



Shade in playgrounds: findings from a nationwide survey and implications for urban health policy

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Abstract

Background Providing effective shade in playgrounds may reduce children's risk of sunburn, skin cancer, and heat stress, and increase play times. We aimed to determine the sufficiency of playground shade in New Zealand, a country with high skin cancer rates but limited research on regional shade practices.

Methods A random sample of one playground per 10,000 population was selected from each territorial local authority (TLA), for a total of 559 playgrounds. Google Earth satellite and Street View images were used to estimate the amount of shade (trees or built structures) covering playground activity areas at solar noon on the summer solstice.

Results Most playgrounds (60%) had no shade over play equipment, seats, and tables. Playgrounds from more deprived areas were 43% less likely to have at least one source of shade (odds ratio = 0.57; 95% CI: 0.35–0.94). Shade sufficiency varied considerably between council regions, with the best shading practice observed in Waikato, Whangarei, and Wairarapa.

Conclusions The findings support policy efforts to increase shade nationwide. Establishing minimum standards for playground shade and showcasing successful efforts to date may help encourage TLAs with less shade to improve. Moreover, the display of sun safety signage may help promote sun protection behaviour among playground visitors.

Keywords Shade · Sun protection · Skin cancer · Google earth · Urban open space

Introduction

Public playgrounds are important sites for promoting outdoor play among children. Evidence has linked outdoor play with a number of physical and mental health benefits, including healthy brain development (Ginsburg 2007; Pellegrini et al. 2007). Play in playgrounds can also contribute a small source of physical activity for children, e.g., through climbing or running. While less rigorous than organized sport, higher levels of outdoor play among children have been associated with more time spent in moderate to vigorous physical activity and lower obesity risk (Ansari et al. 2015; Cleland et al. 2008).

Playgrounds are also free for children to use, and thus valuable sites for families who cannot afford access to private recreational facilities.

However, sun exposure in playgrounds and other outdoor recreational settings may result in sunburn and increase skin cancer risk if sun protection is not used. Skin cancer is a significant public health burden worldwide, accounting for about one in six cancer cases diagnosed globally (World Health Organization 2017). The risk of skin cancer is greatest in countries with high ambient solar ultraviolet radiation (UVR) and predominantly fair-skinned populations, including Australia, New Zealand, South Africa, and parts of Europe and the United States (Whiteman et al. 2016). In these environments, excessive exposure to UVR is estimated to cause most cases of skin cancer, including up to 95% of melanomas and 99% of keratinocyte carcinomas among Australians (Armstrong 2004).

Developing shade is a useful intervention for reducing ultraviolet radiation (UVR) exposure and reducing the risk of sunburn and skin cancer. Shade can also lower the risk of heat stress in hot weather (to which children are more vulnerable) (Vanos et al. 2017), provide shelter from wind and rain, and

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improve a site's aesthetic appeal (Boyers et al. 2014). Interviews with parents from the United Kingdom (Tucker et al. 2007) and New Zealand (Wellington City Council 2016) indicates that shade is a key factor influencing their choice of parks and playgrounds. Moreover, shade development trials in Colorado and Melbourne parks (Buller et al. 2017) and secondary schools in Melbourne (Dobbinson et al. 2009) found that sites with newly built shade were significantly more likely to be used than pre-test/post-test control sites.

Promoting shade for sun protection is especially important in New Zealand due to its relatively high ambient UVR levels (compared with northern latitudes) (Greenwood et al. 2000) and high skin cancer rates (Whiteman et al. 2016). New Zealand currently has the highest rate of cutaneous malignant melanoma in the world, with over 300 deaths from melanoma each year (Ministry of Health 2014). Recent evidence also indicates a lack of hat-wearing among New Zealand children (Gage et al. 2017) and high sunburn rates among youth aged 13 to 17 (17% in the previous summer weekend) (Health Promotion Agency 2016). Direct observations and pilot research using Google Earth imagery also suggested a lack of shade in open urban spaces in New Zealand's main city centres (Gage et al. 2018a, b).

In New Zealand, playgrounds and other public spaces are maintained by 67 territorial local authorities (TLAs), which provide nearly all such public services at a local level. Currently, it is unclear how shade practices compare across TLA areas. A 2012 survey of TLA staff found that around 60% agreed that councils should have responsibility for promoting sun protection for the general public (Kruse and Walton 2013). However, respondents were largely unaware of their council's sun protection policies and practices, with over 50% of respondents stating they were 'unsure' about how sun protection was included in their council's District and Long-Term Plans.

Given this background, we aimed to evaluate the sufficiency and predictive factors of shade across playgrounds in all TLAs in New Zealand, using Google Earth satellite (GES) and Google Earth Street View (GSV) images. In a pilot study, this approach was demonstrated to be reliable and accurate for studying shade in playgrounds (Gage et al. 2018b).

Methods

Sample selection

We aimed to sample one public playground per 10,000 population from each of the 67 TLAs in New Zealand. Playgrounds were defined as any site with play equipment available for the public, excluding skate parks and playgrounds in schools. To help inform decision making at the TLA level, a minimum

sample of five playgrounds per TLA was targeted for inclusion (i.e., five playgrounds for TLAs with $\leq 50,000$ population). All playgrounds were randomly selected using one of two methods. For TLAs with lists of playgrounds available online, playground names were exported into an Excel spreadsheet, then randomly selected (via random numbers generated in Excel). For TLAs without such lists, playgrounds were located by examining GES images, assigned a number (using Google Earth's place mark tool), then randomly selected. Playgrounds found to be unsuitable for further assessment, i.e., not visible in the GES and GSV images, were excluded and replaced with another randomly-selected playground, until the targeted sample number was achieved.

Procedure for estimating shade cover

The method used for assessing shade using GES and GSV has been fully described in previously published work (Gage et al. 2018b). But in summary, a combination of GES and GSV images were used to estimate the amount of shade covering pre-defined activity areas in each playground. Activity areas included play equipment, sitting areas, and eating areas (Table 1). Shade cover for a given activity area was classified as none (0% cover), some (> 0 to 50% cover), majority level ($> 50\%$ to $< 100\%$ cover), or complete (100% cover). Shade cover was estimated by projecting the shade cast by adjacent trees and built shade, based on the shadow patterns expected at solar noon on the summer solstice (approximately 1.30 pm on the 22 December). At this time in New Zealand, the sun is positioned between 11 and 24 degrees to the north of New Zealand, and so casts shade slightly to the south of objects. By using this approach, we therefore ignored the shade pictured in the GES and GSV images (which varies by date of image capture and weather conditions). The presence of shade within 10 m of playground equipment was also measured using the GE ruler function. This was done to indicate the proportion of playgrounds with no direct shade over activity areas, but at least one source of shade near play equipment.

Table 1 Types of activity areas assessed for shade cover

Activity area	Definition
Main playground equipment	Area containing the largest structure, normally with a series of play equipment or a particular design such as a fort or boat.
Stand-alone playground equipment	An area containing a stand-alone item of play equipment, e.g., swings, a slide, rocking equipment, spinning equipment, and climbing equipment.
Sitting area	Area with built seating, but without tables.
Eating area	Area with table and chairs.

Source: (Anderson et al. 2014)

Shade type and composition

Shade that covered activity areas was classified as built or natural (from trees). The composition of built shade was classified as timber, metal, translucent plastic, non-translucent plastic, glass, fabric (light hue), fabric (dark hue), or unidentifiable solid material. The composition of tree shade was classified as heavy, medium, or light, using a canopy density guide (Greenwood et al. 2000).

Analyses

A binary logistic model assessed the influence of predictor variables on the probability of shade cover. The response variables included: 1) probability of shade covering activity areas (this was simplified to ‘no cover’ and ‘at least some’ cover due to the limited shade observed), 2) probability of playgrounds having at least one source of shade, and 3) probability of playgrounds having shade covering or within 10 m of play equipment. The predictor variables tested were: neighbourhood deprivation level, latitude, playground size, and playground activity area type (for the activity area analyses only).

The New Zealand Deprivation Index (NZDep) was used as a measure of socioeconomic deprivation. The index ranks neighbourhoods into 10 deciles, ranging from 1 (least deprived) to 10 (most deprived). In our model, the ten deciles were simplified to three groups: lowest deprivation (NZDep 1 to 3), middle deprivation (NZDep 4 to 7), and highest deprivation (NZDep 8 to 10). Likewise, latitude was divided into three groups: the northern third (34°S to 39°S), the middle third (39°S to 43°S), and the southern third (43°S to 47°S). Playground size was defined by the number of activity areas in each playground, and was modelled as a continuous variable.

Results

Sample characteristics

A total of 559 playgrounds were included in the final sample. Nearly half were from the five most populated city centres: Auckland (1,614,300 population; 161 playgrounds sampled); Christchurch (375,000 population; 37 playgrounds sampled); Wellington City (207,900 population; 20 playgrounds sampled), Hamilton City (161,200 population; 16 playgrounds sampled), and Tauranga (128,000 population; 12 playgrounds sampled). Less than five playgrounds were found in 15 of the 67 TLAs. Of the 555 playgrounds initially screened through online lists, 120 (22%) were excluded and each replaced with another randomly-selected playground. The main reasons for exclusions were: 1) the playground could not be identified in GES and GSV (53% of exclusions), 2) the GES and/or GSV were inadequate for assessing playground shade, e.g.,

blockage by other objects (13% of exclusions), and 3) the playground (when listed on council websites) was not always publicly accessible, e.g., part of a school and closed off by a gate (8% of exclusions).

Shade cover over activity areas

A total of 2896 activity areas were identified in the 559 playgrounds — an average of 5.2 per playground (95% CI: 3.2 to 7.2). Most activity areas (85.5%, $n = 2447$) had no shade cover, 6.8% ($n = 197$) had some shade cover, 4.7% ($n = 141$) had majority level shade cover, and 3.8% ($n = 111$) had complete shade cover (Table 2). Trees were the most common source of shade covering activity areas (82.3%). Most trees had either heavy foliage (78%) or medium foliage (19%). The remaining sources of shade (74 — 17.7%) were built structures with roofing composed of timber (30 structures), dark-hued fabric ($n = 23$), pale-hued fabric ($n = 12$), metal ($n = 7$), translucent plastic ($n = 3$), and unidentified materials ($n = 2$).

After statistical adjustment (Table 2), stand-alone equipment areas were less than half as likely as main play areas to be covered (odds ratio (OR): 0.48, 95% CI: 0.36–0.64), whereas sitting areas were more likely to be covered (OR: 1.53, 95% CI: 1.11–2.10). Deprivation level and latitude had no impact on the amount of shade-covering activity areas in playgrounds. However, playgrounds from more deprived areas ($n = 237$) were 41% less likely to have at least one source of shade than playgrounds from the least deprived areas ($n = 105$) (OR: 0.59, 95%CI: 0.36–0.96) (Table 3). Larger playgrounds were more likely to have shade than smaller playgrounds (both in absolute terms and per activity area), with the odds of shade cover increasing by 12% (OR: 1.12, 95% CI: 1.09–1.15) for each additional activity area in a playground.

While only 40.1% of playgrounds (224 of 559) had shade covering at least one activity area, most (70.9%) had at least one source of shade within 10 m of play equipment (but not covering play equipment, seats, or tables). These sources of shade may offer some cover for playground spectators, although would likely be less popular among spectators than seats/ tables.

Examples of best practice

The sufficiency of playground shade varied considerably between the TLA areas. Twenty-three TLA regions had shade over < 10% of playground activity areas; 27 (the majority) had shade over 10 to 19% of areas; six had shade over 20 to 29% of areas; five had shade over 30 to 39% of areas; and five had shade over > 40% of areas (see [Supplementary Material](#)). Playgrounds in several TLA areas, especially in the north-eastern area of the North Island, made good use of natural and built shading. Trees in Waikato (37° S) and South Wairarapa (41° S) were frequently near playground

Table 2 Shade covering of activity areas by area deprivation, latitude, and area type

Characteristic	Activity area observations (<i>n</i>)	Activity areas with shade cover (%)	Odds ratio ^a (95% CI)	<i>P</i> value
Activity area type				
Main play equipment	500	17.4	1.0 (reference)	
Stand-alone play equipment	1610	10.0	0.48 (0.36–0.64)	< 0.001
Sitting areas	448	26.6	1.53 (1.11–2.10)	0.009
Eating areas	338	23.4	1.21 (0.85–1.72)	0.292
Area deprivation (NZDep deciles)				
1–3 (lowest deprivation)	517	14.3	1.0 (reference)	
4–7	1159	16.0	1.09 (0.81–1.18)	0.558
8–10 (highest deprivation)	1220	16.6	0.99 (0.73–1.35)	0.969
Latitude				
Southern third	270	11.9	1.0 (reference)	
Middle third	1221	15.2	1.15 (0.76–1.74)	0.495
Northern third	1405	16.4	1.36 (0.91–2.05)	0.134
Playground size				
Per additional activity area	–	–	1.12 (1.09–1.15)	< 0.001

^a odds of having shade cover compared to the reference group

equipment, sitting areas, and eating areas (Fig. 1a and b). Several seats and tables in South Wairarapa were also covered by built shade structures (Fig. 1c). Moreover, in Whangarei (36° S), shade sails that covered play equipment were often installed (Fig. 1d).

Discussion

Main finding of this study

This national survey found that most New Zealand playgrounds have limited shade available, particularly playgrounds from the most deprived neighbourhoods. There was no association between latitude and shade (which may be

expected given higher temperatures and UVI in northern regions). However, the amount of shade available in each council region varied substantially. The best examples of shade included large trees near play equipment and built shade installed over key areas.

What is known about this topic

The provision of shade in urban open spaces is a key strategy for skin cancer prevention. Shade provides a physical barrier from UVR (the main modifiable risk factor for skin cancer). Shade also lowers the risk of heat stress, provides shelter, and may improve a site's aesthetic appeal. Studies in New Zealand and the United Kingdom demonstrate that shade is a key factor driving people's choices of urban open spaces (Tucker et al. 2007; Wellington

Table 3 Shade in playgrounds by area deprivation, latitude and playground size

Characteristic	Playgrounds (<i>n</i>)	Playgrounds with shade covering ≥ 1 activity area (%)	Odds ratio ^a (95% CI)	<i>P</i> value
Area deprivation (NZDep deciles)				
1–3 (lowest deprivation)	105	47.6	1.0 (reference)	
4–7	217	41.0	0.69 (0.42–1.12)	0.135
8–10 (highest deprivation)	237	36.3	0.57 (0.35–0.94)	0.026
Latitude				
Southern third	52	38.5	1.0 (reference)	
Middle third	214	37.9	0.87 (0.45–1.67)	0.676
Northern third	293	42.0	1.25 (0.66–2.26)	0.493
Playground size				
Per additional activity area	–	–	1.29 (1.20–1.38)	< 0.001

^a odds of having shade over at least one key area relative to the reference group



Fig. 1 Examples of natural and built forms of shade

City Council 2016). Moreover, Australian and American research shows that shade installed in schools and parks were popular among users (Buller et al. 2017; Dobbinson et al. 2009).

Despite having the highest rate of melanoma skin cancer in the world, little is known about shade practices in New Zealand’s TLAs nor how to improve them. A pilot study found limited shade in 45 outdoor recreation spaces (including playgrounds, beaches, and outdoor pools) in New Zealand (Gage et al. 2018b). However, the research included just four of the 67 TLA regions, and was not sufficiently sampled to compare by regional area, socioeconomic status, and latitude.

What this study adds

To our knowledge, this study provides the first evidence of how shade varies across a country as a whole, and has several important implications for policy and practice. This study’s findings indicate that most families visiting New Zealand playgrounds, particularly smaller sites in more deprived areas, would probably be in full exposure to the sun. Given the high levels of ambient UVR in New Zealand, this lack of shade is likely to increase the risk of sun burn and skin cancer for playground users if other forms of sun protection are not used.

The findings revealed that playgrounds in lower income areas were less likely to have shade, which is consistent with an evaluation of playground shade in Sydney, Australia (Anderson et al. 2014). This may be concerning from an equity perspective, as families in lower income areas may have less capacity to visit the better shaded playgrounds in other areas. For example, a survey of Wellington residents indicated that most (58%) said that their neighbourhood playground (closest to their home) was the one

they would visit most often (Wellington City Council 2016). The results therefore lend support for to improve shade in lower income areas, given the importance of public playgrounds for play and physical activity among lower-income families.

The greater amount of shade observed in larger playgrounds may be explained by TLAs targeting shade development in ‘destination’ types of playgrounds. The Wellington City Council, for example, differentiates between neighbourhood and community playgrounds (smaller sites for residents living within walking distance) and destination playgrounds (premium sites that attract residents, visitors, and tourists and which can accommodate a longer stay with amenities such as toilets, drinking fountains, and shade) (Wellington City Council 2016). From an efficiency perspective, a focus on developing and maintaining several high-quality spaces for recreation may be a practical response to tight budgetary constraints. Nevertheless, from an equity perspective, it seems desirable that playground development resources are spread more equitably — and especially for smaller playgrounds in more deprived areas.

Limitations

A limitation of this study was that the GES and GSV images may have been captured before recent changes to play equipment and shade (though typically these images are under 5 years old). The method also under-represented playgrounds located off-street, as these sites had no GSV images. Moreover, the approach could not precisely ascertain the quality of shade, i.e., UVR protective factors. Nonetheless, the method provided a low-cost and efficient indicator of playground shade in a country where sun protection is particularly important.

Implications for policy and research

The findings of this research support policy efforts to increase playground shade nationwide, particularly in lower-income areas. The showcasing of successful efforts of TLAs to date may help encourage councils with less playground shade to improve (see [Supplementary Material](#)). Alternatively, central government could set national standards for shade in playgrounds. This may involve setting a minimum standard for shade, and the consideration of shade in all new playgrounds and playground upgrades. Currently, New Zealand has national standards for other aspects of health and safety in public playgrounds, e.g., for surfacing and equipment, but not for shade. Such standards could also include the provision of drinking fountains and the display of smokefree signage, which both support healthy outdoor activity. The display of sun safety signage may also help reinforce sun safety messages among children and their caregivers.

An important consideration in shade development, however, is the shading types and materials used. Future research may be warranted to explore the most practical, effective and cost-effective options for shade in New Zealand playgrounds. For example, tree planting might sometimes be favoured over built shade, given the other benefits of trees, for example the cooling effects of trees via transpiration (Konarska et al. 2016) and their aesthetic qualities. However, warmer designs of shade (e.g., translucent plastic) may be preferable in cooler regions (Greenwood et al. 2000).

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Compliance with ethical standards

This research does not contain any studies with human participants performed by any of the authors.

Conflict of interest The authors declare no conflicts of interest.

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