Author/s:
Nicholson, A;Haynes, A;Brennan, E;Maitland, C;Dixon, H

Title:
Clear front-of-pack labelling information can improve sunscreen reapplication knowledge and intentions: findings from an online experiment

Date:
2025

Citation:
Nicholson, A., Haynes, A., Brennan, E., Maitland, C. & Dixon, H. (2025). Clear front-of-pack labelling information can improve sunscreen reapplication knowledge and intentions: findings from an online experiment. BMC Public Health, 25 (1), https://doi.org/10.1186/s12889-025-24920-5.

Persistent Link:
https://hdl.handle.net/11343/367790

BMC Public Health

RESEARCH

Open Access

Clear front-of-pack labelling information can improve sunscreen reapplication knowledge and intentions: findings from an online experiment

Anna Nicholson[1,2*], A. Haynes[1,3], E. Brennan[1,3], C. Maitland[1,4] and H. Dixon[1,3]

Abstract

Background Most people do not apply sunscreen effectively. The Australian and New Zealand standard for sunscreen specifies labels must provide clear and adequate directions for use but does not prescribe specific wording or positioning. Additionally, water-resistant sunscreens must declare the duration of laboratory-tested water resistance, up to 4 h maximum. Formative research found consumers are confused by reapplication directions and water resistance claims. This study aimed to explore whether enhanced sunscreen labelling information can improve sunscreen reapplication.

Methods Adult sunscreen users ($n = 3,363$) were randomised to view one of ten mock sunscreen labels in a 2×5 online experiment. Labels differed according to front-of-pack (FOP) water resistance claim (standard: tested for 4 h water resistance vs. alternative: water resistant) and reapplication information (none vs. any; with four message variations: simple text, simple icon, extended text, extended icon). We used multivariate logistic regression to examine the effect of FOP labelling on knowledge and intention to reapply sunscreen every 2 h and after swimming, sweating and towel drying (henceforth: activity), considering: (i) water resistance and reapplication information and (ii) reapplication message type.

Results Compared to no information, FOP reapplication information increased knowledge (48% vs. 70%) and intention to reapply within 2 h (41% vs. 54%), but not after activity. Compared to the standard claim, the alternative water resistant claim increased knowledge (60% vs. 72%) and intention to reapply within 2 h (47% vs. 56%), but not after activity. Although there was no clear pattern of effects for reapplication message type, only the extended icon (with directions to reapply every 2 h or after activity) increased knowledge to reapply after activity, irrespective of the water resistance claim (52% standard and 57% alternative).

Conclusions Under the current standard, sunscreen labels do not provide clear directions for use, which leaves consumers vulnerable to UV damage. Mandating FOP reapplication directions and adopting an alternative 'water resistant' claim could improve consumer understanding of how often to reapply sunscreen. Due to common

*Correspondence:
Anna Nicholson
anna.nicholson@cancervic.org.au

Full list of author information is available at the end of the article

misperceptions about the limits of water resistance, further user-centred label design and public education is needed to improve reapplication after swimming, sweating and towel drying.

Keywords Skin cancer prevention, Sun protection, Sunscreen, Labelling, Visual design, Labelling regulation, Product claims, Health communication, Experiment

Background

Daily sunscreen use can reduce the risk of squamous cell carcinoma (one of the most common skin cancers) and melanoma (the deadliest type of skin cancer) [1–3]. This is particularly important in Australia, where skin cancer rates are among the highest globally [4]. Although melanoma rates are declining among younger Australians, including those with high-risk ancestry, they continue to rise in some older age groups [5]. Health expenditure on melanoma and non-melanoma skin cancers doubled in Australia in the decade to 2022-23 [6], in part due to expensive new treatments for advanced melanoma, and the economic cost will continue to rise due to projected increases in melanoma diagnoses [4, 7]. The human toll is also significant, with skin cancers responsible for more than 2,000 deaths every year in Australia [8].

National survey data collected over late spring and summer months shows that just under two in five Australians used sunscreen with a sun protection factor (SPF) 30 or higher on most days of the past month [9]. However, 7% were sunburnt in the previous week, increasing to 15% among younger people aged 15 to 24 years [9]. Inadequate sunscreen application, such as missing a spot or failing to reapply sunscreen, is one of the most commonly attributed causes of sunburn (27%), second only to prolonged sun exposure and failing to use any form of sun protection (37% and 33%, respectively) [10]. Rates of sunburn are high among sunscreen users; a phenomenon known as the sunscreen paradox [11, 12]. This is hypothesised to occur because sunscreen use is highest among high-risk populations, who are vulnerable to UV damage, and also in high-risk situations, such as prolonged or intentional sun exposure [13]. It is also possible that ineffective sunscreen application may contribute to the sunscreen paradox. To prevent UV damage, it is essential that consumers clearly understand how to use sunscreens effectively.

To deliver the labelled SPF, sunscreen must be applied generously (2 mg/cm^2) and evenly across all areas of exposed skin [2, 14, 15]. In Australia, a consensus statement from cancer organisations, dermatologists, and other experts states that sunscreen should be reapplied every 2 h during prolonged outdoor activities, or more frequently after swimming, sweating, and towel drying (henceforth: activity) [16]. Sunscreen reapplication helps to compensate for areas of the skin that were missed in the initial application, or where coverage has been compromised during day-to-day activities [2, 17]. The recommendation to reapply sunscreen every 2 hours is also disseminated by cancer societies in Canada and the US [18, 19].

Most people do not apply sunscreen adequately [14, 20]. Experimental research shows that, on average, people apply less than half of the recommended thickness required to achieve the promoted sun protection factor [21, 22]. Further to insufficient quantity, a cross-sectional survey conducted in 20 countries found that only 1 in 6 adults in Australia, Canada and the US reapply sunscreen every 2 h when outdoors, which was slightly lower than the average (16% vs. 24%) [23]. Adherence to this recommendation is similarly low among people who are at high risk of skin cancer [24].

Ineffective sunscreen practices may stem from inadequate or unclear directions for use. In Australia, primary sunscreens (that claim UV protection as their main function) are therapeutic products for which product testing, labelling and advertising must adhere to the Australian/New Zealand (AUS/NZ) Standard, which is enforced by the Therapeutic Goods Administration. The standard mandates clear and adequate directions for use, bans terms like waterproof and sweatproof, and specifies that water-resistant sunscreens must stipulate *the time for which they have been tested to be water resistant, up to a maximum of 4 h* [15]. Importantly though, the length of time for which a sunscreen has been tested to be water resistant (i.e., 'up to 4 h') is a laboratory-based test result that does not indicate the length of time for which sunscreen provides the stated level of UV protection in real-world conditions, where physical activity and friction can compromise the sunscreen layer and subsequent protection; hence the recommendation to reapply every 2 h and after activity [16].

The AUS/NZ Standard does not specify the size or positioning of labelling information, or what information should be included on the front of pack (FOP). Instead, manufacturers may choose where to place directions for use, with most opting to include information about reapplication on the back of pack label. Consequently, there is variation in the placement and visibility of the water resistance claim and reapplication information on sunscreen products, coupled with the possibility that consumers who do see both pieces of information could perceive a conflict between the differing time intervals (e.g. reapply every 2 h, up to 4 h water resistant). Together, these factors could be compromising consumer comprehension of effective sunscreen reapplication.

Informed by formative qualitative research with Australian adult sunscreen users [25], we hypothesise that sunscreen consumers are mistakenly interpreting the statement '4 hours water resistance' (i.e., the maximum claim for water resistance testing) as a direction about when to reapply that sunscreen. Our formative research also found that sunscreen users may fail to reapply water-resistant sunscreens after activity due to a mistaken belief these products retain their stated protection during and following water-based activities [25]. The study identified a desire for key directions for use to be conveyed on FOP labels, using specific and measurable terms, and depicted using icons to boost attention [25].

Although few studies have tested the extent to which FOP sunscreen labelling information influence sunscreen application practices, emerging evidence in this area shows promise. An experimental study conducted among French adults demonstrated that an explanation of the protection provided by products of different sun protection factors led to reduced sunburn [26]. Additionally, research found that GIF-based visual aids could assist US consumers to understand how much sunscreen to apply [27].

The broad aim of this study was to test responses to the current AUS/NZ sunscreen labelling standard, as well as potential alternatives, to determine what label specifications are most effective to communicate reapplication directions to people who use sunscreens. Specifically, this study tested how sunscreen reapplication directions and water resistance claims influence knowledge and intention to reapply sunscreen according to the labelled directions. Using an online experiment, we sought to compare the responses of participants who viewed label designs that systematically varied how the following FOP information was displayed:

- ***Water resistance claim***: the standard time-qualified claim (e.g. tested for 4 h water resistance) versus a simple *alternative* claim ('water resistant').
- ***Reapplication information****: positioning* on the FOP versus back label only; changing the *message type* (icon versus text format, simple vs. extended content).

This design enabled us to address the following research questions:

1. What are the unique and combined effects of FOP water resistance claims and reapplication information on sunscreen reapplication knowledge and intentions?
2. If FOP reapplication information is found to improve sunscreen reapplication knowledge and intentions:
   a. what message type is most effective to improve sunscreen reapplication outcomes?
   b. does the water resistance claim (standard vs. alternative) modify the effect of message type on sunscreen reapplication outcomes?

We hypothesized that sunscreen reapplication outcomes would be improved by both the alternative 'water resistant' claim and FOP reapplication directions (RQ1). We also expected that reapplication outcomes would be improved by messages that used an icon format to communicate reapplication directions (compared with text format), and the extended reapplication content that specified both time and activities that require reapplication (compared to a simple time-only direction) (RQ2).

We also tested for potential unintended effects of the sunscreen labelling manipulation, as it is important that any potential changes to these features do not inadvertently introduce or exacerbate false beliefs about the sunscreen's properties, including that it is waterproof, sweatproof, or long lasting (secondary outcomes). Accordingly, we also explored the impact of label features on false beliefs, but did not form explicit hypotheses for these secondary outcomes.

Methods

Study design

The study had a 2×5 between-subjects experimental design (see Fig. 1). An online survey was used to conduct the experiment and collect all data within a single session.

Participants

Participants were recruited through a market research panel between 22nd January and 5th February 2024. The study aimed to recruit a sample of $N = 3{,}000$ Australian adults who use sunscreen at least sometimes when outdoors in summer.

The sample size was informed by power calculations that determined, accounting for the 2×5 experimental design, we would need a sample size of 1,194 to achieve 80% power to detect a small effect (0.1) at an alpha level of 0.05. Accordingly, a sample of 2,985 would be required for subgroup analyses by education level (40% incidence rate).

Quota-based sampling methods were used so that the sample was representative according to national quotas for gender, age group, jurisdiction (state or territory of residence), remoteness, and highest level of education.

Labelling intervention

Participants were randomised to one of ten mock sunscreen labels that combined one of two water resistance conditions (standard 'tested for 4 hours water resistance'

Fig. 1 Labelling conditions used in the experimental study design. Current practice for Australian sunscreen labelling is represented by the combination of the standard water resistance claim ('tested for 4 hours water resistance'), consistent with the AUS/NZ standard, and no FOP reapplication information, which reflects market norms. Packs with FOP reapplication information typically feature a simple text message (reapply every 2 h). These message combinations have been used as the reference categories for RQ1 and RQ2, respectively

claim vs. alternative 'water resistant' claim) with one of five reapplication information conditions (no information, simple text, simple icon, extended text, extended icon) on the FOP. Simple text and icon messages contained directions about how often to reapply ('every 2 hours'), whereas the extended text and icon messages contained directions about the time as well as activities that prompt reapplication. Due to space restrictions, the direction to 'reapply after swimming, sweating and towel drying' was abbreviated to 'reapply after activity' in the extended text condition, whereas the extended icon specified each of these activities (see Fig. 1).

The mock labels were free of any branding. All FOP labels stated that the sunscreen provided broad-spectrum UVA-UVB protection with a sun protection factor (SPF) of 50+. The back label, which included ingredients and detailed instructions for use, was identical for each of the ten conditions. Apart from the manipulated conditions, other label features and information adhered to the relevant standard (AS/NZS 2604) [15]. A copy of all label designs is included in Supplementary File 1.

Data collection

Eligible participants who agreed to take part in the study completed a short online survey (median completion time: 10 min). Participants were exposed to their randomly allocated mock sunscreen label mid-way through the survey, after completing demographic and baseline questions about their typical sun protection and sunscreen use behaviours. After viewing the FOP and back labels, participants were asked about their understanding of the product features, how to apply that product, and how they would be likely to use that product in different scenarios. To retain the focus on comprehension (and not recall), participants were able to click on a thumbnail to view and enlarge the image of the FOP and back labels whilst responding to questions and could revisit the images as many times as needed.

Outcome measures

The primary outcome measures included two dichotomous knowledge items (correct vs. incorrect) and two dichotomous intention items (yes vs. no).

Knowledge about effective reapplication i.e. As the label directs

Due to our interest in time and activities that prompt sunscreen reapplication, knowledge about effective reapplication was broken into two components. Knowledge to reapply sunscreen every 2 h was derived from correct

identification of 2 h in response to a question about 'the LONGEST amount of time that should be allowed between reapplications of THIS SUNSCREEN for it to be effective'. Other responses (less than an hour, 1 h, 3 h, 4 h, 5 h, 6 h and don't know) were categorised as incorrect (only 2.8% responded don't know).

Knowledge to reapply after activity was derived from correct identification of 'after swimming or towel drying' and 'after sweating' from a multi-response question about 'situations where THIS SUNSCREEN should be applied MORE OFTEN'. Participants who selected both these responses were considered to have responded correctly.

Intention to reapply sunscreen as directed

Intention to reapply sunscreen in a manner that is consistent with labelling information was also broken into two components. Participants were asked to imagine that they took that specific sunscreen to three activities that required them to be out in the sun for extended periods in summer. They were then presented with three scenarios, asked for each scenario: 'What is the LONGEST amount of time you would allow between reapplications?' Response options were presented in a list that was identical for each scenario (less than an hour, 1 h, 2 h, 3 h, 4 h, 5 h, 6 h, prefer not to say). Those who selected any duration less than 2 h to *all three* scenarios were categorised as intending to reapply the sunscreen within 2 h or less (henceforth: within 2 h), as directed.

Intention to reapply sunscreen after activity was derived from selection of 'after swimming and towel drying' and 'after sweating' in response to the multi-response question 'Are there any situations where YOU would apply this sunscreen MORE OFTEN?' Participants who selected both these responses were considered to intend to reapply after activity.

Secondary outcomes: false beliefs

False beliefs were derived from responses to the multi-response question 'What features does THIS SUNSCREEN have?', for which participants were asked to select from a list that included actual and false product attributes. The responses 'waterproof', 'sweatproof' and 'long-lasting' were categorised as false beliefs, as these inaccurate attributes did not reflect the information on the label. In contrast, 'broad-spectrum UVA/UVB protection', 'very high UV protection (SPF 50+)', and 'tested for 4-hrs water resistance' were accurate attributes that reflected information provided on the label. These analyses examined the proportion who believed the product to be waterproof, sweatproof and long-lasting, but not the proportion who identified each real attribute.

Statistical analysis

All analyses were multivariable logistic regressions conducted using Stata V16.1. As a first step, we tested effects of the ten label conditions on each outcome, adjusting for covariates. Outcomes for which there was no significant effect ($p < 0.05$) were not analysed further.

RQ1 focuses on the impact of placing reapplication information on the FOP along with water resistance information. To approach this, we compared outcomes between two groups of conditions: one group comprised all conditions that included a FOP reapplication message (irrespective of the reapplication message content and format), and the second comprised conditions that did not include FOP reapplication information (see Supplementary File 2). Multivariable logistic regression models were used to determine the main and combined effects for (i) reapplication information (none vs. any), and (ii) the water resistance claim (standard vs. alternative).

To address RQ2, which focuses on the best performing reapplication message type, we restricted the sample to those exposed to any FOP reapplication message (i.e., 8 of 10 label conditions; see Supplementary File 2). We assessed main and combined effects of (i) reapplication message content (simple vs. extended) and (ii) reapplication message format (text vs. icon). Analyses were stratified by water resistance condition to determine the best-performing reapplication message type under the current standard (i.e., combined with 'tested 4 hours water resistance') and under the alternative scenario ('water resistant').

Covariates

Potential covariates were informed by the skin cancer prevention literature and included age group, gender, geography (jurisdiction and rurality), highest level of education, main language spoken at home, parental status, skin type, history of sunburn and skin cancer, and baseline sun protection behaviours, including frequency of sunscreen use and routine (daily) sunscreen use [20, 28, 29]. Baseline behavioural data, which was collected prior to the labelling intervention, also included how sunscreen is typically applied and the factors that prompt reapplication.

Covariates were selected for inclusion in the multivariable models where they: (i) differed between experimental groups, and (ii) were associated with at least one of the four primary outcome measures on chi-squared tests of association. Covariates were selected based on a p-value cut-off point of 0.25 to both tests [30].

Sensitivity analyses

To assess for socio-economic differences in our findings, we conducted sensitivity analyses that limited the sample to those with an education level equivalent to Year 12 or

below (both research questions) and those who speak a language other than English at home (RQ1 only, due to the insufficient sample size to proceed with RQ2).

False beliefs did not vary between experimental groups (and therefore did not meet the criteria for inclusion as covariates in all analyses). However, to explore the association between false beliefs and primary outcomes to aid the interpretation of results, a sensitivity analysis was conducted assessing the overall effect of experimental condition on primary outcomes when additionally controlling for false beliefs.

Results

Participants

The final sample (n = 3,363) was broadly representative of the Australian population according to key demographics. As the study excluded people who never or rarely use sunscreen, the sample consequently contained a lower proportion of people whose skin does not burn after 30 min of exposure to strong sunshine (42% nationally vs. 21% in study) [9].

Participant characteristics are summarised in Table 1. Age group, highest level of education, preference for a tan, frequency of incidental sunscreen use, and baseline sunscreen reapplication behaviours (whether usually prompted to reapply: after a certain time; and according to the label) all met the criteria for inclusion as covariates in multivariable logistic regression analyses. Other characteristics were more evenly distributed across the ten experimental conditions.

Overall effect of label exposure

There were significant between-label differences for all four primary outcomes and two of the three false beliefs (see Supplementary File 3). The false belief 'long-lasting' did not differ by labelling condition and was therefore not analysed further. Findings were consistent in sensitivity analyses that additionally adjusted for false beliefs. In these analyses, believing the product was waterproof was associated with knowledge to reapply the product every 2 hours ($p = 0.046$) and negatively associated with knowledge and intention to reapply after activity ($p = 0.002$; $p < 0.001$, respectively). Perceiving the product to be sweatproof was negatively associated with knowledge to reapply every 2 hours ($chi^2 = 23.1$, $p < 0.00$) but was not associated with any other main outcome.

Effects of FOP reapplication information and water resistance claims (RQ1)

The main and combined effects of FOP reapplication information and water resistance claims are summarised in Table 2. Compared to packs with no FOP reapplication information, any FOP reapplication information increased knowledge to reapply every 2 h (48% vs. 70%) and intention to reapply within 2 h (41% vs. 54%). Similarly, compared to the standard claim 'tested for 4 hours water resistance', the alternative claim ('water resistant') increased knowledge to reapply every 2 h (60% vs 72%) and intention to reapply within 2 h (47% vs 56%). Figure 2 demonstrates that these effects were not dependent upon the presence of the other and were additive: that is, when combined, the two message elements increased knowledge to reapply every 2 h to 76%, and intention to reapply within 2 h to 58% (Fig. 2).

The pattern of effects differed for knowledge and intention to reapply the sunscreen after activity. The presence of any type of FOP reapplication information did not affect knowledge or intention to reapply after activity. However, compared to the standard claim, the alternative 'water resistant' claim slightly increased knowledge to reapply after activity (43% vs. 45%) (Table 2). Similarly, compared to packs with the standard claim 'tested for 4 hours water resistance', packs with the alternative 'water resistant' claim increased misperceptions that the sunscreen was waterproof (41% vs. 54%). Additionally, the inclusion of any reapplication information slightly increased the misperception that the sunscreen was sweatproof (19% vs. 20%).

Most effective FOP reapplication message type (RQ2)

The main and combined effects of reapplication message content and format are summarised in Table 3, with results stratified for the standard 'tested for 4 hours water resistance' and alternative 'water resistant' claim. Overall, there was less between-label variability among those that exposed to the alternative 'water resistant' claim than for the standard 'tested for 4 hours water resistance' claim.

Considering message content, outcomes for the extended (time-and-activity) message were similar to the simple (time-only) message. There was one exception to this: compared to the simple message, the extended message decreased knowledge to reapply the sunscreen every 2 h when it appeared on labels with the standard water resistance claim (66% vs. 63%), but not the alternative claim, for which there was no difference (76% and 76%).

Similarly, considering format, outcomes were similar for icon-based messages and text-based messages except that, compared to text, icons decreased knowledge to reapply the sunscreen every 2 h (60% vs. 69%) and intention to reapply sunscreen after activity (38% vs. 41%) when they appeared on labels with the standard water resistance claim, but not the alternative claim.

Labels with the extended (time-and-activity) icon-based message increased knowledge to reapply after activity for labels that contained the alternative water resistance claim (57% vs. 40–41% other conditions), and under the standard claim (52% vs. 40–43% other conditions). The extended icon was also associated with the

Table 1 Participant characteristics ($n = 3,363$)

	N	%	Difference by label condition
Gender			Pearson chi^2 (9) = 8.5, $p = 0.484$
Male	1,600	47.6	
Female	1,752	52.1	
Age group			**Pearson chi^2(45) = 53.0,$p = 0.192$**
18–24 years	347	10.3	
25–34 years	579	17.2	
35–44 years	590	17.5	
45–54 years	549	16.3	
55–69 years	759	22.6	
70 years or older	539	16.0	
State/Territory of residence (Jurisdiction)			Pearson chi^2(63) = 63.7, $p = 0.452$
New South Wales (NSW)	1040	30.9	
Victoria (VIC)	868	25.8	
Queensland (QLD)	687	20.4	
South Australia (SA)	252	7.5	
Western Australia (WA)	363	10.8	
Australian Capital Territory (ACT)	69	2.1	
Tasmania (TAS)	61	1.8	
Northern Territory (NT)	23	0.7	
Remoteness[1]			Pearson chi^2 (9) = 11.4, $p = 0.251$
Metropolitan area	2410	71.7	
Regional or remote area	953	28.3	
Education > Yr 12			**Pearson chi^2(9) = 13.9,$p = 0.126$**
No (Year 12 or less)	1168	34.7	
Yes (Higher than Year 12)	2179	64.8	
Language other than English spoken at home			Pearson chi^2 (9) = 9.1, $p = 0.431$
No (English only)	3046	90.6	
Yes (Speaks a language other than English)	293	8.7	
Skin type: response to 30 min of strong sunshine			Pearson chi^2(27) = 29.3, $p = 0.348$
Burns, does not tan	971	28.9	
Burns then tans	1541	45.8	
Does not burn – tans or no response	688	20.5	
Unsure	156	4.6	
Skin cancer history			Pearson chi^2 (18) = 17.1, $p = 0.513$
None or unsure	2,329	69.3	
Keratinocytic cancer/other spot	758	22.5	
Melanoma	243	7.2	
Preference for a suntan			**Pearson chi^2(9) = 17.4,$p = 0.043$**
No	1949	58.0	
Yes	1377	41.0	
Frequency of incidental sunscreen use			**Pearson chi^2(9) = 18.2,$p = 0.033$**
Sometimes	1079	32.1	
Often-always	2284	67.9	
Usual prompts to reapply: After a certain time			**Pearson chi^2(9) = 24.2,$p = 0.004$**
No	1726	51.3	
Yes	1623	48.3	
Usual prompts to reapply: After swimming AND after sweating (i.e. activity)			Pearson chi^2(9) = 4.5, $p = 0.874$
No	2752	81.8	
Yes	611	18.2	
Usual prompts to reapply: According to label			**Pearson chi^2(9) = 15.2,$p = 0.086$**
No	2529	75.2	
Yes	820	24.4	

Table percents unweighted numbers and percentages. Bold text signifies criteria met for potential inclusion as covariate ($p < 0.25$ on test of association with label condition). Percentages include missing data (≤ 1% of participants) and have been rounded to nearest decimal, so may not add to 100%

[1]Australian Statistical Geography Standard (ASGS)

Table 2 Main and combined effects of FOP reapplication and water resistance information on sunscreen reapplication outcomes

		Knowledge to reapply (% correct)		Intention to reapply (% yes)		False beliefs (% selected)	
		Every 2 h	***After activity***	***Within 2 h***	***After activity***	***Waterproof***	***Sweatproof***
Reapplication information	n=	$p<0.001$	$p=0.082$	$p<0.001$	$p=0.809$	$p=0.979$	$p=0.019$
No FOP information (Ref)	702	48.2% (44.5%–51.9%)	43.3% (39.6%–46.9%)	40.5% (37.0%–44.1%)	41.5% (37.9%–45.1%)	49.3% (45.6%–52.9%)	18.7% (15.8%–21.6%)
FOP information	2661	**70.3% (68.6%–72.0%)**	44.2% (42.3%–46.1%)	**54.1% (52.3%–56.0%)**	39.5% (37.6%–41.4%)	47.2% (45.4%–49.1%)	**20.2% (18.7%–21.8%)**
Water resistance claim	n=	$p=0.003$	$p=0.013$	$p=0.001$	$p=0.472$	$p<0.001$	$p=0.051$
Standard (Ref)	1,716	60.0% (57.7%–62.3%)	42.7% (40.4%–45.0)	47.0% (44.7%–49.3%)	39.6% (37.3%–42.0%)	41.2% (38.9%–43.5%)	20.2% (18.3%–22.1%)
Alternative	1,647	**71.5% (69.4%–73.7%)**	**45.4% (43.0%–47.8%)**	**55.7% (53.4%–58.1%)**	40.2% (37.8%–42.6%)	**54.4% (52.0%–56.8%)**	19.6% (17.7%–21.5%)
Reapplication information X Water resistance claim		$chi^2=0.40$, $p=0.530$	**$chi^2=3.99, p=0.046$**	$chi^2=1.32$, $p=0.250$	$chi^2=0.41$, $p=0.524$	$chi^2=0.87$, $p=0.350$	**$chi^2=5.82, p=0.016$**

FOP Front-of-pack. Standard water resistance claim: Tested for 4 h water resistance. Alternative water resistance claim: Water resistant

Results presented are adjusted percentages (95% Confidence Interval), estimated from logistic regression model that tests main and combined labelling effects and controls for covariates. Bold text signifies significant difference from reference category (Ref), $p<0.05$

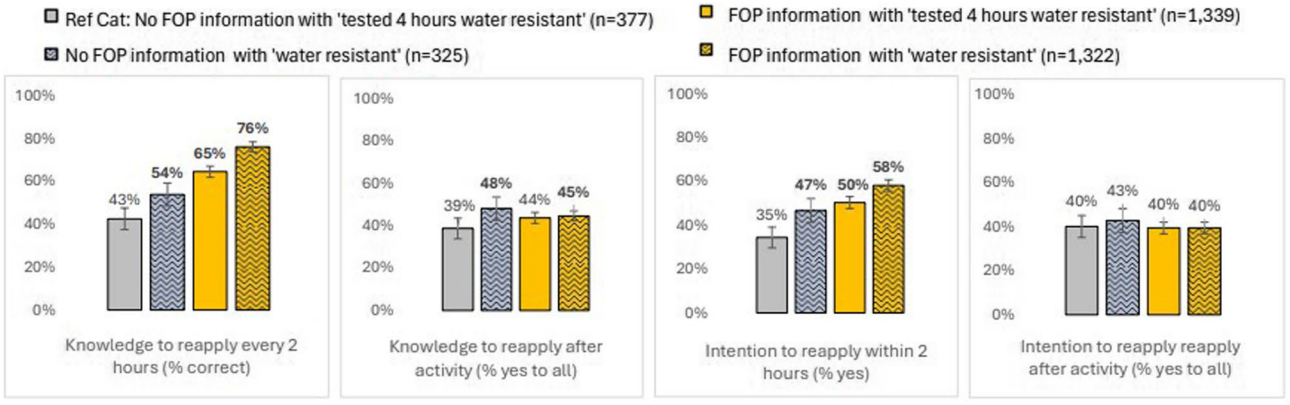

Fig. 2 Combined effects of FOP reapplication and water resistance information on sunscreen reapplication outcomes. Figures display adjusted percentage (95% Confidence Interval), estimated from logistic regression model that tests main and combined labelling effects and controls for covariates. Bold text signifies significant difference from reference category, p<0.05

false belief that the product is sweatproof, under the standard water resistance claim, but not for the alternative claim.

Subgroup analyses (primary outcomes)

For RQ1 (Supplementary File 4), overall, compared to the full sample, the results of subgroup analyses for participants with Year 12 or less education and those who speak a language other than English at home were similar in direction and magnitude for main effects of the FOP reapplication information (versus no FOP reapplication information) and the alternative 'water resistance' claim (versus the standard claim), but there were fewer significant results for the effect of the water resistance labelling condition across all outcomes.

For RQ2 (Supplementary File 5), there were some differences in main effects of message type for participants with education to Year 12 or less, compared to the full sample. For participants with limited education, there was a trend for icons to *increase* knowledge (both outcomes) and intention (after activity only) compared to text information, for labels with the standard water resistance claim, although none of these associations were statistically significant. Main effects for message content (simple versus extended) were similar overall. Combined effects of message format and content were similar to the full sample, with the extended icon increasing knowledge to reapply after activity under both the standard and alternative water resistance conditions.

Discussion

Our research confirmed that time-qualified statements of water resistance, as required under the current AUS/NZ Standard, resulted in misunderstanding about how often to reapply sunscreens. As hypothesised, the use of a simpler alternative claim ('water resistant') increased

Table 3 Main and combined effects of FOP reapplication message content and format on sunscreen reapplication outcomes, by water resistance claim

		Knowledge to reapply (% correct)		Intention to reapply (% yes)		False beliefs (% selected)	
		Every 2 hours	*After activity*	*Within 2 hours*	*After activity*	*Waterproof*	*Sweatproof*
Standard water resistance claim: Tested 4 hours water resistant							
Message content	n=	p=0.029	p=0.62	p=0.37	p=0.61	p=0.81	p=0.94
Simple (Ref)	694	66.3% (62.9%–69.8%)	40.8% (37.1%–44.4%)	50.7% (47.1%–54.4%)	36.9% (33.3%–40.4%)	39.9% (36.2%–43.6%)	17.5% (14.6%–20.4%)
Extended	645	**63.0% (59.3%–66.7%)**	47.3% (43.5%–51.1%)	49.8% (46.0%–53.6%)	42.3% (38.5%–46.1%)	42.4% (38.6%–46.2%)	24.9% (21.6%–28.2%)
Message format	n=	p<0.001	p=0.66	p=0.21	p=0.005	p=0.48	p=0.84
Text (Ref)	699	69.0% (65.6%–72.4%)	42.5% (38.8%–46.1%)	51.4% (47.7%–55.0%)	40.9% (37.3%–44.6%)	40.7% (37.1%–44.4%)	17.9% (15.0%–20.7%)
Icon	640	**60.1% (56.3%–63.9%)**	45.5% (41.7%–49.3%)	49.1% (45.3%–52.9%)	**37.9% (34.2%–41.7%)**	41.5% (37.7%–45.3%)	24.7% (21.4%–28.0%)
Content X format	n=	p=0.07	p=0.08	p=0.35	p=0.004	p=0.19	p=0.003
Simple text (Ref)	375	72.7% (68.2%–77.2%)	41.6% (36.6%–46.6%)	53.0% (48.0%–58.0%)	41.8% (36.8%–46.9%)	41.2% (36.2%–46.2%)	17.8% (13.9%–21.7%)
Simple icon	319	**59.4% (54.0%–64.8%)**	39.9% (34.5%–45.3%)	48.3% (42.9%–53.7%)	**31.4% (26.3%–36.5%)**	38.5% (33.1%–43.9%)	17.2% (13.0%–21.4%)
Extended text	324	**65.1% (59.9%–70.3%)**	43.4% (38.1%–48.8%)	49.6% (44.2%–54.9%)	40.0% (34.6%–45.3%)	40.3% (34.9%–45.6%)	18.0% (13.8%–22.2%)
Extended icon	321	**60.8% (55.5%–66.1%)**	**51.5% (46.0%–57.0%)**	49.9% (44.5%–55.4%)	44.9% (39.5%–50.4%)	44.7% (39.3%–50.2%)	**32.5% (27.4%–37.7%)**
Alternative water resistance claim: Water resistant							
Message content	n=	p=0.59	p=0.85	p=0.68	p=1.00	p= 0.40	p=0.94
Simple (Ref)	676	75.8% (72.6%–79.0%)	40.2% (36.5%–43.9%)	57.1% (53.5%–60.7%)	37.9% (34.2%–41.6%)	53.7% (50.0%–57.5%)	18.4% (15.5%–21.4%)
Extended	646	76.4% (73.1%–79.7%)	48.7% (44.9%–52.5%)	59.0% (55.3%–62.8%)	40.7% (36.9%–44.5%)	53.1% (49.2%–57.0%)	19.6% (16.5%–22.6%)
Message format	n=	p=0.81	p=0.76	p=0.21	p=0.87	p=0.73	p=0.31
Text (Ref)	649	77.1% (73.8%–80.3%)	40.5% (36.7%–44.2%)	60.3% (56.6%–63.9%)	37.6% (33.8%–41.3%)	54.7% (50.8%–58.5%)	16.7% (13.8%–19.7%)
Icon	673	75.1% (71.8%–78.4%)	48.1% (44.4%–51.8%)	55.9% (52.2%–59.6%)	40.9% (37.2%–44.6%)	52.3% (48.5%–56.1%)	21.1% (18.0%–24.2%)
Content X format	n=	p=0.61	p=0.001	p=0.90	p=0.31	p=0.16	p=0.57
Simple text (Ref)	327	76.2% (71.6%–80.8%)	40.8% (35.5%–46.2%)	59.5% (54.3%–64.7%)	37.6% (32.3%–42.9%)	53.1% (47.6%–58.5%)	16.8% (12.7%–21.0%)
Simple icon	349	75.4% (70.9%–79.9%)	39.7% (34.6%–44.7%)	54.8% (49.7%–59.9%)	38.2% (33.1%–43.3%)	54.4% (49.2%–59.6%)	19.9% (15.7%–24.1%)
Extended text	322	78.0% (73.4%–82.6%)	40.1% (34.7%–45.4%)	61.1% (55.8%–66.3%)	37.6% (32.3%–42.9%)	56.4% (50.9%–61.8%)	16.6% (12.5%–20.7%)
Extended icon	324	74.8% (70.0%–79.6%)	**57.0% (51.6%–62.4%)**	57.1% (51.7%–62.4%)	43.7% (38.3%–49.1%)	50.0% (44.5%–55.5%)	22.4% (17.8%–26.9%)

Analyses restricted to those exposed to FOP messages and stratified by water resistance condition. Results presented are adjusted percentages (95% Confidence Interval), estimated from logistic regression model that tests main and combined labelling effects and controls for covariates. Bold text signifies significant difference from reference category (Ref), p<0.05

knowledge about when to reapply. The inclusion of FOP reapplication directions, which are not required under the standard, also increased knowledge about effective reapplication. Together, the alternative water resistance claim and FOP reapplication directions significantly boosted consumer understanding of directions for reapplication.

As shown for other health behaviours, sunscreen label designs should support consumers to process information with minimal effort, including by directing their attention towards the most important labelling information [31]. Previous research using eye-tracking has demonstrated the importance of FOP sunscreen labels to convey directions for use [32]. Data collected through this online experiment (but not reported here) found 10% of participants never engaged with the back-of-pack label, with most reading it once before purchase (51%), or first use (30%) [33]. Low engagement with back-of-pack labelling information has also been reported in US research [34]. Consequently, the industry norm for

directions for use to be positioned on detailed back labels is resulting in consumers missing vital information about how to use sunscreen effectively, as these directions are lost in 'fine print' that fails to signal their importance. Primary sunscreens are categorised as medical products in Australia, not general skin care or beauty products, and so the limited label space should prioritise directions for use. Changes to the standard could require the inclusion of FOP directions for use on all primary sunscreen labels. This also prompts the question of whether the standard should require a larger proportion of FOP label space to be dedicated to directions for use and key product attributes (sun protection factor, broad spectrum performance, water resistance). This would prioritise the importance of this information over other pack design and branding features and may help consumers achieve and sustain the level of protection stated on the label.

Engagement with health information and claims is influenced by underlying beliefs and biases, which can lead consumers to infer product benefits beyond those explicit in the claim [35]. Our formative research identified misperceptions about the performance of water-resistant sunscreens, which led consumers to expect these sunscreens to retain a high level of protection after vigorous water-based activities [25]. This may explain why the alternative (unqualified) water resistant claim tested by this study increased the misperception that the product is waterproof. Additionally, sensitivity analyses demonstrated that perceiving the product to be 'waterproof' was associated with lower knowledge and intention to reapply the sunscreen after activity but perceiving the product to be 'sweatproof' was not (Supplementary File 3). Importantly, controlling for these beliefs did not diminish the overall effect of the labelling condition. This suggests that, although the labelling conditions we tested did not reduce false beliefs, they were effective to improve comprehension of reapplication directions irrespective of whether water resistance terminology was understood. Thus, misunderstanding about water resistance can be addressed through stipulating that our proposed mandate for FOP directions includes the instruction to reapply every 2 h *or after swimming, sweating and towel drying*. These directions communicate clear limits to the properties and performance of water resistance sunscreens. More broadly, these findings emphasise the need for sunscreen labelling to be supported by other communication strategies that combat misunderstanding and misinformation about sunscreens [36, 37].

Whilst not effective at decreasing the false belief that the sunscreen was waterproof, the icon that depicted the extended message (i.e., to reapply after 2 h or activity) was the only labelling condition that increased knowledge to reapply after swimming, sweating and towel drying. This message combination was even more effective at increasing knowledge to reapply after activity when presented with an alternative 'water resistant' claim (57%) than under the standard claim (52%). Other icons generally performed worse than their text-based counterparts, contrary to our hypothesis. Our expectation that icons would improve the communication of sunscreen claims and directions for use was informed by the food labelling literature, which positions visual aids as a promising but under-researched tool to enhance consumer understanding of nutrition information [31, 35]. Rather than conclude icons are ineffective to communicate sunscreen claims and directions for use, we believe this points to the need for further user-centred testing of alternative icon designs, as this was not conducted for the messages tested in our formative study. Further testing should aim to optimise visibility, comprehension and impact of all key elements of effective sunscreen use. In the meantime, sunscreen manufacturers can be reassured that FOP reapplication messages in a variety of formats can be effective to increase knowledge about effective reapplication.

Regulatory bodies could additionally consider consolidating the different times for which a product can be tested for (and claim) water resistance, as there is a bias towards maximum claims (i.e., 4 h water resistance) for high SPF products that are tested for registration and sale in Australia (Personal communications; John Staton). Removing categories to claim shorter periods of water resistance for high SPF primary sunscreens would negate the need to inform consumers of the time for which their sunscreen has been tested (in laboratory conditions) to be water resistant. It would also elevate the already high benchmark for the performance of Australian sunscreens. Changes to the standard, such as specifying FOP information, removing ambiguity in the water resistance claim, and establishing a minimum (rather than maximum) water resistance performance all help to create a level playing field for manufacturers to provide clear and consistent FOP labelling directions that benefit all sunscreen consumers.

Although skin cancer rates are generally higher in more advantaged cohorts, deaths due to skin cancer disproportionately affect the most disadvantaged, including those with limited educational attainment, financial instability, and no health insurance [38]. This is largely attributed to delayed diagnosis and treatment, however lower education and income are also associated with lower uptake of sunscreen and other forms of sun protection [38, 39]. Changes to sunscreen labelling regulations would not address barriers related to affordability and accessibility. Nonetheless, it is important to ensure that population interventions like this do not inadvertently widen health inequalities, especially those related to health literacy. Our sensitivity analyses found that, contrary to

the full sample, icon-based messages were associated with slightly higher knowledge outcomes for people with lower levels of education. These associations were not significant, however they are consistent with previous research on this topic, which suggests icons can improve message comprehension for people with lower education, health literacy, or linguistic diversity [35]. This reinforces our recommendation for further user-tested icon design, which should be conducted with diverse groups of sunscreen users.

This study focused on improving sunscreen reapplication, which is just one component of effective sun protection. Further to improving sunscreen application practices, more needs to be done to raise public awareness about UV radiation and motivate Australians to adopt effective sun protection habits, including sunscreen use, during everyday activities and prolonged exposure [40]. Experts recommend all Australians with fair to olive skin apply sunscreen daily when UV levels are forecast to be 3 and above [16, 41]. However, sunscreen should not be used in isolation or to extend time in the sun. Only about half (54%) of Australians use three or more forms of sun protection when outdoors for more than 15 min in spring and summer months [9]. Continued investment in skin cancer prevention campaigns is critical to address complacency and remind Australians of how, as well as why, to protect their skin [42]. Although labelling improvements can go some way to improving effective sunscreen use, a comprehensive approach including mass media campaigns, settings-based policies, and investment in public shade, will be required to improve sun protection and reduce skin cancer at a population level.

We assessed how labelling features influence knowledge and intentions regarding sunscreen use, because sun protection intentions predict sun protective behaviours in prospective studies [43]. To limit the number and breadth of experimental conditions, we exclusively focused on sunscreen reapplication. Complementary studies carried out in real-world outdoor settings would strengthen the evidence base for the role and impact of sunscreen labelling to change sun protection behaviour at a population level. However, we believe our experimental evidence demonstrating that FOP labelling changes can improve knowledge about effective sunscreen use is sufficient to prompt regulatory action.

Key strengths of the present study include the controlled experimental design and large sample size with quotas applied to ensure adequate representation of demographic groups according to the Australian population. However, we note that participants were recruited via an opt-in online panel and may differ from Australians who do not participate in such panels. Additionally, our sample was restricted to people who already use sunscreens, as it was beyond the scope of our research to investigate whether labelling changes also increase adoption of sunscreen.

Although our findings are specific to communication of the Aus/NZ Standard, the principles are relevant to other contexts and regulatory environments. Adherence to sunscreen reapplication recommendations are poor globally [23]. Additionally, in the US, studies conclude that sunscreen labelling terms are poorly understood and two thirds of adults mistakenly believe that sunscreen can be waterproof [34, 44, 45]. There is a clear opportunity for additional research in this under-explored area. Future research could work towards a more comprehensive understanding of how to optimise visibility, comprehension and impact of all key sunscreen labelling elements, integrating experimental and real-world evidence on directions for how much sunscreen to apply, and how often, with other attributes and claims.

Conclusions

We found that including information about sunscreen reapplication on the FOP and replacing the current time-qualified claim 'tested for 4 hours water resistance' with the simpler 'water resistant' claim can increase knowledge and intention to reapply sunscreen every 2 h. If both changes were implemented to the AUS/NZ sunscreen standard, their combination would have independent and complementary benefits for public understanding about when to reapply sunscreen. Educating Australians about the need to reapply sunscreen after swimming, sweating and towel drying is more challenging, as this involves correcting misperceptions about the performance of water-resistant sunscreens. Although icons that communicate directions to reapply every 2 h and after swimming, sweating and towel drying show promise, further testing of user-centred design concepts is warranted. Policy change is required to create a level playing field for manufacturers to adopt simplified claims of water resistance and provide clear and consistent FOP labelling directions that benefit all sunscreen consumers. In the meantime, sunscreen manufacturers can be reassured that FOP reapplication messages in a variety of formats can be effective to increase reapplication.

Abbreviations

AUS/NZ	Australian/ New Zealand
FOP	Front-of-pack
Ref	Reference category
SPF	Sun Protection Factor
UV	Ultraviolet

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12889-025-24920-5.

Supplementary Material 1.

Acknowledgements
We acknowledge the Project Reference Group (Tanya Buchanan, Anne Gately, Osher Gutnick, Amie Johnson, Vivienne Mellish, Richard Meyrick, Tess Moshakis, Raja Petchimuthu, Craig Sinclair and Megan Varlow), who supported the conceptual design and interpretation of findings, as well as the identification and development of stimuli for testing. We also acknowledge Ashlee Ball, who validated the study results. Additionally, we would like to thank SunSmart Victoria (especially Emma Glassenbury) for contributions to the qualitative research that informed this study and interpretations.

Authors' contributions
AN led the study conceptualisation, design, data collection, data analysis and manuscript preparation. AH and EB contributed to the data analysis and manuscript preparation. CM contributed to the study design and manuscript preparation. HD contributed to the study conceptualisation, design, data collection, data analysis and manuscript preparation.

Funding
Study expenses related to data acquisition were funded by Cancer Council Victoria. No funding was received for study investigators.

Data availability
Non-identifiable data will be made available on request to the corresponding author.

Declarations

Ethics approval and consent to participate
The study received ethical approval from the Cancer Council Victoria Human Research Ethics Committee (HREC 2316(ii)) and was conducted in accordance with the Australian Government National Health and Medical Research Council's National Statement on Ethical Conduct in Human Research 2023. All participants provided their informed consent to take part in the study.

Consent for publication
Prior to indicating their consent to take part, research project participants were informed that only combined results would be reported, and no individuals would be identified in any research outputs.

Competing interests
All authors are employed by Cancer Council Victoria, which is a member of Cancer Council Australia. Cancer Council Australia derives income from the sale of sunscreen products; this income is used to fund cancer research, prevention and support activities. None of the investigators receive funding from the sale of sunscreens.
A Project Reference Group was formed for the study duration with the aim to provide study advice to maximise research translation and public health impact. The Project Reference Group included consumers and representatives from Cancer Council Australia, Cancer Council Victoria and Vitality Brands (a sunscreen manufacturer). The reference group was consultative in nature; to maintain research integrity, all decisions about the research were be made by the research team. This manuscript was prepared independent of the Project Reference Group.

Author details
[1]Centre for Behavioural Research in Cancer, Cancer Council Victoria, East Melbourne, Australia
[2]Melbourne School of Population and Global Health, University of Melbourne, Parkville, Australia
[3]Melbourne School of Psychological Sciences, University of Melbourne, Parkville, Australia
[4]School of Human Sciences, University of Western Australia, Crawley, Australia

Received: 13 March 2025 / Accepted: 15 September 2025
Published online: 29 October 2025

References

1. Green A. Regular application of sunscreen can prevent skin cancer. J Cosmet Sci. 2020;71(4):191–8.
2. Li H, Colantonio S, Dawson A, Lin X, Beecker J. Sunscreen application, safety, and sun protection: the evidence. J Cutan Med Surg. 2019;23(4):357–69.
3. Sander M, Sander M, Burbidge T, Beecker J. The efficacy and safety of sunscreen use for the prevention of skin cancer. CMAJ. 2020;192(50):e1802–8.
4. Arnold M, Singh D, Laversanne M, Vignat J, Vaccarella S, Meheus F, et al. Global burden of cutaneous melanoma in 2020 and projections to 2040. JAMA Dermatol. 2022. https://doi.org/10.1001/jamadermatol.2022.0160.
5. Whiteman DC, Neale RE, Baade P, Olsen CM, Pandeya N. Changes in the incidence of melanoma in Australia, 2006–2021, by age group and ancestry: a modelling study. Med J Aust. 2024;221(5):251–7.
6. Australian Institute of Health and Welfare. Health system spending on disease and injury in Australia 2022–23. Canberra: AIHW. 2024 Cited 13 Mar 2025. Available from: https://www.aihw.gov.au/reports/health-welfare-expenditure/health-system-spending-on-disease-and-injury-aus
7. Gorry C, McCullagh L, Barry M. Economic evaluation of systemic treatments for advanced melanoma: a systematic review. Value Health. 2020;23(1):52–60.
8. Australian Bureau of Statistics. Causes of Death, Australia [Internet]. Canberra: ABS; 2024. [Cited 2025 Oct 10]. Available from: https://www.abs.gov.au/statistics/health/causes-death/causes-death-australia/latest-release
9. Australian Bureau of Statistics. Sun protection behaviours [Internet]. Canberra: ABS; 2024. [Cited 2025 Oct 10]. Available from: https://www.abs.gov.au/statistics/health/health-conditions-and-risks/sun-protection-behaviours/latest-release
10. Tabbakh T, Dobbinson SJ. 2016-17 National Sun Protection Survey: Sun protective behaviours and sunburn incidence on weekends among Australians in summer 2016-17 [Report 2]. Melbourne, Australia: Centre for Behavioural Research in Cancer, Cancer Council Victoria. 2018. Available from: https://www.cancervic.org.au/downloads/cbrc_research_papers/skin_cancer_research/CBRC_Report_NSPS_2016-7_Public.pdf
11. Autier P, Boniol M, Dore JF. Sunscreen use and increased duration of intentional sun exposure: still a burning issue. Int J Cancer. 2007;121(1):1–5.
12. Julian AK, Ferrer RA, Perna FM. Sun protection behavior: health impact, prevalence, correlates and interventions. Psychol Health. 2023;38(6):701–25.
13. Autier P. Sunscreen abuse for intentional sun exposure. Br J Dermatol. 2009;161(Suppl 3):40–5.
14. Henderson SI, King KL, Karipidis KK, Tinker RA, Green AC. Effectiveness, compliance and application of sunscreen for solar ultraviolet radiation protection in Australia. Public Health Res Pract. 2022;32(1):e3212205.
15. Australian/New Zealand Standard AS/NZ 2604. 2021. Sunscreen products - evaluation and classification. Sydney, Australia and Wellington, New Zealand: Standards Australia and Standards New Zealand, 2021.
16. Whiteman DC, Neale RE, Aitken J, Gordon L, Green AC, Janda M, et al. When to apply sunscreen: a consensus statement for Australia and New Zealand. Aust N Z J Public Health. 2019;43(2):171–5.
17. Heerfordt IM, Torsnes LR, Philipsen PA, Wulf HC. Sunscreen use optimized by two consecutive applications. PLoS ONE. 2018;13(3):e0193916.
18. American Cancer Society. How to use sunscreen [Internet]. Atlanta, USA: American Cancer Society. 2024. [Cited 2025 Oct 10] . Available from: https://www.cancer.org/cancer/risk-prevention/sun-and-uv/how-to-use-sunscreen.html
19. Canadian Cancer Society. Spotlight on sun safety [Internet]. Toronto, Canada: Canadian Cancer Society. 2025. [Cited 2025 Oct 10] . Available from: https://cancer.ca/en/cancer-information/reduce-your-risk/be-sun-safe/spotlight-on-sun-safety#Sunscreen-101
20. Carrao AM, Coleman JC, Guo JJ, Kumari H. A novel online survey approach designed to measure consumer sunscreen application thickness—implications for estimating environmental emissions. J Expo Sci Environ Epidemiol. 2024;34(6):1064–71.
21. Jungman E, Maibach H. Enhancing sunscreen efficacy in the 'real' world? J Dermatol Treat. 2010;21(5):261–6.
22. Petersen B, Wulf HC. Application of sunscreen – theory and reality. Photodermatol Photoimmunol Photomed. 2014;30(2/3):96–101.
23. Lim HW, Saint Aroman M, Skayem C, Halioua B, Perez Cullell N, Ben Hayoun Y, et al. Sun exposure and protection habits: self-reported attitudes, knowledge and behaviours. J Eur Acad Dermatol Venereol. 2024;38(10):2024–33.
24. Passeron T, Dreno B, Puig S, Goh CL, Kang HY, Ly F, et al. Sun exposure behaviors and knowledge among the At-Risk population: results from an international survey, the HELIOS project. Photodermatol Photoimmunol Photomed. 2024;40(6):e13014.

25. Nicholson A, Marshall L, Harrison A, Dixon H.. Over-confident and under-informed: Qualitative findings on consumer awareness of recommendations for effective sunscreen application. Aust N Z J Public Health. In press. 2025. https://doi.org/10.1016/j.anzjph.2025.100253.
26. Nicol I, Gaudy C, Gouvernet J, Richard MA, Grob JJ. Skin protection by sunscreens is improved by explicit labeling and providing free sunscreen. J Invest Dermatol. 2007;127(1):41–8.
27. Julian AK, Perna FM, Tribby CP. Visual aids for sunscreen application: a mixed methods study. Photodermatol Photoimmunol Photomed. 2023;39(1):21–6.
28. Norman KG, Loretz L, Kowcz A, Kaufman LE, Ruvolo E, Traudt M, et al. Application habits and practices of regular sunscreen users in the United States: results of an online survey. Food Chem Toxicol. 2023;181:114093.
29. Weig EA, Tull R, Chung J, Brown-Joel ZO, Majee R, Ferguson NN. Assessing factors affecting sunscreen use and barriers to compliance: a cross-sectional survey-based study. J Dermatol Treat. 2020;31(4):403–5.
30. Hosmer DW Jr, Lemeshow S. Applied logistic regression. 2nd ed. New York: Wiley; 2000.
31. Kelly M, McCann JR, Chapple CI, Woods J, Russell CG. Visual communication design: a neglected factor in nutrition promotion via packaged food labels. Front Public Health. 2024;12:e1296704.
32. Lowry M, Julian AK, Tribby C, Perna F. Consumers pay attention to ingredients on the front of a label: an eye tracking study. Transl Behav Med. 2023. https://doi.org/10.1093/tbm/ibad038.
33. Nicholson A, Brennan E, Haynes A, Dixon H. Labelling enhancements to improve effective sunscreen reapplication: Final report [unpublished report]. Melbourne, Australia: Centre for Behavioural Research in Cancer, Cancer Council Victoria. Prepared for: Cancer Council Victoria; 2024.
34. Chao LX, Sheu SL, Kong BY, Rademaker AW, Kundu RV. Identifying gaps in consumer knowledge about sunscreen. J Am Acad Dermatol. 2017;77(6):1172–e32.
35. Nocella G, Kennedy O. Food health claims – what consumers understand. Food Policy. 2012;37(5):571–80.
36. Tamminga MA, Lipoff JB. Understanding sunscreen and photoprotection misinformation on parenting blogs: a mixed-method study. Pediatr Dermatol. 2021;38(1):88–91.
37. Julian AK, Welch J, Bean MM, Shahid S, Perna FM. Information about sunscreen on YouTube and considerations for sun safety promotion: content analysis. JMIR Dermatol. 2020;3(1):e14411.
38. Maloney ME, Bacak C, Tjioe K, Davis LS, Balas EA, Agrawal G, et al. The intersection of melanoma survival and social determinants of health in the United States: a systematic review. J Am Acad Dermatol. 2024;17:126–38.
39. Kumar KD, Desai AD, Samie FH. Effects of education and income on sun-protective behaviors. Arch Dermatol Res. 2024;316(6):309.
40. Nicholson A, Murphy M, Walker H, Tinker R, Dobbinson S. Not part of my routine: a qualitative study of use and understanding of UV forecast information and the SunSmart app. BMC Public Health. 2019;19:1–9.
41. Neale RE, Beedle V, Ebeling PR, Elliott T, Francis D, Girgis CM, et al. Balancing the risks and benefits of sun exposure: a revised position statement for Australian adults. Aust N Z J Public Health. 2024;48(1):100117.
42. Walker H, Maitland C, Tabbakh T, Preston P, Wakefield M, Sinclair C. Forty years of slip! Slop! Slap! A call to action on skin cancer prevention for Australia. Public Health Res Pract. 2022;32(1):e31452117.
43. Starfelt Sutton LC, White KM. Predicting sun-protective intentions and behaviours using the theory of planned behaviour: a systematic review and meta-analysis. Psychol Health. 2016;31(11):1272–92.
44. Prado G, Svoboda RM, Teplitz RW, Farberg AS, Rigel DS. Patient knowledge of FDA-mandated sunscreen labeling terminology: a cross-sectional survey. Photodermatol Photoimmunol Photomed. 2019;35:141–7.
45. Voller LM, Polcari IC. Public misperceptions of common sunscreen labeling claims: a survey study from the Minnesota state fair. J Am Acad Dermatol. 2020;83(3):908–10.

Publisher's Note