What impact would effective solarium regulation have in Australia?

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In September 2007, the highly publicised death of Clare Oliver,[1] a young Victorian woman who had used tanning solaria, drew attention to the solarium industry in Australia and the potential increased risk of skin cancer due to exposure to artificial ultraviolet (UV) radiation. In the wake of her death, the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) commissioned a report on the health effects of solarium use and the potential cost-effectiveness from the government's viewpoint of fortifying the existing voluntary Standard.[2] State governments in Victoria, South Australia and Western Australia recently implemented laws that mandate training for solarium operators and restrict access for people younger than 18 years or with fair skin, and Queensland and New South Wales governments have announced similar plans.

State cancer councils and other health agencies in Australia, in line with international health organisations such as the World Health Organization, have called for tighter controls of the solarium industry. Here, we discuss the case for government regulation of solaria in Australia and present our model of the number of new cases of melanoma, melanoma-related deaths and new cases of squamous cell carcinoma (SCC) that are attributable to solarium use.

ABSTRACT

- Leading international health organisations are concerned about high use of artificial tanning services and the associated risk of skin cancer. Similar concerns exist about the growing Australian solarium industry.
- Pre-teens appear to be ignoring sun safety messages in their desire to tan and use solaria.
- A significantly elevated risk of melanoma exists among people exposed to artificial ultraviolet radiation; the risk is higher for those younger than 35 years at first solarium use. For all users, the risk of squamous cell carcinoma is more than doubled compared with non-users.
- We estimated the numbers of new melanoma cases and melanoma-related deaths attributable to solarium use by younger people in the five most populous Australian states and indirectly quantified potential costs to the health system that could be saved by effective regulation of the solarium industry.
- Annually, 281 new melanoma cases, 43 melanoma-related deaths and 2572 new cases of squamous cell carcinoma were estimated to be attributable to solarium use.
- The annual cost to the health system — predominantly Medicare Australia — for these avoidable skin cancer cases and deaths is about $3 million.
- By successfully enforcing solarium regulations that ban use by people younger than 18 years or with fair skin, favourable health and cost benefits could be expected.

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Failure of self-regulation of the solarium industry

In 2004, the Australian Government Radiation Health Committee issued a position statement[3] that encouraged compliance with the Australian/New Zealand Standard on solaria for cosmetic purposes (AS/NZS 2635:2002) — a voluntary code of practice designed to provide solarium operators with procedures to minimise the health risks associated with indoor tanning.[4] These include:

- banning solarium use by people younger than 15 years or with fair skin, but allowing people between 15 and 18 years to use solaria with parental consent;
- allowing sunbed emission up to UV Index 60 (five times typical summer sun);
- training on standardised skin-type assessment for solarium operators;
- supervision of solaria by trained operators at all times; and
- use of client consent forms before tanning.

However, five Australian studies have revealed that solarium operators comply poorly with the Standard, with respect to prohibiting use by fair-skinned individuals, obtaining informed consent before use, adhering to minimum age limits and displaying warning signs.[5-9] Also, conformity to the technical elements of the Standard (ie, sunlamp emission intensity, replacement of ageing lamps and operator training) is unknown.

Furthermore, a contentious point in the Standard is that it allows radiation intensity levels up to five times those possible from solar radiation. In fact, tests by ARPANSA of 15 sunbeds manufactured in Europe or the United States, used in Melbourne and Sydney, showed that levels of UV radiation intensity were equivalent to a UV Index of 15–38 — three times stronger than the midday summer sun in Brisbane. Although UVB emissions accounted for 0.4%–2.9% of all emissions, they accounted for 70%–80% of the erythemal effect. All solaria had higher total UVB emissions than the midday summer sun in Brisbane, and 30% had higher UVB emissions in the under-310 nm wavelength range.

Conventionally, governments intervene in an industry where there is market failure. The promotion of solaria for non-cosmetic health benefits (Box 1), failure of the industry to self-regulate through the agreed Standard, and lack of risk awareness among solarium users all suggest that government regulation is necessary.

How big is the problem?

Recent audits show that the numbers of solarium-related businesses have increased fourfold in most Australian cities and sixfold in Melbourne since 1992.[14] Compared with findings outside Australia, the prevalence and frequency of the general population's use of solaria is low: about 0.9%–3.0% of the Australian population (approximately 400 000 people) used solaria in 2006. However, use among adolescents and women is higher, with one study showing that 12% of NSW school children had used solaria.[15] Three surveys indicate 22%–39% of solarium users are regular users,[16,17] and one study found 35% used a solarium one to four times a fortnight.[17] Alarmingly, and despite decades of sun-protection campaigns, this survey also showed that Australian adolescents remain bold and experimental, as a substantial propor-

1 Current debate on the health effects of solarium use*

Solarium industry claims	Health industry responses
Indoor tanning is safer than outdoor tanning because sunbeds emit UVA only, which does not cause skin cancer.	There is growing evidence that UVA is implicated in the development of skin cancers. UVB is emitted from most sunbeds to produce a more lasting tan. Solaria should be banned.
Indoor tanning is safer than outdoor tanning because it is controlled and responsible, and avoids sunburn.	Sunburn occurs in solarium users,[10,11] and there is no way of knowing or controlling an individual's cumulative UV radiation exposure over a set period. Solarium users can sunbathe outdoors before and after indoor tanning, or attend multiple solaria.
"Pre-holiday tans" are a good idea as they protect skin from subsequent outdoor UV radiation.	Tans can be induced by UVA and UVB. UVB-induced tans provide a sun protection factor (SPF) of 2–3, while UVA-induced tans have an SPF of 0. Pre-holiday tans provide very little protection from UV radiation.
Not all UV radiation is bad for you; its positive effects include obtaining vitamin D.	Active individuals in Australia are thought to receive sufficient UV radiation for vitamin D synthesis in their everyday pursuits. Compared with sunlight exposure, solarium use results in negligible vitamin D production.
For every study that concludes that solarium use contributes to skin cancer, another refutes this.	UVA and UVB are listed as carcinogens by the World Health Organization. Solaria are a source of UVA and UVB, hence can contribute to the development of skin cancers. Recent expert reviews conclude that solarium use increases melanoma risk.[12,13]

UVA = ultraviolet A. UVB = ultraviolet B.
* Adapted from reference 2. Sources: 2007 media reports, solarium industry websites, Australian Cancer Councils, and the World Health Organization. ◆

tion of pre-teens intended to use a solarium.[15] Childhood exposure to UV radiation is a major determinant of melanoma risk in later life, indicating that childhood may be a critical period in which the skin is vulnerable to irreparable UV-induced damage.[18] Exposure at ages 10–24 years also appears important in promoting melanoma development.[19]

Evidence of the link between artificial UV radiation exposure and melanoma has been accumulating for years. Reviews published in 1994 and 2006 both concluded that solarium users have a higher risk of developing melanoma than non-users.[12,13] The risk was 75% higher for those younger than 35 years at first solarium use (the most common users), and the corresponding risk of SCC of the skin was more than doubled.[13] In comparison, the overall risk of melanoma for all users was increased by 15%.[13] However, most studies have been based in North America or Europe, so their relevance to Australia is unclear.

Fair skin (Type I on the Fitzpatrick scale) is associated with a doubling of skin cancer risk, compared with darker skin.[20] Hence banning individuals with Type I skin should be an integral part of any regulatory program. A high percentage of Australians are fair-skinned,[21] and many exhibit other key phenotypic risk factors for skin cancer, such as blue/green eyes, light-coloured hair and moderate to high prevalence of melanocytic naevi. Additionally, Australia has a high ambient solar UV radiation level for most of the year,[22] which potentiates the risk of skin cancer. If an increasing proportion of young people begin using high-intensity sunbeds, the skin cancer burden in Australia will escalate further. However, in the absence of a well designed Australian study, the precise effects of solarium use on skin cancer rates in Australia[23] remain speculative.

Modelling the impact of solaria in Australia

In 2003, Diffey estimated the annual number of melanoma-related deaths attributable to artificial UV radiation in the United Kingdom to be approximately 100 (95% CI, 50–200).[19] We replicated Diffey's model using Australian data from the five most populous states. Our focus was on tanning behaviour of individuals younger than 40 years. We incorporated the most recent Australian data on outdoor UV radiation exposure,[24] melanoma incidence[23] and mortality,[25] as well as results of recent tests by ARPANSA of UV radiation emission from sunbeds currently used in Australia.

Results of our model are shown in Box 2. We estimated that the annual number of new melanomas attributable to solarium use is highest in Queensland (121), followed by NSW (75) and Victoria (51), and that 43 melanoma-related deaths attributable to solarium use may occur per year across the five states. In addition, 2572 new cases of SCC are potentially attributable to solarium use.

The potential cost savings to the health system (mainly Medicare Australia) of avoiding primary care treatment of these new cases of melanoma is estimated to be $500 000 per year, and an estimated $2.5 million could be saved on treatment of new cases of SCCs (for cost-estimation methods, see reference 2). This includes hospitalisation costs for treatment of 43 patients with advanced-stage cancer only (corresponding to the estimated melanoma-related deaths), as new melanoma and SCC cases are typically treated in primary care settings,[31] where Medicare meets the costs. Skin cancer is the most expensive cancer to treat in Australia, and costs are continuing to rise rapidly.[32] Recent Medicare statistics show that the costs per 100 000 people for standard SCC and basal cell carcinoma excisions rose up to 34% between 2000 and 2006.[33] However, the full annual costs for skin cancers — including doctors' visits, excision, other treatments, pathology and follow-up — are unknown.

Our model has several limitations: it does not account for the latent period between UV radiation exposure and development of melanoma (it assumes incidence and mortality remain constant); it does not explicitly deal with fair-skinned individuals; and, although the action spectrum for human melanoma induction is unknown, it assumes that the spectra from sunbeds and sunlight are equally carcinogenic. However, the model does provide benchmark information by estimating the harmful impact of UV radiation exposure associated with solarium use, and the human and economic costs that could be avoided by effective solarium regulation.

Conclusions

Unlike other risk factors for chronic diseases that are not modifiable (eg, ageing and genetic predisposition), personal exposure to UV radiation can be controlled through structural, behavioural, educational and health promotion initiatives. Many campaigns over the past three decades have promoted sun-protection behaviour at a population level. Workplace standards specify Ultraviolet Protection Factor (UPF) rating of clothing and sunscreens, "SunSmart" policies exist in schools and early childhood centres, and warnings about the solar UV Index are publicised through the mass media. It is possible

2 Estimation of annual numbers of new cases of melanoma and squamous cell carcinoma, and melanoma-related deaths attributable to solarium use by younger people in the five most populous Australian states*

	Victoria	New South Wales	Queensland	South Australia	Western Australia
Latitude of capital city	37.8° S	33.9° S	27.5° S	34.9° S	32.0° S
Total annual ambient UVR (SED)†	8926	9867	12 265	10 694	12 307
Exposure to solar UVR					
Population UVR exposure (SED)‡ (*a*)	268	296	368	321	369
Percentage of younger people who intentionally tan outdoors* (*b*)	30%	22%	16%	22%	22%
UVR exposure due to intentional outdoor tanning (SED)§ (95% CI) ($a \times b = c$)	81 (44–137)	65 (41–98)	59 (35–92)	71 (45–106)	81 (49–126)
Exposure to artificial UVR					
Mean exposure per session (SED)† (SD) (*d*)	3.3 (0.7)	3.3 (0.7)	3.3 (0.7)	3.3 (0.7)	3.3 (0.7)
No. of solarium sessions per year (estimated average¶) (*e*)*[17]	10	10	10	10	10
Percentage of younger people who use solaria* (*f*)	9.0%	6.0%	13.5%	6.0%	6.0%
UVR exposure due to solarium tanning (SED)§ (95% CI) ($d \times e \times f = g$)	3 (1–7)	2 (1–5)	4 (1–11)	2 (1–5)	2 (1–5)
Skin cancer estimation					
Annual no. of new melanomas (2003)[23] (*h*)	1725	3030	2311	633	983
Annual no. of melanoma-related deaths (2005)[25] (*i*)	245	488	272	78	133
Proportion of melanomas attributable to UVR[26] (*j*)	0.825	0.825	0.825	0.825	0.825
No. of new melanomas attributable to UVR ($h \times j = k$)	1423	2500	1907	522	811
No. of melanoma-related deaths attributable to UVR ($i \times j = l$)	180	316	241	200	200
Proportion of total UV exposure from solarium use ($g/(g + c) = m$)	0.036	0.030	0.063	0.027	0.024
No. of new cases of melanoma due to solarium use ($m \times k$)	51	75	121	14	20
No. of melanoma-related deaths due to solarium use ($m \times l$)	7	12	14	5	5
No. of new cases of SCC due to solarium use**	294	636	1369	154	119

UVR = ultraviolet radiation. SED = standard erythemal dose (a measure of the erythemally effective UVR — the effect of UVR on human skin; 2 SED is typically required to produce sunburn of fair skin). SCC = squamous cell carcinoma.

* Estimates are based on different age groups for different states: data are for 14–29-year-olds in Vic (outdoor tanning only),[27] 16–24-year-olds in NSW,[8,16] and 20–39-year-olds in Qld;[28] data for SA, WA and solarium use in Vic are approximations based on a national outdoor tanning level for adolescents of 15%–32%, and a national indoor tanning level for 12–44-year-olds of 3%–12.5%,[29,30] and taking into account the higher growth of the solarium industry in Vic than in other states.

† Erythemally effective UVR doses of solar (1996–2007) and artificial (2007) radiation were recorded by the Australian Radiation Protection and Nuclear Safety Agency.

‡ Calculated as 3% of total ambient UVR,[24] and assigning a log-normal distribution in the model.

§ Derived using Monte Carlo simulation methods; 5000 simulations were run with log-normal distributions for number of solarium sessions per year and population UVR exposure, beta distributions for tanning use, and normal distributions for other parameters.

¶ Assigning a log-normal distribution in the model.

** Estimates were based on the calculated proportion of total UV radiation exposure from solarium use and age-standardised rates of SCC per 100 000 persons in 2002, extrapolated to 2002 population estimates. ◆

that the benefits of these dedicated efforts to protect Australians from developing skin cancer will be partly negated if the solarium industry is not regulated. Thus, there is a strong case for national regulation in Australia, notwithstanding the recognition that intentional sunbathing outdoors is a far greater behavioural problem than indoor tanning (Box 2). Investment in broad sun-protection policies at a population level remains critical. The human and economic burden of skin cancer in Australia is already formidable and will continue to grow in the absence of concerted government, industry and individual efforts to avoid excessive exposure to UV radiation — both solar and artificial.

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Competing interests

Louisa Gordon was paid consultancy fees in an arrangement between the Queensland Institute of Medical Research and ARPANSA. The report cited as reference 2 was the core outcome of this arrangement, and Louisa Gordon received travel assistance to report its findings in Melbourne in November 2007. The model of the impact of solaria in Australia described here is not included in the report. This article was prepared independently as a collaborative effort between the QIMR and ARPANSA researchers who are the named authors.

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In Australia, it was estimated in 2009 that simply restricting solarium use for individuals below age 18 and with very fair skin could potentially avoid around 250 serious skin cancers, save 31 years through avoided melanoma deaths, and result in a cost savings of approximately $250,000 to the federal government via Medicare, over the lifetime of a population of 100,000 persons.[Â What impact would effective solarium regulation have in Australia? Med J Aust 2008 Oct 6;189(7):375-8 Abstract available at http://www.ncbi.nlm.nih.gov/pubmed/18837680. â†‘ Cust AE, Armstrong BK, Goumas C, Jenkins MA, Schmid H, Hopper JL, et al.