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Sun Protection Among New Zealand Primary School Children

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Abstract

Schools are an important setting for raising skin cancer prevention awareness and encouraging sun protection. We assessed the clothes worn and shade used by 1,278 children in eight schools in the Wellington region of New Zealand. These children were photographed for the Kids'Cam project between September 2014 and March 2015 during school lunch breaks. Children's mean clothing coverage (expressed as a percentage of body area covered) was calculated. Data on school sun-safety policies were obtained via telephone. Mean total body clothing coverage was 70.3% (95% confidence interval = 66.3%, 73.8%). Body regions with the lowest mean coverage were the head (15.4% coverage), neck (36.1% coverage), lower arms (46.1% coverage), hands (5.3% coverage), and calves (30.1% coverage). Children from schools with hats as part of the school uniform were significantly more likely to wear a hat (52.2%) than children from schools without a school hat (2.7%). Most children (78.4%) were not under the cover of shade. Our findings suggest that New Zealand children are not sufficiently protected from the sun at school. Schools should consider comprehensive approaches to improve sun protection, such as the provision of school hats, sun-protective uniforms, and the construction of effective shade.

Keywords

sun protection, cancer prevention and screening, child health, shade, school-based health care, school-based health promotion

Skin cancer is a significant public health issue in countries with high solar ultraviolet radiation (UVR) levels and predominantly fair-skinned populations. The World Health Organization (WHO) estimates that one in two Australians will develop skin cancer in their lifetime (WHO, 2009b). New Zealand currently has the highest rate of melanoma skin cancer in the world (Whiteman, Green, & Olsen, 2016). The age-standardized incidence and mortality rates of melanoma in New Zealand are 35.9 and 4.7 per 100,000 population, respectively (International Agency for Research on Cancer, 2014), and annual deaths from all types of skin cancer in New Zealand exceed road traffic crash fatalities (Ministry of Health, 2016). Exposure to UVR is the most important risk factor for skin cancer development (Armstrong, 2004). This risk can be reduced by practicing sun-safe behaviors, including wearing sunscreen and sun-protective clothing, seeking shade, and avoiding the sun during peak UVR hours.

Schools are important settings for skin cancer prevention. Children can receive large amounts of UVR exposure while on school grounds (Wright, Reeder, Bodeker, Gray, & Cox, 2007). Children are also considered potentially more vulnerable than adults to the adverse effects of UVR (Whiteman, Whiteman, & Green, 2001). Sun-safety interventions implemented in primary and middle schools can be effective in improving sun protection, reducing UVR exposure, and decreasing skin cancer risk (Community Preventive Services Task Force, 2012). Furthermore, investing in improving children's sun protection is likely to be cost-effective (Gordon & Rowell, 2015). One study found that every dollar invested in the U.S. SunWise school program produced more than four dollars' worth of benefits (Kyle et al., 2008).

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Many schools worldwide adopt sun-safety policies that encourage or enforce sun protection practices in schools. In New Zealand, the SunSmart Schools Accreditation Programme (SSAP) provides accreditation to schools that have developed and implemented a sun-safe policy in Terms 1 and 4. A school's accreditation under the SSAP has been associated with more comprehensive school sun-safety practices, including the reported use of sun-protective clothing (Reeder, Jopson, & Gray, 2012). Furthermore, a study of 899 Australian schools found that schools with a written policy had more comprehensive sun-protection practices than schools without a written policy (Dono, Ettridge, Sharplin, & Wilson, 2014).

While studies of school-level practices have been conducted, few studies have directly assessed sun-protective behaviors among school children. A reliance on self-reported data is concerning as there may be a gap between reported practices and actual sun-safety behaviors. One study of 33 Australian primary schools compared direct observations of sun protection to the self-reported estimates by the schools' principals (Milne et al., 1999). On average, hat wearing among students was substantially lower than school principal estimations. Furthermore, few studies have assessed the nature of shade use among students, such as the shade types most popular among students, and what they do while under cover (e.g., eating or playing).

This study aimed to assess the clothing worn and shade available to New Zealand primary school children. Photographic data captured by children who took part in Kids'Cam, a project aiming to explore the wider environment in which children live (Signal et al., 2017), was used for this purpose.

Method

Study Sample

Between 2014 and 2015, the Kids'Cam project provided wearable cameras to 168 school children in the Wellington region of New Zealand. These devices, worn on a lanyard around the child's neck, automatically captured images of their environment every 7 seconds. The current article reports on the images captured by a sample of Kids'Cam participants during school lunch breaks (around midday) in the southern hemisphere months between September and April when ultraviolet index values are most likely to exceed 3 and cause sun damage. Methods for selecting these participants have been described previously in a feasibility study (Gage, Leung, Stanley, Reeder, Mackay, et al., 2017). In summary, the participants were 15 randomly selected children aged 11 to 13 years from eight schools in the Wellington region of New Zealand. The participants' cameras captured an average of 340 eligible (i.e., neither blurry nor blocked) photos outdoors during the school lunch breaks. A 10% systematic sample (i.e., 1 in 10) of each of these 15 participants' eligible photos was selected for study. In these images, 1,278 third parties, defined here as the school children captured in the images (not including the camera-wearers), and 108 shade structures were observed.

School Sun-Safety Policies

Between June 2015 and February 2016, the eight schools were contacted by telephone and the school principal was asked to participate in a survey regarding the school's sun-safety policies. Respondents were asked whether the school had a policy relating to sun safety at the time the school participated in Kids'Cam and whether their school was accredited as a SunSmart school. Written copies of sun-safety policies were requested.

Weather Conditions

For each of the eight lunch breaks during which images were captured, mean ultraviolet index (UVI) and temperature values were obtained from the National Institute of Weather and Atmospheric Research (National Institute of Water and Atmospheric Research, 2016). The UVI is a measure of UVR at the earth's surface. The WHO recommends that sun protection is required when the UVI reading is 3 or above (WHO, 2009a).

Measures

A coding protocol was developed based on an initial assessment of the data (Gage, Leung, Stanley, Reeder, Mackay, et al., 2017). The clothing worn by each child was classified with respect to 38 items (Table 1). The Clothing Assessment Procedure (Gage, Leung, Stanley, Reeder, Barr, et al., 2017) was used to calculate mean clothing coverage of the head, neck, trunk, arms, hands, legs, and feet for children within each school. Children were classified as using shade if it appeared that at least three quarters of their body was shaded by a built structure or tree. Clouds were not considered as providing shade because the summertime UVI in New Zealand can reach hazardous levels even when there is no direct sun (Cancer Society of New Zealand, 2008). The behaviors of the camera wearers were not assessed because their clothing was not usually in clear view. Duplicates, defined here as students who appeared more than once over the course of the lunch break, were not excluded. This decision was made because it was difficult to distinguish between some children, and because some children changed their behavior over the lunch break, for example, by removing a hat during play or taking cover under shade. We estimate that at least 5% of the sample were duplicates (ascertained by counting the number of children who appeared more than once in the photos captured by two Kids'Cam participants during the lunch break).

Table 1. The Coverage Values of 38 Clothing Items for Children Aged 10 to 14 Years.[a]

Clothing item	Acov (%)[b]
Head	
Visor	1.01
Cap	5.39
Bucket hat	5.88
Broad-brimmed hat	5.94
Legionnaire hat	5.89
Beanie	7.06
Burka	10.82
Headscarf	4.75
Sunglasses	0.90
Neck	
Collar	0.98
Raised hood	8.35
Neck scarf	2.00
Anterior trunk	
Type I covering	13.00
Type II covering	12.83
Type III covering	12.50
Bikini type I	2.57
Bikini type II	4.80
Posterior trunk	
Type I covering	13.00
Type II covering	12.83
Type III covering	12.18
Bikini type I	0.21
Bikini type II	4.71
Arms	
1/4-length sleeves	1.92
1/2-length sleeves	7.20
3/4-length sleeves	11.21
Full-length sleeves	14.60
Hands	
Gloves Type I	5.00
Gloves Type II	3.70
Legs	
1/4-length coverings	9.13
1/2-length coverings	14.42
3/4-length coverings	23.44
Full-length coverings	29.00
Socks and shoes	
Flip-flops Type I	2.64
Flip-flops Type II	4.04
Closed shoe	7.00
Short socks	7.77
Medium socks	10.70
Long socks	14.43

[a]The coverage values are age-dependent, so the coverage for other age groups is different. [b]Percentage of total body surface area covered (Acov) by the clothing item.

Built shade and trees were classified with respect to 12 shade types (Table 2; Mackay, 2003). Built shade canopies were classified as solid, translucent/transparent, fabric, or "other." Tree canopies were classified as light, medium, or heavy using the canopy density guide (Greenwood, Soulos, & Thomas, 2000). Built shade and trees were excluded if they did not provide sufficient cover for at least one child.

To aid in identifying commonly used types of shade, each structure's use per image (UPI) was estimated. A structure's UPI was derived by dividing the total number of children who used the structure by the number of times it appeared in the images, returning its mean use per frame. Structures returning a high UPI value (relative to the mean across all structures) were presumed to have been more popular among students, and vice versa.

Statistical Analyses

R statistical software (R Foundation, Vienna, Austria) was used for all statistical analyses. A multistage analysis was conducted, with means for clothing coverage and shade use assessed after being first calculated for each school. The mean of individual school means was then calculated. Differences in clothing coverage and shade use between males and females and children from schools with and without school sun-safety policies were explored using the *t* test (assuming unequal variances). The potential correlation between school sun-safety policies, temperature, and UVI on clothing coverage and shade use was assessed using the analysis of variance test.

Ethical Approval

Ethical approval was obtained from the University of Otago Human Ethics Committee (Health; 13/220). Written consent was obtained from all participating schools, communities, children who wore the cameras and their parents. To protect the anonymity of third parties, the faces of anyone captured in published images were obscured. For further discussion on the ethical considerations of Kids'Cam, see Signal et al. (2017).

Results

Sun-Safety Policies

All eight schools completed the sun-safety survey. Six schools, two of which were Sun-Smart accredited, had a written sun-safety policy. Features of the policies included the following:

- Requiring students to wear a sun-protective hat (all policies)
- Providing sunscreen for students and staff (all policies)
- Requiring students not wearing a hat to play in shade (five policies)

Table 2. Shade Types and Their Definitions.

Shade area	Description	Source
1. Covered outdoor learning area	A large space where 35+ students can gather comfortably in a group.	Mackay (2003)
2. Veranda	A roofed porch or balcony extending along the outside of a classroom or other building.	Mackay (2003)
3. Covered way	A roofed structure providing cover between classrooms or other buildings.	Mackay (2003)
4. Entranceway	A roofed structure providing cover for entranceways. Usually small and thoroughfare.	Mackay (2003)
5. Shade over eating/sitting area	A structure or foliage that provides cover for tables or seats.	Mackay (2003)
6. Shade over courts	A structure or foliage that provides cover for a hard surface used for sports and games.	Mackay (2003)
7. Shade over playing equipment	A structure or foliage that provides cover for playing equipment, such as playgrounds, or sandpits.	Mackay (2003)
8. Shade over swimming pool areas	A structure that provides shade for a swimming pool area.	Mackay (2003)
9. Sports and playing field shade	A structure that provides shade for a sports or playing field.	Mackay (2003)
10. Building shade	Shade cast by the walls of a classroom or other structure.	—
11. Lone tree	Trees that do not meet any of the above criteria.	—
12. Other	A structure that provides shade, but does not meet any of the aforementioned criteria.	—

- Sun-safety information incorporated into the school curriculum (five policies)
- Working toward the development of more shade areas (four policies)
- Shade to be considered in all future building construction (two policies)

Three of the schools with sun-safety policies had compulsory bucket hats as part of their school uniform, while the other three encouraged students to bring hats from home. Five of the six schools required children to wear a school uniform.

Weather Conditions

Mean UVI during the eight school lunchbreaks was 8.89 (low: 6.34; high: 12.90). This is well above the UVI at which sun protection is recommended by the WHO (UVI ≥ 3; WHO, 2009a). The mean temperature was 16.41°C (low: 13.08°C, high: 22.50°C).

Clothing Coverage

Mean total body clothing coverage for children across the eight schools was 70.3% (95% confidence interval [CI] = 66.3%, 73.8%; Table 3). The body regions with the lowest mean clothing coverage were the head (15.4% covered), neck (36.1% covered), lower arms (46.1% covered), hands (5.3% covered), and calves (30.1% covered).

Only 21.3% of students across the eight schools wore sun-protective hats (bucket, broad-brim, or legionnaire styles). Schools with compulsory school bucket hats ($n = 3$) had significantly greater head coverage (31.0%) than schools with no policy or schools requiring students to bring hats from home (6.1%; p value < .01), due to more students wearing hats (52.2% vs. 2.7%).

Half-length sleeves, worn by 51.1% of children, and half-length leg coverings, worn by of 69.3% of children, were the most common sources of arm and leg coverage, respectively. The buttocks, genitalia, posterior trunk, and feet were always covered by clothing. While 64.5% of children wore collars, which can expose a small area of the chest if unbuttoned, most collared shirts observed (64.3%) completely covered the anterior trunk region.

Children from schools without a uniform ($n = 2$) had significantly higher total body clothing coverage (79.8%) than children from schools with a school uniform ($n = 6$; 68.1%). This was because more students in nonuniformed schools wore full-length sleeves (65.7% vs. 37.3%) and full-length pants (56.2% vs. 7.0%). Children from schools with collared shirts as part of the school uniform ($n = 5$) wore more collars than children from nonuniformed schools (94.7% vs. 14.1%) and had greater neck coverage (48.1% vs. 15.9%). Males wore more hats of any type than females (30.6% vs. 17.3%) and had a greater mean head coverage (16.4% vs. 9.2%, p value = .02). Males were also more likely than females to wear half-length leg coverings (75.1% vs. 61.8%, p value < .01) and medium-length socks (15.3% vs. 3.1%, p value < .01), though there were no differences in leg coverage by gender. There was no association between the prevalence of a school sun-safety policy, UVI level, and temperature level on clothing coverage.

Shade

Across the eight schools, 21.6% (95% CI = 10.1%, 31.0%) of the children were under shade. There was no association between school sun-safety policies, UVI, temperature, cloud

Table 3. The Effect of Gender and School Uniform on Schoolchildren's Body Coverage (%).

Body region[a]	All schools	Females	Males	Overall gender difference	Uniform	No uniform	Overall uniform difference
Total body	70.0	68.9	69.7	−0.8	68.1	75.8	−7.7*
Head	15.4	9.2	16.4	−7.1*	15.4	15.5	−0.2
Neck	36.1	32.8	36.7	−3.9	41.7	19.1	22.5*
Anterior trunk	99.5	99.0	99.5	−0.5	99.6	99.4	−0.2
Upper arms	93.8	93.2	94.4	−1.2	93.0	94.0	1.0
Lower arms	46.1	53.3	45.7	7.6	38.9	67.9	−29.1
Hands	5.3	6.1	5.4	0.8	4.5	7.9	−3.4
Thighs	85.7	82.5	85.1	−2.6	91.3	83.8	−7.5
Calves	30.1	28.1	26.6	1.6	62.6	19.3	−43.3

[a]For all children, the posterior trunk, genitalia, buttocks, and feet were always covered by clothing.
*$p < .05$.

Table 4. The Number of Shade Structures Observed and Their Mean Use by Students.

Type	*N*[a]	Use per image (95% CI)[b]
All	93	0.6 (0.0-1.4)
Verandas	30	0.9 (0.1-1.7)
Covered ways	2	0
Entranceways	7	1.1 (0.3-2.0)
Shade over sitting areas[c]	15	1.6 (0.1-3.1)
Shade over courts	2	3.4 (0.1-6.8)
Playing field shade	12	0.3 (0-0.7)
Shade from buildings[d]	12	0.6 (0.1-1.1)
Lone trees	21	0
Covered outdoor learning areas	1	6.9 (N/A)

Note. CI = confidence interval.
[a]Excludes 15 structures that were beyond the range at which children could be clearly observed. [b]The mean number of students seen underneath the structures per image. [c]Includes nine structures that were also included in other categories (eight verandas and the one covered outdoor learning area). [d]Includes the covered outdoor learning area.

cover, gender, coverage or hat wearing, and shade use. Although five schools required students not wearing a hat to play in shade, most children observed in exposed areas wore no hat. The schools had a mean of 13.5 shade structures (range 4-30; Table 4). The mean UPI of each structure was 0.6 (95% CI = 0, 1.5), indicating that, in any given image, a mean of 0.6 children were observed using each structure. Verandas were more likely to be used than most other shade types, with a mean UPI of 0.8. In two schools, several large verandas that provided cover over seating areas were observed (Figure 1a and b). Children were seen consuming their lunch and gathering to talk under these structures. Eight structures shaded the entranceway to classrooms and other school buildings. Although these structures had a relatively high UPI (1.3; 95% CI = 0.3, 2.0), their higher use appeared to be due to their positioning in heavily frequented areas rather than the children actively "seeking" shade.

Trees were the only form of shade available on sports and playing fields. Fifteen structures (eight trees, five verandas, a covered outdoor learning area, and a shade sail) provided shade for eating and sitting areas. These structures provided enough shaded space for children to sit and gather as a group, and had a high mean UPI of 1.6 (95% CI = 0.1, 3.1). The most popular shade structure, with a UPI of 6.9, was a covered outdoor learning area. It was clad in a translucent architectural textile that provided cover for a courtyard, sitting areas, and several classroom entrances (Figure 1c and d). Fifty-five students were observed underneath its cover, some of whom were observed eating lunch, playing ball games, and conversing with peers.

Discussion

Most school children were not under the cover of shade and had most of their head, neck, lower arms, and calves exposed to the sun. The WHO recommends sun protection when the UVI is 3 or above (WHO, 2009a). As the UVI for each lunch break exceeded 3, many children would have been at risk of sun damage. Our findings highlight the importance of sun-safety in the school setting and raise several implications for policy and practice.

Although most schools had sun-safety policies encouraging students to wear sun-protective hats, most students did not wear a hat during the lunch break. This is concerning from a skin cancer primary prevention perspective because the face and neck receive higher levels of UVR relative to other body parts. There may be a rationale to encourage schools to have hats as a compulsory component of their school uniform. In our study, students from schools with uniform hats were significantly more likely to wear hats. These hats were usually available at a discounted price and purchasable throughout the school year, thus providing families with a simple and inexpensive option for acquiring sun-protective hats for their children.

Children from uniformed schools had lower total body coverage, but greater neck coverage due to the wearing of

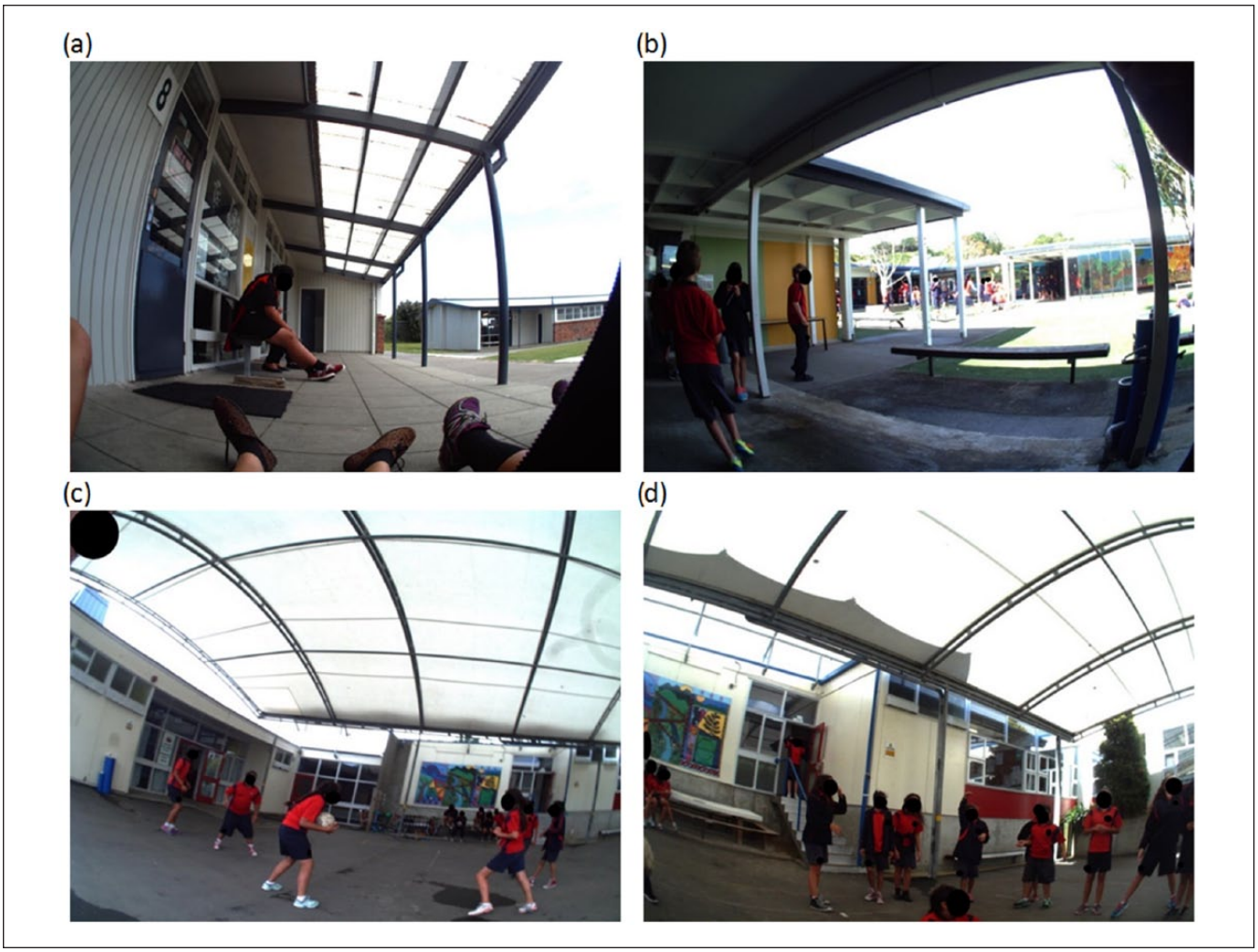

Figure 1. Popular shade structures as observed in the images.

more collared shirts. To our knowledge, the school uniforms observed were representative of those worn in other New Zealand primary schools during the summer. They included a short-sleeved shirt (usually collared) and shorts. As these uniforms leave much of the lower arms and calves exposed, substantial increases in coverage could be achieved by the wearing of long-sleeved shirts (with collars) and either full-length pants or shorts with long socks. An evaluation of uniforms in Australian primary schools reached a similar conclusion (Turner & Harrison, 2014). Although overheating in summer may be a concern with increasing clothing coverage, research indicates that this may not be the case in Australia. North Queensland outdoor workers wearing long cotton pants were found to have a similar body temperature to those wearing cotton shorts (Sinclair & Brownsberger, 2013). Moreover, elbow-length shirts and below-knee shorts were well tolerated by North Queensland school children (Harrison, Buettner, & Maclennan, 2005). Therefore, heat stress should not be a concern to New Zealand and some regions of Europe and the United States, which have lower average temperatures than Australia.

There appeared to be an association between the location and size of shade structures and their use by students. Large structures and trees that provided cover for seating areas, areas near classrooms, and courts (paved areas where students often played ball games) were more likely to be used. These results are consistent with a prior audit of shade in New Zealand primary schools (Mackay, 2003). Shade canopy composition can also be an important factor. In New Zealand, people can find shaded areas too cool for comfort, thus increasing the appeal for canopies composed of translucent or transparent materials (e.g., polycarbonate; Mackay, Sandford, & Hall, 2014). Such materials can block most UVR while letting through some heat and light from the sun (Toomey, Gies, & Roy, 1995).

Limitations and Future Research

This study is limited by the small number of schools ($n = 8$), all of which were in the Wellington region of New Zealand. While Wellington temperatures are about average when compared with the mean of all New Zealand cities, there may

be regional differences in sun-safety practices with respect to temperature, for example, less clothing coverage may be expected in the warmer, northern regions of New Zealand. We did not attempt to assess sunscreen use, due to the uncertainties in doing so with photographic data (though all schools reported they had sunscreen available for children to use). We also could not ascertain whether a child was actively seeking shade or whether they were shaded by chance (e.g., by passing through a shaded area). Our decision to not exclude duplicates (children photographed more than once over the course of the lunch break) may be a source of bias if duplicates were not representative of the general sample. For example, it could have overrepresented the clothing worn by participants' friends, who were closer to the camera and thus more likely to be photographed. However, as the participant, their camera, and third parties were often in constant motion, the method captured a diverse range of images for the study of sun protection in schools.

Our findings suggest that a school's adoption of a sun-safety policy may not translate to better sun-protective behaviors among students. Additional intervention may therefore be warranted to ensure that children within school are sun-safe, such as the development of large shade structures in areas popular with students and sun-safe uniforms with hats, full-length pants, and long-sleeved shirts with collars. Although New Zealand has the highest rate of melanoma skin cancer in the world, there have been no evaluative studies of sun-safety interventions in its primary and intermediate schools and, except for the SSAP, no ongoing interventions focused on improving sun protection nationwide. As school-based sun-safety interventions have demonstrated effectiveness overseas (Community Preventive Services Task Force, 2012; Kyle et al., 2008), they should be considered for implementation, or trial, as a means of improving sun-protection among New Zealand school children.

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