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Sydney Playground Project: A Cluster-Randomized Trial to Increase Physical Activity, Play, and Social Skills

Abstract

BACKGROUND

We assessed the effectiveness of a simple intervention for increasing children's physical activity, play, perceived competence/social acceptance, and social skills.

METHODS

A cluster-randomized controlled trial was conducted, in which schools were the clusters. Twelve Sydney (Australia) primary schools were randomly allocated to intervention or control conditions, with 226 children (5-7 years old) selected randomly to participate. Data were collected at baseline and after 13 weeks. The intervention consisted of introducing recycled materials without an obvious play purpose into school playgrounds and a risk-reframing workshop for parents and teachers.

RESULTS

Children from the intervention schools increased physical activity and reduced sedentary time while control schools decreased physical activity and increased sedentary time. The intervention yielded increases in total accelerometer counts (β = 9350 counts, 95% CI 3490-1522, p = .002), minutes of moderate/vigorous physical activity (MVPA) (β = 1.8 min, 95% CI 0.52-3.12, p = .006), and reductions in sedentary time (β = −2.1 min, 95% CI −3.77-(−0.51), p = .01). Although the changes in time spent in play and nonplay were not statistically different (p = .08) the effect size (d = .27) indicates clinical significance.

CONCLUSIONS

This intervention was effective for increasing MVPA during recess and demonstrated capacity to improve play opportunities in school playgrounds.

Keywords

sydney, playground, trial, social, increase, play, activity, physical, skills, project:, cluster-randomized

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Authors

Anita C. Bundy, Lina Engelen, Shirley Wyver, Paul Tranter, Jo Ragen, Adrian E. Bauman, Louise A. Baur, Wendy Schiller, Judy Simpson, Anita Niehues, Gabrielle Perry, Glenda Jessup, and Geraldine A. Naughton

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RESEARCH ARTICLE

Sydney Playground Project: A Cluster-Randomized Trial to Increase Physical Activity, Play, and Social Skills

ANITA BUNDY, ScD[a] LINA ENGELEN, PhD[b] SHIRLEY WYVER, PhD[c] PAUL TRANTER, PhD[d] JO RAGEN, PhD candidate[e] ADRIAN BAUMAN, PhD[f] LOUISE BAUR, PhD[g] WENDY SCHILLER, PhD[h] JUDY M. SIMPSON, PhD[i] ANITA N. NIEHUES, PhD[j] GABRIELLE PERRY, BappSc (Hons)[k] GLENDA JESSUP, PhD candidate[l] GERALDINE NAUGHTON, PhD[m]

ABSTRACT

BACKGROUND: We assessed the effectiveness of a simple intervention for increasing children's physical activity, play, perceived competence/social acceptance, and social skills.

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CONCLUSIONS: This intervention was effective for increasing MVPA during recess and demonstrated capacity to improve play opportunities in school playgrounds.

Keywords: outdoor play; physical activity; school playground; school recess; perceived competence/social acceptance; accelerometer.

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Disturbing numbers of children in the Western world are overweight, bullied, or have poor mental health.[1] These conditions are prevalent and often not treated until there is a detrimental impact on quality of life. Prevention is the preferred approach[2] and identifying children at risk of poor physical or mental health is difficult. Because all children benefit from increased activity and social interaction,[3] preventive programs conducted at schools can be valuable. Recess is an important part of the school day for most primary school children. Playgrounds promote gross motor play that in turn contributes to energy expenditure. Gross motor play also encourages social interaction and negotiation[4,5] Thus, school playgrounds are an opportune place to promote physical as well as psychosocial development and play skills.

Few studies have evaluated the effects of playground-based interventions involving loose parts. The Play Pods study, carried out in Bristol (UK) from 2006 to 2009[6] and a pilot study from our own group in Sydney (Australia)[7,8] both involved the addition

[a]Professor, (anita.bundy@colostate.edu), Department of Occupational Therapy, Colorado State University, 200 Occupational Therapy Building, 1573 Campus Delivery, Fort Collins, CO 80523-1573.

[b]Research Fellow, (lina.engelen@sydney.edu.au), University of Sydney, School of Public Health, Charles Perkins Centre, Camperdown, NSW 2006 Australia.

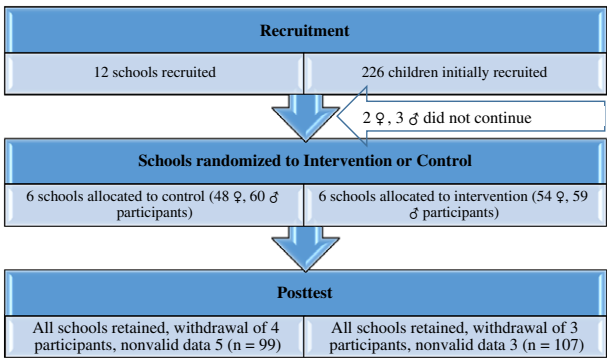
[c]Senior Lecturer, (shirley.wyver@mq.edu.au), Macquarie University, Institute of Early Childhood, Macquarie University, NSW 2109, Australia.

of unstructured, recycled materials to school playgrounds. The 2 studies used different methods, and had different emphases. For example, we used accelerometers to measure physical activity, coded play from video recordings, interviewed some staff and collected anecdotal observations. The Play Pods study used more interviews with a wider range of stakeholders and included photographs to document playground activity. Despite these differences, the studies yielded similar findings, particularly that the materials promoted participation, social negotiation, creativity as well as improving all children's access to play opportunities. Neither of the above studies had a control group, nor benefited from the rigor of randomized control design.

Other school playground-based interventions have shown promise for increasing physical activity. However, few researchers have taken clustering (ie, the effect of children playing together on the same playground) into account in their statistical analysis, increasing the risk of a type I error.[9] Only 3 previous research groups[10-12] have conducted cluster-randomized trials. Of those, only Ridgers et al[12] found significant increases in vigorous physical activity during lunch breaks. Those gains were greatest after 6 months but the actual increase in time was small and the trajectory was not maintained at 12 months.[13]

Whereas outdoor free play promotes both physical and psychosocial health, adults often fear injuries and other undesirable consequences for children. Fear of litigation, for example, results in minimizing ''risk'' at all cost, decreasing the value of time spent on school playgrounds.[14,15] For example, several schools have placed a ban on running on the school playground.[16,17] However, adults' fears seem disproportionate to actual risk and injury severity: whereas children can be injured playing outdoors, most injuries are minor. Exposure to risky activities has been found to promote children's abilities to appraise risk.[18] A systematic review revealed that risky play is associated with a range of developmental benefits in the physical, social, and well-being domains.[19]

Figure 1. **Study Design and Participation**



We attempted to replicate some of the benefits derived previously[6,7] by placing materials with no obvious play value on school playgrounds. Building on an understanding that outdoor free play is a powerful means of promoting physical activity and social interaction, we aimed to promote play through an intervention and using this process, enhance physical activity, social skills, and perceived competence/social acceptance of 5- to 7-year-old children in a school playground environment. The physical activity results have been published[20] but have not been considered in the context of our participants' play and social development.

METHODS

This cluster-randomized controlled trial, in which the participating schools were the clusters, involved a 13-week playground intervention. The intervention was preceded by baseline data collection; post-testing occurred during the final week of the playground intervention (Figure 1). Data were collected from

[d]Associate Professor, (p.tranter@adfa.edu.au), University of NSW, School of Physical, Environmental and Mathematical Sciences, PO Box 7916, Canberra BC ACT 2610.

[e]Senior Research Associate, (jo.ragen@sydney.edu.au), University of Sydney, Faculty of Health Sciences, PO Box 170, Lidcombe, NSW 2141, Australia.

[f]Sesquicentenary Professor of Public Health, (adrian.bauman@sydney.edu.au), University of Sydney, School of Public Health, Charles Perkins Centre, Camperdown, NSW 2006, Australia.

[g]Professor, (louise.baur@sydney.edu.au), University of Sydney, Sydney Medical School, Sydney, NSW 2145, Australia.

[h]Professor, (wendy.schiller@unisa.edu.au), University of South Australia, deLissa Institute of Early Childhood and Family Studies, GPO Box 2471, Adelaide, SA 5000, Australia.

[i]Professor, (judy.simpson@sydney.edu.au), University of Sydney, Sydney School of Public Health, Edward Ford Building A27, University of Sydney, NSW 2006, Australia.

[j]Assistant Professor, (anita.niehues@lr.edu), Lenoir-Rhyne University, 313 McCrorie Building, 625 7th Avenue NE, Hicory, NC 28601.

[k]Research Assistant, (gabrielle.n.perry@gmail.com), Faculty of Health Sciences, PO Box 170, Lidcombe, NSW 2141, Australia.

[l]Research Assistant, (glenda.jessup@sydney.edu.au), Faculty of Health Sciences, PO Box 170, Lidcombe, NSW 2141, Australia.

[m]Professor, (geraldine.naughton@acu.edu.au), Australian Catholic University, School of Exercise Science, Locked Bag 4115, Fitzroy, Victoria 3065 Australia.

Address correspondence to: Shirley Wyver, Senior Lecturer, (shirley.wyver@mq.edu.au), Macquarie University, Institute of Early Childhood, Macquarie University, NSW 2109 Australia.

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June 2009 to December 2010. The full protocol was published before data analysis was completed.[21]

Participants

Twelve coeducational Sydney primary schools were randomized in equal numbers as control or intervention. In each school a random sample of, on average, 19 children in the first 2 years of schooling (ie, kindergarten and year 1) were recruited (N = 226). Details of recruitment, randomization, inclusion, and sample size calculation are reported elsewhere.[21] At postintervention testing, 214 participants remained (115 boys, 99 girls, mean age: mean age: 6.0 years, range 4.7 to 7.3 years).

Intervention

The playground intervention ran for 13 weeks. The intervention consisted of placing recycled materials without an obvious play purpose on school playgrounds for use by all children at participating schools, independent of project consent. Examples of materials included car tires, milk crates, and cardboard boxes; in some cases, materials were reinforced or made more water resistant. New objects were added periodically to maintain variety, replace broken materials, or complement existing objects. During the 13-week period, parents and teachers were invited to participate in a 2-hour risk-reframing workshop. Parents and teachers were encouraged to engage in a cost-benefit analysis of risk-taking and also to see each other's perspectives such that both teachers and parents could share their concerns about potentially beneficial opportunities denied to children as part of the current intervention. However, attendance in the workshops was not mandatory for child participation, so not all parents of participating children attended a workshop. Furthermore, whereas teachers of participating children also attended the risk-reframing workshop, not all teachers who had playground duty were present at a workshop. These results have been reported elsewhere.[22]

Control Schools

Control schools continued access to existing playground resources at recess. Playground materials like the type placed in the intervention schools were provided at the completion of the project to control schools.

Process Evaluation

A series of planned observations and interviews were conducted during site visits. Videos and photographs were collected weekly to enrich understanding of play that was occurring. A record was maintained for each school and included information on what type of play was occurring at the school, how the intervention material was used and stored, and in what state the material was. This component was important for documenting management of the play materials and initial versus later reactions to the materials. For example, in some schools, children initially hoarded materials, but hoarding declined during the intervention. Interviews with school staff included predetermined questions about recess play as well as questions developed by the research team during each phase of the project to tap into unanticipated responses and events. The same questions were delivered to staff of all schools. We made it clear to children, staff, and parents that we were always interested in learning more about use of the materials or any issues relating to recess time at the school. All comments received were noted in the record. These comments and observations were complementary to the planned data collection and were particularly useful in helping us understand: (1) the impact of the intervention beyond what we were measuring; (2) how to intervention was received, including uptake; and (3) facilitators and barriers to implementation of the intervention. Three members of the research team independently summarized the observations and comments into themes, which were then discussed and agreed upon.

Outcome Measures

The outcome measures were physical activity, time spent in play, perceived competence/social acceptance, and social skills. We also assessed after-school time use. All measurements were taken during 1 full school week at baseline and postintervention (Table 1).

Physical activity during school days. Children's physical activity was measured with Actigraph accelerometers (model GT3X, theactigraph.com) fastened on top of clothing with an elastic waist band on the left iliac crest. A researcher attached the accelerometers at 9:00 AM and removed them at 3:00 PM on 5 consecutive school days, at baseline and postintervention. Data were recorded in 5-second epochs, but reintegrated to 15 seconds to fit the cutoff point algorithm. Accelerometers provided total activity counts as well as estimates of time spent in sedentary, light or moderate-vigorous intensity physical activity (MVPA) using existing cutoff points for children. Actigraph accelerometers have been found to be highly discriminating of different levels of physical activity in children aged 5 to 8 years when compared with measures of oxygen consumption and heart rate.[23]

Play and social interactions. Digital hard-drive video cameras (Sony DCR-SR65, sony.com.au) were used together with bluetooth wireless microphones (ECH-HW1, sony.com.au) to capture activity during recess. Children were videotaped for 15 minutes by

Table 1. **Outcome Measures and Schedule of the Study**

Physical activity	Actigraph accelerometer (GT3X)	Fastened on top of clothing over the left iliac crest. Data recorded in 5-second epochs, reintegrated to 15-second to fit cutoff algorithm.	Counts and minutes of sedentary and moderate to vigorous activity.[19]	5 days 9 AM-3 PM
	In-the-moment activity diary	Real-time activity diary collected via Experience Sampling Program (ESP) software; experience-sampling.org) loaded onto Palm Pilot Z22	Details of activities undertaken after school: What is child doing? With whom? What is child using? How much is child moving? etc.	4 days 3:30 PM-7 PM measured at random time points
Psychosocial skills and behaviors	Video recordings coded using a customized coding scheme	Digital hard-drive video cameras (Sony DCR-SR65), Bluetooth wireless microphones (Sony ECH-HW1). Studio Code (v 4.2.4, studiocode.com)	Minutes spent in play and nonplay, nature of social interactions	15 minutes
	SSIS-RS [2]	Parents and teachers completed detailed survey	Social skills and problem behavior	1 occasion
	PSPCSAYC[3]	Teacher and child (gathered through a researcher) reports	Self-competence and acceptance	1 occasion

a camera person, who remained as unobtrusive as possible. Videotaping did not occur on days when children were indoors during recess; researchers avoided taping children during lunch or snack time. The videos were subsequently coded using Studio Code (v 4.2.4, studiocode.com) with a custom designed coding scheme, capturing categories of play and nonplay, as well as quantification of social interactions. All videos were coded by a single trained rater who was uninvolved with the study. A second rater who had been involved with the development of the coding, checked scoring of a random selection of approximately one third of the videos. Interrater reliability was near perfect for play versus nonplay. Where disagreements occurred regarding play versus nonplay or type of social interaction, they were resolved by discussion.

Children's and teachers' perceptions of competence and social acceptance. The Pictorial Scale of Perceived Competence and Social Acceptance for Young Children (PSPCSAYC),[24] was used to assess 2 domains of competence—physical and academic—and 2 domains of acceptance—peer and maternal. Total scores were used. The PSPCSAYC has subscale reliability between 0.75 and 0.89.[24]

Parent and teacher reports of social skills. The Social Skills Improvement System Rating Scale (SSIS-RS)[25] was used to gather information on social skills (ie, communication, cooperation, assertion, responsibility, empathy, engagement, and self-control) and problem behaviors (ie, externalizing, bullying, hyperactivity/inattention, internalizing, and autism spectrum). Results are reported in total scores rather than subscales. Due to the length of time required to complete the forms, compensation was provided to the schools for the teachers' time. Reliability is between the 0.70s and 0.80s for the teacher and parent forms.[25]

Children's activities after school. We collected information about activities between 3:30 PM and 7:00 PM using a real-time activity diary (Palm Pilot Z22 [Palm Inc., Sunnyvale, CA] loaded with Experience Sampling Program [ESP] software; experience-sampling.org). Parents or other caregivers recorded responses at 3 times randomly generated by the program for each of 4 consecutive weekdays. Each response comprised 12 questions (9 multiple-choice, 3 Visual Analogue Scales [VAS]). Multiple-choice responses provided data on who was recording the information, what the child was doing and using, who the child was with, if the television was on, and whether the child was indoors or outdoors. VAS questions were used to estimate activity level, frequency of movement, and level of engagement in an activity.

Predictor Variables

Anthropometry. Height and weight were measured using standard procedures. Height was measured using a portable stadiometer (PE087, Mentone, VIC, Australia; mentone-educational.com.au) to the nearest 0.1 cm. Weight was measured in a single measurement wearing school uniform (without shoes), to the nearest 0.1 kg using digital scales (UC-321, A&D Weighing, Adelaide, SA, Australia, andweighing.com.au). Body mass index (BMI) was calculated as weight/height^2 (kg/m^2) and converted to age and sex adjusted weight status categories.[26,27]

Demographic factors. At baseline, data were gathered on age and sex of children, country of birth of children and parents, and languages spoken at home. The Index of Community Socio-Educational Advantage (ICSEA) was used as a measure of socioeconomic

Table 2. **Characteristics of Participants by Group at Baseline (Data Collected on 221 5- to 7-Year-Old Children June 2009 to December 2010, Sydney, Australia**

School	N	♀	♂	Mean age (SD) (years)	Mean BMI (kg/m^2) (SD)	ICSEA	Enrolled students	m^2 play area /child*	Break time†(min)
Control									
Total	108	48	60				1949		
Average (SD)	18 (6.7)	8 (4.5)	10 (3.3)	6.0 (0.6)	16.3 (2.2)	1097 (73)	325 (120)	4.8 (3.1)	71 (6.6)
Range						980-1170	163-453	0.9-10.2	60-80
Intervention									
Total	113	54	59				2145		
Average (SD)	18 (3.5)	9 (1)	10 (3)	6.0 (0.6)	16.5 (2.0)	1056 (55)	358 (129)	6.4 (2.9)	71 (8.0)
Range						982-1117	255-603	2.0-9.4	65-80
Total all schools	221	102	119				4094		
Average (SD)	18 (5)	9 (3)	10 (3)	6.0 (0.6)	16.4 (2.1)	1076 (65)	341 (120)	5.6 (2.9)	71 (7.0)
Range						980-1170	163-603	0.9-10.2	60-80

BMI, body mass index; ICSEA, Index of Community Socio-Educational Advantage; SD, standard deviation.
*The available play area in m^2 per child during break times.
†Total break time per school day.

status of the families of children attending the schools. The ICSEA was created by the Australian Curriculum, Assessment and Reporting Authority.[28] The average of the ICSEA is set to 1000, with a standard deviation of 100; the range is from 500 to 1300, with 70% of Australian schools having an ICSEA of 900 to 1100.

Square meters of play space available per child. Available play space per child on the playground as expressed in m^2 was obtained by dividing the available playground area (earth.google.com) for each school by the number of children at the school. In cases where a specific play area was used by young primary students, the size of that space was divided by the number of students normally allocated to the area.

Data Analysis

Mixed-effects multilevel regression, taking clustering and repeated measurement into account, was used to compare net change from baseline values between groups. Treatment (control/intervention), phase (baseline/post-test), interaction between treatment and phase (effect of the intervention over time), sex, year (kindergarten/year 1), BMI, square meters available play space per child, and ICSEA values were included as fixed factors, and school and participant ID as random factors. Alpha was set at 0.05. All calculations were done with STATA/IC 12 (stata.com).

RESULTS

All 12 schools and 95% of participants completed the study (Figure 1). Almost all children were born in Australia, but approximately 50% of the children had at least 1 parent born outside Australia. Frequent countries of birth for parents were Australia (N = 280), the Philippines (N = 22), Italy (N = 22), China (N = 16), India (N = 16), and New Zealand (N = 15). Overall, 35 countries were represented. Table 2 shows other characteristics of participants by group. Calculated BMI did not differ at baseline between control and intervention groups; overall, 0.5% were underweight, 79.9% healthy weight, 13.7% overweight and, 5.9% obese.

Physical Activity During School

During the recess period, children in intervention schools increased MVPA and reduced sedentary time over the 13 weeks of the intervention, while those in control schools decreased physical activity and increased sedentary time. At post-test, compared with children in control schools, children in intervention schools had more minutes of MVPA ($\beta = 1.8$ min, 95% CI 0.52 to 3.12, p = .006) and fewer minutes in sedentary activity ($\beta = -2.1$ min, 95% CI −3.77 to (−0.51), p = .01). Full details of the physical activity results have been published elsewhere.[20]

Play and Social Interaction

Increases in observed time spent in play in the intervention group did not reach statistical significance ($\beta = 11.8\%$, 95% CI −1.3 to 24.8, p = .08) but the effect size for play and nonplay (d = 0.27 for both) supports the clinical significance of the intervention (Table 3). Measurable differences in observations of the number of playmates were not altered by the intervention ($\beta = 3.8\%$, 95% CI −3.6 to 11.2, p = .31).

Perceptions of Competence and Social Acceptance

At baseline, most children and teachers perceived the children as socially competent and accepted. Once again, there were no changes from the intervention ($\beta = -0.13$-0.13, p = .11-.6) (Table 3).

Social Skills

Similarly, most baseline scores on social skills fell within the expected range. No effect of the

Table 3. **Adjusted Means and Standard Errors as Well as Results of the Multilevel Regression Analyses (Statistical Significance at p < .05)**

	Control		Intervention				
	Baseline, mean (SE)	Post-test, mean (SE)	Baseline, mean (SE)	Post-test, mean (SE)	Coefficient*	95% CI	p-value (d-value)
Play							
N†	78	80	83	78			
Play	44.8% (4.8%)	42.5% (4.8%)	40.9% (4.7%)	50.1% (4.8%)	11.8%	−1.3-24.8	.08 (0.27)
Nonplay	53.3% (4.7%)	55.7% (4.7%)	57.2% (4.7%)	48.1% (4.7%)	−11.7%	−24.8-1.4	.08 (0.27)
Social interactions	82.3% (2.3%)	85.1% (2.1%)	77.6% (2.2%)	84.4% (2.3%)	3.80%	−3.6-11.2%	.31 (0.19)
Alone	15.9% (2.3%)	12.5% (2.2%)	20.8% (2.2%)	14.7% (2.3%)	− 2.7%	−10.0-4.7%	.48 (0.13)
PSPCSAYC							
n†	104	104	110	107			
Self cognitive	3.56 (0.41)	3.60 (0.38)	3.55 (0.42)	3.57 (0.43)	ns		
Self peer	3.05 (0.60)	3.12 (0.65)	3.19 (0.53)	3.13 (0.57)	−0.13	−0.29-0.28	.11
Self physical	3.33 (0.49)	3.34 (0.49)	3.25 (0.56)	3.29 (0.58)	0.03	−0.11-0.16	.6
Self maternal	2.89 (0.64)	2.92 (0.57)	2.90 (0.58)	2.88 (0.63)	ns		
Teacher cognitive	3.13 (0.65)	3.29 (0.61)	3.01 (0.86)	3.28 (0.67)	0.13	−0.03-0.29	.11
Teacher peer	3.02 (0.68)	3.09 (0.61)	3.11 (0.64)	3.03 (0.76)	−0.13	−0.33-0.07	.19
Teacher physical	2.82 (0.46)	2.88 (0.51)	2.89 (0.61)	2.84 (0.70)	−0.08	−0.23-0.07	.29
SSIS-RS							
n†	97	101	110	93			
Parent social skills	97.3 (1.3)	98.0 (1.3)	97.7 (1.3)	96.6 (1.3)	ns		
Parent problem behavior	104.3 (1.2)	102.2 (1.2)	103.9 (1.2)	101.4 (1.2)	−1.15	−3.81-1.50	.4
Teacher social skills	99.1 (1.9)	98.8 (1.9)	98.4 (1.9)	99.5 (1.9)	2.02	−.98-5.02	.19
Teacher problem behavior	96.9 (2.4)	96.7 (2.4)	100.9 (2.4)	104.2 (2.5)	2.96	−.66-6.57	.1

CI, confidence interval; SD, standard deviation.

*Each multilevel linear regression model included treatment (control/intervention), phase (baseline/post-test), interaction between treatment and phase (effect of treatment over time, ie, the difference between groups in change from baseline), sex, year (kindergarten/year 1), BMI, ICSEA, and available playground space in per child (m^2), values as fixed factors, and school and participant ID as random effects.

†N included in the final analysis after removal of nonvalid data.

intervention was found on SSIS-RS scores ($\beta = -1.15$-2.96, p = .1-.4) (Table 3). We did not have sufficient participants with social skills performance deficits or acquisition deficits[23] to evaluate whether the intervention led to an improvement where deficits were present.

Time Use After School

At baseline, the most common after-school activities were television/computer/screen time (20.9%) followed by free play (12.2%) and crafts/book/puzzle (9.3%). No changes were noted postintervention.

Process Evaluation

Fidelity to treatment was monitored through regular observations on playgrounds, conversations with staff and field notes. The following provides an overview of the key information obtained from our process evaluation. Reported benefits included improved behavior and social skills, increased creativity and play among mixed age and sex groups. One principal said: ''*The students have been actively involved and very creative .... Behavioral problems on the playground have been reduced .... It's good for social skills, language development and fitness*.'' Principals consistently commented on decreased antisocial playground behavior and the shifting emphasis on creative rather than physical skills for leadership in the playground. In other words, the intervention changed the social hierarchy amongst children on the playground.

The materials were popular and in demand, which, however, meant that there was less exposure. Therefore, low exposure became a barrier to the planned implementation of the intervention. Some schools rostered classes onto the materials for only 1 or 2 days each week, resulting in target children having significantly reduced access to the materials. Not all adults were enthusiastic; some complained about mess or noise. Although, some teachers worried about safety, only 1 incident required medical attention, no greater incidence than usual over the time period.

DISCUSSION

We altered the school playground experience using recycled materials. Our aim was to change play behavior, and thereby, increase physical activity, social play and skills, and perceived competence/social acceptance; we had also hoped that changes in play would carry over to home. The intervention increased the children's physical activity at recess. In contrast to physical activity increases in the intervention group, we observed a decrease in physical activity in the

5- to 7-year-old control children—even over 13 weeks. Our research contributes to a growing body of evidence to indicate the important role school-based play interventions can have on children's MVPA.[29]

From video analysis, there was a small effect size for changes in play and nonplay. Children involved in the intervention demonstrated increases in play and reductions in nonplay. Although the differences between intervention and control were not statistically significant, the effect size indicates clinical significance. We believe improvements could be made in the collection of play data in future research. The 15-minute snapshots of play from video analyses conducted at the start and end of intervention may have been insufficient to capture the changed play patterns over 13 weeks of playground exposure. Also, recording the number of playmates may have masked changes in the variety and quality of social interactions. Social engagement on the playground remains difficult to quantify. Some children seemed to perform for the camera or demonstrate in other ways that their behavior had changed as a result of being filmed. The physical characteristics of schools made it difficult to be less intrusive in filming and live coding of play behaviors may be a better option for future research.

We postulate that the measured gains in physical activity in this study are an underestimate of the actual increase in energy expenditure. Measuring energy expenditure in children is difficult, particularly in unstructured situations, such as the ones we created, in which multiple children work together to lift or drag heavy items. Using accelerometers, we were able to measure only changes in speed of movement central to the hip. Thus, we did not capture the full benefits of constructing, pushing and pulling, squatting and climbing. Further, while these actions can be expected to increase energy expenditure, some may result in *slowing* of movement, another indicator that our findings may underestimate the actual value for promoting physical activity.

We found no increases in perceived competence/social acceptance or social skills using standardized measures. In retrospect, this is not surprising. The prevalence of difficulties with perceived competence/social acceptance and social skills in our participants at baseline was small and in general, children with problems at baseline had improved by post-test, regardless of the group they were in. Our use of random selection precluded any bias toward children with social difficulties. We sought more to prevent than to ameliorate, such difficulties. An important consideration is that the changes we made did not negatively impact on social skills, perceived competence/social acceptance or number of playmates. Other interventions aiming to increase physical activity often fail to take a holistic approach and it is therefore unknown if those interventions include some unintended consequences such as reduced interaction with peers. We believe it would be valuable to conduct further research with children who are identified as being at risk in the social domain to determine if this low-cost intervention leads to improvements.

We had hoped to observe carry-over effects to the after-school period, where children would be observed to engage in more active play and use objects in new and creative ways. There was no evidence that transfer had occurred. One interpretation of this finding is that the changes we observed are highly context specific. If this is correct, it suggests all contexts in which children regularly engage need to be conducive to high-quality play. It is not adequate to assume children will be able to transfer skills acquired on the school playground to other contexts.

Qualitative evidence and teacher feedback indicated the intervention was popular with children and valued by teachers. Although there are many commercial products available to assist in playground activity, our project used easily accessed, recycled materials of low cost to schools. The changing nature of play in this environment was described as being more inclusive and creative. School personnel and children were positive about the materials. Positivity was not confined to the 5- to 7-year-olds tested for this study. For example, when asked in a related project to draw their ideal playground, older girls who had had the opportunity to play with the materials, included recycled materials in their drawings.[30]

One principal who moved schools during the study asked for assistance to take up the intervention at her new school and word of mouth led to several nonparticipating schools contacting us for assistance to take up the intervention. At least 2 intervention schools continued to incorporate recycled materials on the playground after the 13 weeks had ended.

Strengths and Limitations

Whereas a variety of specialist programs and materials have been promoted to increase children's health, our approach demonstrates the benefits of a low cost, environmentally sound, and flexible intervention that does not require specialist training or purpose-made venues. Most importantly, it captures children's inherent enjoyment of play. Our approach involved working with teachers and parents as well as the children which is a feature of sustainable school health interventions.[31] Unlike most other studies, we used a wide range of measures and found that increases in physical activity did not negatively impact social skills or perceived competence/social acceptance. We also checked for transfer to other contexts and found no evidence that this had occurred. Our main data

were quantitative, but we supplemented these with qualitative data to gain deeper insight.

The popularity of the playground materials led to restricted access in some schools. This practice also may have diluted the intervention effects. Some teachers continued to view the equipment as hazardous, even though there were no increases in injuries, and some teachers had concerns with esthetics. Future research and any implementation should consider these caveats. Our project commencement coincided with an Australian government initiative to invest in school infrastructure. This meant many school grounds were in varying phases of construction works and limited play space for some project sites. However, the area available for play was constant for each school throughout the duration of the project.

Conclusions

Despite the intervention having a positive but modest effect on physical activity accelerometry measures obtained during recess, the increase was greater than any rigorously controlled playground-based intervention reported previously. We believe that the effect on energy expenditure is greater than could be captured only with accelerometers and video analysis, as used in the current study. Although social and physical engagement in play remain difficult to assess, process evaluation highlighted the inclusive, prosocial and challenging opportunities that were afforded to the children in the intervention. This low-cost environmentally friendly intervention can be implemented without the need for special venues and training, and is suitable for schools in low- and middle-income communities.

IMPLICATIONS FOR SCHOOL HEALTH

Schools have been identified as ideal sites for promoting behavioral change, including increased physical activity[32] and improved playfulness.[33] Recommendations for promotion of physical activity in particular are often tied to increases in trained personnel, greater supervision to ensure safety and programming for physical activity.[32] These changes can be costly and onerous for schools to implement and frequently involve outsourcing to external providers.[34] In this study, we have demonstrated that it is possible to increase physical activity and reduce sedentary time by introducing a low-cost intervention with a focus on children's play rather than physical activity. We encourage schools to adopt our 2-part intervention. In most cases this will involve connecting with community recycling centers to provide materials and engaging an independent consultant to discuss the benefits of risky play with staff and parents. It is also important to keep in mind that the loose parts play component may not be the only or even the ideal solution for all school contexts. The schools in our study had limited natural resources either on or close to the school playground and were lacking in materials that invited creative physical play. The loose parts in our study were a means to an end for these school and should not replace contexts already present in some schools that can potentially support creative physical play. Schools with a rich natural environment that can be accessed by children during recess may only require the risk-reframing component of the intervention to help consider the implications of rules such as no running, no climbing, no cartwheels that may stymie children's play and physical activity.

Human Subjects Approval Statement

The study was approved by the Human Research Ethics Committee at the University of Sydney, Reference Number 02-2006/4/8700, and by the Catholic Education Office of the Archdiocese of Sydney, Australia.

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