A pilot observational study of environmental summertime health risk behaviour in central Brisbane, Queensland: Opportunities to raise sun protection awareness in Australia's Sunshine State

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Abstract

Melanoma skin cancer rates in Queensland exceed the national Australian incidence rate, which together with New Zealand are recognised as the world's highest. Incidence is especially high among younger members of the population. In this study, the sun-protective behaviours of urban Queenslanders (*n* = 752) going about their day-to-day activities during a mid-week noon time hourly period were observed on a summer's day in central Brisbane (27.47° S, 153.03° E), Australia. Observed sun protection practices were poor, given the time of year and peak solar noon-period of the study. More individuals (n=249; 33.1%) were seen wearing sunglasses than a hat (n=101; 13.4%). Ninety-three individuals were actively engaging with mobile phones (phone in hand). A further 231 individuals (30.7%) were observed with a mobile phone on them. Opportunities to modify group behaviour based on mobile phone sun protection notifications and to engage with 'at risk' members of the Queensland population are considered from the variable co-dependencies examined in this study, including the influence of social group size, observed sun protection and mobile phone use. Our preliminary findings suggest that mobile phones provide an under-utilised opportunity for delivering tailored skin cancer prevention messaging.

Keywords: Skin Cancer, Queensland, UV, mobile phone, hats, sunglasses, behaviour

Introduction

Queensland is known as the Australian “Sunshine State”. Unsurprisingly, given its sub-tropical to tropical latitude range (9.3°S-29°S), the predominantly fair resident population of Queensland, which accounts for 20.1% of the national population experiences the highest national age-standardised incidence rates for melanoma (66.7 per 100 000) (1). Queenslanders also account for the highest proportion of Australian non-melanoma skin cancer treatments at 35.8% (1). Host-factors such as sun-sensitive skin type, the number of moderate to severe sun burns, level of incidental sun exposure, and number of pigmented moles are the most relevant predictors of skin cancer (2,3,4). These factors are influenced by lifestyle, personal attitudes, and sun protection habits (3,5). Individuals who work predominantly in offices, or those that spend their working lives in an urban environment can experience elevated health risks as a consequence of incidental exposure to solar ultraviolet radiation (UVR) during their work day, if preventative strategies are not effectively practised (6,7,8).

Taking daily steps to protect oneself from excessive exposure to solar UVR exposure can lower the risk of skin cancer (7,8). Daily use of sunscreen is an important factor (9), in addition to other protective measures such as wearing hats, sunglasses, and avoiding exposure around solar noon, particularly during the summer months when annual UVR levels reach their peak (10). Several studies have observed use of personal sun-protection in different outdoor environments. Ng and Ikeda (5) investigated the use of sun-protective items such as hats, sunglasses and parasols in an urban population showing a generally low use of sunglasses and a significantly high number of adolescents and young adults, predominantly male, not using any form of sun protection. Poor levels of personal sun protection are commonly observed in study populations (11), where improved sun protection behaviour is higher among older adults (12,13,14) and females (15,16), however these findings sharply contrast with those reported for an outdoor event in skin-cancer prone tropical Queensland. Nikles and Harrison (17) found that significantly more children (45.1%) than adults (27.1%) wore wide-brimmed, legionnaires or bucket hats, and sun-protective behaviours were generally better for males than females.

The cost of treating skin cancers in Australia, and internationally, is high (18). It is estimated that $2 billion dollars per year are spent in the US alone on the treatment of skin cancers (19). Putting aside the loss of human lives and potential disability, it has been found that the active promotion of sunscreen use and encouragement of primary preventative sun-protective behaviours such as wearing hats and sunglasses is a highly cost effective practice, due to a reduction of treatment costs and skin cancer occurrence (8,18,19,20,21). The Slip! Slop! Slap! campaign initiated by the Cancer Council Victoria, has been effective in reducing skin cancer and raising awareness in Australia (19,22). However it has also been found that reinforcement of the messages promoted by such campaigns must be repeated often to be effective (8,23), with the main limitation often being a lack of perceived seriousness of the consequences of exposure to solar radiation (24). Ensuring the success of an effective sun-protection campaign, that is perceived as relevant, requires messages to be communicated appropriately to the target audience (3,24,25).

Mobile phone technology is one avenue that has the potential to be a potentially cost effective and highly targeted preventative solar exposure strategy (26). Targeted social media messaging that utilizes population analytics including age, gender and residency information may be another strategy that could be implemented alongside traditional television, print and radio awareness advice. The Australian Cancer Council promotes the use of sun smart apps for mobile phone users (10). Recently, the Queensland Institute of Medical Research released an online melanoma skin cancer awareness application that could be tailored to individual characteristics to provide detail on personalized risk levels (27). In Australians aged 16 – 24 years, a group with traditionally poor sun exposure behaviour and high mobile phone use (26,28), it was found that group behaviour directly influenced mobile phone involvement (29). Friendship, social and personal norms were also found to be major influencers of the level of sun-protection used (30). In the US, 87% of adults use the internet, with 90% owning a mobile phone with the number of teens using the internet being approximately 93%. In Australia, over 80% of the general population and 93% of people aged 16 – 24 years own and use a mobile phone (31). In this research, preliminary baseline data on personal sun-protection and mobile phone use of pedestrians was collected at a popular inner city site during solar noon on a summer's day in Brisbane, Queensland. The study aims to examine the relationships between sun-protection behaviour, gender, phone use and group size to objectively assess the potential value of using mobile phone technology as a means of raising awareness of incidental sun exposure behaviour in a modern urban population.

Materials and Methods

Observations of pedestrians were made at the Southbank foot of the Good Will pedestrian bridge, an inner-city location in central Brisbane, QLD, Australia (27.47° S, 153.03° E). All observations were recorded by the lead author and as such do not suffer from inter-observer reliability bias. Observations were made using a previously tested data collection sheet including columns coded for quickly noting gender, group size, sun protection and mobile phone use. Data were collected on 28 February 2018 (austral summer) for one hour from 11.30 am to include solar noon occurring at this time of year at 12.00 pm, with observations ending at 12.30 pm (solar zenith angle range 20.7^{o} to 19.4^{o}). Sun-protection and mobile phone use statistics were collected by observing pedestrians crossing the foot of the bridge during this period (Figures 1-3). The ambient temperature during data collection was between 27°C and 28°C and the UV index was predominately measured in the extreme range, fluctuating between 5.5 and 12.6 under broken cloud cover for the hour-long observation period (32).

FIGURE 1

FIGURE 2

FIGURE 3

Recorded pedestrian characteristics included: Gender (Male/Female); Hat wearing (Yes/No); use of sunglasses (Yes/No); and phone behaviour. This information was recorded manually using the following coding system. Phone behaviour was subdivided into four categories including: no phone visible = 0; speaking on phone with the phone held to the ear = 1; engaging or using phone screen = 2; and, phone in hand but not actively engaged = 3. The size of the group that each individual was interacting with was also recorded (singles were recorded as a group size of 1). For the purposes of this research, gender was inferred by the observer based on presentation of individual pedestrians. No difference in the size of hat, measured by the degree of UV protection they offered was recorded at the time of observation. That is, caps and broad brimmed hats were classified as positive hat wearing behaviour. Sunglasses were distinguished separately from spectacles by observation of notable tinting of the lenses. This includes possible positive identification of transition type glasses as ‘sunglasses’.

After data collection, the four phone use categories were merged to create two broader categories related to the ease of access each person had to their phone for the hypothetical purpose of receiving UV exposure information or sun-protection warnings delivered to their phone at that moment. Phone use categories 0 and 1 were combined to create a ‘no easy access category’, as any message or notification delivered to their phone at that moment could not be quickly or easily read by the pedestrian. Phone categories 2 and 3 were combined to create an ‘easy access category’.

Statistical Analyses

Log-linear analysis can be used to determine if there are statistically significant relationships among three or more categorical variables measured as counts or frequencies. The analysis is similar to Chi-square contingency table analysis which is limited to the analysis of only two categorical variables at a time (33). Log-linear analysis was used in this study to determine the relationships among the four observed categorical variables: hat wearing, sunglass wearing, phone use and gender. The binary form of the phone use variable (easy, or no-easy access) was used in this analysis. The analysis tests the change in observed frequencies from a chosen ‘reference category’ of each variable to each of the other categories of a variable. The chosen reference category for each of the four binary variables used in this study was the zero coded category (i.e. No hat, No sunglasses, No easy phone access and Male, respectively).

Data analysis was conducted using R software (Core Team, Vienna, 2017) within RStudio (RStudio, Inc., MA, 2017). Hat and sunglass use was tabulated for all observed pedestrian group sizes. Phone behaviour sub-categories were also presented for each group size. Group size was not considered in the log-linear analysis. The assumption of log-linear analysis requires that less than 20% of contingency table cells have expected frequencies less than 5, and no cells should have an expected frequency of less than one (33). Contingency tables for pairs of variables were used to check this assumption prior to analysis. All four main effects (hat, sunglasses, phone behaviour, and gender) and their interactions were fitted in the log-linear analysis and then a backward elimination process was used (sequentially removing terms) to produce nested models which were compared using ANOVA to identify the simplest (final) model that showed no significant improvement in residual deviance with additional terms included.

Results

Sun protection and access to mobile phone observation categories for all pedestrians are listed in Table 1. During the data collection period 752 individual pedestrians were observed. The distribution of Brisbane male and female pedestrians were similar (51.3% male vs 48.8% female). The prevalence of hat-wearing was low at 13.4% while a higher proportion of pedestrians were observed wearing sunglasses (33.1%). A similar proportion of pedestrians

(30.7%) were observed to have ready access to a mobile phone, while 33.1% of pedestrians were observed with a phone (although not necessarily easily accessible).

TABLE 1

Almost 47% of males (n=386) were observed wearing a hat or sunglasses, compared to 38.0% of females (n=366) (Table 1). This trend was not evident for phone users, with a larger proportion of the females (40.2%) observed with a mobile phone compared to 26.4% of the males (Table 2).

TABLE 2

Log-linear analysis

Contingency table analysis indicated that only two of the sixteen cells examining the dependencies of hat wearing, sunglass wearing, phone use and gender had expected frequencies less than 5 (12.5%). Furthermore, all expected frequencies were greater than one, indicating that the test assumption was not violated and that each behaviour had some influence on each of the other observed categories (Table 3). The change in residual deviance of the final fitted model (Table 4) when compared to the saturated model was not significant ($\chi^2(9) = 7.47$, $p < 0.589$), indicating that additional terms would not significantly improve the fit of the model.

The use of sunglasses, hat use and easy access to a phone were all statistically significant ($p < 0.0001$) with negative estimates indicating a decrease in frequency associated with pedestrians wearing hats or sunglasses or having easy access to their phones (Table 3). This result gives the general indication that only one of these behaviours is typically observed in the studied summertime Brisbane population of pedestrians. Gender was not a significant main effect, however males were significantly more likely to be seen wearing a hat (OR=0.249, p<0.0001) and less likely to have easy access to a phone (OR=1.957, p<0001) (Table 3).

TABLE 3

Comparison of the observed and fitted model (estimated) frequencies of each of the 16 possible combinations of the four characteristics recorded for each pedestrian are shown in Table 4. Residual differences ranged between -6.35 under-estimation for the female/no hat/yes sunglasses/no easy phone access combination to a maximum of 9.71 over-estimation for the female/no hat/no sunglasses/no easy phone access combination. The close fit of the model frequencies listed in Table 4 supports the statistical relationships described in Table 3, suggesting that most Brisbane pedestrians wear neither a hat or sunglasses, and very few pedestrians wear both.

TABLE 4

Group Behaviour

Of the 752 pedestrians observed, 407 were observed passing by the foot of the Good Will Bridge alone (group size 1) while most of the remaining 352 pedestrians were observed in groups of 2, 3, and 4 people (Table 5). Only one group of 5 and one group of 8 were observed. In the group of 5 only one person was wearing a hat while none of them were wearing sunglasses. No one in the group of 8 had a hat on and one person was wearing sunglasses. Regardless of group size, the maximum number of people within a group wearing a hat or sunglasses was two and three respectively.

Only 14% (57/407) of lone individuals were wearing a hat and 34% (140/407) were wearing sunglasses (Table 5). Only in 3% of the 100 groups of 2 people were both people wearing a hat, while both people were wearing sunglasses in 22% of these groups. There were no groups of 3 or 4 in which all people within the group were observed wearing a hat. Unanimous use of sunglasses was observed in 11% (3/28) of groups of 3, but in no groups of 4 people. Although sunglasses are more popular than hats, these results suggest the prevalence of wearing hats and sunglasses declines with group size.

TABLE 5

Discussion

Sun exposure and awareness of exposure risk are fundamental to the prevention of skin cancer and sun related disease. In Queensland, particularly during summer, sun exposure risk is high. Lunch breaks and incidental exposures received in an urban environment can present an elevated environmental risk to unprotected pedestrians during peak noon exposure periods where shade levels are at a minimum and pedestrians are often surrounded by reflective concrete and artificial surfaces. Ultraviolet exposure awareness in Australia is generally higher than in other nations due largely to the effectiveness of public health campaigning. However the effectiveness of such preventive health messages is largely dependent on campaign frequency and perceived relevance to the target audience.

An observational methodology has been piloted here for a period of one hour, providing preliminary baseline data on the incidental sun protection practices of pedestrians at a single inner city location in Brisbane. The results of the current study advocate the necessity of renewed sun health campaigning to raise awareness and encourage improved public protection from summer sun exposure. These results illustrate the potential utility of mobile phones in raising sun protection awareness, particularly in populations at risk of sun damage as a consequence of incidental, non-purposeful sun exposure. Observational data is presented for solar noon during a peak summer time exposure period and, as may be expected, shows limited use of sun protection compared to studies that examine populations that experience purposeful sun exposures, such as beachgoers and those participating in outdoor sports (11,34,35). However, further data needs to be collected during noon exposure periods to confirm the results presented in this preliminary research are not specific to the chosen location. Ideally this data should be collected simultaneously at several inner city sites, by a number of trained observers.

Current sun exposure campaigns in Australia encourage the active use of five preventative strategies; *slip* on protective clothing, *slop* on high SPF sunscreens, *slap* on effective hat wear, *seek* shaded environments, and *slide* on sunglasses (10). These messages are conveyed to the public through television and internet advertising. Sun awareness apps for mobile phones have also been released and can be publically accessed which advise during which periods of the day sun-protection is required (10). Fundamental to sun awareness apps and public advocacy of sun-protection is the ultraviolet index (UVI), a unit-less scale that weights the erythematic ultraviolet depending on the predicted cloud free or measured surface irradiance. Sun-protection is recommended when the UVI exceeds 3, which occurred during the current study between 8:00 am and 4:00 pm (32). Although sunscreen use could not be observed, and may be high in females (36,37), our findings demonstrate that most pedestrians were not wearing hats or sunglasses during peak solar noon. Cancer Council Australia recommends a combination of all 5 sun-protection strategies to reduce skin cancer risk. A very low proportion (4%) of the pedestrians observed in Brisbane were noted to be wearing both a hat and sunglasses (21 males and 9 females).

We found that females were less likely to be wearing a hat or sunglasses as reported previously by others (15,16,36), making women an important candidate for targeted sun-exposure campaigning (37). While women were less likely to be wearing hats or sunglasses, they were more likely to have easy access to their phone than males, suggesting that a phone based warning system could be beneficial in reaching this group. However, given that the women observed in this study are not engaging with fairly basic sun-protection behaviours they may not use a specific app for this purpose. The use of peer pressure and existing social media platforms marketing the delivery of current sun-exposure advice would likely aide the delivery of an effective sun-exposure mobile phone notification system.

In Australia it has been found in 16-24 year olds that age and self-identity are significant predictors of the frequency of mobile phone use along with being female and in-group norms (29). Phones have replaced many traditional devices such as phone books, alarm clocks, cameras, and even to some extent newspapers and televisions (31). The proliferation of mobile phones and their use has introduced a new avenue for engaging with people to help them with health and preventative measures. It has been found that 82% of mobile phone users in Australia have used their phones to search for health information and that 71% of health based webpages were mobile friendly (38). Mobile phones have been used previously in Australia to raise awareness of several public health issues, including monitoring of children's health, respiratory disease, sex education and nutrition (39,40,41,42). They provide a new tool that is being used increasingly to improve awareness of important public health issues and for measurement of personal characteristics and behaviours that can be used for targeting more effective public health advice (42). Our findings suggest that mobile phones may provide a cost-effective avenue for delivering tailored skin cancer prevention messaging to a high proportion of Queensland's skin-cancer prone population and may provide an avenue for replacing television campaigns previously used quite effectively by Queensland Government and NGOs now that younger people in particular watch more streamed entertainment via their phones than they do free-to-air television.

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Tables

Table 1: Observed frequencies (N=752) of all combinations of behavioural conditions and gender.

Gender	Hat	Sunglasses	Phone access	Observed
Male	Yes	Yes	Easy	6
Male	Yes	Yes	Not Easy	15
Male	Yes	No	Easy	14
Male	Yes	No	Not easy	44
Male	No	Yes	Easy	21
Male	No	Yes	Not easy	81
Male	No	No	Easy	51
Male	No	No	Not easy	154
Female	Yes	Yes	Easy	2
Female	Yes	Yes	Not easy	7
Female	Yes	No	Easy	3
Female	Yes	No	Not easy	10
Female	No	Yes	Easy	40
Female	No	Yes	Not easy	77
Female	No	No	Easy	94
Female	No	No	Not easy	133

Table 2: Frequency table of phone use based on gender.

	Phone behaviour				
Gender	No Phone	Using Phone	Phone in Hand	Phone to ear	Total
Male	284	75	17	10	386
Female	219	63	76	8	366
Total	503	138	93	18	752

Table 3: Results of log-linear analysis showing the factors significantly influencing relationships between sun-protection, easy access to a phone, and gender.

Model	Estimate	Std Error	Z	Pr (>|z|)	Odds Ratio (95% CI)
Sunglasses (1)	- 0.70	0.077	- 9.074	< 0.0001	0.495 (0.425, 0.576)
Hat (1)	- 1.36	0.126	- 10.760	< 0.0001	0.257 (0.200, 0.328)
Phone use (1)	- 1.16	0.119	- 9.725	< 0 .0001	0.313 (0.246, 0.394)
Gender (1)	- 0.09	0.093	- 0.985	0.324	-
Hat (1): Gender (1)	- 1.39	0.254	- 5.491	< 0.0001	0.249 (0.148, 0.402)
Phone use (1): Gender (1)	0.67	0.161	4.174	< 0.0001	1.957 (1.430, 2.688)

(1) Represents change in noted behaviour of the zero coded category. (Sunglasses (1) = wearing sunglasses; Hat (1) = wearing hat; Phone use (1) = easy access to phone; Gender (1) = Female; Hat(1):Gender(1) = females wearing hats; Phone use (1):Gender (1) = females with easy phone access)

Table 4: Observed and fitted frequencies of all combinations of sun-protective and phone use behavioural conditions and gender.

Gender	Hat	Sunglasses	Phone access	Observed	Fitted
Male	Yes	Yes	Easy	6	6.23
Male	Yes	Yes	Not Easy	15	19.92
Male	Yes	No	Easy	14	12.59
Male	Yes	No	Not easy	44	40.25
Male	No	Yes	Easy	21	24.23
Male	No	Yes	Not easy	81	77.42
Male	No	No	Easy	51	48.94
Male	No	No	Not easy	154	156.4
Female	Yes	Yes	Easy	2	2.77
Female	Yes	Yes	Not easy	7	4.52
Female	Yes	No	Easy	3	5.59
Female	Yes	No	Not easy	10	9.13
Female	No	Yes	Easy	40	43.26
Female	No	Yes	Not easy	77	70.65
Female	No	No	Easy	94	87.39
Female	No	No	Not easy	133	142.71

Table 5: The number of people within groups wearing hats or sunglasses.

		Group Size						
		1	2	3	4	5	8	Total
Groups per Group Size		407	100	28	12	1	1	549
Hats per group	0	350	82	20	5		1	458
	1	57	15	4	4	1		81
	2		3	4	3			10
Sunglasses per group	0	267	49	17	4	1		338
	1	140	29	5	3		1	178
	2		22	3	3			28
	3			3	2			5

Figure Captions

Figure 1: Study site, Inner Brisbane, Goodwill Bridge (27.47ºS, 152.03ºE). Pedestrians crossing the Observation line (orange) in either direction were included.

Figure 2: Study location relative to greater Brisbane (Google maps, 2018).

Figure 3: Observation site looking toward the foot of the Goodwill bridge, solar noon, 28 February 2018.

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