Sun protection and shade availability in New Zealand's outdoor recreation spaces

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ABSTRACT

AIMS: We aimed to investigate sun protection behaviours and shade availability in outdoor recreation spaces using image captured by children who, in 2014/15, wore wearable cameras for four consecutive days.

METHODS: The 168 participants visited 16 outdoor recreation spaces between 10am and 4pm, capturing 378 images, on average, in each setting. People observed in the images (n=2,635) were coded for age, sex, clothing worn (38 clothing types) and shade used. Mean temperature and ultraviolet index (UVI) values were linked with the time-stamped and geo-referenced images.

RESULTS: The UVI in most settings was high enough to warrant sun protection, but only 4.3% of people wore sun-protective hats (broad-brim, bucket and legionnaire styles) and 10.7% used shade. Areas most popular with children, including playground equipment, beach sand and pool areas, had little or no shade available.

CONCLUSIONS: Despite New Zealand having the highest incidence of melanoma skin cancer in the world, the results indicate that few New Zealanders wear hats and seek shade in outdoor recreation settings. The findings highlight the need to improve policy and environmental support for skin cancer prevention activities.

Skin cancer accounts for up to 80% of total cancer cases in New Zealand.[1] Each year, there are over 2,000 incident cases and 350 deaths from melanoma,[2] and over 90,000 incident cases of keratinocyte carcinomas (formerly known as non-melanoma skin cancers).[3] The estimated annual cost of skin cancer in New Zealand (from a societal perspective) in 2006 was $123.1m (at 2008 prices).[1] Given that exposure to the sun causes most cases of skin cancer,[4] prevention activities in New Zealand have focused on discouraging excessive sun exposure and encouraging sun protection.

Outdoor recreational spaces, including beaches, outdoor pools and playgrounds, are important settings for sun protection behaviour. Visits to these settings can result in excessive exposure to UVR that increases the risk of sun burning and skin cancer.[5] This UVR exposure can have an intermittent pattern (eg, beachgoers in summer) or continuous, chronic pattern (eg, surf lifeguards). In recent years, evidence suggests that both intermittent and chronic exposure patterns may play a role in the development of melanoma.[6] The Community Preventive Services Taskforce recommends sun safety interventions in outdoor recreational settings due to strong evidence of their effectiveness on reducing sunburns and improving sun protection behaviour.[7]

However, there is limited observational evidence of sun protection behaviours in New Zealand's outdoor recreational settings. The 2016 triennial Sun Exposure Survey (SES) found that 17% of respondents aged ≥13 years reported sunburn in the weekend prior to survey completion, and about half reported hat wearing.[8] However, the survey had a low response rate (27%), and did not assess the sufficiency of shade that was available in each setting, nor people's interaction with it. Moreover, the sampling frame did not include children under 13 years of age, who are perceived to be more vulnerable to UVR skin damage.[9]

Wearable cameras provide a unique opportunity to explore sun protection behaviours. In 2014/2015, the Kids'Cam project provided 168 children in the Wellington region with wearable cameras.[10] The devices captured an objective sample of images from the camera wearer's perspective, without the bias of self-report data or researcher intrusion. Although the Kids'Cam project was primarily focused on food marketing, participants were blinded to the study's purpose, thus allowing an objective analysis of other health behaviours/exposures. In a feasibility study, the cameras were found to be a practical tool for studying the sun-safety behaviours of children observed in the images.[11] In the current study, we explore sun protection of children and adults in the outdoor recreation spaces visited by the Kids'Cam children, using image data captured on their wearable cameras. The aim of this paper is to describe the shade available, clothing worn and the shade used by children and adults in these settings.

Methods

Study sample

The Kids'Cam participants were 168 randomly-selected children age 11 to 13 years (Year 8), from 16 randomly-selected schools in the Wellington region of New Zealand. Each child wore a wearable camera and GPS unit on lanyards around their necks for four consecutive days (Thursday, Friday, Saturday and Sunday) in 2014/15. The cameras passively recorded images of the child's environment every seven seconds from their perspective. In total, the cameras captured approximately 1.3 million images in many settings, including schools, sports grounds and shopping malls. Image data was successfully linked with GPS data to provide geo-referenced image data. The participants were not informed of the purpose of the study, nor asked to modify their behaviour in any way. More detail on the Kids'Cam methods are available elsewhere.[10]

As part of the primary research study (food marketing), all images were manually coded for setting of image capture (eg, school, street, outdoor recreation space).[10] For the current study, we extracted all images captured in outdoor recreation spaces between 10 am and 4pm during weekends on school terms 1 and 4 during which the SunSmart Schools programme operates. Images captured outside these hours or at any time during the May to August period were excluded because sun protection is not generally recommended in New Zealand at these times.[12]

Measures

Coding for shade availability

All extracted images were viewed and assessed for the presence of shade. Built shade was classified as either permanent (eg, shade sails) or temporary (eg, sun umbrellas). The composition of built shade canopies was categorised as solid (eg, timber or metal sheeting), plastic, fabric or other. Trees were classified as having light, medium or heavy foliage using the canopy density guide.[13] Built shade and trees were excluded if their canopy appeared to be less than two metres wide.

Coding for sun protection behaviours

A 10% systematic sample of images captured in each setting (ie, 1 in 10) was extracted for the study of sun protection among third parties (those people captured in the images). The child wearing the camera was excluded since his/her clothing was not visible in images. Duplicates, defined here as people who appeared in more than one image across a sequence, were not excluded. This approach was used because of the difficulty distinguishing people captured in the images, and because people can often add or remove clothing layers. Based on our prior assessment of sun-safety in schools,[11] we estimate that approximately 5% of the sample were duplicated.

Clothing worn by each person was classified with respect to 38 items, including five types of hats, sunglasses, collars, five types of sleeves, 10 types of anterior/posterior trunk protection and four types of leg coverings.[14] Sun-protective hats included broad-brim, bucket and legionnaire styles. People were recorded as using shade if they were standing directly under a shade structure, or had more than three-quarters of their body shaded. To help assess the context of sun protection behaviour, the activity in which each person engaged was also recorded (eg, sitting, playing, sunbathing). The demographic information recorded included estimates of age (under 18 years (excluding infants) or 18 years and over) and gender.

Coding reliability

In a feasibility study, the coding procedure was found to have excellent reliability (greater than 90% agreement between three coders) for classifying gender, shade use, and hat and sleeve wearing, and high reliability (greater than 80% agreement) for classifying collar wearing.[11] To help achieve rigour in the current study's coding, the coders saved images containing sun protection or demographic information they were unsure about. Saved images were cross-checked by an additional researcher; the images were then discussed until a consensus about the classification was reached.

Analyses

Mean body coverage from clothing was calculated for people within each setting using the coverage assessment procedure (CAP). The CAP links the clothing items worn with established coverage values to calculate the body surface area covered.[14] For descriptive purposes only, results for clothing coverage are reported as the percentage of body surface area covered. For example, 10% coverage at the head means that 10% of the head area is covered by clothing. Other descriptive analyses include comparisons of sun protective clothing and shade use by gender and age. To give context on the weather conditions, the time-stamped and geo-referenced images were linked with temperature and ultraviolet radiation index (UVI) values, extracted from the National Institute of Climate and Atmospheric Research database.[15] The UVI is a measure of UVR at the earth's surface. The WHO recommends sun protection when UVI levels exceed UVI 3.[16]

Results

Twelve Kids'Cam participants (7.4% of the total sample of 168 children) visited 16 outdoor recreation settings during the study period between 10am and 4pm, including eight beaches and an outdoor pool complex (with a 25-metre main pool, toddlers' pool, waterslide, eight eating areas and open grass areas), one fairground (containing a play area, open grass area and court area with food stalls) and six playgrounds. Participants spent 44 minutes, on average, in each setting (range: six minutes to three hours), capturing an average of 378 photos (range: 49 to 1,537). Mean temperatures were similar across settings, ranging from 16.5 to 20°C at the pool (between 10am and 3.30pm), 16.5 to 22.7°C at the beaches, 15.3 to 19.1°C at the fairground and 15.6 to 20.8°C at the playgrounds. The mean UVI across all settings was 6.2 (range 1.8 to 9.5). Only one area (a playground) had a UVI below 3.

Sun protection environment—shade and signage

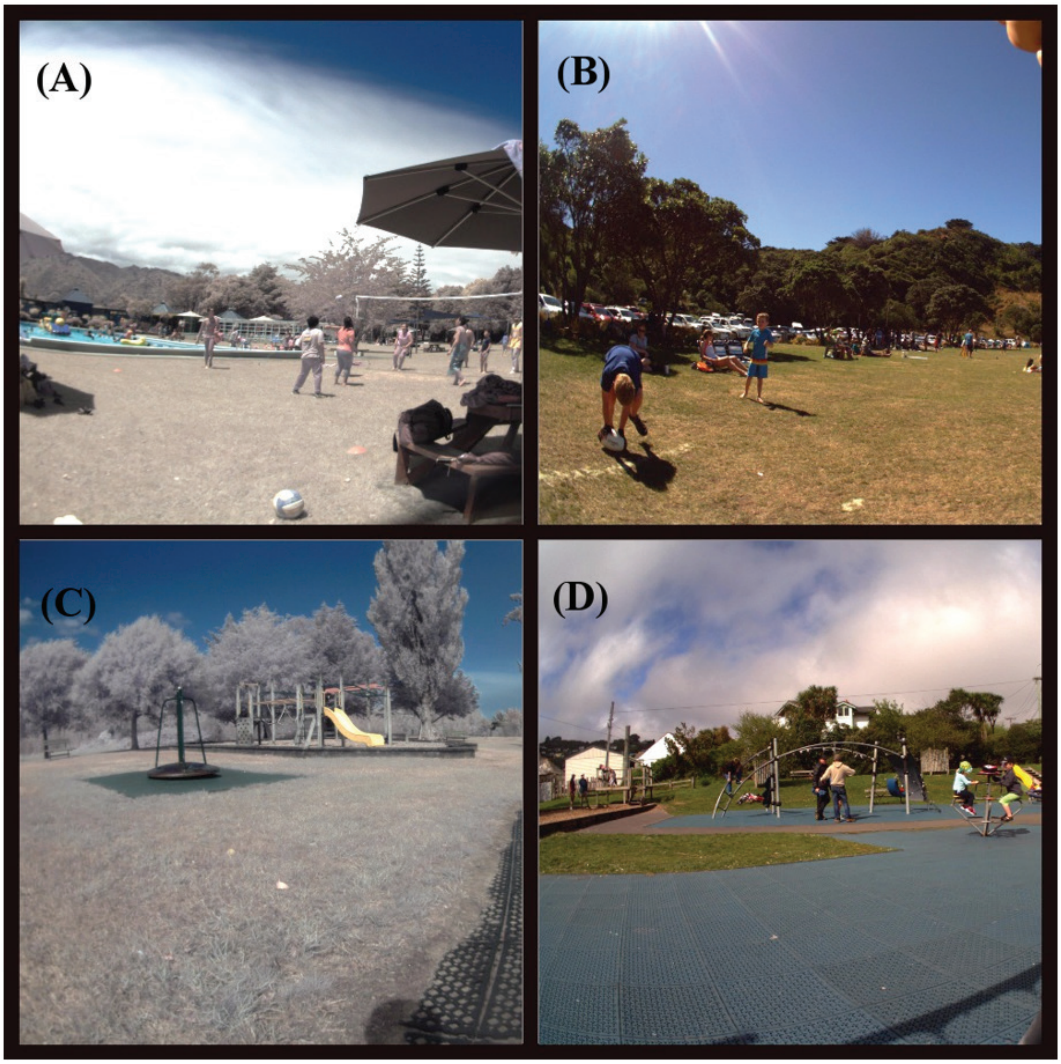
Shade varied considerably between setting types. The outdoor pool complex had the most comprehensive shade, including a combination of trees and built structures covering spectator areas, eating areas and parts of the toddlers' pool (Figure 1A). However, the area most popular for swimming (the main pool) was uncovered. There was relatively less shade in the beach, playground and fairground settings. Shade in beaches was limited to trees in grass areas adjacent to beach sand, which were less popular sites for people (Figure 1B). Shade in the playgrounds was limited to natural shade that did not cover any play equipment, seats or tables (Figure 1C and 1D). No sun-safety signage was observed in any setting.

Sun protection—clothing and shade use

In the 10% systematic image sample, 2,635 people were observed across all areas. Use of sun protective clothing was poor across all setting types; only 4.3% of people wore sun protective hats (broad-brim, bucket and legionnaire styles), 5.6% wore sunglasses and 18.0% wore collars. Mean total body clothing coverage was 69.9%. Body regions with the lowest clothing cover were the hands (5.8% covered), head (8.9% covered), neck (12.4% covered), lower arms (50.8% covered) and lower legs (57.9% covered).

A greater proportion of people at the beaches and pool wore collars, long sleeves and long pants than those at the fairground and playgrounds (37.3% vs 7.3% for collars, 78.2% vs 26.4% for long sleeves and 67.6% vs 27.1% for long pants), and thus had greater total body coverage (82.7% vs 59.1%) and coverage for the neck, arms and legs (Table 1). Moreover, a greater proportion of people at beaches and pools were topless (6.3% of observations vs. 0% in the fairground and playground) and barefoot

Figure 1: Kids'Cam image examples



(41.1% of observations). Use of sun-protective hats and sunglasses was low across all setting types.

Only 10.7% of people were under shade. Shade use was proportionately higher among people in the outdoor pool complex (17.2%) and beaches (9.2%) than those in playgrounds (2.0%). This was not surprising as the playgrounds had limited shade covering the most popular areas, ie, the playground equipment, seats and tables. Greater shade use at the pool was explained by the abundance of sun umbrellas surrounding the pool. However, those swimming in the pool were in full exposure to the sun.

A smaller proportion of children than adults wore hats of any style (23.9% vs 8.0%), sun-protectives styles of hats (8.9% vs 1.3%) and sunglasses (12.4% vs 0.8%) (Table 2). As a consequence, on average the head area of children had approximately one-third of the coverage of adults (4.9% vs 14.3%). A smaller proportion of children than adults used shade (8.4% vs 12.6%) because of their tendency to play in unshaded areas (ie, beach sand, play equipment areas and the pool area).

With the exception of bathing suits, clothing cover between males and females was relatively similar. Exceptions included a greater proportion of males who used hats (specifically caps) (22.8% vs 7.8%) and shade (13.4% vs 7.2%).

Table 1: Proportion of people using sun protective clothing and clothing coverage, by setting type.

	Beaches and pool (n=1,525)	Playgrounds and fairground (n=1,110)
Sun-protective clothing (% wearing item)		
Hats (all styles)	16.8	12.2
Hats (sun protective)[1]	4.9	4.2
Sunglasses	6.8	5.2
Collars	7.3	37.3
Long sleeves	26.4	78.2
Long pants	27.1	67.6
Clothing coverage by body region (% of area covered)		
Head	9.9	8.0
Neck	7.3	20.4
Upper arms	61.0	94.5
Lower arms	29.0	79.7
Anterior trunk	90.6	95.4
Posterior trunk	90.2	99.8
Thighs	80.0	92.5
Lower legs	37.8	73.7
Hands	3.2	9.3
Feet	40.9	89.9
Total body	59.1	82.7

[1]Broad-brim, bucket and legionnaire styles.

Table 2: Sun protection across all settings by gender and age.

	Males	Females	Age <18	Age 18+
Sun-protective clothing (% wearing item)				
Hats (all style)	22.8	7.8	8.0	23.9
Hats (protective styles)[1]	5.6	3.2	1.3	8.9
Sunglasses	4.5	6.7	0.8	12.4
Collars	18.7	12.6	14.9	16.4
Long sleeves	44.2	46.8	48.6	36.1
Long pants	39.0	44.3	42.5	46.1
Clothing coverage by body region (% of area covered)				
Total body	67.3	68.2	67.7	68.0
Head	12.9	5.3	4.9	14.3
Neck	10.6	11.1	9.5	12.9
Upper arms	77.4	70.9	73.5	67.4
Lower arms	44.8	49.7	50.6	39.0
Anterior trunk	89.8	97.1	93.8	93.8
Posterior trunk	90.0	97.0	93.8	94.0
Thighs	87.1	84.2	83.4	90.2
Lower legs	43.4	58.0	50.6	56.8
Hands	5.3	5.6	5.8	4.3
Feet	61.1	47.2	60.3	56.1
Shade use (% under shade)	7.2	13.4	8.4	12.6

[1]Includes bucket, broad-brim and legionnaire styles.

Discussion

The results indicate a poor use of sun protective clothing and shade in outdoor recreation spaces, and limited shade availability in the most popular areas. The findings are consistent with recent observations of sun protective behaviour in Wellington primary schools,[17] and shade audits of playgrounds, beaches and outdoor pools in Auckland, Wellington, Christchurch and Dunedin.[18,19] The findings have applicability for other New Zealand cities, given that past sun-safety campaigns have been national in scope and because most councils, including Wellington, do not have sun safety policies supporting shade development and sun protection in outdoor recreation spaces.[20]

When compared to the self-reported sun protection behaviours of the 2016 SES, our study found a markedly lower use of hats (8% vs 34% among youth; 24% vs 43% among adults) and sunglasses (1% vs 23% among youth; 12% vs. 53% among adults).[8] This is consistent with prior studies that have compared field observations of sun protection behaviour with self-report data.[21–23] Part of this difference may be due to methodological differences between the studies. The 2016 SES sampled a broader demographic area, which may differ to the Wellington population for sun protection behaviours and outdoor activity. The SES also only samples when sunny weather was forecasted, whereas our study investigated all weekends between September 2014 and April 2015. Moreover, the 2016 SES asked respondents whether they were wearing a ~~a~~ clothing item 'most of the time' over the last weekend. In contrast, our study recorded observed behaviours at one time point, regardless of prior behaviour (eg, a hat that was removed was not counted). Biases inherent in survey design may also help explain this discrepancy, such as social desirability bias, which leads to over-representation of behaviours perceived to be healthy.[24]

Children were less likely to use hats, sunglasses and shade than adults. This finding is consistent with SES findings.[8] Poor rates of sun protection among New Zealand children is a significant public health issue, as children are perceived to be more vulnerable to UVR skin damage.[9] Moreover, from a health promotion perspective, it is important to establish healthy sun protection habits from a young age. Future research could investigate the barriers to sun protection among New Zealand youth, and the types of strategies that could best support sustained sun protection behaviour change.

This study provides further evidence to support sun protection activities in water-based recreation settings, given that people in these settings had substantial skin area exposed to the sun. International research proposes the particular risk posed by visits to such settings, characterised by high UVR levels (due to reflections off water and the openness of the sites), intentional sunbathing and the need to reapply sunscreen after swimming.[7] Strategies for supporting sun protection in these settings could include establishing minimum standards for shade and displaying signs about sun protection.

Strengths and limitations

This is one of the first studies to objectively assess sun protection in New Zealand's outdoor recreation spaces. Using wearable cameras allowed an analysis of sun protection without the risk of researcher obtrusion, nor the bias associated with self-report methods, and enabled us to explore people's interaction with shaded environments.

Nonetheless, the methodology has some limitations. We did not quantify the level of cloud cover in each setting, which may influence people's intention to use sun protection, as well as the shade observed in the images. However, we note that shadow patterns were visible for most built structures and trees in at least one image (most images were captured in clear-sky conditions, except for one playground visit that had a mean UVI value below 3). Image capture also depended on where the participant spent their time, which may have resulted in over-sampling of some areas and people. Moreover, we could not determine whether people actively sought shade or whether they were shaded by chance (eg, by passing through a shaded area). We also could not ascertain whether people wore sunscreen, which may have underestimated actual levels of sun protection. However, New Zealand surveys suggest that only about half of New Zealanders apply

sunscreen over the weekend in summer,[8] and overseas evidence suggests that sunscreen is often insufficiently applied.[25] Thus, assessment of shade use and clothing coverage remains an important indicator of sun safety.

Conclusions

Most people observed in the outdoor recreation spaces did not use sun-protective clothing or shade, despite potentially damaging levels of UVR. The findings highlight the need to increase environmental and policy support for sun protection in outdoor recreation spaces. Encouraging local councils to adopt sun safety policies would be a useful first step for achieving this. Moreover, planting trees or building shade in popular recreational areas, eg, play equipment in playgrounds, beach sand and pool areas, could help reduce the risk of UVR over-exposure.

Competing interests:
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REFERENCES:

1. O'Dea D. The Costs of Skin Cancer to New Zealand. Wellington: Cancer Society of New Zealand; 2009.
2. Ministry of Health. Cancer: New registrations and deaths 2013. Wellington: Ministry of Health; 2016.
3. Sneyd M, Gray A. Expected non melanoma skin (Keratinocytic) cancer incidence in New Zealand for 2018. Wellington: Health Promotion Agency; 2018.
4. Armstrong BK. How sun exposure causes skin cancer: an epidemiological perspective. In: Hill D, Elwood JM, English DR, editors. Prevention of Skin Cancer. Dordrecht: Springer Netherlands; 2004. p. 89–116.
5. Gandini S, Sera F, Cattaruzza MS, et al. Meta-analysis of risk factors for cutaneous melanoma: II. Sun exposure. European Journal of Cancer. 2005; 41(1):45–60.
6. Armstrong BK, Cust AE. Sun exposure and skin cancer, and the puzzle of cutaneous melanoma: A perspective on Fears et al. Mathematical models of age and ultraviolet effects on the incidence of skin cancer among whites in the United States. American Journal of Epidemiology 1977; 105:420–427. Cancer Epidemiol. 2017; 48:147–156.
7. Community Preventive Services Task Force. Skin Cancer: Interventions in Outdoor Recreational and Tourism Settings. 2014 [cited 2017 05/09]; Available from: https://www.thecommunityguide.org/findings/skin-cancer-interventions-outdoor-recreational-and-tourism-settings

8. Health Promotion Agency. Sun Exposure Survey 2016 Demographic Report. Wellington: Health Promotion Agency; 2016.
9. Whiteman DC, Whiteman CA, Green AC. Childhood sun exposure as a risk factor for melanoma: a systematic review of epidemiologic studies. Cancer Causes Control. 2001; 12(1):69–82.
10. Signal LN, Smith MB, Barr M, et al. Kids'Cam: An Objective Methodology to Study the World in Which Children Live. Am J Prev Med. 2017; 10.1016/j.amepre.2017.02.016.
11. Gage R, Leung W, Stanley J, et al. Studying third-parties and environments: New Zealand sun-safety research. Health Promot Int. 2017; 10.1093/heapro/dax094.
12. Cancer Society of New Zealand. Sun Exposure and Skin Cancer 2012 [cited 2014 23/02]; Available from: http://www.cancernz.org.nz/reducing-your-cancer-risk/sunsmart/about-skin-cancer/sun-exposure-and-skin-exposure/
13. Greenwood J, Soulos G, Thomas N. Under cover: Guidelines for shade planning and design. Wellington: Cancer Society of New Zealand; 2000.
14. Gage R, Leung W, Stanley J, et al. Clothing Protection from Ultraviolet Radiation: A New Method for Assessment. Photochem Photobiol. 2017; 93(6):1513–1518.
15. National Institute of Water and Atmospheric Research. Climate data and activities. 2016 [cited 2016 6/03]; Available from: https://www.niwa.co.nz/education-and-training/schools/resources/climate
16. World Health Organization. Global Solar UV Index: A Practical Guide. Geneva: World Health Organization; 2002.
17. Gage R, Leung W, Stanley J, et al. Sun Protection Among New Zealand Primary School Children. Health Educ Behav. 2017; 10.1177/1090198117741943.
18. Gage R, O'Toole C, Robinson A, et al. Wellington Playgrounds Uncovered: An Examination of Solar Ultraviolet Radiation and Shade Protection in New Zealand. Photochem Photobiol. 2018; 94(2):357–361.
19. Gage R, Wilson N, Signal L, et al. Using Google Earth to Assess Shade for Sun Protection in Urban Recreation Spaces: Methods and Results. Journal of Community Health. 2018; 10.1007/s10900-018-0522-0:1-8.
20. Kruse K, Walton D. Sun Safety Promotion in Territorial Authorities. Wellington: Health Promotion Agency Research and Evaluation Unit; 2013.
21. Bennetts K, Borlands R, Swerissen H. Sun protection behaviour of children and their parents at the beach. Psychology & Health. 1991; 5(4):279–287.
22. Buller DB, Borland R. Skin cancer prevention for children: a critical review. Health Educ Behav. 1999; 26(3):317–43.
23. Dudley DA, Cotton WG, Winslade MJ, et al. An objective and cross-sectional examination of sun-safe behaviours in New South Wales primary schools. BMC Public Health. 2017; 17(1):21.
24. Choi B, Pak A. A Catalog of Biases in Questionnaires. Prev Chronic Dis. 2005; 2(1):1–13.
25. Petersen B, Wulf HC. Application of sunscreen--theory and reality. Photodermatol Photoimmunol Photomed. 2014; 30(2–3):96–101.