TITLE: Significant reduction in ultraviolet exposure under portable beach shelter by dynamic side wall positioning: Implications for primary prevention of skin cancer and melanoma beyond the UPF.

BACKGROUND

Queenslanders have the highest rate of skin cancer and continue to experience sunburn including at the beach. People chose a beach shelter on the promise of the UPF however that refers only to the fabric and does not account for the UV radiation entering through the open sides. No other studies have looked at UV exposures under portable beach shelters or with dynamically positioned side walls.

METHOD:

On 12th February 2026, a Solarmeter 6.5 was used to record real world ultraviolet index measurements at Mooloolaba beach, Queensland. A UPF50+ portable beach shelter with no side walls and a UPF30+ with dynamically positioned side walls were compared.

RESULTS:

There was an 86% reduction in the upwards UVI readings ≥ 2 and a 76% reduction in sideways UVI readings ≥ 2 under the UPF30+ shelter with 2 dynamically placed side walls. There were zero readings ≥ 3 in the UPF30+ shelter.

Measured UVI readings under the UPF50+ canopy exceeded the predicted UVI based on the UPF50+ rating. At times under the UPF50+, UVI readings approached ambient UVI and total standard erythema dose was 5.4 times the potential for sunburn threshold for a fair skinned individual under the UPF50+ canopy.

CONCLUSION:

Dynamically positioned side shade walls on portable beach shelters significantly reduce exposure to ultraviolet radiation and should encourage industry to create fit for purpose beach shelters with this flexibility.

Improved education campaigns and product labelling is greatly needed regarding using additional sun protection measures when using portable beach shelters and if spending prolonged periods of time outdoors.

KEY WORDS: sunburn, melanoma, non-melanoma skin cancer, ultraviolet radiation, ultraviolet injury, primary prevention, beach, shade, diffusion

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INTRODUCTION

Queenslanders have the highest rates of melanoma and non-melanoma skin cancer (NMSC) in the world(1).In Australia in 2021, melanoma of the skin was the third most common diagnosed cancer and was the most common cancer in Australians aged 15 – 29 years (2).69% of Australians will have at least one histologically confirmed NMSC in a lifetime (3) but as others are treated without histology by destructive methods like cryotherapy, this figure is likely higher.

Approximately 63% of all melanomas and virtually all NMSC could be attributed to the high background levels of ultraviolet radiation experienced by Australians (4).Furthermore ocular disorders such as photokeratoconjunctivitis, pterygium, cataracts and uveal melanoma are linked to UV exposure (5).The economic impact is significant and in 2023-24, the non-melanoma skin cancer cost was $1.87B and melanoma expenditure was $596.36M (2).

Many Queenslanders continue to experience sunburn. In 2024 the Report of the Chief Health Officer of Queensland stated 44.6% of adults and 47.1% of children had been sunburnt in the prior year and 5.4% of adults and 4.2% of children reported a blistering sunburn(6).Tick tock trends encouraging sunburn tan lines are also a concerning new direction(7).

Sunburn severe enough to warrant admission to hospital has been reported and in those, up to 4% needed ICU admission in a 10 year period identified from the Burns registry of Australia and New Zealand(8).

Total sun exposure and severe sunburn is associated with early onset melanoma(9). There is an increased risk of melanoma with increasing numbers of sunburns in all life-periods (10).Furthermore exposure to high levels of sunlight in childhood is a strong determinant of melanoma risk but sun exposure in adulthood also plays a role(11).

For NMSC, an increase in the number of sunburns at any age has been linked to an increased risk of BCC(12). High frequencies of painful, blistering and or severe sunburns in childhood are associated with increased cutaneous SCC(13).

To inform the public of the dangers of excessive ultraviolet radiation the Ultraviolet Index (UVI) was developed in 1994 by the World Health Organisation(14) and adopted by the Cancer Council. It is an indication of the amount of UV reaching the earth from the sun and is an indication of the potential for sunburn. Grading from 1 (low) to 11+ (extreme) is accompanied by advice on how to protect our skin to accompany the categories. Recommendations start to sunprotect when the UVI is 3 or higher. However the UV index does not indicate the amount of diffuse UV radiation from the environment which may play a significant role in total UV dose received by a person, contributing to the risk of melanoma and non-melanoma skin cancer, as well as eye disorders related to UV exposure(15).

The UVI is an instantaneous intensity and 1 UVI is equivalent to 25 mW/m^2 of skin damaging UV radiation. In order to calculate dose in units of standard erythema dose (SED), where 1 SED is 100 J/m^2 of skin damaging UV, the length of time of exposure is important. SED is independent of skin type. The relationship between UVI and SED is calculated as shown below

SED = 0.9 x UVI x t (hours) (16).

In a fair skinned individual, the minimum erythema dose (MED) to achieve reddening after 24 hours and is about 2-2.5 SED (17).

It should be noted that the damaging effect of exposure to a higher UVI for a short time may be similar to a lower UVI exposure for a longer period.

The ultraviolet protection factor (UPF) refers to how much transmission of UVA and UVB occurs through a fabric. A UPF 50+ will allow $1/50^{th}$ of the transmission or about 2% to pass through, but a UPF 30+ will allow $1/30^{th}$ or 3.3%. AS/NZS 4399:2020 covers Sun protective clothing but specifies that products such as umbrellas and shade structures are not in close proximity with the skin and therefore the protection is less than that indicated by the UPF of the material (18).

The new Australian Standard AS4174:2018 referring to knitted and woven shade fabrics incorporates an ultraviolet effectiveness factor (UVE%) or how effective a shade is at preventing UV transmission based on average transmission and average blocking of ultraviolet with unstretched material (19).This is not a legislative requirement to adhere to. The standard adds the amount of radiation the person sitting under an umbrella or shade structure receives depends also on the distance from the product and any reflection from adjacent surfaces and reflecting under the overhead canopy. Therefore additional measures like clothing and sunscreen are important. Relying on the UPF or even the UVE of the material will, as a result, be inaccurate.

Many portable sun shelters that are commercially available carry a UPF50+ rating. People are relying on this canopy fabric rating as providing the UV protection they are seeking. In addition the promised protection of the overhead canopy may induce people to stay longer and underestimate the potential cummulative UV radiation dose during this time.

To the author's knowledge, this study is the first reported looking at real-world UV index measurements under two commercially available rated portable shade structures, one with dynamically positioned side walls. There have been other studies looking at diffuse UV measurements under artificial built structures, in public parks, with tree shade or with a sun umbrella utilising various techniques (20) (21) (22) (23). This study aims to highlight the ultraviolet exposure under portable beach shelters and suggests a means of reducing this UV exposure.

METHOD

Field testing was undertaken in summer on 12th February 2026 at Mooloolaba beach, Queensland, Australia (latitude 26.6811°S, longitude 153.1217°E) (24)Sunrise was at 5.29am (107°ESE) and sunset at 6.33pm (254°WSW) with solar noon 12.01pm(25). All the times are provided as Australian Eastern Standard Time. The sun arising in ESE and arcing towards north, setting in WSW direction. The temperature maximum was 32-33 °C during the day. The UV Index was predicted to be 13 and in the extreme for Brisbane(26). Wind velocity was highest at 25.9 km/h averaging 11.5 km/h (27).

A hand held Solarmeter model 6.5 (Solar Light Co. USA) range 280-400nm and calibrated by the supplier to NIST standards was used for the UVI readings (accuracy +/- 10%). This type of Solarmeter is available on loan from ARPANSA for the purposes of UVI index measuring and documenting effectiveness of shade structures.

Ambient UV index readings, in the open outside the canopies, were carried out by holding the meter at arms length away from the body, 1m from the front of the shade structure every hour between 8am and 3pm. The Solarmeter was also pointed straight down to enable the calculation of the albedo (28).

UVI measurements were made every hour between 8 am and 3 pm with the Solarmeter under the UPF50+ canopy, with no side walls, and the UPF30+ shade with two dynamically placed side shade walls, seated in a chair positioned at the left of the central pole or to the right. Readings were suspended between 11.15 am and 12.30 pm due to cloud cover overhead. The height of the Solarmeter was constant at 52 - 54 cm placed on the left thigh whilst seated. The UVI readings were collected in the horizontal plane to the right, front and left at this height. The rear reading was taken at the height of the back of the respective chair.

UVI readings were recorded in the vertical plane whilst seated under the respective canopy in either left or right chair by pointing the Solarmeter up towards the above canopy whilst held at the left thigh.

The researcher wore SPF50+ 4 hours water resistant sunscreen which was reapplied after 2 hours, as well as a UPF50+clothing and polarised sunglasses.

Two commercially available beach shades were erected (Figure 1).
The UPF50+ canopy without side walls was 80% polyester/20% cotton mix measuring 2 m x 2 m with fabric legs at each corner allowing sand in the bottom to anchor the canopy. A

central umbrella mechanism opened the canopy with the pole being pushed into the sand providing 4 m² of shade.

The other with a UPF30+ rated canopy had one detachable side wall. This also had a central umbrella opening mechanism and the canopy was a polyester, water resistant fabric measuring 1.83 m x 1.83 m with fabric legs at the corners and sand at the base to stabilise the canopy. Two other walls were purchased of the same UPF30+ material and extra attachment points were sewn on the 30+ UPF canopy on 2 other sides to allow moving a wall in the course of the day with the angle of the sun. The right side shade wall was in position for the morning, and a left side shade was attached in the afternoon. A shade wall was positioned all day at the rear of the UPF30+ canopy and was split down the middle to allow breeze through to avoid producing a sail. All 3 side walls had pockets at the bottom for sand to stabilise the respective wall. The product provides 3.5 m² of available shade.

The front face, facing north to the sea, was open in both the UPF50+ and the UPF30+ canopy.

Figure 1a

Figure 1b

Figure 1c

Figure 1d

Figure 1: UPF50+ shade structure at 9.04 am (Figure 1a) and at 3.03 pm (Figure 1c) and UPF30+ shade structure at 9.04 am with shade wall placed on right and constant rear wall (Figure 1b) and at 3.13pm, with shade wall placed on left and rear wall (Fgure1d) on 12th February, 2026.

FINDINGS

There was a significant reduction in ultraviolet exposure under the UPF30+portable beach shelter by dynamic side wall positioning compared to the UPF50+ portable beach shelter without side walls. The UPF50+ canopy recorded UVI readings in the horizontal plane ≥ 1 (left, front, right and rear) in 69% of measurements across both chairs, compared to just 35% under the UPF30+ (Table 1). This is a 49.3% reduction under the UPF30+ canopy with dynamically positioned side walls. The difference becomes even more pronounced at readings ≥ 2 where 18% of readings under the UPF50+ canopy without side walls compared to only 4% under the UPF30+ canopy were ≥ 2. This is a 76.6% reduction in UVI readings ^{3}2 to the sides under the UPF30+canopy with two side walls.
The UPF30+ canopy with 2 movable shade walls and a rear fixed shade wall totally eliminated UVI readings ≥ 3 in the horizontal plane.

Table 1: UVI readings for the UPF50+ and UPF30+ canopies in the horizontal plane for the left and right chairs

	UVI ≥ 1		UVI ≥ 2		UVI ≥ 3	
Canopy	Count	%	Count	%	Count	%
UPF50+ canopy	50/72	69%	13/72	18%	2/72	5%
UPF30+ canopy	25/71	35%	3/71	4%	0/71	0%

In the afternoon, the UVI readings under the UPF50+ canopy in the vertical plane approximated the ambient UV indicating the left chair was in direct sunlight and the above canopy was not providing shade (Figure 2). Similarly in the morning the readings for the right chair under the UPF50+ canopy would have been higher if the readings were conducted on the right thigh instead of the left as was standardised throughout the testing.

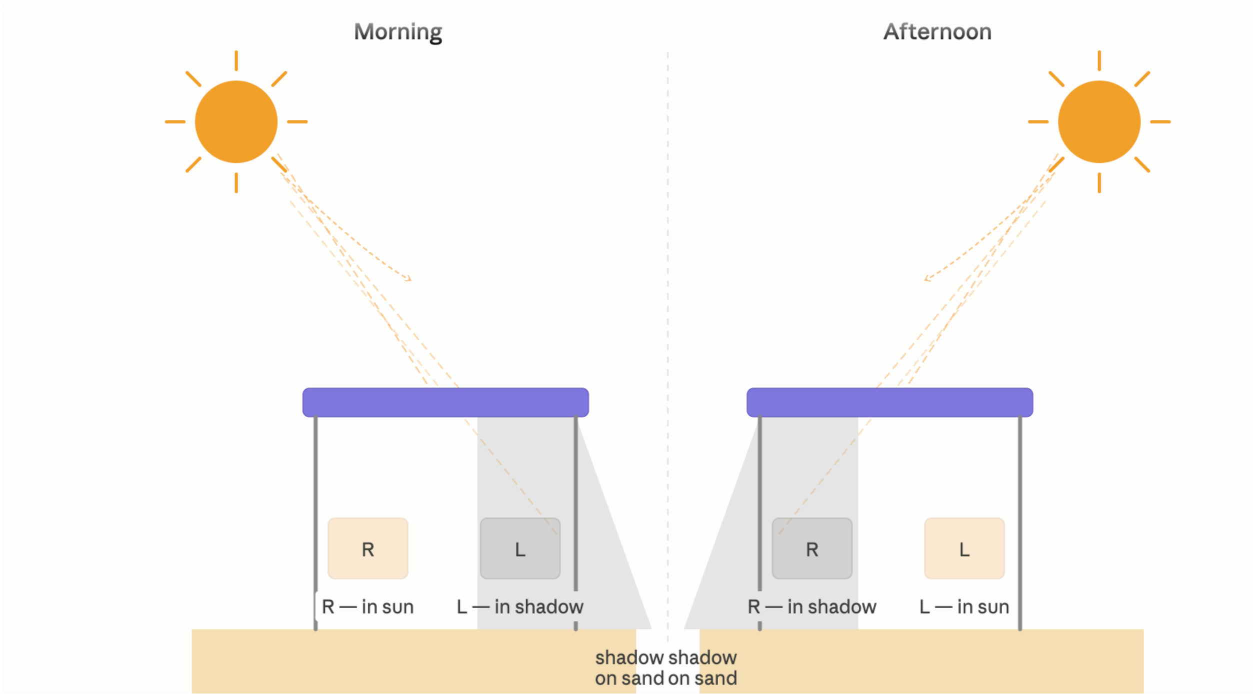

Figure 2: Schematic drawing of the shade thrown by the UPF50+ canopy in the morning and afternoon highlighting the exposed right chair in the morning, and the left chair in the afternoon.

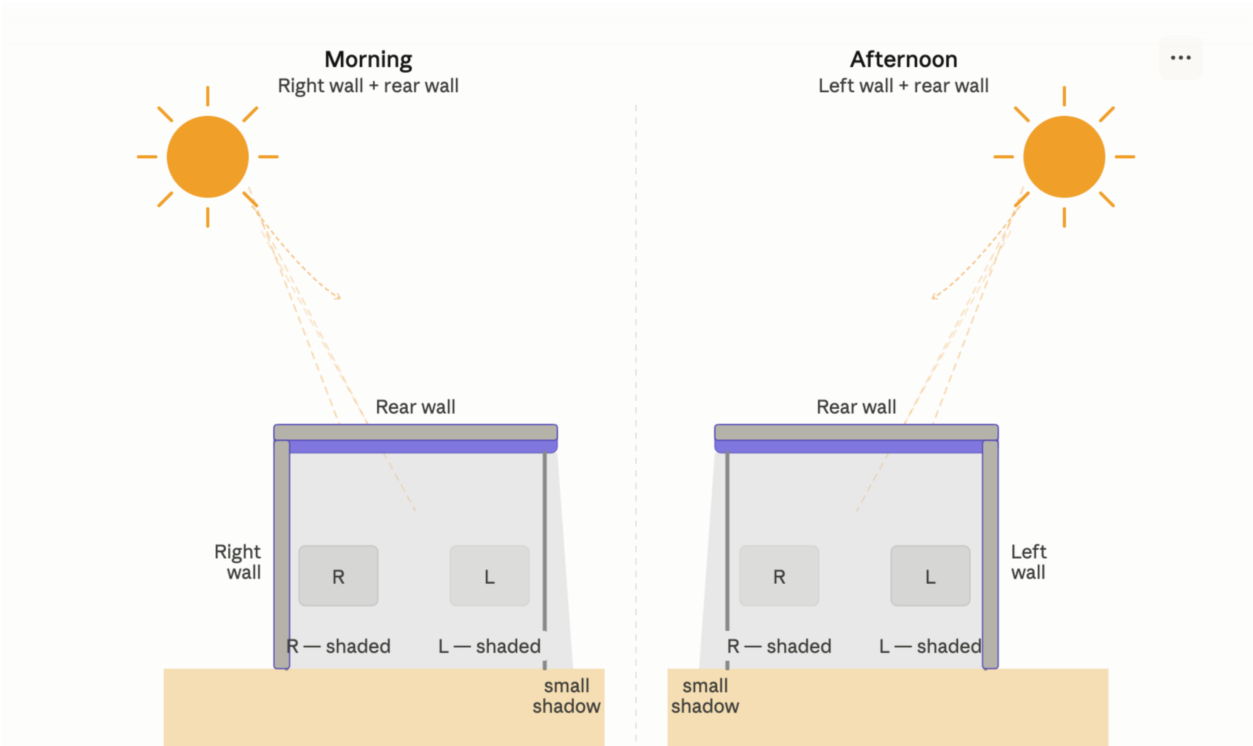

Figure 3: Schematic drawing of the shade thrown by the 2 walls under the UPF30+ canopy in the morning and the afternoon showing both chairs in the shade all day.

Furthermore the UVI readings recorded in the vertical plane under the UPF50+ canopy were considerably higher than the predicted based on the UPF. Under the UPF30+ canopy, vertical UVI readings were lower and closer to those predicted (Figure 3).

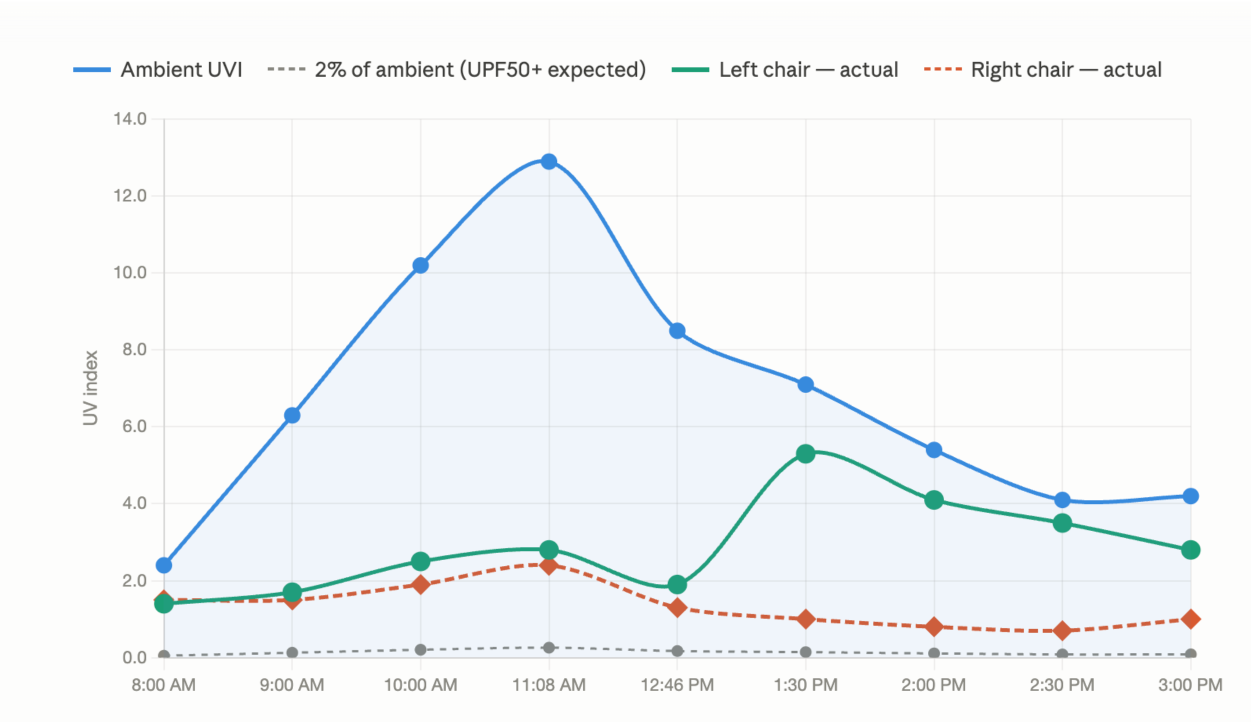

Figure 4: UVI in vertical plane under UPF50+ canopy, predicted UVI based on the UPF50+ canopy, and ambient UVI on 12th February, 2026.

Because the UVI readings were standardised to the left thigh, the readings in the morning for the UPF50+ canopy would have been higher as the right thigh was in full sun and a possible scenario is mapped hypothetically in the below graph.

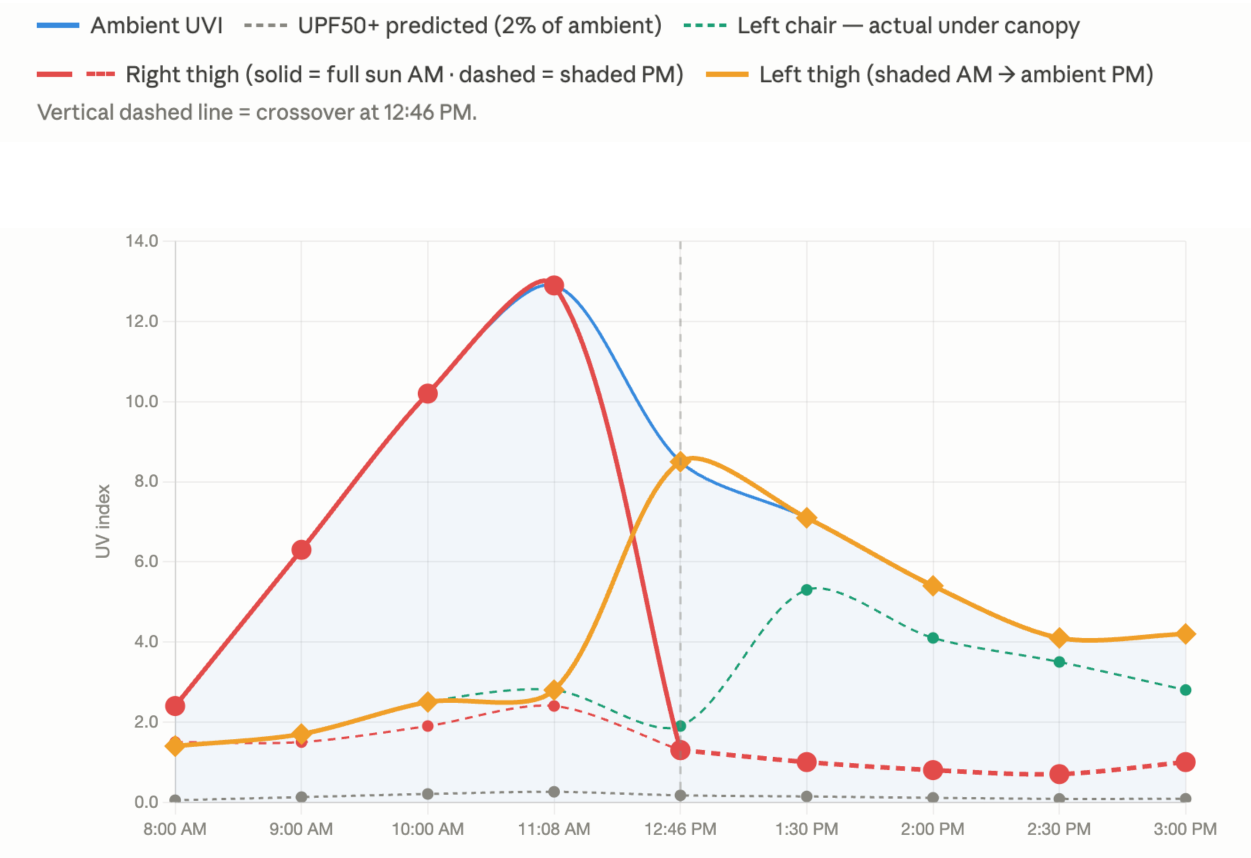

Figure 5: Hypothetical UVI in the vertical plane under the UPF50+ canopy , actual readings, predicted UVI based on UPF50+ and ambient UVI on 12th February 2026.

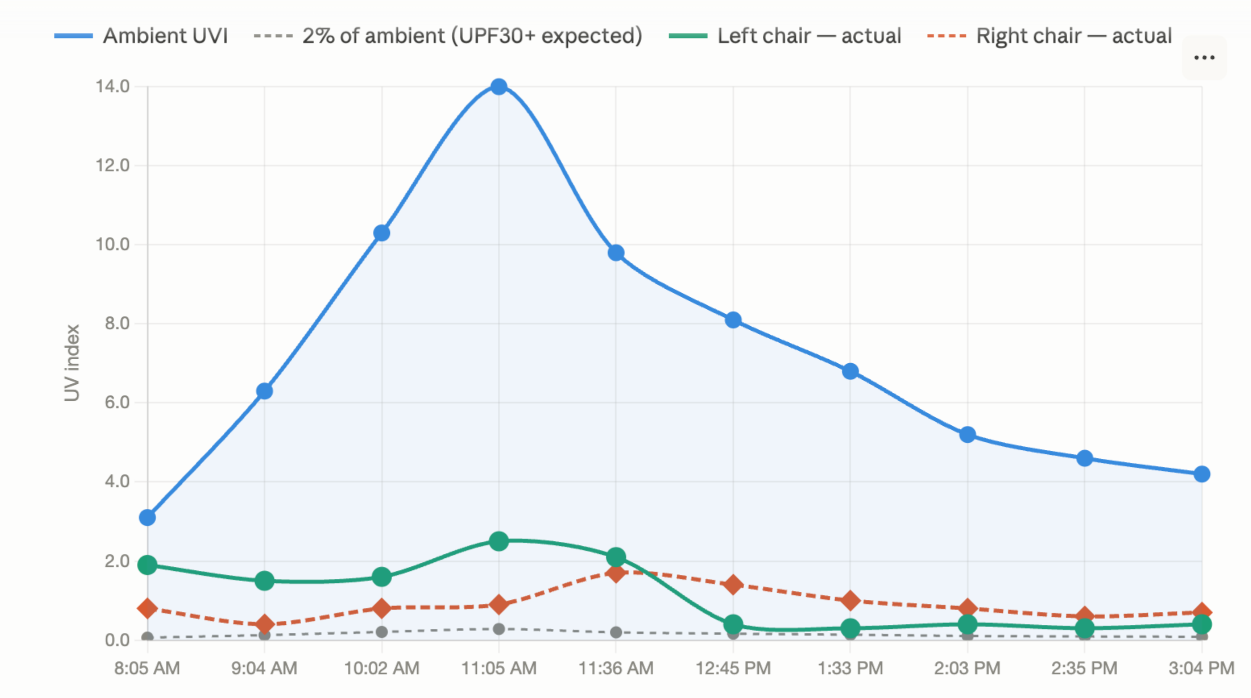

Figure 6: UVI in vertical plane under UPF30+ canopy, predicted UVI based on the UPF30+ canopy, and ambient UVI on 12th February, 2026.

In the vertical plane the UPF30+ canopy with side walls recorded UVI ≥ 1 in only 27.8% of readings compared to 88.9% for the UPF50+ alone, and no readings at all reached ≥ 3 under the UPF30+ canopy (Table 2).

Table 2: Vertical Plane UVI readings under 50+ UPF and UPF30+canopy (for both left and right chairs).

	UVI ≥ 1		UVI ≥ 2		UVI ≥ 3	
Canopy	Count	%	Count	%	Count	%
UPF50+ canopy	16/18	88.9%	7/18	38.9%	3/18	16.6%
UPF30+ canopy	5/18	27.8%	1/18	5.5%	0	0%

Measuring the combined average UVI over the course of the day resulted in a total SED of 13.4 for the UPF50+ and 6.6 for the UPF30+ canopy (Figure 4). For a fair skinned individual sitting under the UPF50+canopy this would equal 5.4 times the MED - significant sunburn risk. Whilst there was a 50.8% reduction in SED readings under the UPF30+ canopy, a fair skinned individual would still accumulate about 2 MED over the day under the UPF30+ canopy hence additional sun protection measures would still be recommended.

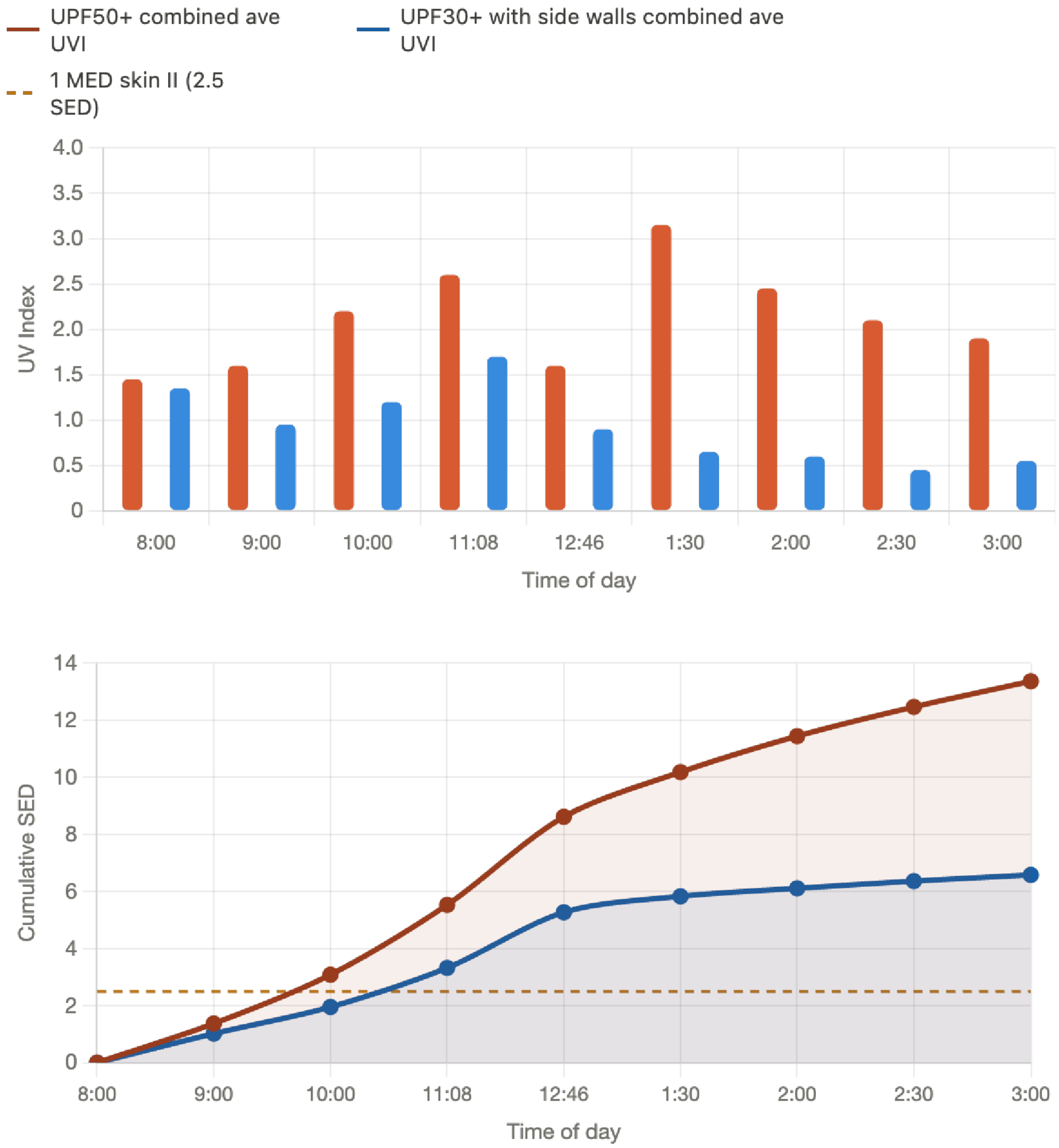

Figure 7: Cumulative SED, combined average UVI under the UPF50+ canopy and UPF 30+ canopy and MED for skin type II.

DISCUSSION

Whilst this is a single day UVI study, it was conducted under extreme UV conditions that are found in Queensland (predicted UVI 13 verified extreme by ARPANSA). Such a high UVI is by no means unique at this time of the year making the findings potentially conservative. The single geographical location of Mooloolaba at latitude 26.68°S represents a high UV subtropical environment relevant to Queensland. In addition, while a single researcher conducted the readings, standardisation of the measurements for example height of the Solarmeter for readings in either chair under the respective canopy was consistent (fixed chair height 52-54cm).
The findings are also likely conservative as the left thigh was the standard chosen for placing the Solarmeter readings and in the morning under the UPF50+ canopy the right thigh was exposed to full sun.

For the UPF50+ shade structure, without side walls, the UVI readings in the horizontal were 69% $\geq$ 1, 18% $\geq$ 2 and 5% $\geq$ 3. This indicates significant diffuse UV radiation reaching the chairs under the UPF50+ canopy without walls. 88.9% of UVI readings were $\geq$ 1 in the vertical plane under the UPF50+ canopy, 38.9% $\geq$ 2 and 16.6% $\geq$ 3.

Under the UPF50+ canopy without side walls, finding diffuse UV radiation readings in the vertical plane ≥ 3 and a total SED that was 5.35 times the MED, should strengthen the recommendation to use additional measures for sunprotection and not rely on the UPF or UVE rating of the fabric alone. These readings would have also been higher if the right thigh was used for recording the UVI in the morning under the UPF50+ canopy.

Recently studies are emerging showing UVI less than 3 is damaging to DNA and there may also be harmful effects on the epidermal skin DNA in individuals with Fitzpatrick type I/II who are exposed to UV for a prolonged period of time below their threshold for erythema and sunburn(29). Furthermore at repeated low level sunlight there is observation of unrepaired cutaneous DNA damage (30).
If the tendency is to remain longer in the environment using portable beach shelters then people will be significantly exposed to UV radiation.

This study heralds the importance to highlight increased awareness regarding employing additional sunprotection measures when using portable beach shelters without side walls or for prolonged periods. There is the potential for diffuse ultraviolet radiation from adjacent environments such as sand to reach under the canopy. We cannot rely alone on the UPF or UVE factor stated for the canopy material to provide sufficient protection from the diffuse UV.

Such awareness can include public education campaigns arranged by the Department of Health or the Cancer Council as well as respective Colleges managing skin cancer.

Additionally manufacturers of portable beach shelters should include in their product information to use additional methods of sunprotection due to significant reflection from sand or adjacent structures. Such information can include updating of websites and social media posts advertising these products as well as affixing labels on the products and in instruction booklets.

When dynamic side walls were added to the UPF30+ shade shelter there was also an 86% reduction in the UVI in the vertical plane ≥ 2 and 76% reduction in the horizontal UVI ≥ 2 and zero measurements were in the UVI ≥ 3, compared to the UPF50+ beach shelter. Most of the portable beach shelters currently available are made overseas and do not have the capacity for flexible multiple side shade wall attachment. Increased industry participation is encouraged to manufacture fit for purpose portable beach shelters with the flexibility to put up additional shade walls over the course of the day.

Current portable beach shelters list the UPF factor in their advertising as providing the sunsafety needed and there is little labelling warning that the actual solar radiation under the canopy may be significant and advise to use additional sunprotection measures.
Presently there is no legislation in place governing Portable beach shelter ratings. The Australian Standard AS 4174:2181 for knitted and woven shade fabrics exists and does go on to have the caveat that “when shade fabric is used for human protection purposes, such as shade structures the calculated ultraviolet effectiveness (UVE) results do not take into account important factors that may decrease the effective UVE, such as design features, height and size of the shade structure, the distance of the shade from the subjects, the effect of direct and indirect solar UVR and the physical location of the subjects within the shade structure. For this reason the UVE value determined for classification of the fabric does not indicate the actual reduction of solar radiation by a structure incorporating that fabric. A warning statement to this effect has been specified for inclusion in the labelling of fabric to be used for human purposes”. We need legislative change to address the lack of adherence to the AS4174:2018 standard for portable beach shelters and thereby improve compliance with the need to inform the public to use additional sunprotection measures in order to avoid sunburn and reduce cumulative UV radiation which contributes to the risk of skin cancer, melanoma and solar eye disease. These have significant impact on the health budget and individuals and families.

This study underpins potentially important interventions that could have significant implications for public health regarding using portable beach shelters. These include public education not to rely solely on the UPF+ or UVE rating of the canopy, to use additional sunprotection methods, and the creation of fit for purpose portable beach shelters with flexible side wall positioning to reduce the cumulative UV exposure in the prevention of skin cancer and melanoma. Legislative change would encourage compliance with the Australian Standard and appropriate warning labels advising additional sunprotection is needed when using portable beach shelters.

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