td>Bed</td>
<td>UVE Sunstream Bronzium</td>
<td>2</td>
<td>1988</td>
<td>2</td>
<td>30 minutes</td>
</tr>
</tbody>
</table>
8. During the past ten years have you used tanning equipment at home?

   Yes   No  (If no: please go to page 5)

Here we are interested in your tanning habits and the equipment you used at home. Some sketches are enclosed to assist you.

9. Please complete the chart below for each piece of tanning equipment you have used at home during the past ten years. If the equipment is not included in the sketches, please describe it as clearly as possible. Please start a new line for each piece of equipment.

<table>
<thead>
<tr>
<th>Type of equipment used</th>
<th>Name of machine</th>
<th>Sketch # or description if no sketch is provided</th>
<th>Year(s) used</th>
<th>Number of sessions/year</th>
<th>Average duration of each session (in minutes)</th>
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If you need more space, please continue on page 5

- Equipment Definitions:
  A facial lamp is a tanning device which is only used to tan the face.
  A tanning canopy is a tanning device with tanning lamps only in the upper section of the unit.
  A tanning bed is a tanning device with tanning lamps in both the upper and lower sections of the unit.

- Please refer to the sketches enclosed.
Test your Sun Care knowledge and you could win the Reader’s Digest Great Health Hints & Handy Tips book.

Reader’s Digest Great Health Hints & Handy Tips
From absentmindedness to Zen meditation, authorities from the most prestigious medical centres give their solutions to everyday health and medical questions on diet, lifestyle, exercise, disease prevention and more.

Try the Health Canada Quiz. Simply answer the following questions by circling True or False. Plus, be one of the first 50 readers to mail your answers to Reader’s Digest, and you will win the Reader’s Digest Great Health Hints and Handy Tips book.

1. Up to 80% of the total UV life dose is received before the age of 18. T or F
2. UV B rays are 1000 times more harmful than UV A. T or F
3. UV B is one of the main causes of skin cancer. T or F
4. Skin cancer is increasing rapidly in Canada. T or F
5. You should always use a sunscreen lotion with a Sun Protection Factor (SPF) of 15 or higher. T or F
6. You should avoid prolonged and unprotected exposure to the sun between 11:00 am and 3:00 pm. T or F
7. Children are more sensitive to UV rays than adults. T or F
8. Some UV rays weaken the immune system. T or F
9. Some UV rays can damage the lens of the eyes and may cause cataracts. T or F
10. Having two or more serious sunburns as a child or adolescent significantly increases a person’s risk of getting skin cancer. T or F

Mail your entry to: Reader’s Digest Sun Care Offer
250 Bloor St. E., Suite 502, Toronto, Ontario M4W 1E6
Name
Address
Phone #
Prov. City
Postal Code
The sun's rays never take a holiday.

As you know, being physically active is an essential part of a healthy lifestyle. In warmer weather, walking, gardening, cycling and swimming are just a few of the activities which can get you outside and keep you fit. While it's great to be out in the sunshine, you should always keep sun safety in mind. That means covering up and using the proper sunscreen whenever you'll be exposed to the sun's rays. Keep reading and discover more about the sun's UV rays and ways in which you can enjoy the outdoors safely.

What is UV?

Ultraviolet radiation (UV) is a type of light emitted by the sun and tanning equipment. This type of light is a part of sunlight, but in large doses, it can be harmful to your health.

UV rays are divided into three wavelength ranges: UV-A (just adjacent to the purple light you can see in a rainbow), UV-B and UV-C.

Ultraviolet emissions from the sun and from sun lamps are invisible to the human eye, so it's not easy to determine your level of exposure. The best solution is not to take any chances.

What about the ozone layer?

The ozone layer in the earth's stratosphere normally screens out much of the sun's UV rays — in fact, all of the sun's UV-C rays and half of the UV-B rays.

UV-A rays are not filtered by the ozone layer. Similar to visible light, these rays all reach the earth's surface, and their intensity depends mainly on the sun's position in the sky and the presence of clouds.

Much to everyone's concern, the ozone layer has been getting thinner because of many pollutants in our atmosphere. Over the last 10 years or so, the ozone has been eroded by such chemicals as chlorofluorocarbons (CFCs), and to some extent by natural processes such as volcanic eruptions.

Why the sudden concern about the sun's rays?

As a result of the thinning ozone layer, slightly more UV-B now reaches the earth's surface. Research has shown that UV-B rays are more harmful than UV-A rays and are 1,000 times more likely to cause sunburn.

It is estimated that for every 1% decrease in ozone, there is a 1.1% increase in UV-B rays at the earth's surface. Today, UV-B levels are considered to be about 5% to 10% higher than before 1980. Of much greater significance is the degree to which our lifestyles have changed in the last four decades. We have been exposing ourselves to more and more ultraviolet radiation while we take part in outdoor activities. Moreover the phrase "healthy tan" has become an accepted notion. There is no such thing as a healthy tan. Tanning is a protective reaction of the body as it senses over-exposure to UV.

Overall, it's important to remember that while UV radiation has intensified, it has always been with us. And avoiding over-exposure to the sun is always a good idea.

How might exposure to UV rays affect your health?

Too much exposure to UV light can cause short-term damage such as sunburn, itchy eyes, allergies and depression of the immune system. Long-term damage can range from skin cancer and cataracts to premature skin aging.
Some exposure to UV-B rays is actually necessary to facilitate Vitamin D3 production, but that isn't a license to sunbathe! Your routine outdoor activities will supply you with all the exposure you need.

Wrinkling and premature aging of the skin are also associated with overexposure to both UV-A and UV-B.

Of course, skin isn't the only area that is damaged by UV radiation. Your eyes don't develop a tolerance to the sun. UV-A and some UV-B can damage the lens of the eye and likely cause cataracts; UV-B can damage the cornea, the outside layer of the eye. That's why wearing sunglasses which filter out harmful light is essential no matter what the season.

UV-A and UV-B have also been shown to affect the immune system. This means that your body may have a reduced ability to fight certain diseases, such as infections and cancer.

**UV-B is one of the main causes of skin cancer.**

Most people don't realize that skin cancer is the most common type of cancer in Canada: over 55,000 Canadians will develop the disease this year. What's more, the prevalence of skin cancer is increasing rapidly.

The major increase in skin cancer in Canada in the last 20 or 30 years is likely due to overexposure to the sun earlier in life, not to the recent thinning of the ozone layer. Today's ever-increasing ozone problem will likely make the situation worse for future generations.

**Types of skin cancer.**

There are three main types of skin cancer: basal cell carcinoma, which is the most common and least dangerous; squamous cell carcinoma, which is faster-growing and may spread to other parts of the body; and malignant melanoma, which is less common but the most likely to be fatal.

Skin damage will not always appear right away. Most skin cancers appear later in life on parts of the body that have been repeatedly exposed to the sun for many years. UV-A adds to the damage caused by UV-B and may help to lead to the development of skin cancer.

Fortunately, if diagnosed in time, skin cancers can be easily removed by surgery, even malignant melanoma.

**When and where should you be most concerned about exposure to the sun?**

The threat of sunburn is greatest at the time of year and time of day when UV-B rays are most intense — in midsummer from about 11 a.m. to 4 p.m. Risk of overexposure is also greatest on clear days, but cloud cover is no guarantee of protection: up to 80% of the harmful rays can penetrate light clouds, haze and fog. Going south in the winter poses increased risks because, even in the winter, the sun's rays at the equator are more intense.

Reflection from snow, ice, sand and water can increase the risk of damage to your skin and eyes. So take extra care when participating in such activities as boating or spring skiing.

Altitude also affects UV exposure: for every increase of 300 meters (1,000 feet) above sea level, there is approximately a 4% increase in UV-B and a 1% increase in UV-A.
Are some people at greater risk than others?

Yes. Children have thinner skin than adults and are more sensitive to UV rays. Children and teenagers also spend more time in the sun, especially in the summer. It has been estimated that up to 80% of the total UV life dose is received before age 18. Two or more serious sunburns as a child or adolescent significantly increases the risk of getting skin cancer later in life.

Pigmented people with light-coloured eyes who burn easily and rarely tan should also take extra precautions when enjoying activities in the sunshine.

How can you protect yourself and your family?

Fortunately, the detrimental health effects of UV exposure are largely preventable. Take the following simple precautions and have fun!

* Avoid getting a sunburn. The most effective sun block is protective clothing — a wide-brimmed hat, long-sleeved shirt and long pants made from a tightly woven fabric. UV rays, just like light, can penetrate sheer clothing.

* Consider moving your outdoor activities to a shady spot.

* When you’re out in the sun for extended periods, liberally apply a sunscreen lotion with a Sun Protection Factor (SPF) of 15 or higher. You should also choose a sunscreen which provides UV-A and UV-B sun block.

Unfortunately, no sunscreen offers complete protection from the sun, but the higher the SPF, the greater the protection. When applying sunscreen pay particular attention to the most exposed parts, like the nose, ears, shoulders and tops of the feet. And remember to reapply it every two hours and after swimming.

* Even if you don’t burn, avoid prolonged and unprotected exposure, especially between 11 a.m. and 4 p.m., during the late spring and in the summer.

* Wear sunglasses that absorb UV-A and UV-B rays.

* Consider any medications you may be taking: certain prescriptions such as tetracycline can increase your skin’s sensitivity to UV rays and cause adverse skin reactions. Consult your doctor if you have any questions.

* Avoid getting a tan. Sun lamps and tanning parlours do not provide a safe way to tan.

What is Health Canada doing about this issue?

Health Canada is educating the Canadian public on this issue and is conducting research to determine the true sensitivity of the population and how to better adapt its education program. For further information on sun safety contact:

Health Canada/Santé Canada/Publications
Ottawa, Ontario K1A 0K9
Phone: 613-954-5994
Fax: 613-941-5366

* Examine your skin regularly for any changes in moles, freckles or skin discolourations. Report any changes to your doctor.

* Provide your children with extra care: don’t let them stay out in the sun without adequate protection. Keep babies under one year of age out of direct sunlight as much as possible.

* Teach your children the importance of being sun sensible: it’s not cool to burn!
University of Toronto, Human Subjects Review Committee Approval
Approval by Review Committee on the Use of Human Subjects

Protocol Reference #725/95

Principal Investigator : Dr. L.D. Marrett, Epidemiology

Title : A Pilot Study of the Use of Sunlamps and Tanning Beds (Amendments)

Review Committee : Dr. J.I. Williams, Clinical Evaluative Sciences
Mr. E. Frerichs, Community Representative
Professor M. Chipman, Preventive Medicine & Biostatistics

Documents Submitted to Review Committee : A letter dated October 25, 1995 from Dr. Marrett, a revised protocol, a finalized questionnaire and final contract letters

Subjects : A random sample of households listed in the Metropolitan Toronto telephone book

Procedures : As approved July 28, 1995 but now telephone calls will be placed first to ask permission to send out the questionnaire

Method for Obtaining Consent : Introductory letter, amended as attached. Consent is implied by completion and return of the questionnaire

Remarks : During the course of the research, any significant deviations from the approved protocol and/or any unanticipated developments within the research should be brought to the attention of the Office of Research Services.

Date of Approval : November 10, 1995

*A copy of this approval form is available to Review Committee members upon request.

cc: Dr. R. Badgley
Dr. A.B. Miller

Susán Pilon, Executive Officer
Human Subjects Review Committee

Simcoe Hall 27, King's College Circle Toronto Ontario M5S 1A1 Telephone 416/978-2163 Fax 416/971-2010
APPENDIX E

Tables 25, 26 and 27
Cumulative UV Exposure = UV/Session (J/m²) x Total Number of Sessions

Table 25: Estimated cumulative UVA and UVB estimates: total UVA irradiance/session = 50 W/m²

I. UVB/UVA% = 0.7 or 1.4-1.5

<table>
<thead>
<tr>
<th>UVA/Session (J/m²)</th>
<th>Number of sessions</th>
<th>Acc. UVA (J/m²)</th>
<th>Acc. UVB (J/m²)</th>
<th>UVB/UVA% = 0.7</th>
<th>UVB/UVA% = 1.4-1.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>90000</td>
<td>1 (mode)</td>
<td>90000</td>
<td>630</td>
<td></td>
<td>1350</td>
</tr>
<tr>
<td>90000</td>
<td>6 (median)</td>
<td>540000</td>
<td>3780</td>
<td></td>
<td>8100</td>
</tr>
<tr>
<td>90000</td>
<td>490 (maximum)</td>
<td>44100000</td>
<td>308700</td>
<td></td>
<td>661500</td>
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</table>

II. UVB/UVA% = 4.8

<table>
<thead>
<tr>
<th>UVA/Session (J/m²)</th>
<th>Number of sessions</th>
<th>Acc. UVA (J/m²)</th>
<th>Acc. UVB (J/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60000</td>
<td>1 (mode)</td>
<td>60000</td>
<td>2880</td>
</tr>
<tr>
<td>60000</td>
<td>6 (median)</td>
<td>360000</td>
<td>17280</td>
</tr>
<tr>
<td>60000</td>
<td>490 (maximum)</td>
<td>29400000</td>
<td>1411200</td>
</tr>
</tbody>
</table>

III. UVB/UVA% = 8.5

<table>
<thead>
<tr>
<th>UVA/Session (J/m²)</th>
<th>Number of sessions</th>
<th>Acc. UVA (J/m²)</th>
<th>Acc. UVB (J/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>30000</td>
<td>1 (mode)</td>
<td>30000</td>
<td>2550</td>
</tr>
<tr>
<td>30000</td>
<td>6 (median)</td>
<td>180000</td>
<td>15300</td>
</tr>
<tr>
<td>30000</td>
<td>490 (maximum)</td>
<td>14700000</td>
<td>1249500</td>
</tr>
</tbody>
</table>
Table 26: Estimated cumulative UVA and UVB estimates: total UVA irradiance/session= 80 W/m²

I. UVB/UVA% = 0.7 or 1.4-1.5

<table>
<thead>
<tr>
<th>UVA/Session (J/m²)</th>
<th>Number of sessions</th>
<th>Acc. UVA (J/m²)</th>
<th>Acc. UVB (J/m²)</th>
<th>UVB/UVA%</th>
</tr>
</thead>
<tbody>
<tr>
<td>144000</td>
<td>1 (mode)</td>
<td>144000</td>
<td>1008</td>
<td>2160</td>
</tr>
<tr>
<td>144000</td>
<td>6 (median)</td>
<td>864000</td>
<td>6048</td>
<td>12960</td>
</tr>
<tr>
<td>144000</td>
<td>490 (maximum)</td>
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<td>493920</td>
<td>1058400</td>
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II. UVB/UVA% = 4.8

<table>
<thead>
<tr>
<th>UVA/Session (J/m²)</th>
<th>Number of sessions</th>
<th>Acc. UVA (J/m²)</th>
<th>Acc. UVB (J/m²)</th>
</tr>
</thead>
<tbody>
<tr>
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<td>96000</td>
<td>6 (median)</td>
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<tr>
<td>96000</td>
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III. UVB/UVA% = 8.5

<table>
<thead>
<tr>
<th>UVA/Session (J/m²)</th>
<th>Number of sessions</th>
<th>Acc. UVA (J/m²)</th>
<th>Acc. UVB (J/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>48000</td>
<td>1 (mode)</td>
<td>48000</td>
<td>4080</td>
</tr>
<tr>
<td>48000</td>
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<td>24480</td>
</tr>
<tr>
<td>48000</td>
<td>490 (maximum)</td>
<td>23520000</td>
<td>1999200</td>
</tr>
</tbody>
</table>
Table 27: Estimated cumulative UVA and UVB estimates: total UVA irradiance/session=150 W/m²

<table>
<thead>
<tr>
<th>UVA/Session (J/m²)</th>
<th>Number of sessions</th>
<th>Acc. UVA (J/m²)</th>
<th>Acc. UVB (J/m²)</th>
<th>UVB/UVA%=0.7</th>
<th>UVB/UVA%=1.4-1.5</th>
</tr>
</thead>
<tbody>
<tr>
<td>270000</td>
<td>1 (mode)</td>
<td>270000</td>
<td>1890</td>
<td>4050</td>
<td></td>
</tr>
<tr>
<td>270000</td>
<td>6 (median)</td>
<td>1620000</td>
<td>11340</td>
<td>24300</td>
<td></td>
</tr>
<tr>
<td>270000</td>
<td>490 (maximum)</td>
<td>132300000</td>
<td>926100</td>
<td>1984500</td>
<td></td>
</tr>
</tbody>
</table>

II. UVB/UVA% = 4.8

| UVA/Session (J/m²) | Number of sessions | Acc. UVA (J/m²) | Acc. UVB (J/m²) UVB/UVA%=4.8 |
|--------------------|--------------------|-----------------|-----------------|----------------|
| 180000             | 1 (mode)           | 180000          | 8640            |
| 180000             | 6 (median)         | 1080000         | 51840           |
| 180000             | 490 (maximum)      | 88200000        | 4233600         |

III. UVB/UVA% = 8.5

| UVA/Session (J/m²) | Number of sessions | Acc. UVA (J/m²) | Acc. UVB (J/m²) UVB/UVA%=8.5 |
|--------------------|--------------------|-----------------|-----------------|----------------|
| 90000              | 1 (mode)           | 90000           | 7650            |
| 90000              | 6 (median)         | 540000          | 45900           |
| 90000              | 490 (maximum)      | 44100000        | 3748500         |