Cool and Covered

Literature Review

Benchmarking Shade in NSW Playgrounds

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1.1 Introduction

Australia has one of the highest rates of skin cancer in the world with a strong association between UVR from the sun and the development of skin cancer (Buller et al., 2017). According to the Australian Institute of Health and Welfare (AIHW), skin cancer accounts for the largest number of cancers diagnosed in Australia each year (AIHW, 2016).

In 2017 there were 4866 new cases of melanoma in NSW and it is estimated that one person in every sixteen will be diagnosed with skin cancer by the age of 85 years (Cancer Institute NSW (CINSW), 2017). Melanoma accounted for 10.9% of all cancers in 2017 in NSW and this is projected to slightly decrease to 10.5% in 2022 (CINSW, 2017).

Prevention and early detection strategies have been shown to be effective in reducing skin cancer risk. Prevention strategies include utilising personal protection (clothing, sunscreen, hats and sunglasses) and effective shade when outdoors (Cancer Council NSW (CCNSW), 2020). The last of these strategies, use of effective shade, goes beyond reducing exposure to ultraviolet radiation (UVR) to also providing cooling and heat mitigation benefits in open outdoor spaces. (Anderson et al., 2014; Gage et al., 2018; Gage et al. 2019; Parisi & Turnbull, 2014).

Effective shade strategies provide aesthetically pleasing environments with benefits that can include increased societal engagement and a range of improved health outcomes (Igoe et al., 2020). The inclusion of shade as an important design consideration is widely acknowledged to protect against UVR and contribute to safe and healthy communities (CCNSW, 2013; National Heart Foundation of Australia, 2004).

Shade provision in public areas is usually within the remit of state and local government planning authorities. However, the design of shade to meet site specific environment and community needs often falls within the remit of urban planners, architects, landscape architects, building designers and engineers. This denotes the importance of a multi-disciplinary approach to shade strategy, planning, implementation and measurement (Kapelos & Patterson et al., 2014; Schneider et al., 2020).

1.2 About this review

The creation of targets for any health or social outcomes requires careful consideration. This includes three broad but interconnected steps. The *development* of the targets requires an informed approach based on scientific evidence and broad consultation with stakeholders. Tools to support the *implementation* of action to help achieve these targets must be useable, relevant and able to be integrated into usual practice for the relevant discipline, in this case, built environments. Finally, *monitoring and evaluation* of progress enables incremental assessment of the barriers and enablers towards achieving targets. This assessment informs relevant adjustment of strategies and approaches to help achieve longer term attainment (Fleming and Fitzgerald, 2019; Haynes et al., 2020).

To achieve this, a series of sub-questions are investigated:

- How is shade used, measured and reported in playgrounds and other public settings?
- How does shade relate to other built environment design considerations?
- How is shade incorporated in existing built environment metrics and indicators?
- Are there examples of work towards shade targets, metrics and measures?

These sub-questions are important to investigate to inform potential achievable and effective targets for the provision of adequate shade in playgrounds.

Databases searched included Scopus, PubMed, Compendex via Engineering Village, EbscoHost, Informit and Web of Science. In addition, reference lists were cross checked, separate Google documents cross checked and additional searches were undertaken in a university library database. Combinations of search terms used with Boolean operators included (shade) (sun protection) (heat) (urban heat island effect) (indicators) (planning) (policy) (built environ*) (urban design*) (Neighbo* activity) (Land use mix) (walkability) (liveability) (transport walking) (GIS) (Measure*) (Metric*) (Trees) (playgrounds) (Play spaces).

As part of a broader study, this review considers how the literature can guide future broad action, including improving shade creation and associated targets as part of the overarching goals of NSW skin cancer strategies and programs. Section 1.3 investigates how shade is used, measured and reported. Section 1.4 explores how shade relates to other built environment designs, including elements for effective shade. Section 1.5 investigates how shade relates to other healthy built environment indicators, measures and metrics (including current built environment metrics and indicators). Finally, Section 1.6 provides an overview of policy relating to shade indicators and metrics.

1.3 How is shade used, measured and reported in public settings?

Measuring shade usage can be useful for many reasons. It helps to inform the siting and location of shade and offers insights into the additional benefits of shade such as encouraging and facilitating outdoor recreation activity. Similarly, opportunities to investigate literature relating to shade usage in different geographic and socioeconomic locations can help to inform the creation of targets and implementation of progressive actions to achieve state-wide targets (Gage et al., 2018; Gage et al., 2019; WHO, 2017).

Differences in playground shade provision in low and high socioeconomic areas

Several studies have investigated the differences between shade provision in lower and higher socioeconomic areas, consistently reporting that there is more shade available over playgrounds in higher socioeconomic areas, than in playgrounds within lower socioeconomic areas (Anderson et al., 2014; Crawford et al., 2008). Furthermore, studies, including one study focused on Sydney, have found that higher socioeconomic areas tend to have a higher level of natural tree shade in public open spaces than lower socioeconomic areas (Anderson et al., 2014; Crawford et al., 2008). The higher socioeconomic areas studied in Sydney consisted of up to 72% of natural shade, compared with 44% of shade in the lowest socioeconomic areas (Anderson et al., 2014). This study also found that up to 54% of activity areas in playgrounds in lower socioeconomic areas had no shade at all

(Anderson et al., 2014). These findings are supported by a New Zealand study identifying lower socioeconomic areas as 43% less likely to have at least one source of shade (Gage et al., 2019).

Similarly, children's activity levels have been linked to socioeconomic status and public open space conducive to increased physical activity, including presence of shade. While the number of playgrounds or recreational facilities in neighbourhoods did not differ, findings suggest that higher socio-economic areas had more amenities including trees that provided shade, giving children greater opportunity to participate in physical activity (Crawford et al., 2008). Park improvement studies have included installation of shade sails as part of refurbished parks in low socioeconomic areas. A Melbourne study also found that parks which are well designed, safe and provide shade were highly rated by park visitors as being important for promoting physical activity (Dobbinson et al., 2020).

Other associations of the role of shade in encouraging physical activity have been investigated. This role of shade is considered as one of a suite of built environment features that, through its implementation, can increase physical activity or active recreation. Association of observed or reported physical activity levels in public or school settings have been correlated with a suite of built environment features. For example, Timperio et al. (2008) found the presence of trees in open spaces correlated with physical activity, showing the provision of trees in public spaces was positively associated with adolescent girls' physical activity.

Use of shade versus non-shaded areas in playgrounds

Useability of playground areas is important when considering any justifications or advocacy for greater shade. This is also important when considering, proposing or developing metrics to guide increasing shade or other built environment attributes for population health. Studies consistently identify that shaded areas attract greater use by children with certain demographics. For example, older children in a pre-school setting favouring shaded areas in playgrounds to play (Boldeman and Wester, 2004).

Similar results have been found for increased use of renovated schoolyards with a focus on resting areas for adults and boys (Colabianchi et al., 2011). Observation and self-report of shade use at pools and beaches was reported to stabilise over a 13-year study period in Melbourne. Attributions for this stability, as opposed to the hypothesized increase, may reflect low acceptability of shade use. In the same study, analysis of female specific data noted a slight decline in shade use over the time period (Haynes et al., 2021).

The Gage et al. (2018) study from New Zealand found that shade use was relatively low, observed as 10% of 168 participants who were randomly selected children of age between 8 – 11 from randomly selected schools in the Wellington region. The study found shade use was higher at the pool and beaches in the study than the playground. A corresponding study (Gage et al., 2019), spanning North and South island populations also noted a high rate of shade absence in playground locations.

Passive recreation areas

Shade use has also been investigated across active and passive recreation areas within parks. A cross-country study involving the United States of America (USA) and Australia investigated the effect of installing built shade in passive recreation areas (Buller et al., 2017). The research

undertook a pre and post test at passive recreation areas in 144 parks across Melbourne, Victoria and Denver, Colorado. The study involved installing shade in a sample of intervention parks and the post testing assessed sun protective shade use. The study found greater use of shade post test in the Denver locations than for Melbourne. The findings supported public investment in shade as a cancer prevention strategy (Buller et al., 2017). Public open spaces which provide passive opportunities also appear to have greater tree shade present with studies such as Timperio et al. (2008) reporting 61% of public open spaces having trees for shade in Melbourne.

School settings

School settings are traditionally recognised as ideal locations for health promoting actions relating to policy, education and offer a supportive environment. This notion of developing a supportive environment for shade was explored by Dobbinson and colleagues (2014). In this study, purpose-built shade was installed in selected secondary schools. The study found that shaded tables and seats attracted greater use than similar non-shaded areas by secondary school adolescents. However, students were unaware of changes to their shade use habits pre and post the shade sail installations. In another West Australian school study, 14.5% of playgrounds were found to be shaded (Milne et al., 1999).

The location of shade in school playground areas has also shown varying results in the limited studies which have investigated this topic. Shade has been associated with greater learning and educational opportunities around school outdoor spaces. There is a wealth of design guidance, consideration and urban planning specific considerations provided to inform design of shade in educational settings for both education and social benefits (Hyndman, 2017).

Sunburn experience and the presence of tree shade has been studied in the school setting in the United States of America (Tribby et al., 2020), finding schools with less tree cover shade were associated with more sunburns. Such studies reinforce the notion that sun exposure occurs in multiple locations often in short, cumulated doses (Cancer Council, 2020). Avoiding sun exposure is therefore important in both school settings and other community spaces where young people spend time such as playgrounds and parks.

Proportion of shade over playgrounds

There is limited literature on the existing proportion of shade over public facilities. Of the studies available, most investigate small, geographically bound areas with a limited number of sites. The Anderson et al. study (2014) which investigated differences in shade in higher and lower socioeconomic areas, measured shade in 139 NSW playgrounds. Results indicated an average of 37% shade over main play activity areas in the public parks audited. Specifically, it was identified that the main play areas where children spend time were less shaded than eating areas in the park (Anderson et al., 2014).

Other work in NSW coastal towns has measured shade in 30 recreation areas. This study aimed to measure current shade in a sample of locations to help inform future work in sun protection policy and strategies in conjunction with local government. Of the 30 sites, nine were beaches, seven were pools, eight were sports grounds and six were skate parks. The study reported ‘insufficient’ shade in over half of the sports grounds audited and just under half of the beaches and skate parks. This same

study however noted the pools in the study area had more permanent shade, yet an absence over main outdoor pool areas (Potente et al., 2011).

The absence of shade over main pool areas is consistent with findings from Gage et al. (2018) who used body cameras on children to monitor sun protection behaviour and shade availability in some public spaces in New Zealand. The same study found that shade in playgrounds was in the form of natural shade only, not covering the play area or surrounding seats and tables.

A finding of 60% of playgrounds with no shade emerged from a New Zealand national study of 559 playgrounds. This study considered shade over playgrounds, seats and tables and found a lack of built and constructed shade for children's play spaces (Gage et al., 2019). Similarly, a German study noted a strong association with greater shade in parental supervision areas yet less shade in main play areas for children (Schenider et al., 2020).

Measuring shade

The creation of targets for any supportive environment strategy requires indicators and progressive measures towards achieving those goals. In the absence of already established targets, audits and measures for quality and quantity of shade in outdoor spaces can provide a useful opportunity for creating baseline data that can subsequently inform future goals, targets and indicators. Understanding current approaches to measures and auditing and opportunities for the future, can assist the development of indicators and associated metrics. Such measures also require an agreed methodology for consistency and wide application at a state-wide level. The intersection between resource intensive onsite measures for built environments, versus strategies to apply measures over large geographic regions, needs to be understood to guide the development of targets and goals (Gage et al., 2018b; Holman et al., 2018).

Globally, research on shade audits, measures and presence of shade in public spaces is limited (Holman et al., 2018). The majority of the published research derives from Australia, the United States of America and Canada and New Zealand. Within the limited literature, a range of methodologies have been used. These include:

- a visual inspection of the given area to address a set of predefined questions
- Google maps imagery with predefined visual inspection elements
- interviews with potential shade users and facility managers
- the use of software to model and map the shade provided at different times of day and year.

Visual, onsite shade audits with validated observational tools provide a reasonably cost-effective method of shade measures in small sample size studies. However, additional methods are required for large population-based studies where onsite visits are not practical nor efficient (Haynes et al., 2021; Potente et al., 2011). Table 1 provides an overview of relevant identified studies which have used shade measures in some form. This is intended to be used as potential guidance towards the creation of shade targets, measures, indicators, and potentially, an overall goal for shade.

Table 5. Summary of selected studies using shade measures or metrics

Author	Country	Relation to potential targets	Use of metrics/ measures / indicators
Anderson et al. (2014)	Australia	Calls for shade inclusion in local government policy and planning documents.	Informs the need for specific shade metrics. Study notes the key limitations. Study used an audit tool using estimated percentage of activity area covered by shade from 0-100%.
Colabianchi et al. (2011)	USA	Outlines other features for holistic consideration of playground attributes for urban planning.	Direct observation on site. Used a rating scale of 1-3 with 1 being poor coverage and 3 being excellent coverage.
Copeland et al. (2011)	USA	Can inform targets for structured early learning environments.	Developed a new instrument, the Early Learning Environments for Physical Activity and Nutrition Environments Telephone Survey (ELEPHANTS), including a question on shaded area of playground at greater than or equal to 1/3 of playground covered. Self-administered visual audit by early learning centre staff.
Crawford et al. (2008)	Australia	Guides use of whole number counts in onsite shade measures for small sample sizes.	Presence of shade or sheltered "(man-made)" (sic) counted as sum of. Number of playgrounds counted as a metric with number of "trees that provide shade" as a whole number.
Dobbinson et al. (2014)	Australia		Shade use observation through video footage of secondary school adolescents with purpose - built shade and content analysis; supplemented with focus groups with students on shade use in school settings.
Dobbinson et al. (2020)	Australia	Study informs usage targets for low socioeconomic areas.	Shade use was counted in whole number of participants who used any part of any shaded area.
Downs et al. (2008)	Australia		Equipment specific measures in-situ.
Downs et al. (2019)	Australia	Can provide informed data on the UV protection afforded by different tree canopy and species to aid recommendation of tree species shade across varying geographical regions.	Could provide a more accurate sub sample measure of small number of onsite shade sites to validate recommended metrics and the UV protection afforded by shade density.

Author	Country	Relation to potential targets	Use of metrics/ measures / indicators
Gage et al. (2018)	New Zealand	Paper calls for "Strategies for supporting sun protection in these settings could include establishing minimum standards for shade and displaying signs about sun protection" (2018, p. 35).	Built shade was classified as either permanent (e.g., shade sails) or temporary (e.g., sun umbrellas). The composition of built shade canopies was categorised as solid (e.g., timber or metal sheeting), plastic, fabric or other. Trees were classified as having light, medium or heavy foliage using the canopy density guide. Built shade and trees were excluded if their canopy appeared to be less than two metres wide.
Gage et al. (2019)	New Zealand	Paper calls for "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" (2019, p.674).	Shade cover classified as none (0% cover), some (> 0 to 50% cover), majority level (> 50% to < 100% cover), or complete (100% cover). Shade cover estimated by projecting the shade cast by adjacent trees and built shade, based on the shadow patterns. Shade classified as built or natural. Built shade classified as timber, metal, translucent plastic, non-translucent plastic, glass, fabric (light hue), fabric (dark hue), or unidentifiable solid material. Trees classified as heavy, medium, or light, using a canopy density guide.
Haynes et al. (2021)	Australia	Conclusions focus on messaging via advertising campaigns to raise awareness of sun protection measures.	Fieldworkers undertook onsite observations of sun protective behaviours in outdoor leisure settings. Written recording sheets included shade use noted as (not available or not using, partial, or total). The survey did not account for the availability of natural or purpose-built shade.
Holman et al. (2018)	Australia	Paper notes no standard metric to evaluate shade effectiveness and recommends further research and development. Also noted is that any future efforts in promoting shade would benefit from incorporating complementary benefits of shade such as aesthetic, active transport,	"Shade audits can include 1 or more of the following: a visual inspection of the given area to address a set of predefined questions, interviews with potential shade users and facility managers, and the use of software to model and map the shade provided at different times of day and year". P. 1608

Author	Country	Relation to potential targets	Use of metrics/ measures / indicators
		reducing urban heat island effect and energy conservation.	
Milne et al. (1999, Apr)	Australia		Aerial photographs of each school were taken and the proportion of shade in play areas available at lunch time was estimated by calculating shade as a portion of the total play area. Visual estimations of shade proportions over play areas; shade use measured by individual dosimeters. Methods were pilot tested for larger study.
Milne et al. (1999)	Australia		Shade manually counted from aerial photographs and the total shaded area expressed as a percentage of total area available for students.
Olsen et al. (2019)	USA	Influence of design on temperature exposure and notes the central role that greenspace can have in playground design.	
Parisi and Turnbull (2014)	Australia		Article considers examples of best practice for undertaking shade audits including table of existing shade audit tools.
Parsons et al. (1998)	Australia	Good quality shade can reduce UV exposure by up to 75%.	Measures for tree shade.
Potente (2011)	Australia		Metrics used: visual scan of the area and coded the shade as available in most areas (covering more than 50% of designated area); limited to small areas or certain times of the day (20-50% of area shaded); or no adequate shade available (less than 20% of area covered).
Schneider et al. (2020).	Germany	Shade should be incorporated in the planning process for new design or playground renovations	Validated use of Google maps and onsite shade visits to conduct large scale shade audits. With over 150 playgrounds, this study represents the biggest investigation of UV exposure on playgrounds worldwide.

Author	Country	Relation to potential targets	Use of metrics/ measures / indicators
Tabatabaie et al. (2019)	USA		Consumer feedback using Likert scales
Timperio et al. (2008)	Australian	Highlights an opportunity to combine shade targets in parks and public open space with other urban planning features.	……"Incorporate interesting and age appropriate playground equipment and features to promote children's physical activity" (p517).
Tribby et al. (2020)	USA		Tree cover was assessed using a database from U.S. Forest Service as part of the 2011 National Land Cover Database (NLCD)
Vanos et al. (2017)	USA	Validated measure to compare personal UV exposure in outdoor shaded environments.	
Vanos et al. (2016)	USA	Supports the need for shade for multiple benefits in playgrounds.	Study used airborne temperature, in situ and infrared to measure heat.

Whilst various metrics can be attributed to elements of healthy built environments, as Holman et al. (2018) note currently, there is not a standard metric to evaluate the effectiveness of shade, another area of research that, if examined, might benefit future shade development. A significant number of reviewed papers call for the need for shade metrics, standardised measures and development of targets (Anderson et al., 2014; Gage et al., 2018, 2018b, 2019; Haynes et al., 2021).

Combination of personal measures and environmental measures

School environments have been the location of studies which compare ambient or environmental ultraviolet radiation and heat measures to erythemal doses experienced by individuals, students or teachers. These studies have developed physics-based models which, whilst time consuming and resource intensive, identify the dynamic nature of surface irradiance depending on solar position. They reinforce the need for a combination of personal sun protection behaviours with environmental sun protection to reduce overexposure to UVR (Downs et al., 2008; Vanos et al., 2017). Such studies, which have measured ambient UVR and correlated with personal UVR exposure collected by individual dosimeter, have shown that shade can significantly reduce personal UVR exposure (Vanos et al., 2017).

In situ measures for effectiveness of tree shade in UVR protection have been undertaken to further guide selection of tree species in certain geographical regions (Downs et al., 2019; Parsons et al., 1998). A study in Queensland used in situ measures to identify levels of UVR protection from 21 common tree species. Such local data can also be used to guide local government policy and action where locally relevant measures have been undertaken (Downs et al., 2019). Tree shade studies have identified that denser canopy trees with reduced sky view provide increased UVR protection. However all trees, like built shade structures, are susceptible to diffuse, reflected UVR. This supports

the need for integrated design rather than the exclusive use of one form of shade (Downs et al., 2019; Parsons et al., 1998; Dobbinson et al., 2014).

1.4 How does shade relate to other built environment design considerations?

Consideration of the broader built environment is important when considering shade. Multiple planning, design and legislative components inform final design, construction and maintenance. Ideally, shade forms an intrinsic part of such built environments. However, the integrated nature of built environment design indicates the need for shade consideration to be combined with other design, access and safety requirements of public facilities. Therefore, understanding the literature regarding influence of other built environment factors on facility usage is important in creating recommendations for shade. Similarly, investigating how shade is used and understanding the literature relating to availability of shade, use of shade in active and passive settings, and association between shade and educational settings, can create informative approaches to shade targets (Kapelos et al., 2014; Schneider et al., 2020).

The design of shade is an important consideration for UV protection, heat control and useability. Built environments are subject to consideration around several design factors. These include many geographic and topographical considerations, including water, air, accessibility, inclusion, to name a few. Therefore, considering where shade intersects with the broader domain of architectural practice is important if any real-world improvements are to be achieved in shade provision for environmental UV protection.

Consistent findings support that larger shade structures offer greater protection over the designated location for the shade such as a playground, with wide overhang over the intended usage area. Other features to support more UV protection include overhang or addition of 'side on' protection which considers the vertical sides of the shade area. Side protection has been shown to assist with decreasing diffuse UV which reflects from surrounding surfaces. Additionally, well designed effective shade includes surrounding surface planting with trees and shrubs to reduce diffuse UV which can reflect from surfaces including grass, concrete and pathways (Holman et al., 2018; Parisi and Turnbull, 2014).

A comprehensive review of shade maximising techniques highlighted the need to improve the protection factor and useability of shade structures (Turnbull and Parisi 2014). To achieve this, Turnbull and Parisi recommend the following considerations in the design of shade:

- minimize the amount of unobstructed sky visible from the shaded area.
- use natural ground covers with a low rate of diffuse reflection of sunlight (referred to as albedo) or surfaces under shade structure that have a lower albedo than concrete or sand.
- avoid locating shade structures near high albedo vertical or horizontal surfaces, or use extra side-on UV mitigation strategies.
- ensure the shade provided is over the sites where the users are located and specifically over picnic tables, sandpits or other playground equipment.
- provide side-on protection in the form of vegetation, trees or UV blocking material.

- ensure stand-alone structures with no side-on protection have shade structures with larger overall covered roof area.
- use roofing material with a low UV transmission that provides a Ultraviolet Protection Factor (UPF) of 20 or higher; and replace aged or weathered roofing materials to maintain the UPF.
- trees are an important part of shade provision strategies. Trees with higher canopy density and trees near other trees or structures need to form a component of shade provision.This includes both single trees in open areas, groups of trees and trees near other structures.

Heat control is a further factor for consideration in overall playground safety and design (Olsen et al., 2019; Vanos et al., 2016) and is another benefit of effective shade. This consideration pays further weight to the need for comprehensive approaches to playgrounds and open space design for local government and design and planning industries.

As urban and regional planning requires consideration of multiple local demographic and environmental factors, shade structures need to be designed to be relevant to specific locations (Dobbinson et al., 2014; Haynes et al., 2021). This includes the consideration of sun angles, heat control, and reflective diffuse irradiation from surrounding surfaces (Horner et al., 2018). Research has previously shown that many shade structures present in local government locations in Australia are pre-ordered from general stock shade items and not designed nor sited specially for the user location (Baldwin, 2019).

Combining healthy built environment approaches

Action to foster healthy environments and improve health behaviours requires a multi-disciplinary, multi-strategy approach. In this case, the roles of urban planning, local government, architecture, building and design sectors are crucial to achieve improved shaded environments whether in playgrounds or other outdoor amenities (Holman et al., 2018). Timperio et al. (2008) highlight an opportunity to combine shade targets in parks and public open spaces with other urban planning features.

1.5 How is shade incorporated in existing built environment metrics and indicators?

Other areas relevant to shade metrics include those relating to heat. The Urban Heat Island (UHI) Effect has received much attention over recent years. The UHI Effect refers to the density of heat that becomes concentrated in built up urban zones, as opposed to nearby suburban locations or those in rural localities (Santamouris et al., 2017). A study conducted in Sydney investigated data from six locations in Sydney over a ten-year period and found that the UHI Effect occurs in mid-summer (Santomouris et al., 2017). It used metrics of 'Cooling Degree Days' in the weather data analysis which refers to the severity of the climate and cooling energy demand and concluded that Western Sydney experiences approximately three times more Cooling Degree Days than Sydney's Eastern suburbs.

To assist local governments in identifying mitigation strategies for UHI, the Urban Heat island Mitigation Performance Index was developed (Ding et al., 2019). This online index tool uses four objectives for mitigation: outdoor thermal comfort, health risks, energy demand and water demand.

The online tool provides a series of mitigation strategies which can be selected for a specific Australian geographic region including central, Eastern, and Western Sydney. Mitigation strategies are ranked from highly suited to somewhat suited, to less suited with aspects as follows:

- Cool and permeable pavements
- Street trees and planting
- Water features and evaporative cooling
- Green open spaces
- Public space shading structures
- Cool roofs
- Cool facades
- Shading devices
- Green roofs
- Vertical greenery
- Built form and design
- Street orientation
- Anthropogenic heat reduction.

Whilst the index provides mitigation strategies, with references to research on their effectiveness, it does not give specific targets or indicators for local governments to use. In addition, information in relation to health effects is limited to those caused by heat causing effects without links to other issues including sun exposure and skin cancer. This however may provide an opportunity to build on some relevant research from this Index and other work from the Low Carbon Living (CRC) initiative to develop future shade targets and metrics. Combining urban planning policies and practice recommendations for shade seems necessary to complement this growing work in UHI Effect mitigation.

Despite the lack of formal indicators for UHI Effect, Pakzad and Osmond (2016) developed a series of proposed heat mitigation indicators based on green infrastructure. This study undertook a comprehensive literature review and semi-structured interviews across Australia. The broad indicators developed range across ecological, health, socio-cultural and economic domains. Suggested performance indicators related to shade are summarised in Table 2.

Table 6. Suggested indicators to help inform Urban Heat Island Effect mitigations potentially related to shade (Pakzad and Osmond, 2015).

Ecological Indicator	Climate and microclimatic modifications (e.g. UHI effect mitigation; temperature moderation through evapotranspiration and shading; wind speed modification)
	Reduced building energy use for heating and cooling (through e.g. shading by trees; covering building by green roof and green walls)
Health Indicators	Improving physical well-being (e.g. physical outdoor activity; healthy food; healthy environments)
	Opportunities for recreation, tourism and social interaction (community liveability)

Socio-cultural Indicators	Improving pedestrian ways and their connectivity (e.g. increasing safety; quality of path; connectivity and linkage with other modes)
	Provision of outdoor sites for education and research

Physical activity and built environments

There is an abundance of literature exploring the relationships between elements of the built environment, walkability and physical activity. Learnings from this well-researched area of public health and supportive environments can help to inform future work in shade targets, metrics and indicators.

The body of research linking built environments with physical activity has seen the development of several scales for measuring associations and correlates of built environment features and local health outcomes data. Consistently, these scientific scales, metrics and indicators show a lack or absence of consideration for shade, heat and sun protection. In some rare cases, tree canopy or presence of trees has been included but with little detail. However, given the broad application of these targets, goals and indicators globally, understanding the body of work can help inform future action in associated areas such as shade.

The following section of this review provides an overview of other health and built environment indicators and metrics, which could potentially inform the development of relevant shade measures and targets.

Urban planning, environments and public health

Of the extensive literature relating to indicators and walkability, physical activity and local environments, three key globally relevant studies have been identified. These studies summarise key features of integrated targets, indicators and measures.

Firstly, a seminal paper by Giles-Corti and colleagues (2016) considered the global public health challenge for city planning and population health. Specifically, the research noted that:

a) Local and regional action influences urban transport planning and design with a potential impact on behavioural and social risk factors.
b) Well implemented urban planning policies need to be integrated across governments and are essential for healthy liveable cities, and
c) Indicators are needed for city planning to monitor progress and enable relevant comparison of cities.

As such, Giles-Corti and colleagues suggest a comprehensive and extensive list of potential indicators and associated measures. This list, as outlined in Table 3, includes but is not limited to: legislation and policies, planning, employment, transport, green space, density, air pollution, diet and obesity indicators. Measures for these indicators are broad and include presence of legislation, urban design codes, ratio of roads to footpaths, frequency of commuting trips and road injury data. See the full outline in Table 3.

Table 7. From Giles-Corti et al. (2016) - Example of recommended indicators for city planning and population health

Indicator	
Legislation and policies	
Integrated transport and urban planning	Federal and state transport and urban planning legislation requires integrated transport and urban planning actions to create healthy and sustainable cities and regular review of progress
Air pollution	Federal and state air pollution legislation seeks to protect and enhance air quality to promote the health of urban populations
Destination accessibility	Federal and state transport and urban planning legislation requires coordinated planning of transport, employment, land use, and infrastructure that ensures access by public transport
Distribution of employment	Urban planning and design codes require a balanced ratio of jobs to housing (e.g. 0.8–1.2)
Demand management	Urban planning, building codes, and local government policies limit car parking; price parking appropriately for context
Design	Urban design codes create pedestrian-friendly and cycling-friendly neighbourhoods, requiring highly connected street networks (e.g., ped- sheds ≥0.6 within 0.8–1.2 km, particularly within walking distance of shops, services and transport hubs.); pedestrian and cycling infrastructure provision, public open space; lot layouts that maximise natural surveillance
Density	Urban design codes require minimum and maximum context-specific housing densities, including higher density development around activity centres and transport hubs
Distance to public transport	Urban design codes require frequent service public transport to be within 400–800m of residential walkable catchments
Diversity	Urban design codes require a diverse mix of housing types and local destinations needed for daily living
Desirability	Urban design codes incorporate crime prevention through urban design principles, manage traffic exposure[†] and establish urban greening provisions
Government transport investment	
Transport infrastructure investment by mode	Percentage of total government transport expenditure in a given financial year spent on pedestrian infrastructure, cycling infrastructure, public transport and road infrastructure
Urban and transport planning and design interventions	
Public transport access	Percentage population living within 400–800m of high-frequency public transport
Employment	Percentage of population with employment within ≤30 min of their home by walking, cycling, or public transport
Distribution of employment	Jobs to housing ratio
Transport infrastructure	Ratio of roads (km) to footpaths (km) and designated cycle lanes (km)

Indicator	
Density	Dwellings or area within 1.2km of activity centres and public transport hubs, and in urban fringe developments
Distance to transit	Percentage of population living within 400m of a bus stop and 800m of a rail stop.
Destinations	Percentage (urban) land area allocated to destinations required for daily living
Open or green space	Percentage (urban) land area allocated to open or green space
Transport outcomes	
Trip mode share	Proportion of total and commuting trips made by walking, cycling, public transport and private motor vehicle
Risk exposure outcomes	
Road trauma	Road death and injury rate expressed as the number of cases per 100,000 population; proportion of road injuries and deaths involving pedestrians and cyclists
Respiratory conditions	Number of respiratory-related hospital admission cases per 100,000 population
Physical activity	Prevalence of insufficient physical activity, expressed as a percentage of adults, adolescents, and children who are physically inactive
Diet	Prevalence of adults, adolescents, and children consuming ≥5 servings of fruit and vegetables a day
Obesity	Percentage of adult, adolescent, and child population classified as overweight or obese

Secondly, another recent significant report by Giles-Corti et al. (2020) considered the United Nations Sustainable Development Goals (SDG) and evaluated the indicators proposed to work towards healthy and sustainable cities. Limitations of the current SDG indicators included that the reporting is on outcomes only and does not include policy or interventions. The authors note, however, that the UN Habitat Framework includes intervention indicators but does not report on health outcomes. There remains an absence of heat and or shade indicators even in these broad international indicators. The SDG indicators link to each of the SDG goals. The methods used for measuring each of the indicators include proportion measures, total sums, expenditure, ratios (e.g. land consumption), length of travel network, time for travel, economic density, street intersection density, land allocated to streets, residential density, open space 'share' proportions, land use mix, passenger freight volumes, access to services, emissions, crime victims, prevalence of food insecurity (using a sub scale), drinking water and sanitation (Giles-Corti et al., 2020; United Nations, 2020).

Thirdly, in a large country-wide approach, several Canadian research, practice and policy organisations have formed the Canadian Urban Environmental Health Research Consortium (CANUE). The purpose of CANUE is to identify existing data sets across Canada relating to urban planning and public health to enable cross correlation of urban, environment and health data to guide further national action to improve health and social outcomes. This approach broadly uses existing data sets collected routinely by Government and other sectors on environmental activities

along with the regularly collected national and province level health data. This approach enables the creation of big data sets to optimise urban planning and benefit public health. The Consortium is using six domains of existing environmental data across air pollution, noise, greenness, weather and climate, transportation, and neighbourhood factors and attributing these to post codes. The post codes will then be linked to routinely collected population health data. The protocol for the Consortium notes that metrics are also planned for walkability and food environments, green space access and function and life-long climate-related exposures based on local climate zones (Brook et al., 2018).

Cerin et al. (2014) aimed to develop multi-site evidence to guide global action for activity-supportive environments. This study reviewed actions across 11 countries in conjunction with the International Physical Activity and Environmental Network. The study combined both individual measures from recruited participants and several neighbourhood measures. These included the walkability scale, (using the NEWS scale reported below) and available data on socio-demographic characteristics. The study identified progress towards a global definition of activity-supporting environments which would be influenced by high levels of perceived land use mix, street connectivity, residential density, aesthetics, pedestrian infrastructure and safety.

Other studies have contributed to research environmental attributes associated with physical activity outcomes. Some studies have investigated relevant state policy for walkability and associated measures. This includes the Liveable Neighbourhoods policy guidelines in Perth, Western Australia (WA), which includes requirements and evaluation measures. One section of the policy includes reference to shade from street trees. The guidelines require 'generous canopy' for pedestrian shade and shelter and 'appropriate street trees' to be provided in all streets for pedestrian shelter on footpaths. These are evaluated by objective metrics of:

- Tree density along footpaths: % number of trees along footpaths (within a 5m buffer)
- Length (km) of footpaths within the development
- Tree canopy cover %: area of footpath shaded by tree canopy cover, total footpath area within the development.

It should be noted that the requirement of 'generous' canopy is subjective and there are no guidelines on tree types to accompany the requirements (Hooper et al., 2014; WA Planning Commission, 2009).

A review by Badland et al. (2015) provides a comprehensive assessment of existing urban liveability indicators which relate to the social determinants of health. These determinants were grouped for the study under natural environment, crime and safety, education, employment and income, health and social services, housing, local food and other goods, public open space, social cohesion and local democracy and transport. For these areas, some of the indicators related to quantity and quality measures relating to air quality, water, greenhouse gases, household waste and recycling. In relation to public open space indicators, quantifiable (objective) measures included access and amount of publicly accessible open space. Other indicators noted by the authors were more subjective (Badland et al., 2015).

The importance of healthy built environment metrics complementing urban planning policies and practices has been recognised in a review by Durand et al. (2011). This review used existing research on smart growth planning to identify links with physical activity and obesity. Smart growth planning is defined as "as set of broad principles that provides a framework for making development decisions that result in vibrant, diverse, economically healthy communities which have a strong sense of place' (Durand et al., 2014: e174). These principles (which although USA-based can inform targets and indicators) include:

- Create a range of housing opportunities and choices
- Create walkable neighbourhoods
- Encourage community and stakeholder collaboration
- Foster distinctive, attractive communities with a strong sense of place
- Make development decisions predictable, fair and cost effective
- Mix land uses
- Preserve open space, farmland, natural beauty and critical environmental areas
- Provide a variety of transportation choices
- Strengthen and direct development towards existing communities, and
- Take advantage of compact building design.

A summary of relevant built environment metrics are provided in Table 4. This work is intended to potentially guide any future efforts in developing shade targets, metrics and indicators to be consistent with other built environment efforts.

Table 8. Summary of other relevant research on built environment metrics, measures and indicators.

Author	**Range of metrics**	**Include shade or heat?**	**How are metrics measured**
Badland et al. (2017)	Aimed to inform transport walking. Policies addressed across Australia to identify metrics of ease of walking for transport. Metrics included average block area, dwelling density, land use, mix and diversity, access to activity centres.	No	Study noted not all policies had included metrics for 'how much' and 'where'. Purpose of study was to identify spatial measures for metrics.
Badland et al. (2014)	Existing urban liveability indicators which related to the social determinants of health. These determinants were grouped for the study under natural environment, crime and safety, education, employment and income, health and social services, housing, local food and other goods, public open space, social cohesion and local democracy and transport.	No	Objective and subjective measures

Author	Range of metrics	Include shade or heat?	How are metrics measured
Brook et al. (2018)	This is a protocol paper for the methods to acquire, develop and index exposure data; along with examples of how to generate big data to optimise urban planning and benefit public health. Six domains of metrics include air pollution, noise, greenness, weather and climate, transportation and neighbourhood factors.	No, however heat is included and measures for UHI effect.	Range of sources from multiple data sets
Cerin et al. (2014)	Review aimed to develop multi-site evidence for activity-supportive environments. Study based on perceived environmental attributes with objectively measured physical activity outcomes. Study identified 10 perceived neighbourhood attributes to be associated with positive physical activity. Aesthetics and land use mix were significant predictors of both physical activity outcomes in the fully adjusted models	No	Used the Neighbourhood Environment Walkability Scale (NEWS and NEWS-A)
Cerin et al. (2019)	Aimed to develop the youth version of NEWS scale to form the NEWS-Y subscales: Accessibility and walking facilities; Traffic safety; Pedestrian infrastructure and safety; Safety from crime; and Aesthetics	No	Mix of scales including 4-5 point Likert and rating scales; proximity to services from residence; composite indexes created by combining some scales e.g. dwelling density, street intersection density and land use mix
Downs et al. (2020)	Aimed to develop metrics for sustainable food environments. To inform this, the paper outlines the definition of a sustainable food environments framework, typology and methodological toolbox to inform the development of objective and subjective measures.	No	Literature informs criteria for the development of metric - both for the external food environment and individual level factors.

Author	Range of metrics	Include shade or heat?	How are metrics measured
Durand et al. (2011)	Five of the ten smart growth factors (diverse housing types, mixed land use, housing density, compact development patterns and levels of open space) were associated with increased levels of physical activity. The full ten factors are: 1. Create range of housing opportunities and choices 2. Create walkable neighbourhoods 3. Encourage community and stakeholder collaboration 4. Foster distinctive, attractive communities with a strong sense of place 5. Make development decisions predictable, fair and cost effective 6. Mix land uses 7. Preserve open space, farmland, natural beauty and critical environmental areas 8. Provide a variety of transportation Choices 9. Strengthen and direct development towards existing communities 10. Take advantage of compact building design.	No	Not reported
Giles-Corti et al. (2020)	Study notes that SDG indicators report on outcomes and not policy or interventions; UN Habitat framework includes intervention indicators but not health outcomes.	No	Proportion measures, total sums, expenditure, ratios (e.g. land consumption), length of travel network; time for travel, economic density, street interception density, land allocated to streets, residential density, open space 'share', proportions, land use mix, passenger freight volumes, access to services, emissions, crime victims, prevalence of food insecurity (using a sub scale), drinking water and sanitation.

Author	Range of metrics	Include shade or heat?	How are metrics measured
Giles-Corti et al. (2016)	Legislation and policies Integrated transport and urban planning Air pollution Destination accessibility Distribution of employment Demand management Design Density Distance to public transport Diversity Desirability Government transport investment Transport infrastructure investment by mode Urban and transport planning and design interventions Public transport access Employment Distribution of employment Transport infrastructure Density Distance to transit Destinations Open or green space Transport outcomes Trip mode share Risk exposure outcomes Road trauma Respiratory conditions Physical activity Diet Obesity	Open or green space and mentions UHI effects could be reduced to achieve better health outcomes	Federal and State legislation requires integrated transport and urban planning actions: to create healthy and sustainable cities and regular review of progress; to protect and enhance air quality to promote the health of urban populations; to allow for coordinated planning of transport, employment, land use, and infrastructure that ensures access by public transport. **Urban design codes** • Create pedestrian-friendly and cycling-friendly neighbourhoods, requiring highly connected street networks (e.g., ped sheds within 0.8–1.2km); pedestrian and cycling infrastructure provision; public open space; lot layouts that maximise natural surveillance. • Require frequent service public transport to be within 400–800m of residential walkable catchments. • Incorporate crime prevention through urban design principles, manage traffic exposure and establish urban greening provisions. **Percentage metrics** • Percentage of total government transport expenditure in a given financial year spent on pedestrian infrastructure, cycling infrastructure, public transport, and road infrastructure. • Percentage population living within 400–800m of high-frequency public transport. Percentage of population with employment within ≤30 min of their home by walking, cycling, or public transport. • Ratio of roads (km) to footpaths (km) and designated cycle lanes (km). • Dwellings or area within 1·2 km of activity centres and public transport hubs, and in urban fringe developments.

Author	Range of metrics	Include shade or heat?	How are metrics measured
			• Percentage of population living within 400m of a bus stop and 800m of a rail stop. • Percentage (urban) land area allocated to destinations required for daily living. • Percentage (urban) land area allocated to open or green space.
Gunn et al. (2017)	Three domains: community design, movement network, and lot layout. Features found to encourage walking include high street connectivity, high destination diversity, and high residential density.	No	Distance thresholds using GIS mapping
Hall & Ram (2018)	Walk Score is an index which assesses walking potential. It is based on the elements of distance to pre-selected locations; the length of the block and the interception density.	No	This study showed use of Walk Score is inconsistent and rarely relied on as a sole measure of walkability. The Index is owned by a private company of the same name. Walk Score consists of software where the locality is entered and the underlying algorithm assesses walkability.
Hooper et al. (2014)	Study evaluated the Liveable Neighbourhoods Guidelines in WA. These guidelines include shade in terms of presence of street trees. The guideline states 'generous canopy' for pedestrian shade and shelter and 'appropriate street trees should be provided in all streets for pedestrian shelter' on footpaths.	Yes	Evaluation measures for trees are: Tree density along footpaths = number of trees along footpaths (within a 5-m buffer), length (km) of footpaths within the development. Tree canopy covers = area of footpath shaded by tree canopy cover divided by total footpath area within the development.
Hooper et al. (2015)	Article notes the dearth of 'what type' and 'how much' information for healthy built environments.	Yes	Includes same tree metrics as WA Liveable Neighbourhood Guidelines (Western Australia Planning Commission, 2009); notes quality design contributes to walkable and enjoyable neighbourhoods including trees for heat control and

Author	Range of metrics	Include shade or heat?	How are metrics measured
			shade.
Lanza et al. (2021)	Explored correlations between transport authority boardings data, air temperature data and aerial measures of trees from the US National Agriculture Imagery Program.	Yes	Correlations between existing data.
McCormack et al. (2021)	Used a measure of Space Syntax to build on usual walkability metrics which measured distance and added topography and 'number of turns' for connectivity to local services and amenities.	No	Applied to assist with urban planning and policy.
Meyer et al. (2015)	Links between fast food availability, built environment metrics and individual level data from a longitudinal study.	No	Built environments with GIS mapping; geo coding of food and supermarket listings.
Ding et al. (2019)	The interactive index is based on four objectives of outdoor thermal comfort, health risks, energy demand and water demand. The index enables selection of Australian climate regions and urban context.	Heat	Includes tree canopy percentage.
Pakzad & Osmond (2016)	Paper informs development of indicators for green infrastructure performance.	Heat	Range of performance indicators across Ecological, health, socio-cultural and economic indicators.

Other metrics not related to walkability and physical activity

To inform the development of potential metrics, indices and / or measures for shade, it is also useful to consider the informative work undertaken for other social and health issues. The sustainable food sector is also a new area needing measures and indices. As such the work of Downs et al. (2020) is pertinent to consider, in terms of how foreground work to developing such metrics is undertaken.

This work undertook to:

a) Develop a definition of sustainable food environments framework
b) Explore the typology of sustainable food
c) Create a methodological toolbox to inform the development of objective and subjective measures

To do this, an extensive scientific review was undertaken and combined with broad stakeholder consultation and consensus.

Like walkability, indicators for liveability have been well researched. The culmination of this research has informed the development of the Australian Urban Observatory (AUO), based at the Centre for Urban Research at the Royal Melbourne Institute of Technology (RMIT) in Melbourne (AUO, 2020). The online observatory measures seven domains across:

- Social infrastructure
- Transport
- Food
- Alcohol
- Public open space
- Employment
- Housing.

In relation to shade for skin cancer prevention, and in particular playground spaces, the public open space domain would appear the most relevant. However, whilst the domain descriptor mentions cooling, the public open space measures do not relate to shade.

Building on these combined urban planning and liveability indices metrics to include a more specific measure for shade could make the index more comprehensive (AUO, 2020). Additionally, the Urban Liveability Checklist developed by the Healthy Liveable Communities National Health and Medical Research Council (NHMRC) Centre for Research Excellence outlines a series of domains for healthy communities. Whilst shade is notably absent, this again gives rise to opportunity to incorporate shade targets with existing work in liveable communities. The checklist provides domains for walkability, public transport, education facilities, employment, food, housing and open space (Badland et al., 2019).

Recent work from Western Sydney University on Healthy Placemaking after COVID-19 may also give rise to momentum and collaboration for shade targets. In this work, green infrastructure and open space remains a priority. Recent workshop outcomes note that the definitions and understanding of healthy places and environments remain unclear and highlighted opportunities for enhanced collaboration (Morrison et al., 2020).

1.6 Policies and guidelines for shade

The scientific literature is scant in its inclusion of shade targets, measures and metrics. An overview of relevant policy and guidelines documents is outlined here. Whilst specific targets and metrics are notably absent, the overview provides a launchpad for future work to potentially develop such

targets, indicators and metrics for shade in NSW. In the absence of any robust examples of policies which provide strong evidence for targets for shade, a selection of relevant examples to guide future work are provided in the table below.

Table 9. Overview of policies with shade reference and targets

Source	Year	Relevance of shade in policy	Relation to targets
Canada			
Shade Guidelines City of Toronto https://www.toronto.ca/wp-content/uploads/2019/08/8ecf-AODA_Shade_Guidelines_2010_Final_Report-002.pdf	2010	• Guidelines intended to assist with implementation of the City of Toronto Shade policy.	• No specific targets outlined
Policy for the provision of shade at parks, forestry and recreation sites Toronto, Canada https://www.toronto.ca/legdocs/mmis/2008/pe/bgrd/backgroundfile-10540.pdf	2007	• Policy provides overarching commitment to shade in parks, forestry and recreation sites	• No targets mentioned
United Kingdom			
National Institute for Health and Care Excellence (NICE) https://www.nice.org.uk/	2011	• Skin cancer prevention guidelines cover all aspects of primary prevention. • The guidelines include a specific section on shade recommendations	Recommendation 6: Providing shade • Who should take action? Architects, designers, developers, planners and employers. • What action should they take? When designing and constructing new buildings, consider providing areas of shade created either artificially or naturally (for example, by trees). When developing or redeveloping communal outdoor areas, check whether it is feasible to provide areas of shade. Shade could be created by constructing a specific structure or by planting trees. For all new developments, ensure there is adequate access to areas of shade for people with a disability. • Note: the guidelines state there are no recommendations for the addition of shade structures to existing buildings as these were found to be not cost effective. •

Australian Capital Territory (ACT)			
ACT Government Design Standards for Urban Infrastructure Playgrounds and Playground Equipment, Australia https://www.cityservices.act.gov.au/__data/assets/pdf_file/0012/396876/ds15_playgrounds.pdf	n.d: "Edition 1, Rev 0"	• Sun/shade protection, other climatic factors and tree location defined. • References siting of trees and playground equipment, noting location warning for tree species that drop branches	
Queensland			
Scenic Rim Regional Council Playground Strategy, Australia https://www.scenicrim.qld.gov.au/downloads/file/2230/playground-strategy	2019	• Provide at least 50-75% shade over play equipment • Min. 50% by shade sails + balance by trees • Tree planting to provide min. 50% over play equipment & seating. • Additional metrics regarding mature trees and additional trees to increase cover to greater than 50% • Seating with min. 50% shade and 1-2 standard park seats.	• 50 – 75% of playground area shaded.
New South Wales (NSW)			
Sydney 2050, Australia https://www.greater.sydney/metropolis-of-three-cities	2019	• Reviewing the Sustainable Sydney Strategy 2030 and developing Sydney 2050. • Consultation closed 2019 and was based around four areas of Shared Spaces, A resources efficient City, A natural city and Moving around the city.	• Sydney 2050 data stories link to data hub and overall targets. • Grow our green canopy cover by 50% by 2030.
Government Architect NSW (GANSW): Draft Greener Places Design Guide https://www.governmentarchitect.nsw.gov.au/resources/ga/media/files/ga/discussion-papers/greener-places-discussion-draft-2017-11.pdf	2020		• Specifies 50% - 80% natural or built shade for very young and Local children's play and older children's activity space (p57) and youth recreation space; Local recreation space and Active recreation space (p58); • Large community outdoor recreation area; Fitness and exercise space; and Trail and path-based recreation (p59); • Organised sport and recreation outlines "Good solar access but with a

			preferred 40% shade cover for "off-field" perimeter areas" (p60). • Only Active recreation space and Dog exercise area notes that shade should be co-located with water for drinking, seats and toilets.
Greening our City, Premier's Priority, Deptment of Planning, Industry and Environment (DPIE) https://www.nsw.gov.au/premiers-priorities/greener-public-spaces	nd	• 5 million trees commitment great public spaces: mentioning walkable shady streets parks for people • Guide "seeks to help communities, industry, councils and state government take action in creating great public spaces."	• Increase in number of trees; • Tree registration; • Grants for council to enhance urban tree canopy and green cover (stream 1: cooler suburbs by boosting tree planting, stream 2: green innovations and scalable solutions to overcome barriers to tree planting)
Great Public Spaces Guide, Dept of Planning, Industry & Environment. https://www.dpie.nsw.gov.au/__data/assets/pdf_file/0008/357506/final-great-public-spaces-guide-english-march-2021.pdf	Draft for comment 2021	• Evaluation encourages citizen science approach • Links to Great Public Spaces toolkit	• No specific targets outlined. The four evaluation criteria of a Great public place are "Am I able to get there? Am I able to play and participate? Am I able to connect? Am I able to stay? • The 'stay' criteria includes as an idea to achieve "Comfortable places to sit in the sun or shade" and "Landscaped with trees and plants." • Evaluation asks for rating of public space for improving quality • Tick box option for presence of trees/plants • Options include: Can people sit in shade or sun? Does public space have enough grass, trees, plants?
Urban Forest Strategy, Melbourne, Australia https://www.melbourne.vic.gov.au/community/greening-the-city/urban-forest/Pages/urban-forest-strategy.aspx	2012	• Tree canopy targets from 22% to 40% by 2040	• Sets clear metrics with yearly requirements measured by Urban Forest Visual map • http://melbourneurbanforestvisual.com.au/
"Everyone can play Guideline" NSW Government http://www.planning.nsw.gov.au/everyonecanplay	2019	• "Can I get there? Can I Play? Can I Stay?": An inclusive strategy for playspace environments • Playspace evaluation checklist for new and existing playspaces including principles & goals for universal design.	• Principles for inclusive design for playspaces, no specific shade targets included. "Adequate amount of shade to cover play activities (pp. 25, 60)." • Checklist suggests inclusion of both built and tree shade (p. 69).

GANSW "Better Placed" https://www.governmentarchitect.nsw.gov.au/policies/better-placed		• Integrated design policy documents for built environment of NSW. "Good design makes better places (p.6)". Higher level holistic strategic advice, seven objectives defining design.	• No shade targets included.
GANSW Design Guide for Schools https://www.governmentarchitect.nsw.gov.au/guidance/schools	2018 issue no.02	• Accompanies State Environmental Planning Policy SEPP 2017 & lists 7 design quality principles, no.4 includes "provide covered areas for protection from sun and rain".	• No shade targets included.
GANSW Environmental Design Guide in Schools Manual https://www.governmentarchitect.nsw.gov.au/guidance/schools	2018 issue no.01	• Design manual to provide holistic understanding of environmental design	• No shade targets included. Natural and built shade encouraged as passive design elements for buildings including covered outdoor learning areas (COLAs)
Gosford urban design framework, Australia https://www.governmentarchitect.nsw.gov.au/resources/ga/media/files/ga/other/gosford-urban-design-framework-2018-10.pdf	2018	• Provide green infrastructure including creation of new green spaces, linkages, street tree and urban canopy projects.	• No specific shade targets included.
Lismore community sun protection policy. https://lismore.nsw.gov.au/files/Community_Sun_Protection_Policy.pdf	1997	• All playground equipment and supervision areas to have minimum natural shade. • Preferred constructed shade over all (100% shade) equipment. • 40% of ground shaded by natural and constructed shade • Specific targets included for other outdoor public facilities	• Specific shade targets included.
Newcastle Playgrounds Plan of Management https://newcastle.nsw.gov.au/getmedia/d9efe6d5-656d-4a4b-baee-	2003	• Section 3.5 Shade • current site planning for playgrounds to include provision for shade and shelter with mature trees, new trees or shade structures close to equipment. No inclusion for retrofitting existing	• No specific shade targets included.

b4e3c287f511/Playgrounds_Plan_of_Management		playgrounds which lack shade however acknowledges there are older playgrounds.	
Blacktown city Council https://www.blacktown.nsw.gov.au/Community/Sustainable-living/More-canopy-more-cooling	nd	• "more canopy, more cooling" successful NSW grant 5 million trees for Greater Sydney • "planting more trees near playgrounds" • plant more trees along streets, parks and increase canopy cover over city	• No specific shade targets mentioned
Blacktown City Council Local Strategic Planning Statement 2020 https://www.blacktown.nsw.gov.au/Plan-build/Planning-for-the-growth-of-our-City/Blacktown-Local-Strategic-Planning-Statement-2020/North-West-Growth-Area	2020	Recreation and Open Space strategy 2018: reviewing to improve and incorporate "Everyone can play" guidelines • Planning priorities and actions • Valuing green spaces and landscape (ref D8) • Improved tree canopy, green grid connections under sustainability provisions for precincts (ref C16) • Tree canopy currently covers 19% of city (p. 72) • Diminished amenity and quality of walking environments • Increase canopy cover to increase shade and connection into Greater Sydney green grid (NSW Government's target of 40% canopy cover).	• "Increasing urban tree canopy cover and delivering green grid connections" p.28
Sutherland Shire Council https://www.sutherlandshire.nsw.gov.au/Development/Local-Strategic-Planning-Statement	2020	• Planning priority 8: Embellish existing parks for more extensive and varied use with "a seat in the shade, opportunities for incidental play for all ages, exercise" (p.48) • Action 8.1 under Liveability: Develop a demand management plan for playgrounds	• No specific shade targets included.
Lane Cove Council Open Space plan https://ecouncil.lanecove.nsw.gov.au/TRIM/documents_	2016	• Survey of open space included playgrounds (p. 23). • Action included to "plant shade trees or install sun	• No specific shade targets included.

TE/224442915/TRIM_Final%20%20Open%20Space%20Plan%20Adopted%2015%20August%202016%20Ordinary%20Council%20Meeting_1103110.PDF		shades and shelters to protect members of the community from the elements" • Survey of residents indicated a mean satisfaction rating for playgrounds of 3.4/5.	
Bega Valley Shire Council Community Strategic plan		• Community survey responses included: safer fenced playgrounds (p. 88) and incorporated into natural environments. Request for more shaded park areas, bigger parks, improved amenities	• No specific shade targets included.

1.7 Conclusion

This review has provided an overview of evidence, guidelines and practice in relation to the investigation of targets for shade and heat control. The review has identified a limited but useful range of scientific articles investigating how shade is used, measured and reported in public settings and how shade relates to other build environment design considerations.

This review has found an absence of targets, indicators and agreed measures or metrics for shade. There is a strong theme in the literature of the importance of shade in public spaces such as playgrounds and the integral nature of useability for both passive and active recreation. While there is consensus on the effectiveness of onsite and virtual shade measures to help track quality and quantity over large geographic regions, there are strong calls for greater collaborative action to create metrics and measures. This review has further provided an overview of opportunities to incorporate shade in existing metrics and indicators for healthy built environments and liveability. The review noted an absence of shade as a measure in existing examples, particularly in strategic planning documents. However, there is potential for developments in these areas to incorporate shade measures and advocate for inclusion of specific measures in policy and guideline documents. There are opportunities for best practice examples of how to implement shade strategies both for retrofitting existing playgrounds and for the design and delivery of new playgrounds.

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