Landscapes for play: Effects of an intervention to promote nature-based risky play in early childhood centres

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Abstract

The outdoor space at childcare centres can be many preschoolers’ primary experience of outdoor play. Trends prioritizing risk reduction have diminished access to nature and risky play. We examined the effects of an intervention to increase opportunities for nature and risky play in the outdoor play environments of two childcare centres using a repeated measures mixed methods design. We used the Seven Cs play space design criteria, adding natural materials to enhance affordances for play. We measured changes in play, social behaviour, psychological wellbeing, and physical activity in 45 children aged 2 to 5. Findings indicated significant decreases in depressed affect, antisocial behaviour and moderate to vigorous physical activity, and increases in play with natural materials, independent play, and prosocial behaviours. Early Childhood Educators observed improved socialization, problem-solving, focus, self-regulation, creativity and self-confidence, and reduced stress, boredom and injury. Outdoor play spaces are important for promoting children’s wellbeing and development.

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1. Introduction

High quality early childhood education supports child development and can attenuate the impact of social disadvantage (Lo et al., 2017). Attending childcare centres is the norm for preschoolers worldwide (OECD, 2016), including 60% of Canadian children (Sinha, 2014). While outdoor play spaces of childcare centres have received little attention, their quality can influence children’s development and wellbeing, particularly since these can be the only outdoor play space children experience daily (Copeland, Khoury, & Kalkwarf, 2015; Cosco, Moore, & Smith, 2014).

Risk taking in play is fundamental to children’s exploration and understanding of the world (Smith, 1998; Sutton-Smith, 2001). Risky play is thrilling play involving uncertainty and includes six categories: play at speed, at height, with dangerous tools (e.g., hammers, saws), near dangerous elements (e.g., fire, water), rough and tumble play, and play where there is a chance of getting lost (Sandseter, 2007). A systematic review found that risky outdoor play was positively associated with physical activity and social health, and negatively associated with sedentary behaviours (Brussoni et al., 2015). Other research indicates associations with risk management, self-confidence, mental health, and independence (Hüttenmoser, 1995; Lavrysen et al., 2015; Sandseter & Kennair, 2011). Despite these benefits and little evidence that risky play increases likelihood of injury (Brussoni et al., 2015), it is increasingly restricted due to perceived safety concerns (Wyver et al., 2009).

Many childcare centres struggle with providing stimulating outdoor play environments due to limited resources and safety/liability concerns (Wyver et al., 2009). The focus on risk reduction has resulted in more homogeneous outdoor play spaces with prefabricated equipment, limited natural materials and increasing limits on risky play (Herrington & Nicholls, 2007; Woolley & Lowe, 2013; Wyver et al., 2009). Children attending childcare centres and schools with play spaces containing more natural materials, and physical and cognitive challenges experience more positive social relationships, happiness and increased physical activity (Cosco et al., 2014; Farmer et al., 2017; Herrington & Lesmeister, 2006; Pivik, Herrington, & Gummerum, 2011).

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2. Theory and research on optimal play environments

Environments and their features can be described according to the possibilities they afford for action (Gibson, 1979). Affordances vary depending on users, such that grassy fields may afford running for some children but not others with mobility impairments. Evidence favours providing versatile play environments that maximize affordances allowing children to play as they choose, including taking risks (Herrington, 1997; Sargisson & McLean, 2012; Woolley & Lowe, 2013). Affordance-rich environments support play opportunities for diverse children (e.g., differentially-abled or less socially skilled children) and help reduce gendered play (Barbour, 1999; Dyment & Bell, 2008). Less socially dominant children have higher rates of depressive symptoms, display less prosocial behaviour and less positive peer relationships (Boye et al., 2012). Thus, interventions that promote affordances may help shift children’s social hierarchies and ultimately influence their mental and physical health (Bundy et al., 2011; Herrington & Brussoni, 2015).

Natural play environments contain natural elements (e.g., plants, sand, water) as sources of play. Play in these settings is more complex, diverse and of longer duration than in equipment-based playgrounds (Luchs & Fikus, 2013; Samborski, 2010). Furthermore, ongoing and repeated exposure to nature benefits physical activity, emotion regulation, social development and readiness for learning (Gill, 2014; Gray et al., 2015; Thompson, Oliveira, Wheeler, Depledge, & van den Bosch, 2016). A greater dose of nature is associated with more benefits (Shanahan et al., 2016). Childcare centres are ideal venues for inclusion of nature given children’s daily access.

Seven Cs criteria for outdoor play space design (character, context, connectivity, clarity change, chance, and challenge) prioritize use of natural materials. The highest-quality play spaces are: scaled to the child, sensitive to climate, include living materials and elements that children can manipulate (e.g., water, mud, loose parts), and spaces for individual and group play (Herrington, Lesmeister, Nicholls, & Stefenu, 2007; see Appendix for Seven Cs characteristics). These characteristics promote affordances for play, increasing flexibility to allow children’s imagination to shape play. Seven Cs have been used internationally to design children’s play spaces and child-friendly neighbourhoods (Herrington & Studtmann, 1998; Herrington, 2012; Larcombe, 2010; Mountain, 2014; Sajadi & Khoshnesi, 2016).

This study is the first to investigate the effects of natural risky play environments on children’s health and wellbeing. We examined the effects of a Seven Cs design intervention to increase access to nature and risky outdoor play opportunities in two childcare centres on children’s play, social behaviours, mental health and physical activity.

3. Material and methods

Reported below are all measures, conditions, and data exclusions for our study.

3.1. Participants and settings

We used a convergent mixed methods repeated measures design to examine the effect of the intervention (Fig. 1) (Creswell, 2016). Data were collected at Time 1 (T1; February–April 2014) pre-intervention and Time 2 (T2; May–July 2014) two-weeks after the Seven Cs intervention to decrease the effects of novelty. Children aged 2–5 years and the Early Childhood Educators (ECEs) at two childcare centres in Vancouver, Canada participated. The centres’ outdoor play spaces scored lowest on the Seven Cs among 16 centres participating in previous research (Herrington et al., 2007; Pivik et al., 2011). The University of British Columbia/Children’s and Women’s Health Centre of British Columbia Research Ethics Board approved the study. ECEs provided informed consent and parents consented on behalf of their children.

Of 56 eligible children, 48 were enrolled, with complete data on 45, since three children left at T2 (Fig. 1). The final quantitative sample included 53% boys (M age = 4.28 years; SD = 0.63), 69% Caucasian, 7% Asian, 7% African, 13% Mixed. The centres did not differ significantly by gender; χ²(1, N = 45) = 0.04, p = 0.84, or age, t(43) = -1.01, p = 0.32. We collected complete qualitative data for eight children from Centre A and seven children from Centre B because one boy left Centre B at T2.

3.2. Measures and data analysis

3.2.1. Seven Cs

Seven Cs were assessed for each centre at each time point (see Appendix). The 27 items are rated on a 5-point scale, for a maximum score of 135. Seven Cs criteria were derived from a multidisciplinary study of outdoor play spaces at child care centres and a literature review of outdoor play spaces that support child development and integrate the unique qualities of playing outdoors (Herrington & Lesmeister, 2006). Unlike most measures of outdoor play spaces, Seven Cs assess the quality of the design, rather than simply auditing the presence or absence of features. Higher character, challenge and chance ratings are associated with more positive social interactions, cooperative play and less unoccupied behaviours, and higher overall Seven Cs ratings are associated with more emotionally positive interactions between children (Pivik et al., 2011).

3.2.2. Questionnaires

ECEs completed questionnaire packages for each child, including:

1. Children’s sociometric status was determined by two items rating how “dominant or influential” and “popular” each child is with peers. Reliability coefficients were 0.43 and 0.66, respectively, between teacher ratings and correlated 0.46 (p < 0.05) with peer ratings (Ostrov & Keating, 2004).

2. Strengths and Difficulties Questionnaire (SDQ) teacher version (Goodman, 1997) includes 25 items measuring emotional symptoms (“many fears, easily scared”), conduct problems (“often loses temper”), hyperactivity/inattention (“constantly fidgeting or squirming”), peer relationship problems (“generally liked by other children”), and prosocial behaviour (“considerate of other people’s feelings”). A review indicated internal consistencies above 0.70 for all teacher-reported scales, except peer problems (0.63), and test-retest from 0.68 to 0.85 (Stone, Otten, Engels, Vermulst, & Janssens, 2010). The five-factor model was confirmed in most studies with satisfactory factor loadings >0.40–<0.70, and higher scores are associated with greater likelihood of a psychiatric diagnosis. Cronbach’s alpha ranged from 0.70 to 0.88.

3. Preschool Social Behaviour Scale—Teacher Form (PSBS-T; Crick, Casas, & Mosher, 1997) includes 19 items measuring relational aggression (“tries to get others to dislike a peer”), overt aggression (“kicks or hits others”), prosocial behaviour (“is kind to peers”) and depressed affect (“looks sad”). The four-factor structure accounted for 81% of the variation, had cross-loading >0.40 and within factor loadings ranging from 0.62 to 0.90. Cronbach’s alpha ranged from 0.88 to 0.96 (Crick et al., 1997).

Children’s scores on the SDQ and PSBS-T were compared before and after the intervention using a Wilcoxon signed-rank test
because data were not normally distributed.

3.2.3. Accelerometers

ActiGraph GT3X/GT3X + accelerometers provided data on physical activity counts, energy expenditure, steps taken and intensity level. Children wore the accelerometers on a belt at the level of the iliac crest, for five days, from arrival at the childcare centre, to departure. Correct placement was ensured by a research assistant. Accelerometers were pre-programmed to filter non-human motions, limit recording in the 0.25-2.5 Hz, and collect data in 15-second epochs.

Stata statistical analysis software was used to process ActiGraph data. We examined activity between 11:05-11:25am because this was scheduled outdoor time at both centres where children were most likely to be present and not napping. Measurement days including more than 75% of zero activity over the 20 min (>60 zero counts over the possible 80 measurement epochs) were dropped. Activity was defined according to Pate, Almeida, McIver, Pfeiffer, and Dowda’s (2006) cut-offs: sedentary = <199 count/15 s; light = 200-419 count/15 s; moderate = 420-841 count/15 s; vigorous ≥ 842 count/15 s.

3.2.4. Play observations

Observations and videotapes of play activity and social interactions were collected on eight pre-selected children at each centre (total n = 16). To assess between-individual differences in play (Barbour, 1999; Sargisson & McLean, 2012), children were selected to ensure representation by age (<4 years and ≥4 years) and gender, as well as high/low sociometric status to assess whether the effects of the intervention varied by this variable.

Each child was observed twice over 30 min of outdoor play at T1 and T2 by two researchers. Since they helped fit accelerometers, researchers were known to the children and visible to them, but stood at a discrete distance, adjusting position when view was obstructed. Data were collected on days with no precipitation because both centres limited outdoor play on rainy days, and to limit the influence of weather since data collection occurred across different seasons.

Videotapes of the 30-minute play sessions were coded by 10-second intervals for 32 variables based on existing coding schemes and concepts (Ladd, Price, & Hart, 1988; Pepler, Craig, & Roberts, 2001; Sandseter, 2009), supplemented by study-specific coding: prosocial behaviours (co-operative play, social conversation), antisocial behaviours (physical and verbal aggression, object possessiveness, rejected bids for engagement), lack of engagement in play (onlooking, unoccupied), channel surfing (transitioning frequently between activities), child-teacher interactions (teacher-initiated, child-initiated, interruption by teacher), play with natural materials (natural loose materials, natural play elements), risky play (rough and tumble, height, mastery, unstable, speed, risk of getting lost), and gender-segregated play. Children’s body language, facial and verbal expressions were referenced for intensity to identify the combinations of exhilaration and fear that characterize risky play.

Three authors independently viewed the videos to identify preliminary codes, which were then discussed and refined. Codes were further refined based on the interpretations of two coders in consultation with the authors. Coders were blinded to the child’s
sociometric status. Interrater reliability at the beginning of coding, at midpoint, and after completion indicated Cohen's κ > 0.79. Videos were viewed in their entirety and narratives were written for discrete play episodes, capturing essential activities and characteristics. Play episodes were qualitatively compared at each time point for each centre and were used to interpret quantitative findings.

Generalized linear mixed effects models (GLMM) with random intercepts by child, binomial distribution, and Laplace approximation were used to examine change in likelihood of engaging in coded behaviours. A random effect by video session was also included to account for potential effects (e.g., length of video, time of day, day of week). Model building included: first, unconditional means model; second, unconditional growth model where the intervention variable (before/after) was introduced as a fixed effect; third, other covariates were entered, one by one, as fixed effects: gender, age (centered to the lowest value, 3 years), centre, dominance, peer acceptance, and interactions. Non-significant covariates remained in the model until all variables were introduced. In subsequent rounds of model building, significant covariates were entered first. Consistently not significant covariates (p > 0.05) were removed in the final model, and multivariably significant covariates were retained.

3.2.5. Spatial behaviour maps
For each 30-minute play session, we recorded the child’s movement in the play space using plan maps, keeping a pen to the paper and stopping only if the child left the space (to go inside). When the child stopped in an area of the playground, the researcher marked the pause with a dot. Thus, movement was represented by lines and pauses were represented by dots (see Fig. 5, section 4.3 for sample maps).
Maps were scanned and traced in Adobe Illustrator, facilitating layering and comparison of lines and dots. A randomly-selected T1 and T2 intervention map for each child was qualitatively compared, examining area played in and amount and location of pause points.

3.2.6. ECE focus groups
We conducted two semi-structured focus groups with ECE staff at T2, one at each centre, to elicit perceptions on the play space prior to the intervention, changes to the play space and observations on changes in children’s behaviour.
ECE observations were recorded by the facilitator on a flip chart while a researcher took notes on specific responses. Due to equipment malfunction, one focus group was not audio recorded. Both the facilitator and researcher wrote field notes on the focus groups. We reviewed the audio recording and notes to develop codes for discrete phenomena identified in the data. First level codes were then grouped and condensed into themes that related to ECE’s perspectives on the play space and children’s behaviours before and after the intervention.

3.3. Intervention procedures
We spent CDN$8000 and 499 volunteer hours on the Seven Cs intervention (Centre A = $3000; Centre B = $5000). Centre A modifications can be seen in Fig. 2, while Centre B can be seen in Fig. 3.
The intervention addressed each of the Seven Cs. The overall character was improved through the addition of vegetative (bamboo, flowering shrubs, grass) and natural (boulders, gravel, sand, sea glass, stone pavers) materials, “softening” the overall feel of the space. These materials and the addition of color to ground plane and structures (Centre B) created a diverse character palette of color and materials. Both spaces are fenced, secure from street traffic and incursion, but allow view of the larger landscape. Context was improved through the addition of 4–5’ height bamboo shrubs, which provided shade areas and created a more attractive space from outside view. Connectivity was ameliorated by adding a hierarchy of pathways promoting and directing movement throughout the different “play zones.” These paths were designed to loop in circuits throughout the space with decision points (right, left, centre) for children to navigate. In Centre B, tricycle traffic was controlled through designated routes allowing children to easily enter and exit the play space. Clarity was augmented by creating well defined ‘play zones’ designed to inspire different types of play behaviour. Planting material, used to define play zone boundaries, and other natural materials became primary play elements (sand, gravel, pavers) in each play zone. Chance was improved by arranging plant material into tight spaces (alleys to explore, enter, hide behind) that offered mystery and chance encounters. Loose materials elevated chance, by allowing children to build with, manipulate, and move them. Opportunities to experience Change was increased through arrangements of planting that resulted in: small spaces for individuals, medium spaces for small groups, large spaces for group assembly and free movement. These open-ended spaces accommodated a range of play opportunities. Boulders and large rocks created topographical changes making the space more stimulating and challenging. Plants were chosen based on their seasonal characteristics, ensuring change throughout the year.

4. Results

4.1. Seven Cs
Seven Cs scores increased from 44 to 97 in Centre A, and 35 to 125 in Centre B (maximum score: 135). Detailed Seven Cs scores are provided in the Appendix.

4.2. Questionnaires
Mean sociometric status scores at Centre A were 3.42 for dominance and 3.44 for acceptance; and at Centre B were 2.70 and 3.25, respectively. Ratings remained stable over time. Only two children in our sample were rated 1 or 2 on both scales. As such, the variance we sought in selecting children for targeted observation based on low sociometric status was limited. Wilcoxon signed rank tests for paired samples indicated a significant decrease from T1 to T2 in the SDQ peer problems scale (Median T1 = 2.3, T2 = 2.0; z = −2.10, p = 0.036). This result may be spurious, since data violated the symmetry of differences assumption. The PSBS depression score decreased significantly from T1 to T2 (Median T1 = 6.0, T2 = 3.0; z = −2.24, p = 0.03). No other scores differed significantly.

4.3. Play observations
We videotaped 1971 min of play and coded 11,825 10-second intervals. Table 1 and Fig. 4 summarize results of the GLMM. The Unadjusted Intervention Effects column in Table 1 displays the odds ratio (OR) with 95% Confidence Intervals (CI) indicating the odds of the behaviour increasing (positive value) or decreasing (negative value) at T2 compared to T1. In the Adjusted Intervention Effects columns, the intervention effects have been controlled for any covariates that remained significant for each of the outcome variables, as shown in the Covariates column. Where relevant, significant interaction effects are provided. Fig. 4 visually represents the significant intervention effects as outlined in Table 1.
Risky play did not increase significantly from T1 to T2. Play with natural materials increased significantly, especially in Centre B (58
times versus seven). Girls and older children were more likely to engage in prosocial behaviour than boys and younger children. In Centre A, prosocial behaviour increased post-intervention (OR = 2.81), but in Centre B, it decreased (OR = 0.17). Antisocial behaviour was infrequent at both time points, did not change in Centre A, and decreased significantly in Centre B (OR = 0.16).

Overall, boys exhibited more lack of engagement in play, compared with girls (OR = 5.11), and children in Centre B were less unengaged than children in Centre A (OR = 0.23). Intervention effects varied by gender and centre: in Centre A, there was no significant change for girls, but boys were less unengaged post-intervention (OR = 0.35). In contrast, girls in Centre B were more likely to be unengaged post-intervention (OR = 10.87). This effect was less pronounced for boys in Centre B (OR = 3.85, Intervention × Boy × Intervention × Centre).

Children in Centre B showed significantly less interactions with ECEs post-intervention (OR = 0.13). Boys displayed more solitary play than girls, and the intervention did not significantly change its frequency. Channel surfing and gender-segregated play did not change.

Qualitative analyses of play observations and corresponding spatial behaviour maps revealed that, overall, use of natural loose and fixed elements increased. The bamboo grove in Centre A prompted exploration, hiding, make-believe play, and physically active play. There were instances when the children pretended that the grove was a jungle or forest, or fled from “monsters” hidden within. The inclusion of loose parts and natural materials in Centre B provided children materials to support their creative play. One girl was observed arranging bamboo poles into a house, then inviting peers to explore her creation. Children were also interested in watering the plants, learning to take stewardship of their natural environment. Placing sod over concrete in Centre B also appeared to encourage more rough-and-tumble play. One ECE was observed spinning a child around, then setting her gently on the grass headfirst, letting her topple over, laughing. Children also spent time balancing on the rocks and boulders that studded both centres.

To illustrate some of the changes observed, Fig. 5 shows the spatial behaviour maps at T1 and T2 for a 3-year-old boy at Centre B with low sociometric status. While his movement patterns at both time points indicate considerable wandering, there appears to be less movement at T2, possibly indicating a greater engagement in play in specific sections of the play space. Video stills (Fig. 6) of the child’s play episodes reiterates findings described above. At T1, he engages almost exclusively in solitary play or unsuccessfully attempts to join other children’s games. Furthermore, he has physical confrontations with four different children, mostly instigated by him. At T2, he primarily engages in parallel play and observing, but his attempts to join other children’s play appear more successful.
Also, there are fewer instances of antisocial behaviour.

4.4. Spatial behaviour maps

Qualitative analysis of spatial behavioural maps indicated changes in children’s movement throughout the space. In general, the intervention promoted use of different areas of the play space. For example, areas became available for individual or small group play and hiding, and more areas of the play space were used by the children. These patterns can be seen in Figs. 7 and 8, which show the cumulative pause points for a random selection of the spatial behaviour maps in Centres A and B, indicating considerably more pauses in T2, as well as greater coverage of areas of the play spaces.

4.5. Accelerometers

In the 20-minute interval measured, there was a significant decrease across centres in moderate to vigorous physical activity (MVPA; \( \geq 420 \) count/15 s) minutes from T1 to T2 (\( M \) decrease = 1.32 min, SE = 0.37, \( p < 0.001 \)).

4.6. ECE focus groups

Sixteen ECEs (14 women, 2 men) participated in the focus groups. Similar themes emerged from both centres, particularly the overall improvement, which was described as “night and day.” ECEs qualified the play space at T1 as “not inviting,” “boring,” “ugly,” “dusty,” “hot,” and “unsafe” with many injuries occurring. ECEs at Centre B characterized children’s behaviour as hard to manage and noted that extensive teacher involvement and guidance was required. The only aspect that the ECEs preferred at T1 was that it was easier to count the children. ECEs described play spaces post-intervention as “more inviting,” and commented that children appeared to have greater awareness of nature, self-regulation, creativity and self-confidence. They noted that children had increased socialization skills, problem-solving and focus. They perceived that children experienced less stress, boredom and injury, and thought the play space was quieter. ECEs also described having more “quality time” and engagement with the children, with play being less directed by teachers.

5. Discussion

We applied the Seven Cs design principles to improve the outdoor play space of two childcare centres to increase access to nature and risky play opportunities. Findings indicate an increase in the quality of the outdoor play space and significant positive effects on children’s play, social behaviours and mental health and a decrease in physical activity. Overall, changes in children’s outcomes were more substantial and far-reaching in Centre B, than Centre A. This is not surprising given the two pieces of fixed play equipment at Centre A limited intervention options and the more modest increases in Seven Cs scores for Centre A compared to Centre B.

5.1. Effect of intervention

Seven Cs ratings more than doubled in Centre A, and increased by 3.5 times in Centre B, indicating improvement in the design.
characteristics of both play spaces. ECEs expressed greater satisfaction with the space post-intervention and perceived positive changes in children's behaviours, which were supported by our data. Children's depressed affect decreased significantly, which could be associated with an increase in the quality of the play environment, but also greater exposure to nature, since contact with nature is associated with improved mental health (Chawla, 2015; Gill, 2014).

Fig. 4. Significant intervention effects for coded play behaviours.
Play with natural materials increased, particularly in Centre B (by a factor of 58), where there were few natural materials at T1. The magnitude of increase suggests affordances for play offered by the natural materials were actualized by the children.

Antisocial behaviour was rare at both centres at T1, though more likely in Centre B. Notably, while antisocial behaviour decreased in both centres, the effect was larger in Centre B. A decrease in peer problems as measured by the SDQ confirmed this result, but must be interpreted cautiously given the violation of data assumptions.

We hypothesize that increasing affordances for play resulted in less competition over scarce toys and resources (e.g., ECE attention). In addition, children’s general improvement in mental health may have influenced their likelihood to interact negatively with their peers, as could developmental changes in social competencies.

Prosocial behaviour increased in Centre A at T2 but decreased in Centre B. This paradoxical result may have resulted from the low affordances at T1, which meant more forced interactions and cooperation with other children.

"Share" was frequently heard and ECEs dedicated considerable time developing games and amusements. This hypothesis may also explain the apparent lack of engagement in play in Centre B at T2: more play affordances provided more opportunity for independent play and quiet contemplation, which can look unengaged in video footage. Consistent with past research, girls and older children engaged in more prosocial behaviour, regardless of Centre and time point. Children typically reflect sociocultural gender roles in their play behaviours and gender norms would dictate that girls exhibit stereotypically feminine (e.g., sharing, helpfulness, kindness) versus masculine

![Fig. 5. T1 (left) and T2 (right) spatial behaviour map of <4 year-old boy at Centre B with low sociometric status.](image)

### Table 1

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Unadjusted Intervention Effects (95% CI)</th>
<th>Adjusted Intervention Effects</th>
<th>Covariates: OR (95% CI)</th>
<th>Intervention effect and interactions: OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risky play</td>
<td>1.22 (0.60–2.50)</td>
<td></td>
<td>Centre A: 0.15 (0.05–0.39)</td>
<td>Intervention effect B: 1.11 (0.55–2.27)</td>
</tr>
<tr>
<td>Play with natural materials</td>
<td>43.20 (12.40–188.80)***</td>
<td></td>
<td>Centre A: 0.03 (0.00–0.28)**</td>
<td>Intervention effect B: 7.29 (1.53–38.09)**</td>
</tr>
<tr>
<td>Prosocial behaviour</td>
<td>1.29 (0.66–2.55)</td>
<td></td>
<td>Centre A: 3.96 (1.49–10.70)**</td>
<td>Intervention effect B: 2.81 (1.17–6.91)**</td>
</tr>
<tr>
<td>Antisocial behaviour</td>
<td>0.54 (0.00–0.02)*</td>
<td></td>
<td>Boy: 0.34 (0.17–0.67)**</td>
<td>Intervention effect B: 0.17 (0.05–0.63)**</td>
</tr>
<tr>
<td>Lack of engagement in play</td>
<td>0.88 (0.49–1.57)</td>
<td></td>
<td>Age: 1.77 (1.07–2.94)**</td>
<td>Intervention effect B: 1.40 (0.47–4.13)</td>
</tr>
<tr>
<td>Child-teacher interaction</td>
<td>0.40 (0.23–0.72)**</td>
<td></td>
<td>Centre A: 4.08 (0.63–26.52)</td>
<td>Intervention effect B: 0.16 (0.03–0.75)*</td>
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<tr>
<td>Solitary play</td>
<td>1.09 (0.58–2.05)</td>
<td></td>
<td>Centre A: 0.23 (0.10–0.49)**</td>
<td>Intervention effect B: 0.52 (0.24–1.14)</td>
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<td>Channel surfing</td>
<td>0.89 (0.57–1.39)</td>
<td></td>
<td>Boy: 5.11 (2.37–11.27)**</td>
<td>Intervention effect B: 0.35 (0.14–0.85)*</td>
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<tr>
<td>Gender-segregated play</td>
<td>1.13 (0.51–2.52)</td>
<td></td>
<td>Centre A: 8.60 (4.16–18.03)***</td>
<td>Intervention effect B: 1.30 (0.65–2.57)</td>
</tr>
</tbody>
</table>

* p < 0.05; **p < 0.01; ***p < 0.001.

1. Intervention effect controlled for random effects by child and video session.
2. Intervention effect, after controlling covariates found to be significant in step-wise model building.
3. Covariates to which the intervention effect was adjusted; Odds Ratios (OR) and 95% Confidence Intervals (CI) indicate effect of each covariate on the outcome variable at T1.
4. Intervention effect; i.e., odds of observing instances of the outcome at T2 compared with T1.
5. Reference category is Centre A.
6. Age centered to 3 years.
7. Intervention effect, irrespective of Centre.
8. Intervention effect in Centre A, irrespective of gender and age.
10. Intervention effect in Centre A, among girls aged 3.
11. Intervention effect in Centre B, among girls aged 3.
12. Intervention effect in Centre A, among boys.
(e.g., aggression, competitiveness, and dominance) traits (Honig, 2006). Furthermore, children typically exhibit more prosocial behaviour with age as their social competencies develop (Johnson, 2006).

Instances of child-teacher interactions in play were different between centres. The relatively impoverished play environment in Centre B at T1 meant that ECEs were more involved in creating play opportunities than in Centre A. ECEs in Centre A would step back after organizing children’s play, whereas ECEs in Centre B maintained involvement. At T2, child-teacher interactions remained stable in Centre A but decreased by 22% in Centre B, as children had more diverse play opportunities to draw from. This finding was echoed in the focus groups, where ECEs, particularly those in Centre B, reported that children engaged in more independent play and that their interactions with children were of higher quality, rather than managing difficult behaviours or manufacturing play.

Seven Cs rating for challenge increased from 2 to 7/10 in Centre A and 0 to 8/10 in Centre B, indicating that affordances for risky play were present at T2, yet instances of risky play did not increase. We hypothesize that this resulted from insufficient change in ECE supervision. ECEs were not trained to change their attitudes and alter their practices toward risky play. This was a limitation of our study.
as previous research indicates the importance of training educators to ensure supervision practices provide opportunities for challenge and risky play (Bundy et al., 2011; Cosco et al., 2014; Niehues et al., 2013). Overall, the lack of change in risky play suggests that our findings relate to the increased exposure to nature play, rather than risky play per se.

Stability of channel surfing may be due to coding difficulties since it was sometimes difficult to differentiate from lack of engagement, solitary play, or a child’s desire to run around the play space. We saw no change in gender-segregated play, despite our expectation that boys and girls would be more likely to play together with provision of natural materials. The lack of gender coding of natural materials and their diverse affordances can reduce gendered-play (Barbour, 1999; Lucas & Dyment, 2010). Our measures differed from those used in previous studies and may not have been sensitive enough to detect changes. We did not measure gendered-play, nor did we examine the proportion of children of different genders playing in a given area of the play space, regardless of whether they were playing with each other.

Research indicates that play in nature increases MVPA (Coe, Flynn, Wolff, Scott, & Durham, 2014). However, in our study MVPA decreased by 1.3 min over the 20-minute period examined. This may reflect children’s deeper engagement in play, as illustrated by the pauses in the spatial behaviour maps at T2. Previous research indicates that children’s play episodes are longer, more complex and diverse in natural play spaces compared to fixed equipment-based playgrounds (Luchs & Fikus, 2013); also that play spaces with more affordances facilitate less physically competent children’s opportunities to engage in play, allowing them to gradually increase their physical skills and mastery (Barbour, 1999). We were not able to run separate analyses based on physical competence, but speculate that greater affordances for play would improve these children’s longer term physical activity and motor competence. Furthermore, children could not choose the timing and duration of their outdoor time. Past research suggests that, had the choice been available, there may have been increases in MVPA resulting from children’s increasing interest in being outdoors.

5.2. Limitations and future research

It is difficult to isolate intervention effects from typical development in longitudinal intervention research with children. In particular, social competencies develop with age, as was evident in our data showing that older children engaged in more prosocial behaviour. However, our results indicated differential changes in prosocial and antisocial behaviour at each centre across time, suggesting that changes reflected effects of the intervention. To minimize the effects of developmental change, we limited the data collection period to five months. However, this meant that data were collected in different seasons (T1 = Winter; T2 = Spring), which could have independently influenced the children’s well-being and play behaviours. To mitigate potential weather effects, we limited data collection to days without precipitation.

The study design may have been strengthened by a third phase returning the play space to original condition. This was not possible because when given the option to keep the play space in the T2 state, both centres chose to do so. We had limited variance to examine the effects of the intervention on children of low sociometric status since few children scored low on both scales. While the video recorder had microphones, the children did not wear lapel microphones, making it sometimes difficult to hear dialogue, limiting our understanding of interactions.

Our study is the first to examine the effects of natural risky play environments on children’s health and wellbeing. Previous research has been limited by cross-sectional designs and/or focus on physical activity as a sole outcome (Bundy et al., 2011; Cosco et al., 2014; Luchs & Fikus, 2013). Our design allowed us to test an intervention based on the Seven Cs and examine a broad range of children’s outcomes. Furthermore, our mixed methods data permitted deeper understanding, facilitating interpretation and highlighting avenues for future research. Our results encourage further testing of the Seven Cs intervention through a randomized controlled trial design that includes risk reframing for ECEs.

5.3. Conclusion

As research evidence mounts regarding the importance of outdoor play and repeated exposure to nature, inexpensive and evidence-based interventions to promote affordance-rich nature play have the potential to positively influence health and wellbeing for children worldwide. Early childhood centres represent priority venues for early intervention given the number of waking hours that children typically spend in childcare. Our findings indicated the utility of the Seven Cs criteria for play space design in improving affordances for play. Providing high quality, natural outdoor play environments for children does not require expensive equipment, nor complex interventions to have a significant and positive impact on children’s health and wellbeing.
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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jenvp.2017.11.001.

References


