Exploring early childhood playground design as a strategy for obesity prevention

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ABSTRACT: Increasing physical activity is a crucial preventive strategy to develop young children’s health habits across their lifespan. Participation in physical activity, particularly among children, not only reduces obesity but also contributes to the prevention of chronic diseases. One way of establishing early habits of physical activity is by increasing active play in preschool children. Limited evidence exists at the preschool level on young children’s use of pre-school playgrounds, and even less on seasonal variation of play. This pilot study aimed to map activity levels of three to five-year olds in a pre-school playground in order to identify physical activity levels undertaken in the outdoor play areas and how these physical activities varied across seasons. The findings indicate a variation in play patterns and activity levels in different seasons and highlight the need for a larger research study that examines this phenomenon in more diverse contexts. More importantly, the findings suggest the need for appropriate methodologies that can best capture data for examining the relationship between the physical environment of pre-school playgrounds and improved physical activity outcomes in young children.

Keywords: Playground design, child obesity, active play, seasonal variation

Introduction

The prevalence of obesity and overweight has dramatically increased in Australia in the last 30 years. The rise in obesity in children is associated with reduced daily physical activity levels, modes of travel and consumption of high kilojoule foods (ANPHA, 2014). It is recommended that three to five-year olds (toddlers and pre-schoolers) accumulate at least 3 three hours of physical activity (light, moderate or vigorous) and avoid more than one hour of “screen time” each day (Australian Government, 2014). Yet national data derived from parents has revealed that over a quarter of Australian children aged 2–4 years are not meeting recommended physical activity levels and are exceeding sedentary behaviour screen time guidelines (Active Healthy Kids Australia, 2016). Since most children in the three to five-years age group attend preschool for at least 15 hours per week, pre-school settings present a unique opportunity to increase physical activity levels in this age group (Wolfenden et al., 2011). Establishing early physical activity habits is critical in preventing the onset of disease later in life.

Outdoor play areas in preschools provide space and can facilitate physical activities. Several studies have examined how outdoor physical environmental factors influence levels of physical activity in young children (Cosco, Moore, & Islam, 2010; Dyment & O’Connell, 2013; Gray et al., 2015; Herrington & Brussoni, 2015). In particular, the introduction of
different ground surfaces, looped pathways, the presence of game equipment and the provision of movable play equipment can all have positive influences on young children’s health, risky play and motor development. (Fjørtoft, 2001; Pate, 2004).

In order to positively influence levels of outdoor physical activity in preschool children, it is important to examine associations between outdoor design and the active play of children. Additionally, outdoor play areas are likely to be affected in the future, following the prediction of rising outdoor temperatures (B. Hyndman, 2017). Consequently there is a need to investigate the design of appropriate outdoor play areas that facilitate increased physical activity levels as well as retaining comfortable conditions.

**Playground guidelines**

The playground equipment standards in different Australian states and territories give considerable attention to the safety requirements of play equipment. The guidelines control the sitting, layout and design of play equipment and specify impact-absorbing surface materials, the heights of equipment, maximum fall heights, the hazards to be avoided in play equipment material, as well as the materials to be used in their construction (ACT Government, 2016; Australia, 2004; Kid Safe NT, 2016; Kidsafe WA). These guidelines vary within different states and territories but, overall, they are designed to eliminate hazards and reduce the risks of playground injuries. The policy makers and educators also have to be mindful of the Sun Smart guidelines for outdoor play for children. The Sun Smart policies are designed to reduce harmful exposure to ultraviolet (UV) radiation to minimise the risk of skin and eye damage, sunburn and eventual skin cancer (Dudley et al., 2015).

Pre-school experts are realising the need for physical changes in outdoor play areas and are involving architects and play equipment vendors in the design of outdoor play areas and equipment. However, as Dyment & O’Connell (2013) argue, these professionals are unable to deliver appropriate designs because evidence-based design guidelines are lacking. The quality assessment scales used for licensing are available, but they deal almost exclusively with indoor environments and provide limited guidelines for outdoor spaces, hence containing insufficient guidance for outdoor design (Moore, Sugiyama, & O’Donnell, 2003). Furthermore, when creating playgrounds, the designers are constrained by issues of budget, safety regulations and the space available (B. Hyndman, Telford, Finch, & Benson, 2012; B. P. Hyndman & Telford, 2015).
To improve health outcomes in young children, evidence-based design guidelines are vital for the design of pre-school outdoor play areas. As there is currently minimal data on the influence of playground design in early childhood settings, such as pre-schools, this pilot study aims to examine the physical activity levels undertaken in different outdoor pre-school playground settings and how such activities vary across seasons.

**Theory of Affordances**

The theory supporting the approach taken in this research is ‘Affordance theory’ by J.J Gibson, an American psychologist (Gibson 1986). It is used to understand the play settings and the level of activities they allow. According to the affordance theory, the *perception* of the environment inevitably leads to resultant courses of action. It explains that the environment is perceived by individuals as an invitation to particular behaviours and possibilities for action (Gibson, 1986). It has various implications for design because design can make affordances explicit.

This theory was further developed by Heft (1988), who proposed that children perceive the properties of their physical environment and adapt their actions according to their capabilities, such as their competence or strength. Herrington et al. (2015) advanced seven criteria for examining the affordances for outdoor play for toddlers and pre-schoolers in outdoor play spaces. These were character, context, connectivity, change, chance, clarity and challenge. These affordances were used to guide the design of outdoor play spaces. For this research, affordance theory not only allows examination of different play settings within pre-school playgrounds but also how the play settings lend themselves to active play across different seasons.

**Method**

A preschool was selected in central Australian town of Alice Springs. Alice Springs has an arid climate with low rainfall, hot summers and cold winters. Climate projections indicate that the annual number of hot days is likely to increase due to future climatic changes. For example, the annual average number of days over 40 °C in Alice Springs is likely to by nearly double by 2030 and nearly triple by 2090, even under a medium greenhouse gas emissions scenario (Watterson, 2015). Thus choosing a school in Alice Springs provided a good case study to explore preschool physical activity under extreme hot and cold, yet dry, conditions.
On different days, two groups of children attended the preschool selected for our case study. The group with the more equal distribution of boys and girls was selected. The study received ethics approval from the researchers’ institution and the Northern Territory Department of Education. The preschool staff were presented with an overview of the proposed study. All parents of the chosen group were invited to give consent for their child to participate in this study.

The following data was collected:

1. On-site observation and videoing of outdoor play for 30 minutes. This was conducted three times in winter, spring and summer.
2. Measurement of height and weight of the pre-schoolers
3. Parental survey

Outdoor play observation and videoing data

Several direct observation systems are available for coding children’s physical activity such as OSPRAC-P, EPAO and SOPLAY. The Observational System for Recording Physical Activity in Children- Preschool (OSRAC-P) is a direct observational system designed to collect information about children’s physical activity and behavioural and contextual circumstances (Dowda et al., 2009). However a single child serves as the focus of observation in this system. The Environment and Policy Assessment and Observation (EPAO) evaluates the environmental, nutritional and physical activity intervention in child care (Bower et al., 2008). The System for Observing Play and Leisure Activity in Youth (SOPLAY) was used to assess the physical activity levels in predefined school playground settings (McKenzie, 2002). SOPLAY was selected as the method for data collection as it allowed measuring activity in different play areas within the school playground for a number of participants when their physical activity changed frequently.

The SOPLAY observational procedure uses a momentary time sampling technique which records systematic and periodic scans of individuals’ physical activity intensities, activity types and contextual factors within pre-determined target areas. During a scan the
activity of each individual is manually or electronically coded as Sedentary (lying down, sitting, or standing), Walking or Very Active (jogging, sprinting, skipping and climbing)” (McKenzie, 2002). Other technical details, such as the type of surfaces and details of the play area types were also recorded. The collection of the SOPLAY data allows for physical activity level comparisons to be made between the different play settings, as well as young children’s choice of play settings at different observed time periods.

Our field notes complemented the SOPLAY mapping instruments by recording what could be seen, heard, experienced and thought of during the children’s engagement with the play equipment (Bogdan & Biklen, 1998). Video cameras captured each defined target area within the pre-school playgrounds. The video-facilitated direct observation increased the reliability of direct observation measurement. No indoor observations were conducted during the study. Monitoring was conducted between 10:30 and 11:00 am during outdoor free play time during each season. Direct observations were made of the designated target areas that represented all the play locations of the children participating in the various levels of physical activity. The pre-determined areas identified for observation were:

1- Sandpit
2- Bike Path A
3- Bike path B
4- Open Space A
5- Manufactured Play equipment small
6- Manufactured Play equipment large
7- Dramatic play (boat)
8- Trampoline
9- Covered shelters
10- Open Space B

(See figure 5)

The SOPLAY procedure of recording data was conducted where the pre-schoolers’ level of activity was mapped at each play setting six times over a half hour period, generating 60 observations. This data was reduced to calculating mean activity counts to provide a single count for each activity level at each setting during that period.

**Measurement of height and weight of the pre-school children**

Using standardised processes the gender, height and weight of all pre-schoolers was collected and a Body Mass Index calculated (BMI), to identify the number of children not within a healthy weight range. The BMI was calculated using the Center for Disease Control and Prevention (CDC)’s chart; the assumption being that children who are overweight or obese are likely to be less active in the playground (CDC, 2015).

**Parental Survey**
Parents completed a short, written, questionnaire to ascertain the play patterns of children outside of school and the involvement of parents and siblings in organised sport.

**Results**

All 35 parents provided consent for their pre-school children to be observed during their play activities. All the parents (35) were given the parents’ questionnaire and 25 filled forms were returned (response rate=71%).

**Socio-metrics and anthropometrics**

A total of 24% of the pre-schoolers were between 4 and 5 years of age and 76% were aged over 5 years. In this group 48% were girls. It was evident from the survey that none of the children had any disability or health condition that would stop them from playing, since all the parents replied in negative to this question in the survey. The BMI is expressed as a percentile and this is relative to other children of the same sex and age. Table 1 shows the CDC’s guidelines and the weight category status of the students at the preschool (CDC, 2015).

<table>
<thead>
<tr>
<th>Weight status category</th>
<th>Percentile range</th>
<th>Percentage of boys at preschool</th>
<th>Percentage of girls at preschool</th>
</tr>
</thead>
<tbody>
<tr>
<td>Underweight</td>
<td>Less than the 5(^{th}) percentile</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>Normal or healthy weight</td>
<td>5(^{th}) percentile to less than the 85(^{th}) percentile</td>
<td>66</td>
<td>71</td>
</tr>
<tr>
<td>Overweight</td>
<td>85(^{th}) to less than the 95(^{th}) percentile</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>Obese</td>
<td>Equal to or greater than the 95(^{th}) percentile</td>
<td>13</td>
<td>0</td>
</tr>
</tbody>
</table>
**Play pattern of pre-schoolers**

Figure 2: Play settings and level of activity in winter

![Graph showing play settings and level of activity in winter](image)

Figure 3: Play Settings and level of activity in spring

![Graph showing play settings and level of activity in spring](image)
Figures two to four reveal the large variance in play patterns across different seasons. The trampoline play area was used extensively for vigorous level physical activity but was not used at all during the observation periods in the summer months. Similarly, the covered shelters were used by young children for moderate level physical activity in spring but were not used at all in winter or summer. Bike path A & B, manufactured play settings (large and small), the dramatic play area and open area B were predominantly used in one season. The Sandpit and the Open Space A area were the only play spaces which had some level of activity in all seasons, although the intensity level of the physical activity in these areas differed.
**Settings and use across the seasons**

The Sandpit: The sandpit had the highest number of children engaged in sedentary activities in all the three seasons (see figures 2, 3, 4 Setting 1). However, by the very nature of sand play, this setting generated both sedentary and moderate levels of intensity of physical activity participation. In summer, the intensity level of physical activity changed from sitting and digging to playing on a castle and the water hose that were placed there by the preschool educators. This allowed different activities - such as walking, climbing, constructing a moat – all of which were more intense than sedentary behaviour. The sandpit was shielded by a shade cloth, which allowed filtered light through. The height of the shade cloth also permitted direct sunlight in winter, which made this a thermally comfortable place. In summer the shade provided protection from the sun.

![Figure 6: Sandpit and bike path A around it](image1)

![Figure 7: Bike path B, Open Space A and manufactured play equipment small](image2)

Bike Path A: This looped pathway was a small track going around the sandpit and a small green patch. It was not used as much as the central longer looped path, since it was a shorter route was on flat ground and to one edge of the playground. The pre-schoolers were active in this area only in spring and winter (see figures 2, 3 Setting 2). The path was not shaded, which resulted in the children not using it during summer observations.

Bike Path B: This was used more than the smaller bike path (see figure 2, 3, 4 setting 2 & 3 for comparison). Part of it had a sloping surface which was used by children for riding down quickly or for running down with plastic hoops. In winter and spring, the pre-school children would engage in moderate-to-vigorous level activity on the path. The pre-school children would ride their bikes, roll hoops down, or run and walk across the path. This path was not used at all during summer. The path was exposed to sunlight and had no shade in summer or winter. Only the shadow of the play equipment provided any relief from UV rays for the pre-
school children. As a result, the path was more popular in winter, for its full sun exposure, rather than in summer.

Open Space A: This was the central space of the outdoor play area. The bike path B is around Open Space A, so the two spaces work in tandem. In winter, when the children finished riding a bike they would usually step into this sunny space. It had small manufactured play equipment at one end and large manufactured equipment at the other end. The children were constantly crossing this space to get to the next activity. Even though it was not shaded the grass surface did not reflect heat as much as did the paved bike path. It afforded activities in all seasons, whereas other spaces were used in a particular season. It was one of the most used spaces in the playground (see figures 2, 3, 4 setting 4).

Manufactured Play equipment small: This area had a combination of a slide and two swings. The roof was a combination of shade cloth/metal sheet. The ground surface was sand surrounded by a concrete border. The children playing in the Open Space A would occasionally come for a swing but this activity was not sustained for more than 10 minutes. After one or two turns at the slide and swing, the pre-school children moved to another activity. Since the play equipment only afforded two types of activities, the children were inclined to move away after a few turns at the slide and the swings.

Manufactured Play equipment large: This had a slide, a tunnel, a see-saw and space for dramatic play. The structure occupied the central space of the playground. It had a metal roof and the ground surface was artificial turf. It was a cold and dark space in winter. The equipment was used more for moderate intensity levels of physical activity. When the children were between activities they would cross this space and interact with the manufactured equipment by sitting or resting on the seesaw. As with the small manufactured
play equipment, once the children had a couple of turns they moved away to other activities. This facility was used more in summer (see figure 4, setting 6) since it afforded shade.

Dramatic play-boat and a small water spout: This space was the least-used play setting. It was at one end of the playground and was separated by a slope. A boat placed on grass could be used by the children for various activities. However, as is evident from the table, it did not afford much physical activity for the pre-schoolers.

The trampoline: In winter some of the pre-schoolers were continuously on the trampoline for the half an hour that we observed. There was a bit or rumble and tumble and rough play. In spring, the pre-schoolers were there for a shorter time. This could be because the children were there before our observations were being recorded and they might have become tired and moved on to other activities. In summer there often were children on the trampoline but, again, they got off when we started our observations. The trampoline was under the shade of a tree but in summer the vigorous level of physical activity of jumping was often undertaken earlier in the day (mentioned by the educators).

Shelters: There were three covered pavilions- one was used for dress-ups, the second for tables for eating lunch and the third was a shallow pool. The dress-up area was used mainly by girls. The lunch area was not used during our observations, since they were before lunch. The dry pool was used in winter for playing in and in summer months for the children to splash. This area had heavy tree shade and this led to all three spaces being used far less in winter. During spring the dry pool was used for imaginative play. In summer the pool was filled and the children used it for swimming. The data of children swimming could not be
used for ethical reasons since they were changing clothes or were in their swimming costumes.

Open space B-Tunnel, sloping area and tyre swing: This open space was shaded by trees. In winter it was one of the least-used spaces. In spring the activities increased and it generated vigorous level of activities such as running on the sloping ground. In summer, although it was shaded, the activities generated in this area were more sedentary and moderate. The preschoolers were either swinging gently in the tyre swing or just walking and exploring the space. This space was again at the other edge of the playground.

*Play patterns outside school hours*

The parents’ survey showed 44% of children played between 2 to 3 hours outdoors after school. Also 33% of the children had parents playing organised sport and 64% of the preschool children had siblings that played sport. The time that children played outdoors after school can just be taken as anecdotal evidence since this information is based on the perception of the parents and not measured by them.

**Discussion**

Physical activity levels in different seasons, from one selected pre-school, are presented in this pilot study which also trialled the SOPLAY method for gathering data. The preschoolers were observed for half an hour at a time for three times, in winter, spring and summer. This study was a pilot study and a trial of our methodology; several factors were identified that indicate the need for a larger research study.

**SOPLAY method**

SOPLAY was used to capture the physical activity intensity levels and predominant activity types through half an hour snapshots and was combined with field note observations. The
latter assisted the researchers to determine how each of the pre-school playground areas were used by pre-school children. For example, the open space had the highest number of pre-school children engaging in vigorous level activity. Yet SOPLAY alone (without field notes) did not capture whether these children were playing in the open space, or whether they were just using the space to go across from one play setting to another. Also, having a greater level of vigorous level physical activity from the trampoline did not indicate whether several children were using the trampoline at the measurement time-points or whether it was the same group of children who used it for an extended period of time. Nonetheless, SOPLAY provided a strong snapshot into the physical activity patterns within the pre-school playground areas. Being an area-level measure of children’s physical activity, there is also scope to use more individual-level physical activity measurements alongside SOPLAY. This could gauge the level of physical activity of a specific child with particular equipment or within a certain play area. Combining physical activity measures can provide a more comprehensive picture of children’s physical activity participation (B. Hyndman, 2017). The field notes suggested that pre-schoolers were not using any setting (except for the trampoline) at any time for more than 10 minutes. The length of time the children engaged with any activity is important information to gather, since the health guidelines recommend physical activity levels relative to time. Future research could use global positioning systems to gauge the length of time individual children spend engaged in a specific outdoor location.

**Comparable data**

Although three days of data were measured, only one day of data could be used for comparison of physical activity intensity levels and play area engagement. This was because of the variations within the pre-school timetable. Although the observation days were decided in consultation with the pre-school, any changes in activities, school hours or special visits (eg of artists and activity teachers) on the day of observation, impacted the play patterns and energy levels of the children. The pre-school hours for Friday were different from rest of the week, with the school starting and finishing earlier than the other weekdays. Therefore, by the time of our playground observations on Fridays, it is possible that the children had been playing for longer and were tired. A parent also led some children indoors for physical activities during the observation time, which that resulted, in some instances, in fewer children being in the observation zones. Not having comparable data for all three days was a major limitation; yet this study provides pilot data aimed to map activity levels of three to five year olds and provides research and methodological direction for further investigation.
This implies that finding ‘typical’ days for analysis is difficult in a pre-school context, where there can be more informal timetabling structures in place. Recording a week of full day activities in each season has the potential to present a better picture of pre-schoolers’ outdoor play patterns.

Results indicative but not conclusive

Some of these preliminary results indicate great variation in play patterns between winter and summer. In primary schools, children’s enjoyment of school play activities have been reported to be higher earlier in the year (start of autumn) compared to later seasonal time-points (Hyndman, Chancellor & Lester, 2015). More recently, primary school students have been reported to be significantly less physically active when temperatures are above just 22 degrees Celsius (Remmers et al., 2017). Yet little seasonal or weather investigation has been conducted with early childhood participants. Although the Kid Safe guidelines recommend shade for play equipment, this has more to do with the Sun Smart policies of eliminating harmful UV rays (Kid Safe NT, 2016). Comfortable or conducive weather conditions for children in different seasons that encourage active play have not been appropriately considered within school (Hyndman, 2017) or playground equipment guidelines. Bike paths and the trampoline generated vigorous levels of physical activity in winter, yet were not used at all during summer observations. Similarly, the data reflected that the shaded manufactured play equipment was used extensively in summer observations for sedentary, moderate and vigorous level physical activities but was used infrequently by pre-schoolers during our winter observations. Several settings such as the dramatic play area with a boat were used infrequently. By contrast the other open space was commonly used throughout the all seasonal observations. Further research is therefore required into why pre-schoolers neglect some equipment, such as the dramatic play area, and readily engage in other areas. Further research is also necessary to determine how pre-schoolers utilise the play areas at other times during the day. It should be acknowledged that, during warm days, assumptions that the trampoline was unused due to temperature should be applied with caution. It is possible that the children had used the trampoline earlier in the day, when their energy levels were higher.

Therefore, methods to capture a full day of physical activity can aid in capturing a more comprehensive picture of pre-school children’s engagement with playground features for physical activity participation.

Diverse contexts
The pre-school selected was from a middle class neighbourhood and the children came from mostly professional families. The context was therefore sociologically atypical and the findings may be different in low socio-economic contexts. The parental surveys indicated that 44% of children engaged in active play after school. A high percentage of children had parents and siblings that participated in organised sport. In order to get more representative information, there is a need for this study to be conducted across different pre-school contexts. It will be more relevant in contexts where there is higher prevalence of young children experiencing physical inactivity and sedentary behaviour.

**Conclusions**

The pilot study indicates that there is a variation in play in different seasons in play settings such as the trampoline, shaded and unshaded areas. More conclusive results that can inform policy will only be obtained through a larger research study. A future study that includes preschools from varied social-economic contexts is required for more conclusive results. Additionally a longitudinal study, testing seasonal variation as well as collecting in depth comparable data, would present more generalizable findings.

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