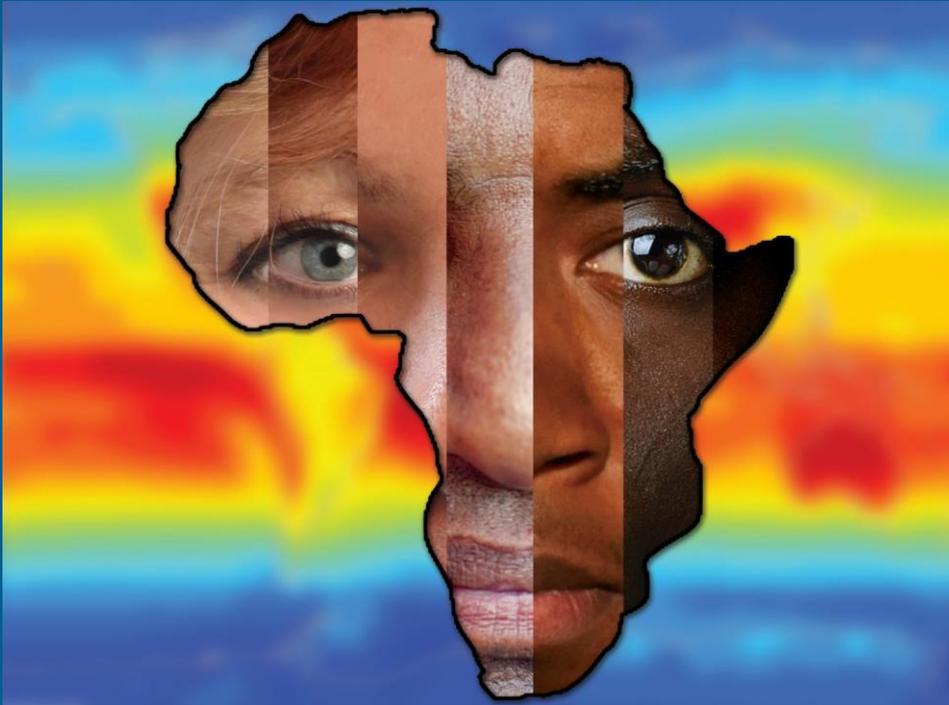


STRATOSPHERIC OZONE, SOLAR UV RADIATION AND HUMAN HEALTH



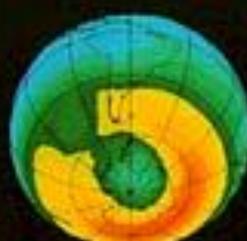
*Caradee Y Wright*¹

¹ Environment and Health Research Unit, South African Medical Research Council (MRC), and Department of Geography, Geoinformatics and Meteorology, University of Pretoria, Pretoria, South Africa

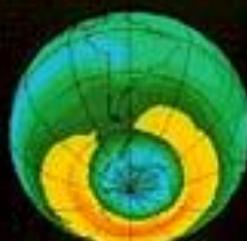
29 November 2016, MOSS – Not for distribution, confidential



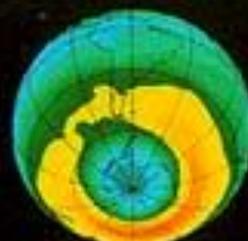
Nimbus-7 TOMS Images: The 14 Octobers



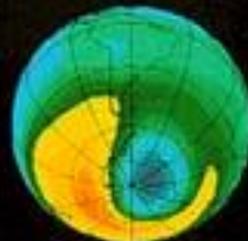
October 1979



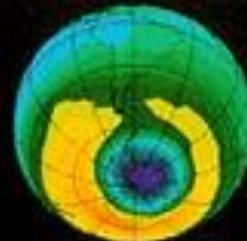
October 1980



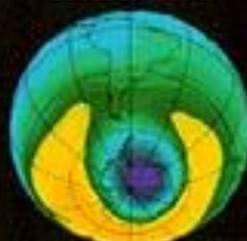
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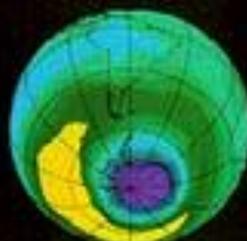
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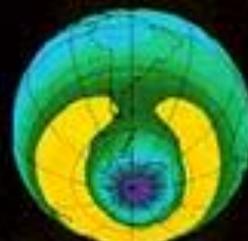
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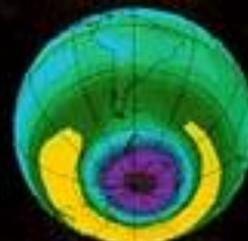
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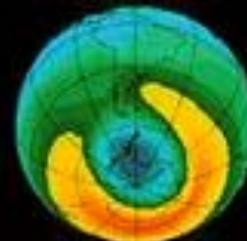
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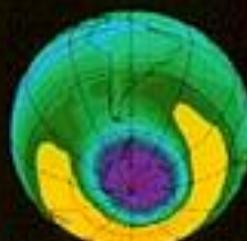
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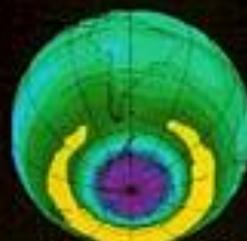
October 1987



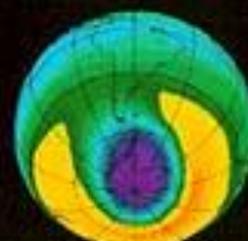
October 1988



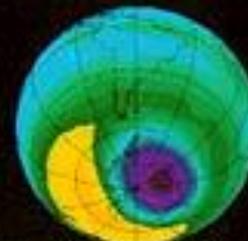
October 1989



October 1990



October 1991



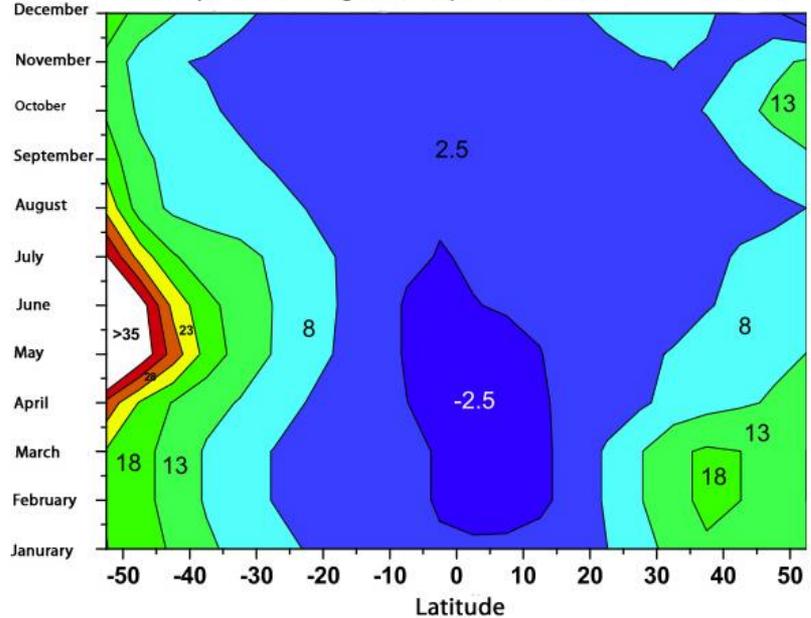
October 1992

MONTHLY MEAN
TOTAL OZONE



NIMBUS 7 TOMS
NASA/GSFC

Monthly Percent Change in UV exposure from 1979 to 2008 (305 nm)

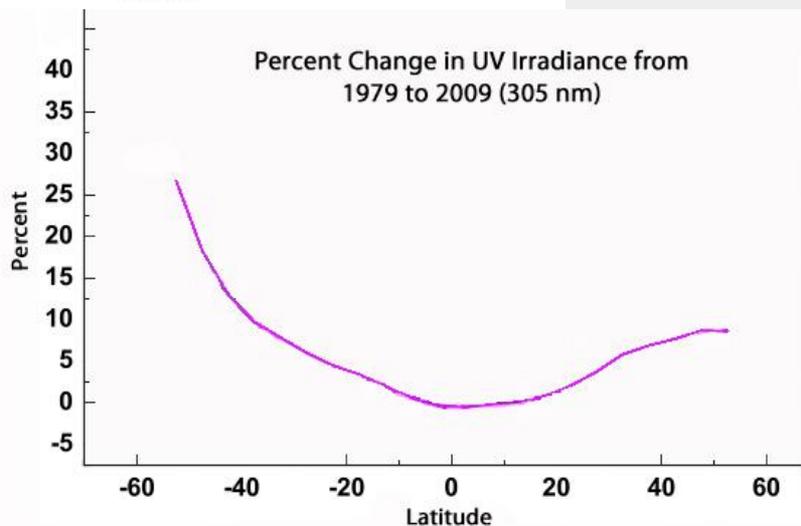


The largest increases in UV (shown in white, red, orange, and yellow) have occurred in the southern hemisphere during April, May and June.

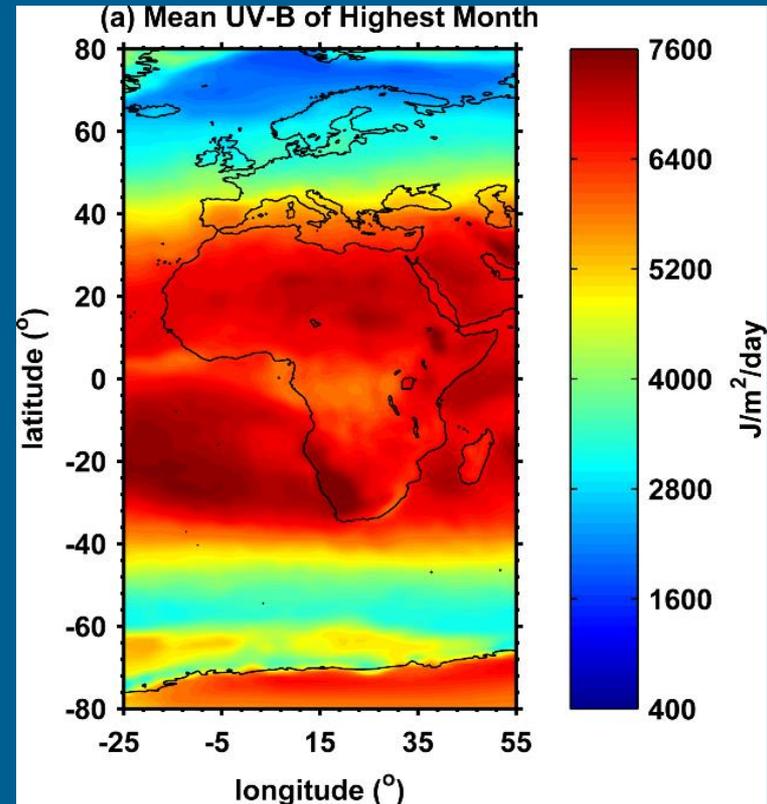
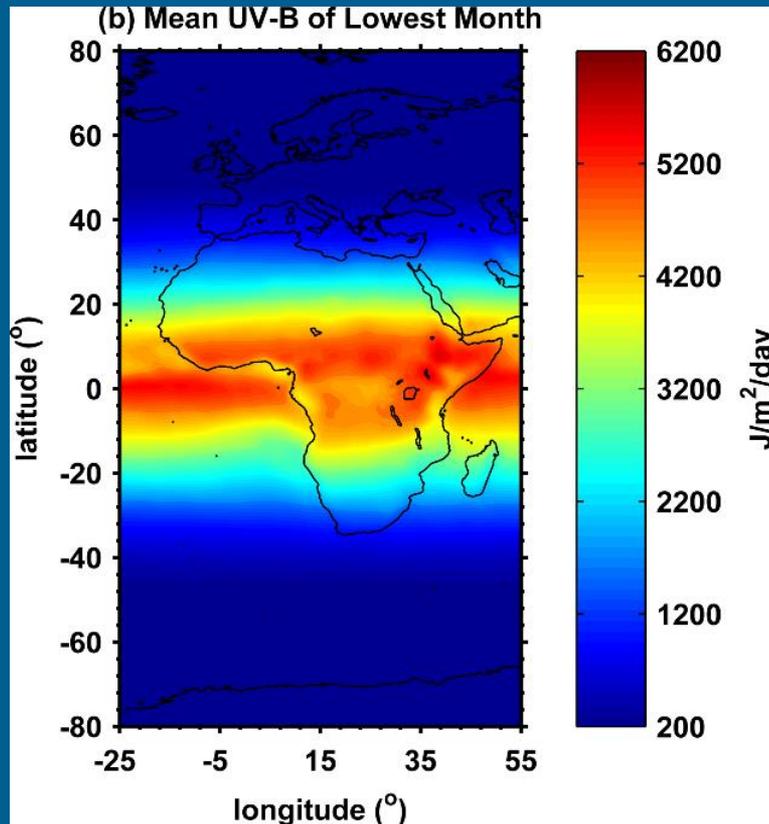
In the tropics, increases in UV have been minimal (shown in blue).

Though the size of UV wavelengths ranges from 290 to 400 nanometers, 305 nanometer UV is one of the most damaging types for humans. **Credit:** NASA's Goddard Space Flight Center/Jay Herman

Percent Change in UV Irradiance from 1979 to 2009 (305 nm)



Mean UV-B levels across Africa



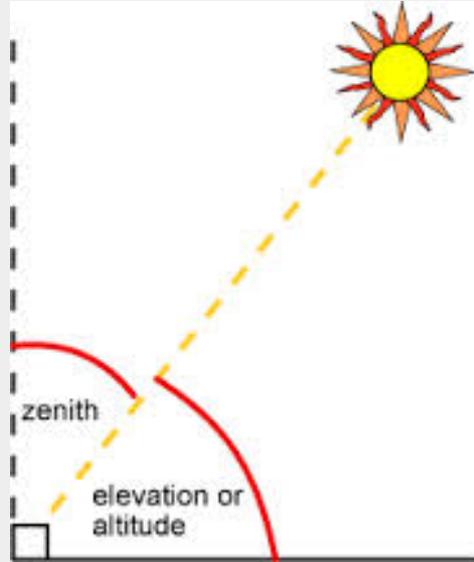
[Source: Lucas, Norval, Wright. Photochem & Photobiol Sci 2016; 15(1): 10-23]

Factoring influencing solar UV radiation ????

1



- Solar zenith angle
- Ozone concentration
- Cloud cover
- Season
- Altitude
- Albedo, or surface reflection
- Presence of aerosols
- Geographical latitude



2



3

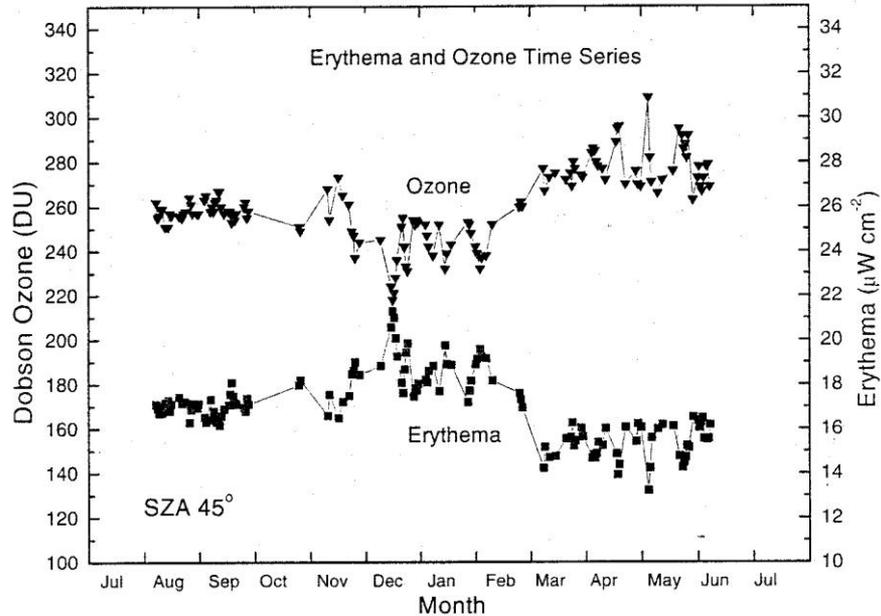
4

5

6

7

8



Investigating the anti-correlation between
Ozone and Ultraviolet radiation over Cape
Point and a possible association with
Antarctic ozone hole events

Jean du Preez – University of Pretoria
Supervisor: Dr. C. Wright - Medical Research
Council



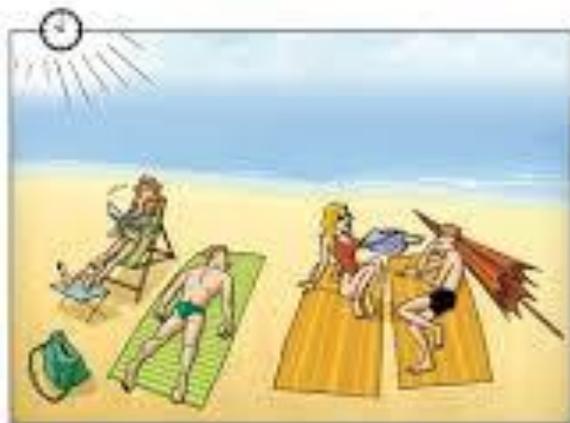




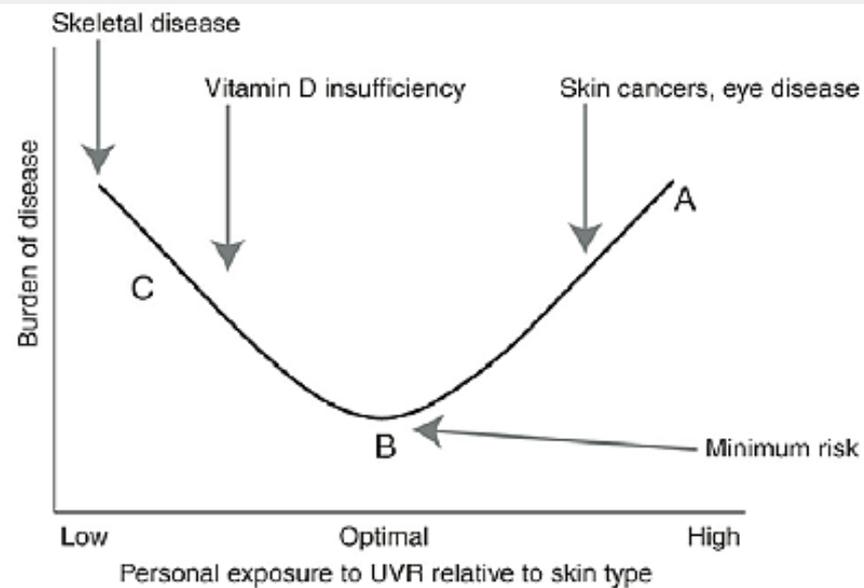
ATMOSPHERIC SCIENCE



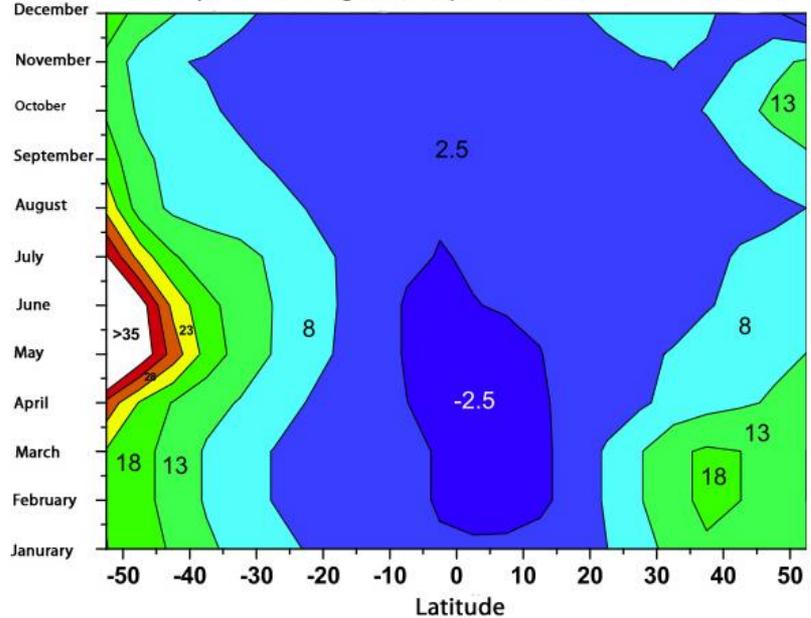
PUBLIC HEALTH



RISK = HAZARD x EXPOSURE



Monthly Percent Change in UV exposure from 1979 to 2008 (305 nm)

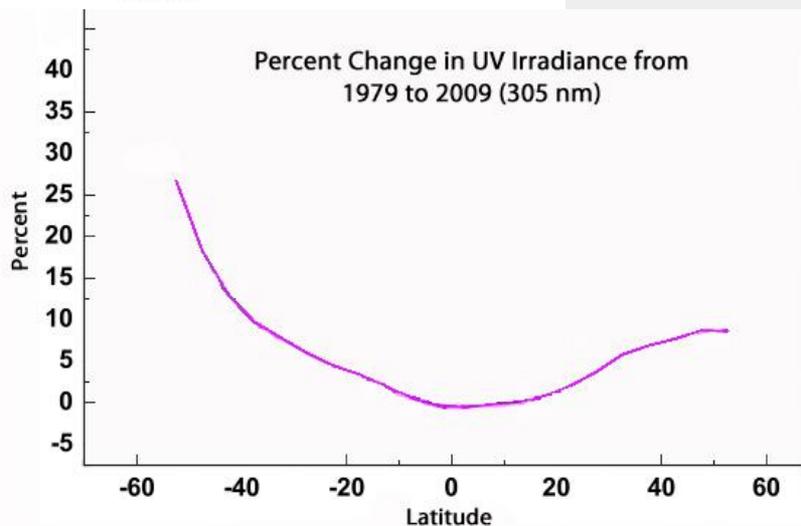


The largest increases in UV (shown in white, red, orange, and yellow) have occurred in the southern hemisphere during April, May and June.

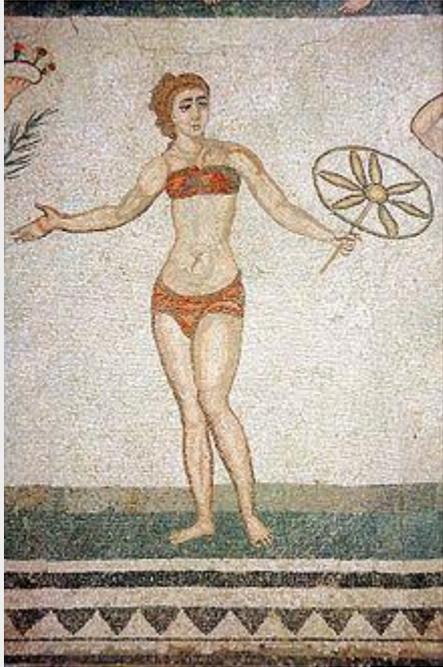
In the tropics, increases in UV have been minimal (shown in blue).

Though the size of UV wavelengths ranges from 290 to 400 nanometers, 305 nanometer UV is one of the most damaging types for humans. **Credit:** NASA's Goddard Space Flight Center/Jay Herman

Percent Change in UV Irradiance from 1979 to 2009 (305 nm)



French engineer, Louis Réard, introduced the modern bikini on 5 July 1946, borrowing the name for his design from the Bikini Atoll where post-war testing on the atomic bomb was taking place.



Continuous UV exposure estimated to elicit sunburn on un-tanned skin

| Skin type | Description of skin type & phenotypic characteristics | UV exposure (SED) * |
|-----------|---|---------------------|
| V-VI | Brown or black skin, dark hair, brown eyes, rarely burns | 6-20 |
| IV | Light brown skin, brown eyes, burns rarely | 4.5-6 |
| III | White or light brown skin, brown hair, may burn | 3-5 |
| II | Fair skin, fair/red hair, freckles, burns very readily | 2.5-3 |
| I | Fair skin, fair/red hair, light eyes, freckles, always burns on minimal sun exposure | 2-3 |

(Fitzpatrick, 1988) * SED = standard erythemal dose, 1 SED = 100 Jm²

South African population



Population groups are categorised due to historical segregation as

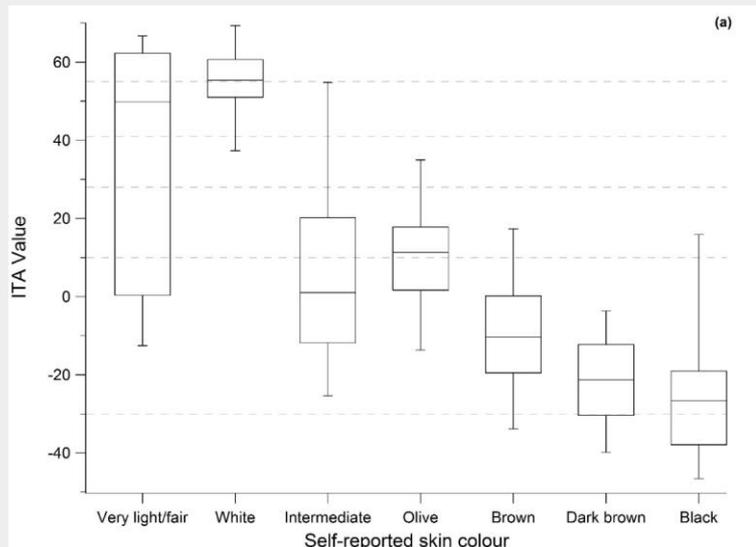
- Black African (80.2% of the 2014 population),
- Coloured (8.8%; defined as mixed European [white] and African [black] or Asian/Indian ancestry with skin colour ranging from pale to dark brown)
- White (8.4%) and
- Indian/Asian (2.5%)



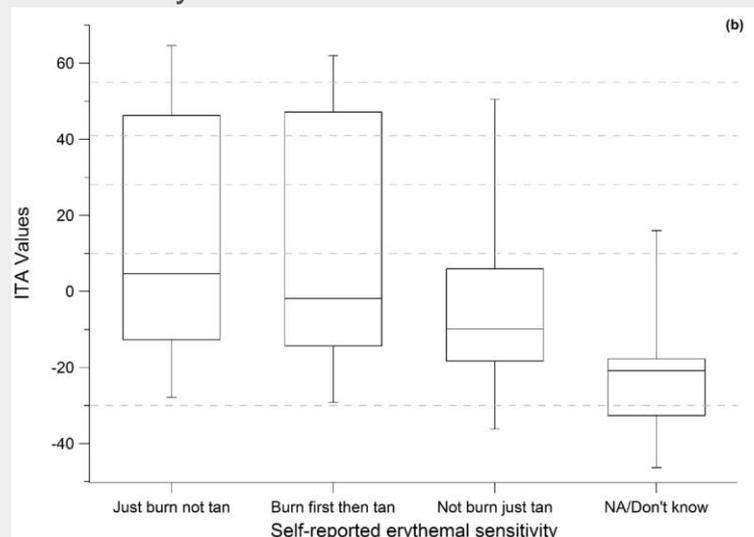
There is a range in skin phototypes /colours so sun protection advice needs to be relevant

Sample: 556 adults, 70% Black Africans

Self-report biases in under- and over-estimation of skin colour were evident.



Many participants with 'dark brown' and 'black' skin had difficulty in classifying erythematous sensitivity.



95% of Black African participants acknowledged that they were photosensitive

[Wilkes, Wright, du Plessis, Reeder. JAMA Dermatol 2015; DOI: 10.1001/jamadermatol.1.2015.0351]

[Figures from Wright, Wilkes, du Plessis, Reeder. Self-reported skin colour and erythematous sensitivity versus objectively measured constitutive skin colour in an African population with predominantly dark skin. Photodermatol Photoimmunol Photomed 2015; 31: 315-324]

'Skin cancer does not discriminate'

LIFESTYLE / 21 January 2016, 6:00pm

 **Vuyo Mkhize**

Johannesburg - It started off looking like a beauty spot on the left side of her leg.

Actress and TV presenter Naniki Seboni, 25, didn't think much of it at first, aside from the pain she felt from it. So she dismissed it as a little spot that would go away with self surgery, if she just took a needle and gouged it out.

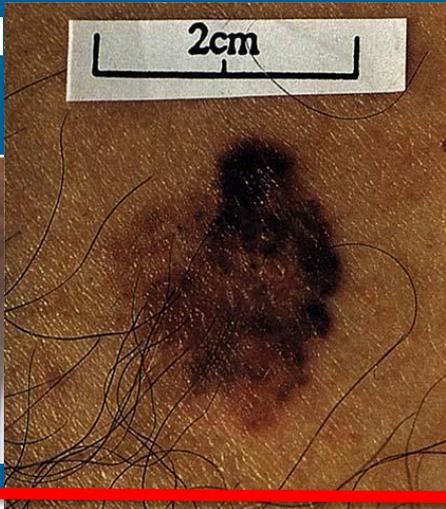


Naniki Seboni was diagnosed with malignant melanoma at the age of 25. Picture: Supplied.

Credit: SUPPLIED

“After her initial diagnosis, Seboni said it took her a couple of months to go back to the hospital because she feared what it meant for her life.”

Melanoma



Basal Cell Carcinoma



Actinic Keratosis (early Squamous Cell Carcinoma)



Squamous Cell Carcinoma



NMSC

A melanoma risk factor: blistering sunburn



An increased risk of melanoma was seen with increasing number of sunburns for all time-periods (childhood, adolescence, adulthood and lifetime).

Other risk factors are skin type, family history, sun exposure etc.

Mean age-standardised annual incidence of reported squamous cell carcinoma of the skin (SSCC), basal cell carcinoma (BCC) and cutaneous melanoma (CM) per 100,000 persons in the Black, Asian, Coloured and White populations of South Africa, 2000-2004

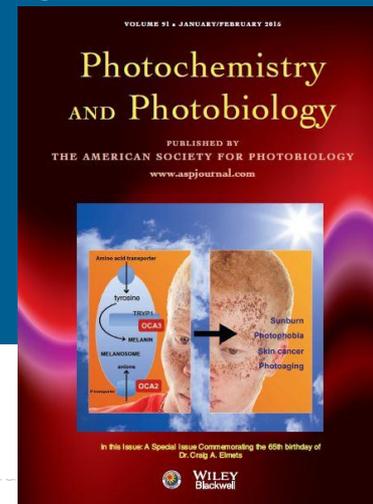
| | Black | Asian | Coloured | White | All |
|-------------|-------|-------|----------|-------|------|
| BCC: | | | | | |
| Male | 3.0 | 7.7 | 59.2 | 198.3 | 51.3 |
| Female | 1.7 | 5.3 | 26.5 | 112.8 | 25.4 |
| SCC: | | | | | |
| Male | 3.0 | 4.3 | 26.1 | 69.5 | 20.8 |
| Female | 1.6 | 2.7 | 15.4 | 31.8 | 8.5 |
| CM: | | | | | |
| Male | 1.0 | 0.7 | 5.9 | 20.5 | 5.3 |
| Female | 1.2 | 1.1 | 4.1 | 16.5 | 3.9 |

[Table from Norval, Kellett, Wright. The incidence and body site of skin cancers in the population groups of South Africa. Photodermatol Photoimmunol Photomed 2014; 30: 262-265.]

The South African Melanoma Advisory Board estimated an incidence in 2009 of 69 cases of CM per 100,000 White people living in the Western Cape. [www.melanoma.co.za/D_MFS.asp]

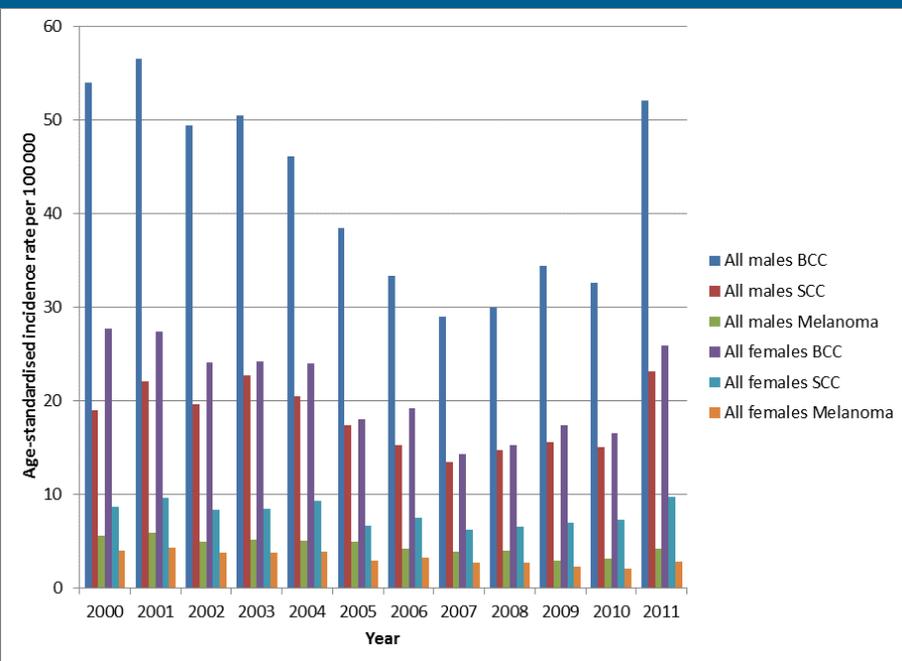
Skin cancer is common among Black Africans with oculocutaneous albinism. SCC is becoming increasingly more common among Black Africans living with HIV/AIDS.

[Stein et al Int J Cancer 2008; 122: 2260-2265; Nthumba et al Ann Plast Surg 2011; 66: 1267-1274 York et al, accepted in SAMJ; Diffey et al, accepted in SAMJ]



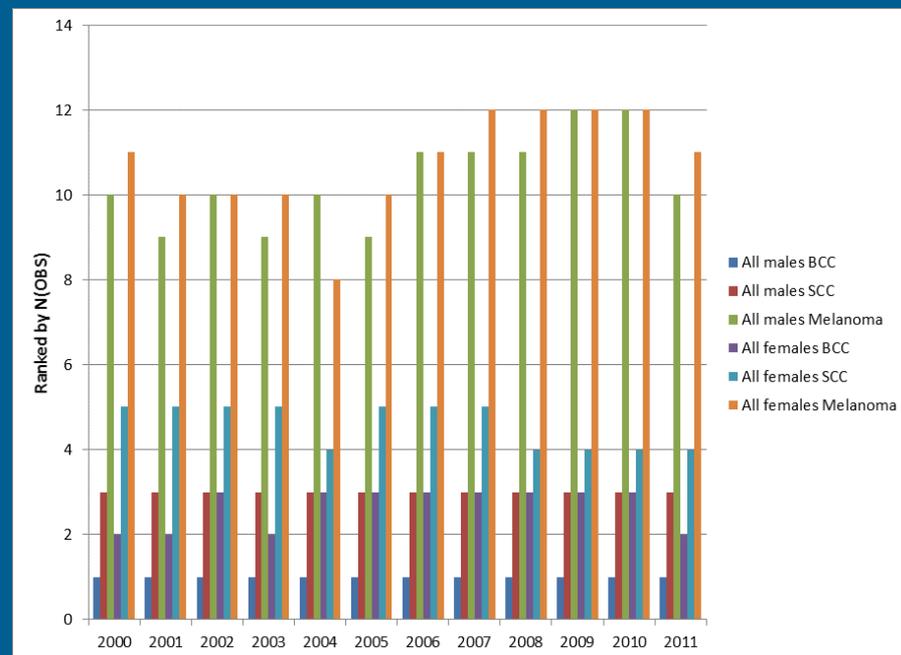
Skin cancer morbidity in South Africa

Age-standardised incidence rates per 100 000
(National Cancer Registry data)



Marked change in 2011 data.

Cancer ranking by N(OBS) among all other cancers listed
(National Cancer Registry data)



Male BCC is always ranked No 1.

RESEARCH ARTICLE

Open Access



Modelling the healthcare costs of skin cancer in South Africa

Louisa G. Gordon^{1,2*}, Thomas M. Elliott^{1,2}, Caradee Y. Wright³, Nicola Deghaye⁴ and Willie Visser⁵

Abstract

Background: Skin cancer is a growing public health problem in South Africa due to its high ambient ultraviolet radiation environment. The purpose of this study was to estimate the annual health system costs of cutaneous melanoma, squamous cell carcinoma (SCC) and basal cell carcinoma (BCC) in South Africa, incorporating both the public and private sectors.

Methods: A cost-of-illness study was used to measure the economic burden of skin cancer and a 'bottom-up' micro-costing approach. Clinicians provided data on the patterns of care and treatments while national costing reports and clinician fees provided cost estimates. The mean costs per melanoma and per SCC/BCC were extrapolated to estimate national costs using published incidence data and official population statistics. One-way and probabilistic sensitivity analyses were undertaken to address the uncertainty of the parameters used in the model.

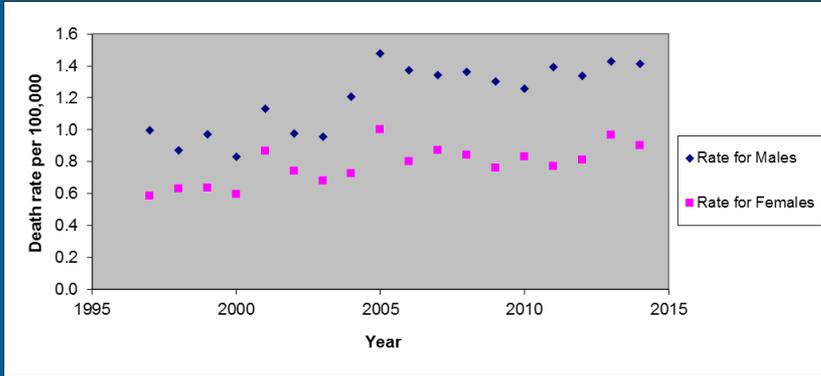
Results: The estimated total annual cost of treating skin cancers in South Africa was ZAR 92.4 million (2015) (or US\$ 15.7 million). Sensitivity analyses showed that the total costs could vary between ZAR 89.7 to 94.6 million (US\$15.2 to \$16.1 million) when melanoma-related variables were changed and between ZAR 78.4 to 113.5 million (\$13.3 to \$19.3 million) when non-melanoma-related variables were changed. The primary drivers of cost analysis were the cost of excisions, follow-up care, radical lymph node dissection, cryotherapy and radiation therapy.

Conclusion: The cost of managing skin cancer in South Africa is sizable. Since skin cancer is largely preventable through improvements to sun-protection awareness and skin cancer prevention programs, this study highlights these healthcare resources could be used for other pressing public health problems in South Africa.

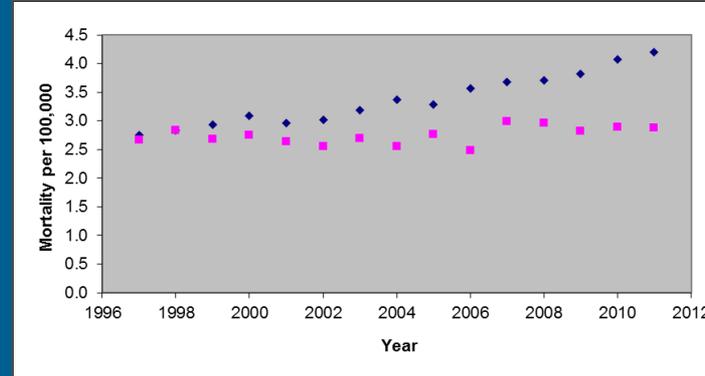
Keywords: Cost-of-illness, Melanoma, Squamous cell carcinoma, Basal cell carcinoma, Skin cancer

Melanoma mortality rates per 100 000 in South Africa

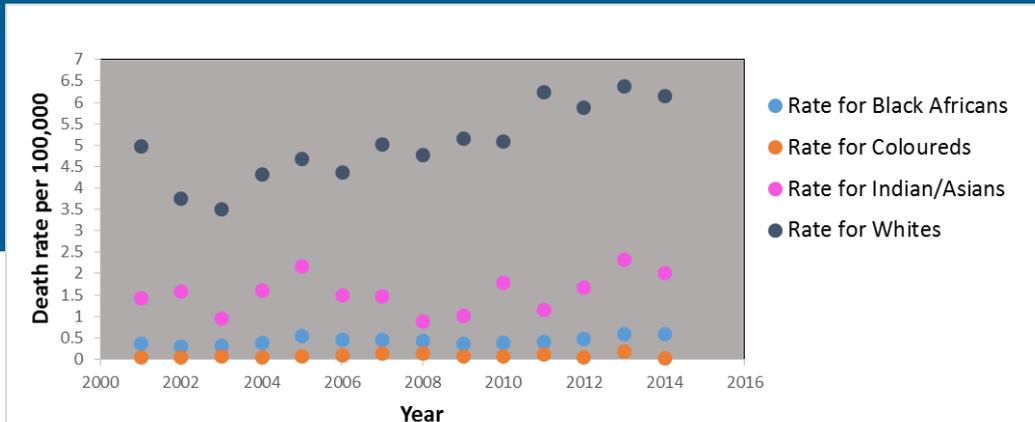
South Africa



England [England data from BL Diffey]

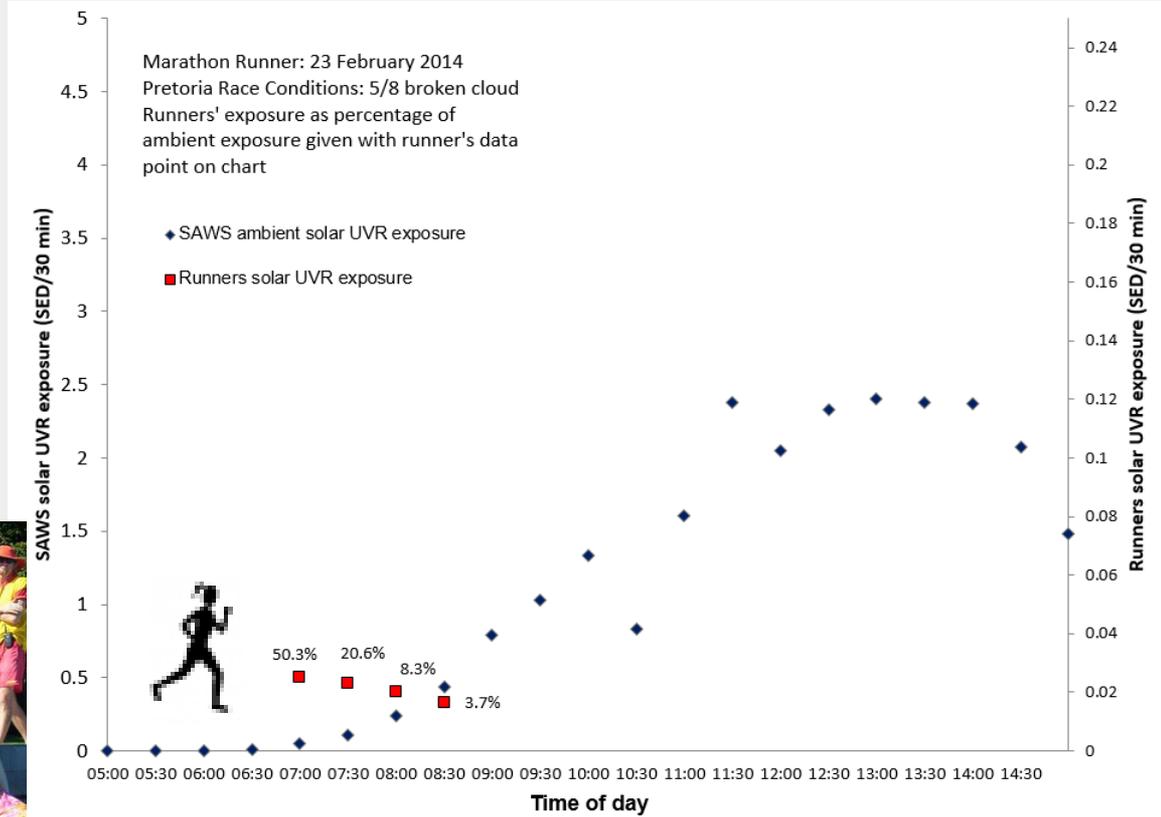


The number of deaths from melanoma skin cancer doubled from 319 in 1997 to 623 in 2014.



[Research underway – not for distribution or citing]

Personal solar UV radiation dosimetry – personal dosimeters



Nurse, V, Wright CY, Allen M and McKenzie, RL. 2015. Solar ultraviolet radiation exposure of South African marathon runners during competition marathon runs and training sessions: a feasibility study. *Photochemistry and Photobiology*, 91(4): 971-979. DOI: 10.1111/php.12461

OCCUPATIONAL SUN EXPOSURE

- Outdoor workers > twofold risk for NMSC
- Solar UVR dosimetric measurements high (SA?)
- Define country-specific exposure limits for outdoor workers (WHO; ICNIRP; ARPANSA)
 - The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) provides the maximum exposure guidelines for occupational exposures - the occupational exposure limit is 30 Jm^{-2} per day but this has a different weighting function from that of the CIE erythral action spectrum (Radiation Protection Series No 12).
- Skin cancer **is** recognized as an occupational cancer in several countries around the world
- Challenges
 - Lack of sun risk knowledge among workers (skin and eyes)
 - Higher risk behavior
 - Low health literacy
 - Rarely health surveillance by employer
 - Seldom organization changes at worksite
 - Poor instructions from employer

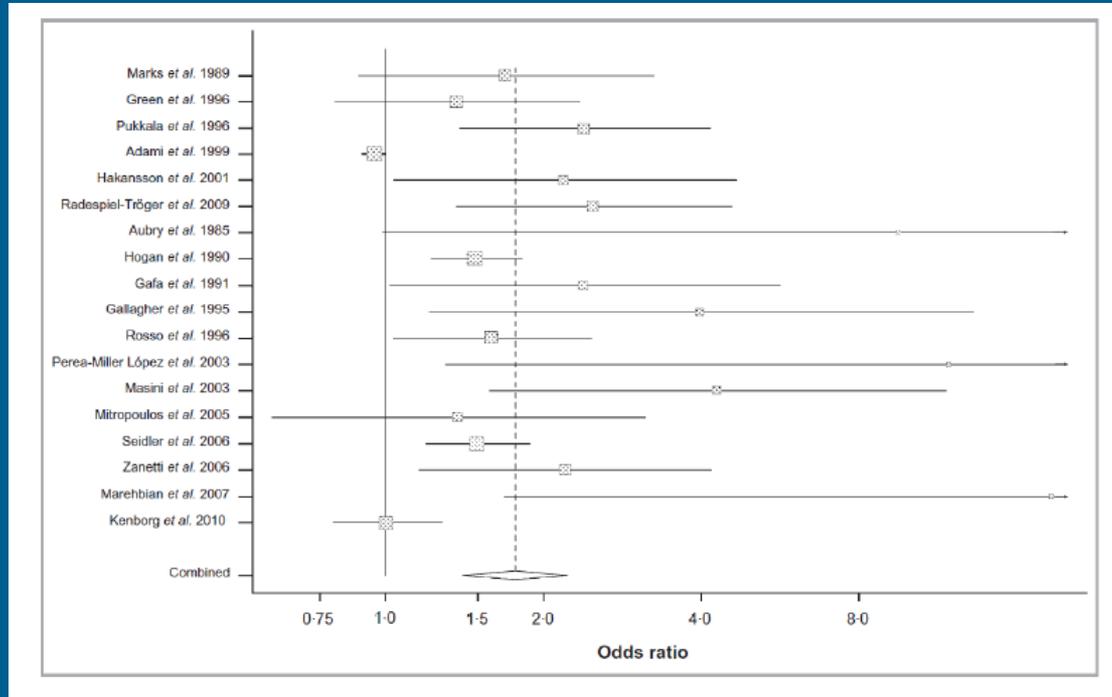


International Labour Organization has published its latest ILO List of Occupational Diseases in 2010, in which it lists “diseases caused by optical (UV, visible light, infrared) radiations including laser”.

1.2. Diseases caused by physical agents

- 1.2.1. Hearing impairment caused by noise
- 1.2.2. Diseases caused by vibration (disorders of muscles, tendons, bones, joints, peripheral blood vessels or peripheral nerves)
- 1.2.3. Diseases caused by compressed or decompressed air
- 1.2.4. Diseases caused by ionizing radiations
- 1.2.5. Diseases caused by optical (ultraviolet, visible light, infrared) radiations including laser
- 1.2.6. Diseases caused by exposure to extreme temperatures
- 1.2.7. Diseases caused by other physical agents at work not mentioned in the preceding items where a direct link is established scientifically, or determined by methods appropriate to national conditions and practice, between the exposure to these physical agents arising from work activities and the disease(s) contracted by the worker

Results of meta-analysis shows the OR values for SCC in individuals with outdoor versus indoor occupations



[Schmitt J, Seidler A, Diepgen TL *et al.* Occupational ultraviolet light exposure increases the risk for the development of cutaneous squamous cell carcinoma: a systematic review and meta-analysis. *Br J Dermatol* 2011; **164**: 291-307.]

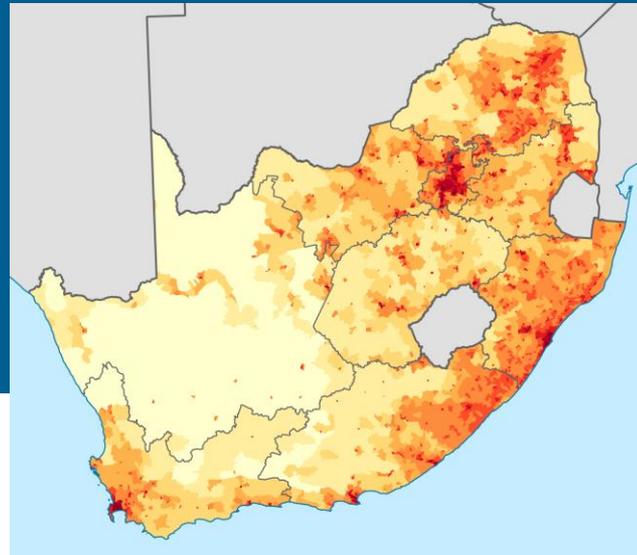
| Occupational skin cancer | | | | | 17 |
|--------------------------|--------------------|-------|------|-----------|----|
| Flight | Destination | Time | Gate | Status | |
| SA 001 | Prevention | | | Delayed | |
| SA 002 | Workers' education | | | Cancelled | |
| SA 003 | Early detection | | | Cancelled | |
| SA 004 | Treatment | | | Delayed | |
| SA 005 | Compensation | | | Cancelled | |
| UA 4587 | via Dakar | 20:15 | A14 | | |
| AA 6446 | London-Heathrow | 20:15 | A16 | Cancelled | |
| SA 7242 | Zurich | 20:20 | A4 | | |
| UA 4592 | Frankfurt | 20:20 | A11 | | |
| TK 081 | Istanbul | 20:25 | A1 | | |

CAREX Canada model applied and adapted for South Africa

SA population: 51 770 560 (2011)

Total working population: ~13 204 496

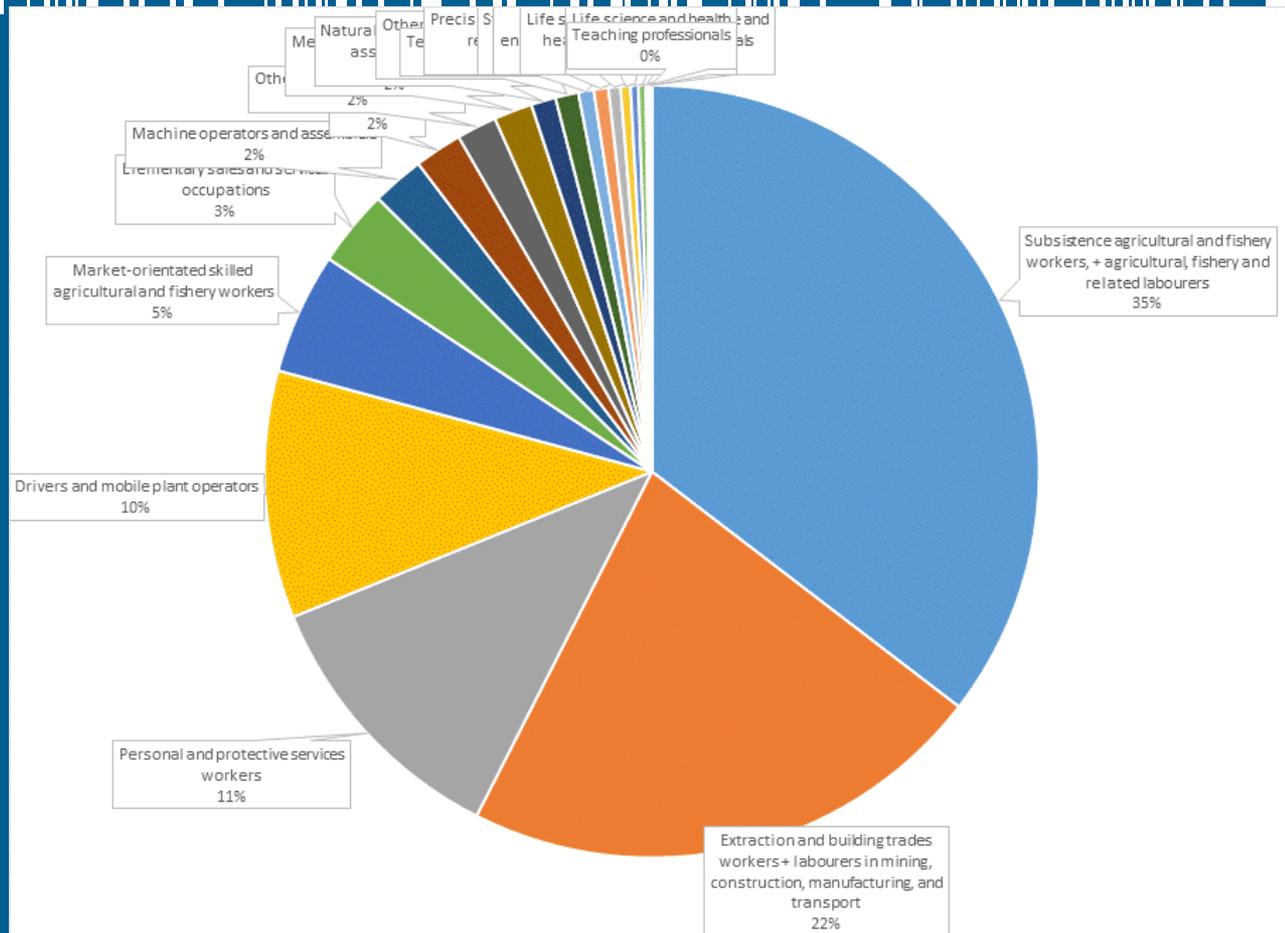
Total working population exposed: ~1 156 000 (8.7% of working population)



[Research currently underway in collaboration with CAREX;
Data analysis courtesy of Cheryl Peters, Canada]

Number exposed (n=1 156 000)
in South Africa by Occupation
sub-group

(Using Statistics SA 2011 data)



Examples of countries/territories (in Canada) with NMSC as a recognized occupational disease



State
legislation /
Media



Compensable
disease



Strong
labour
unions



Acknowledging NMSC
as an occupational
disease opened the door
for prevention

Reporting, notifications and recognition

Recognized Occupational Skin Cancer in Denmark – Data From the Last Ten Years

Tanja K. Caroe¹, Niels E. Ebbeløj¹, Hans Christian Wulf² and Tove Agner^{2*}
 Departments of ¹Occupational and Environmental Medicine and ²Dermatology, University of Copenhagen, Bispebjerg Hospital, Bispebjerg Bakke 25, DK-2400
 København NV, Denmark. *E-mail: t.agner@dadlnet.dk
 Accepted Aug 20, 2012; Epub ahead of print Jan 1, 2013

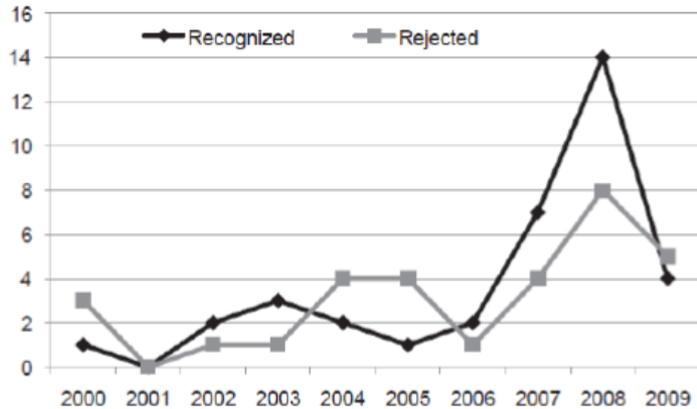


Fig. 1. Number of recognized occupational skin cancer and rejected cases during the period 01/01 2000–31/12 2009.

2000–2009: 36 cases recognized as occupational skin cancer

Acta Derm Venereol 93

Germany

6800 in 2015
reported

Notifications 2005–2011: 548
 Recognitions 2005–2011: 74

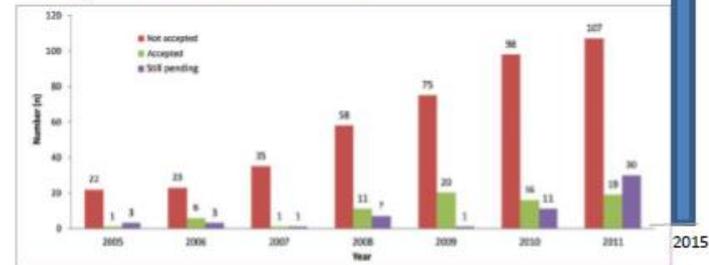
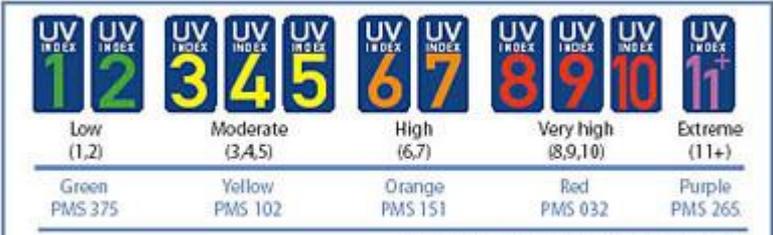


Figure 1. Notified cases of occupational skin cancer due to UV radiation according to paragraph 9, section 2 of the German Social Security Code (SGB VII) and outcome of procedures in 2005 to 2011 (n = 548).
 Schmitt J, Diepgen TL, *JDDG* 2014, 49:1–497

[Source: John SM. The EADV global call for action. 2016]

UV Index

- The UVI is a measure of the level of UV radiation.
- The values of the index range from zero upward - the higher the UVI, the greater the potential for damage to the skin and eye, and the less time it takes for harm to occur.
- The UVI is an important vehicle to alert people about the need to use sun protection.



| | | | | | | | | | | |
|------------------|---------------|---------------------|---------------|---------------|-------------------|---------------|-----------------------|---------------|----------------|-------------------|
| UV INDEX 1 | UV INDEX 2 | UV INDEX 3 | UV INDEX 4 | UV INDEX 5 | UV INDEX 6 | UV INDEX 7 | UV INDEX 8 | UV INDEX 9 | UV INDEX 10 | UV INDEX 11+ |
| Low (1,2) | | Moderate (3,4,5) | | | High (6,7) | | Very high (8,9,10) | | | Extreme (11+) |
| Green PMS 375 | | Yellow PMS 102 | | | Orange PMS 151 | | Red PMS 032 | | | Purple PMS 265 |

Table 4: Presenting the UVI: International colour codes¹

Known UVR / UVI networks in Africa



Central Namibia UV Index Forecast

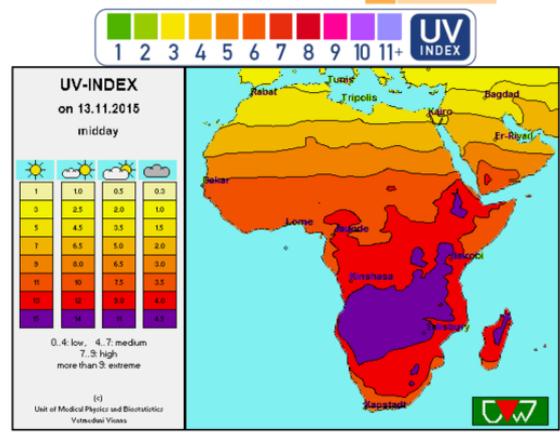
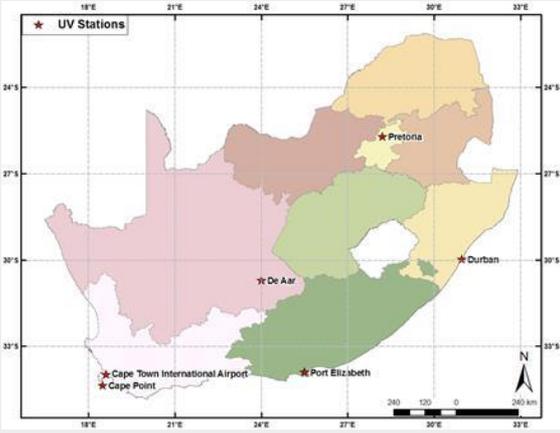
UV rays can cause skin cancer - click here to know your skin type and how to protect yourself
 Reduce your risks of skin cancer - click here

For more information visit the CANCER ASSOCIATION OF NAMIBIA



UV forecast courtesy of and Copyright © KMI/ESA (http://www.temis.nl/). Used with permission.

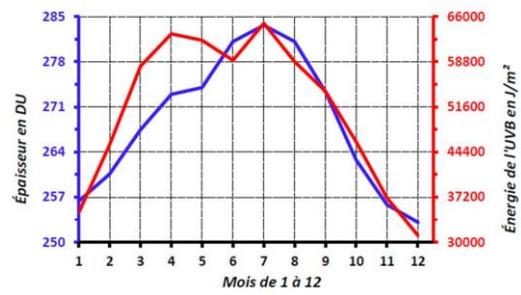
South African Biometer Network



Tamarassett, Algeria (Brewer spectrometer)

Egyptian UVR Network

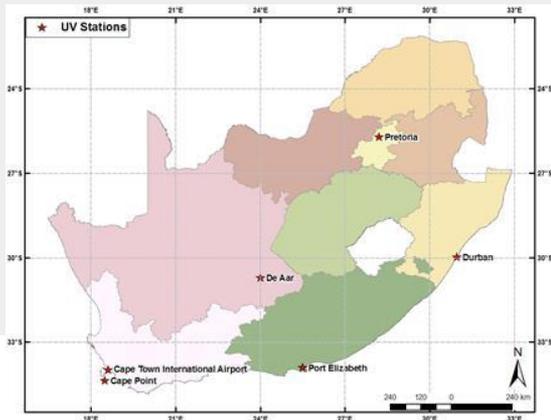
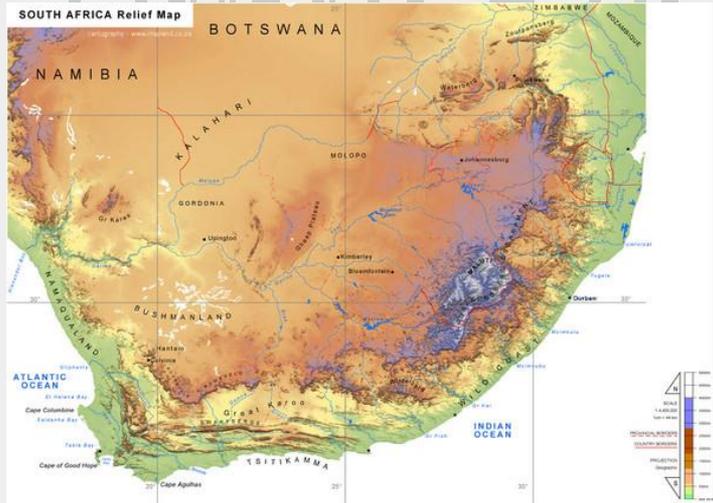
| | Aswan | Qena | Cairo | Rafaah | Matrouh |
|-----------------|-------------------|-------------------|-------------------|-------------------|------------|
| UV Instrument | Epply Radiometer | Epply Radiometer | Epply Radiometer | - | - |
| Started at | Aug. 1989 | Apr. 2000 | Mar. 1989 | - | - |
| UV-B Instrument | UVB-1 Pyranometer | UVB-1 Pyranometer | UVB-1 Pyranometer | UVB-1 Pyranometer | Brewer MII |
| Started at | Sep. 1998 | Apr. 2000 | May 1996 | Jun. 2000 | Jan. 1998 |



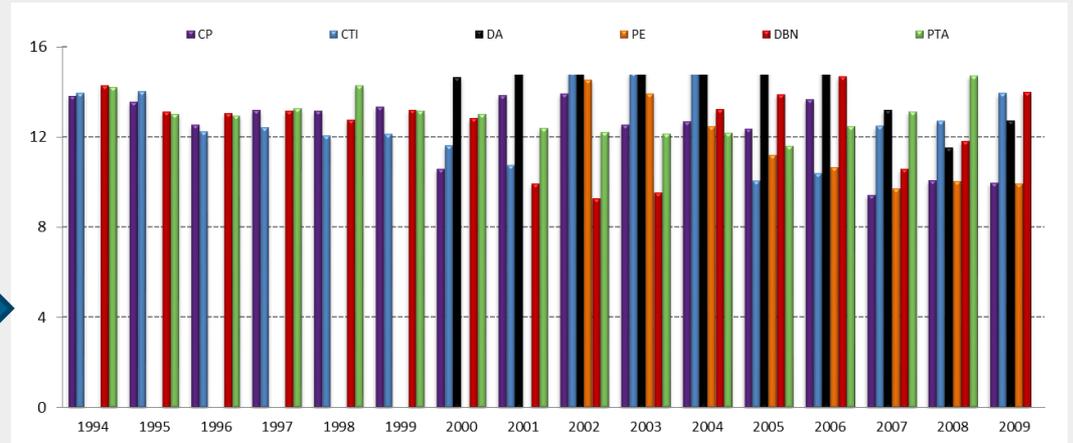
EVOLUTIONS SAISONNIERES
 Ozone stratosphérique & Rayonnement UVB
 Site : Tamarassett
 Période : 1997 à 2013



South Africa



Maximum UV Index values by station and year



Plot produced by K. Ncongwane, SAWS



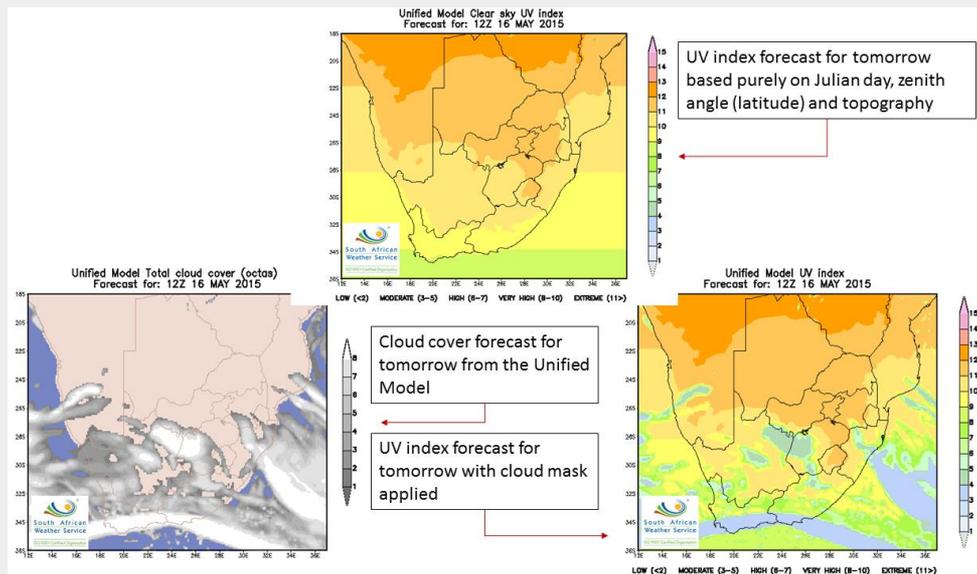
How, when and by whom is the UV Index provided in South Africa?

UVI forecasts were made by the South African Weather Service and publicized through media weather broadcasts between 1990 and 2001. The UVI appeared on the TV (SABC), in radio announcements and in the newspapers. They were discontinued due to poor uptake by broadcasting companies (the number didn't change for weeks at a time) and lack of sponsorship (suntan companies did sponsor for a while).

Some radio stations, e.g. Classic FM (a Gauteng Province radio station in South Africa), still give the UVI midday forecast in its weather reports.

Despite some countries monitoring ambient solar UV radiation, only Namibia provides a UVI forecast but whether it is broadcast on the news is unknown.

SAWS does give forecasts during summer for major centres (with biometers) and they include cloud effects.



Plots produced by S Landman, SAWS

What do we know about people's knowledge and understanding of the UV Index in South Africa?

Grade 7 schoolchildren (n = 707) from 24 schools across all 9 Provinces
62% of children had NOT seen or heard about the UVI (mostly on the TV or at school)

[Wright, Albers, Reeder, S Afr Med J, December 2015]

512 Science Council employees (n = 2 254) in Pretoria
77% HAD heard about the UVI (response bias likely high as well as respondent bias)

[Wright, Albers, SASAS Conference paper, September 2011]

What do we know about people's use of sun protection in South Africa?

Use of umbrellas, clothing, hats, shade more common than sunscreen (except possibly among White population group). "Turning one's back to the sun" is also common.

[Wright et al Photochem Photobiol 2015; 91: 27-32]

Sunscreen is made available free of charge to South Africans with oculocutaneous albinism but not well taken up.

Use of clays and ochre among some Black Africans is popular and culturally-acceptable. They may have an SPF between 3 and 10 and offer broad-spectrum protection.

[Dlova et al Photodermatol Photoimmunol Photomed 2013; 29: 164-169. Rifkin et al PLOS ONE 2015; DOI: 10.1371/journal.pone.0136090]





Finally.....

- UVI forecasts are not (widely) broadcast
- The UVI is likely not well understood (more evidence needed)
- A single simple protection message per UVI category is unlikely to be helpful in some countries due to range in skin phototypes and lack of understanding of terminology (UVI needs to be tested locally)
- Children, people with fair skin, those with compromised immunity and people with oculocutaneous albinism (up to 1 in 1 000 in some communities) require special attention



SUNSMART SKIN CANCER AWARENESS MONTH

01-28 FEBRUARY



Designed by SAMHS Corp Comm
Pte M. J. Mampane

[Source: <http://www.mhs.mil.za/>]



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