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Observing children's playground activity levels at 13 Illawarra primary schools using CAST2

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Abstract

Declining levels of children's physical activity may contribute to Australia's increasing childhood obesity epidemic. School recess is an underutilized opportunity to increase children's physical activity. Methods: Thirteen regional Australian public primary schools participated in the study (2946 children). The Children's Activity Scanning Tool 2 (CAST2) collected observational playground physical activity data. The research also addressed: length of break, socioeconomic status (SES), gender, number of scanning days, and instrument calibration. Results: The proportions of Moderate or Vigorous Physically Activity (MVPA) children at the observed schools ranged from 0.4 to 0.7. The odds ratio of boys being MVPA relative to girls ranged from 0.8581 to 2.137. There were significant differences between the mean proportions of 3 days of activity (range P = .001 to P = .015) and no association between SES school groupings (deviance ratio: 0.48; P = .503). Interrater reliability for instrument calibration using Spearman correlations coefficients ranged from r = .71 to r = .99. Conclusions: There were significant differences between proportions of MVPA children at the 13 schools and between male and female populations. There was no association between playground physical activity and SES. The monitoring period for CAST2 should be at least 3 days. Interrater reliability indicates that correlations between observers were consistently high.

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Observing Children's Playground Activity Levels at 13 Illawarra Primary Schools Using CAST2

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Background: Declining levels of children's physical activity may contribute to Australia's increasing childhood obesity epidemic. School recess is an underutilized opportunity to increase children's physical activity.[1] ***Methods:*** Thirteen regional Australian public primary schools participated in the study (2946 children). The Children's Activity Scanning Tool 2 (CAST2) collected observational playground physical activity data. The research also addressed: length of break, socioeconomic status (SES), gender, number of scanning days, and instrument calibration. ***Results:*** The proportions of Moderate or Vigorous Physically Activity (MVPA) children at the observed schools ranged from 0.4 to 0.7. The odds ratio of boys being MVPA relative to girls ranged from 0.8581 to 2.137. There were significant differences between the mean proportions of 3 days of activity (range $P = .001$ to $P = .015$) and no association between SES school groupings (deviance ratio: 0.48; $P = .503$). Interrater reliability for instrument calibration using Spearman correlations coefficients ranged from $r = .71$ to $r = .99$. ***Conclusions:*** There were significant differences between proportions of MVPA children at the 13 schools and between male and female populations. There was no association between playground physical activity and SES. The monitoring period for CAST2 should be at least 3 days. Interrater reliability indicates that correlations between observers were consistently high.

Keywords: children's activity, observational instrument, physical activity, scanning tool, socioeconomic status

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Regular physical activity in children and adolescents yields physical and mental health benefits that track at low and moderate levels into adulthood[2,3] The amount of daily physical activity undertaken by children has declined dramatically over the last 30 years.[4,5] Children's physical activity levels in the urban environment are compromised by a lack of space for safe play areas. 'Stranger danger' and the busyness of urban streets precipitate parental fear consequently preventing their children from walking to school and playing outdoors.[6,7] Children's activity is further jeopardized by domestic sedentary pastimes including television, computers, and PlayStations.[8]

In 2002, a ministerial round table of The World Health Organization emphasized the need to create 'enabling environments' for children's physical activity in institutions such as schools.[9] The macro-environment of the school plays a key role in children's physical activity levels and may be a medium to reduce escalating rates of obesity. Most children Australia wide access schools, therefore schools represent a prime medium for the promotion of physical activity[10]. However, children's physical activity at school can be limited by curriculum pressure to meet academic targets, resulting in constrained timetabling of physical education classes.[11,12] Access to school playgrounds at recess and lunchtime provides an alternative environment to increase children's physical activity levels. Currently such opportunities appear to be underutilized.[13] Studies show that that children spend around 50% or less of their school break time in moderate or vigorous activity (MVPA).[14–17] Several studies have indicated that primary aged boys were more physically active than girls were during recess.[2,18–20] In Australia the school environment is particularly important for girls as they obtain most of their activity during school hours.[21]

Physical activity is measured in various ways including self-report, electronic or mechanical monitoring, direct observation, indirect calorimetry, doubly labeled water, and direct calorimetry.[22] Choice of physical activity assessment depends upon the specific research question and the age of the participants.[22] The instrument must be accurate enough to assess activity

patterns yet sensitive enough to monitor intermittent activity, especially when used in children.[23] The environmental complexity of the school playground makes it difficult to gather children's physical activity data as they move in undirected chaotic conditions.[2,19] Direct observation and mechanical monitoring are the best methods for monitoring activity patterns in large groups of young children.[22] However, monitors are extremely costly for large groups of participants and can be inconvenient for the user.[23]

Direct observation is the most practical, economic, noninvasive, and valid measure of children's physical activity in large populations. Although direct observation can be reactive, it is successful in situations where participants are in a defined area such as the school playground.[22] There are several direct observation tools which are sufficiently reliable and valid.[16,22,23] However, to date only 2 instruments have been specifically designed to measure school playground activity: the System for Observing Play and Leisure Activity in Youth (SOPLAY)[24] and the Children's Activity Scanning Tool (CAST).[2,3] These instruments make use of SOFIT (System for Observing Fitness Instruction Time) activity categories, which are a valid and reliable estimate of energy expenditure.[25] Both instruments use noninvasive checklists to calculate playground physical activity levels. CAST and SOPLAY have similar limitations. The cost of gathering large amounts of data can be high, if observers are employed. To date neither instrument has been used extensively in research. SOPLAY was developed for middle school children (aged 11 to 14 yrs). SOPLAY 'code' validity was established using heart rate monitors, but to date there are no field based validity studies.

The CAST instrument was preferred for this research as it was field tested for validity and reliability in the Australian environment and developed for primary aged children (5–12 yr olds). Originally CAST required 5 observers to monitor 5 categories of activity (lying down, sitting, standing, walking, or equivalent energy expenditure and more vigorous than walking).[1] The instrument was modified in 2004 by Budgen and colleagues[26] to use 3 instead of 5 observers as only 1 observer was required to monitor the 3 sedentary categories combined (lying down, sitting, and standing) and named CAST2. CAST2 is a momentary time sampling technique developed to measure children's physical activity levels in a school playground environment. CAST2 uses continuous 75 second scans of the break period, which may be more reliable than intermittent scans. In each 75 second period the observers scan the playground first for children's activity and a second time for equipment availability/usage, teacher presence/behavior. Temperature and humidity are measured at the start of each break. CAST2 reliability and validity were field tested in the 'Move it Groove it' program at 18 Primary schools (children aged 5 to 12 yrs) using a Gold Standard Video.[3] In previous research, Zask et al [2] indicated that 1 day of observational data collection was insufficient for accurate assessment of school playground physical activity. McKenzie[19] found that 3 to 4 days of data collection provided adequate sampling for reliability.

This study aimed to determine whether there were significant differences between the proportions of MVPA children at 13 schools. If significant differences exist, school environmental and policy variables will subsequently be compared as part of a larger study. In addition, this study assesses: if there is an association between playground activity and length of break time, instrument interrater reliability obtained from observer instrument calibration, and the number of days of observation required for adequate sampling of observational data. Finally, the study examines disparities between playground activity levels of males and females and between schools with lower and average SES.

Methods

Public schools in the Illawarra region of NSW were classified by the Department of Education as lower SES or average SES based on the income of families whose children attended the school. From a list of schools with average and low SES, 6 and 4 schools respectively were randomly selected using a random table of numbers.[27] In addition, 3 schools designated as the most disadvantaged in this region, were included. This resulted in the inclusion of 13 public schools (2946 children) in the study (refer to Table 1). Passive consent was gained from participating schools. All families were informed of the research, its risks and were given the opportunity to prevent their child from being included in observational data collection.

In Australia, there are 2 breaks during the school day (the shorter is referred to as recess and the longer is lunch). To account for daily changes in the school or physical environment, children were observed for the same 3 days of the week—Tuesday, Wednesday, and Thursday—at each school (4 breaks). The first recess break and all 3 lunch breaks were used to calculate the proportions of active children at each of the 13 schools. One school had incorrect data in 1 recess period and 1 recess break was used for instrument calibration.

Observations did not proceed during inclement weather; in this event, the observations were rescheduled for another day. Most observations occurred during autumn (Feb. 15, 2005 until June 9, 2005). Schools ranged in size from 27 to 588 students (see Table 3) and the largest school was the only school with more than 400 children. The school populations comprised 2 different age categories, infants (Kindergarten to Year 3: 4 to 9 yrs old) and primary students (Year 4 to Year 6: 10 to 13 yrs old). Temperature and humidity were recorded immediately before the commencement of each break.[2]

Observers were trained to use CAST2[2,26] at a full day training course and practiced its use during 3 days of observation at a pilot school. The first day of training

included category identification (SOFIT categories), use of the CAST scoring instrument, use of school maps to segment playground areas for observational viewing and guided field practice.

Before the commencement of scanning at each school (ie, Day 1) the playground was segmented and observers agreed on the location, size, and boundaries of each target area. Three observers rotated between all playground segmented areas over the 3 days of observations. The number of times that the observers moved during 1 break period was dependent upon the size of the school playground, the number of children playing in the playground, and the number of supervised playground areas available for play. If observers were required to move to a different vantage point during the 1 break, the time spent at each vantage point was evenly distributed and movement between vantage points was considered.

Three observers stood beside each other and simultaneously scanned the predetermined viewing area from right to left in 1 continuous sweep. Observers held a pen (to assist their view) in an extended arm and counted the number of children in their assigned activity category as their arm moved in 1 motion over the segmented viewing area. Each observer scanned 1 of the activity categories (low, mod and high) per day and observers changed allocated categories each day. Two scans occurred during each 75 second scanning period until the break ended (timing was assisted by an audio taped signal). In the first scan the numbers of active/inactive children were counted and recorded. Then observers simultaneously scanned the playground a second time to record teacher presence/behavior, equipment availability, and equipment usage. Scanning data were recorded on a CAST2 scoring sheet after each scan. A new scan began at the commencement of each 75 second interval. Observations alternated between males and females for each 75 second interval.

It was possible for the same child to be counted twice in the 1 scan if the child moved as the observers swept the scanning area. The specific ages of the children involved in scans were not known. At some schools infants and primary children played in separate areas, however in most instances all children shared the same play areas. Observations rotated through all playground areas, ensuring that children of all age groups were included in the data set.

When monitoring teacher categories observers indicated whether the teacher was encouraging, observing or managing playground activity. Equipment categories recorded the number of balls, the number of children playing with balls, the number of fixed and nonfixed equipment. Children were considered to be playing with a ball if they were engaged in a game with a ball (even if they were not in physical contact with the ball at the moment of scanning).

Statistical Analysis

To account for schools that were smaller, or had less break time, proportions of low, moderate, and highly active children were calculated using the sum of active children, divided by the sum of all children scanned for each school. Multiple comparisons were performed to find which schools differed significantly. The proportions of active children were compared across each of the 13 schools in the study. In previous research, gender differences in activity levels consistently showed that males are more active than females in the school playground environment.[2,19,20] In this study, odds ratios were used to examine whether school playground activity levels of males and females were consistent with the previous findings.

McKenzie[19] noted that 3 days of observation provided adequate sampling for reliability when assessing males and 4 days for females. A limitation noted by Zask et al [2] when CAST2 was originally developed was that each school was only surveyed on 1 day (2 breaks). In this study an analysis of variance was conducted on the mean proportions from the 3 days of observed activity to determine whether 1 day of activity data were representative of 3 days of activity data.

In this study the CAST2 instrument was calibrated during 1 recess at 9 of the 13 schools to maintain observer consistency (interrater reliability). At 8 of the 9 schools, 3 observers stood beside each other and simultaneously scanned the playground monitoring moderately active children during 20 second scans, as additional monitoring of teachers or the environment were not required for instrument calibration.[2,28] At 1 small school (N = 27) only 2 observers scanned the playground during reliability testing. Scanning alternated between males and females [1.] Moderate activity category was the most difficult category to count. Children were moving and as there were more moderately than highly active children, it was therefore a greater test of reliability. To test the reliability of the CAST2 instrument for instrument calibration, Spearman's correlation coefficients were calculated in SPSS (version 13) for each scanning period between each pair of observers (ie, observers 1 & 2, 2 & 3, and 3 & 1).

This study examines the effect of SES on children's playground physical activity by logistic regression. The analysis was performed using GenStat (10th edition).To determine whether the amount of time children spent in the playground during a break period was significantly associated with the proportions of active children, a Spearman's correlation analysis was conducted in SPSS (version 13). This study was approved by the University of Wollongong Human Ethics committee and the NSW Department of Education and Training.

Results

Only 6 of the 42 days of scanning were rescheduled due to inclement weather. In total, 2946 children aged between 4 and 13 years participated in the study. Total time available for scanning break times at the thirteen schools over a 3-day period ranged from 55 to 130 minutes (mean 97.5 mins). There were a total of 1013 scans over the duration of the study.

Age Groupings

As displayed in Table 1, the proportions of infants' children (kinder to year 3) were similar across the 13 schools involved in the study (minimum = 0.4639, maximum = 0.6296).

Ranking of Schools by Activity Level. The proportions of children who were moderately or highly active at the observed schools ranged from 0.4 to 0.7 (mean = 0.58, SD = 0.1; Table 1). The difference between these proportions (Table 2) at the most and least active schools was significant ($P < .0001$). From the multiple comparisons, it was seen that the school with the least proportion of active children (ie, School F) was significantly different from all other schools (School F v schools A, B, C, D, E, $P < .001$; School F v G, $P = .0002$; School F v J, $P = .0003$).

Gender Differences in Activity. The odds ratio of boys being MVPA in the school playground relative to girls ranged from 0.8581 to 2.137 (Table 3). At 12 of the 13 schools the odds ratio favored boys being more active than girls. Notably the school at which the odds of girls being MVPA in the school playground relative to boys, was the school with the lowest number of students (N = 27).

Analysis of the Number of Days of Scanning. To address the question of the number of days of observation required for adequate sampling, an analysis of variance of the mean proportions of the 3 days of activity was calculated for each of the 13 schools. At 6 of the 13 schools there was not a significant difference between the mean of the 3 days of activity (significance ranged from $P = .143$ to $P = .814$). At 4 of the schools there were significant differences between the mean proportions of the 3 days of activity (significance ranged from $P = .001$ to $P = .015$). At the 3 remaining schools, the

Table 2 Schools SES Status and Associated Proportions of Active Children

Ranking: most to least active	School	Proportions of MVPA children	SES status of school
1	B	0.70366	Low SES
2	E	0.69081	Low SES
3	K	0.68924	Average SES
4	D	0.65438	Average SES
5	I	0.62889	Average SES
6	L	0.60952	Low SES
7	C	0.59481	Average SES
8	H	0.57103	Average SES
9	A	0.53051	Low SES
10	M	0.50681	Low SES
11	G	0.47318	Low SES
12	J	0.45899	Average SES
13	F	0.39988	Low SES

Abbreviations: MVPA, Moderate or Vigorous Physical Activity.

Table 1 Composition of Age Groupings at the 13 Schools

School	Infants (K–Yr3)	Primary (Yr4–Yr6)	Total
A	195	185	380
B	45	52	97
C	88	52	140
D	169	151	320
E	91	65	156
F	205	166	371
G	86	46	132
H	312	276	588
I	89	76	165
J	38	37	75
K	17	10	27
L	105	95	200
M	155	140	295

Table 3 The Odds Ratios of Boys Being Moderate or Vigorously Physically Active (MVPA) Relative to Girls

School	Odds of boys being MVPA relative to girls
A	1.601
B	1.784
C	1.449
D	1.9
E	2.137
F	1.057
G	2.088
H	1.79
I	1.185
J	1.203
K	0.858
L	1.941
M	1.648

differences were not significant but approached significance (ie, $P = .075$, $P = .08$, $P = .093$).

Instrument Calibration for Observer Consistency. Spearman correlations coefficients between pairs of observers at the 9 schools ranged from 0.71 to 0.99, with 8 of the 9 schools producing correlations coefficients above 0.91. Interrater reliability determined by Cronbach's Alpha ranged from 0.965 to 1.0 across the 9 schools. Note: at 1 small school (N = 27) only 2 observers were available for playground instrument calibration (ie, 1 recess period), but all observers were present for all other observational data collection at that school (including lunch on the same day).

Confidence intervals (95%) were used to estimate the correlation coefficient between the scores of pairs of observers. For these confidence intervals, the least value of all lower bounds was 0.718 and the greatest value of all upper bounds was 1.0. However, 22 of the 25 lower endpoints of the confidence intervals were above 0.915 (Table 4).

Socioeconomic Status and Proportions of Active Children. A logistic regression demonstrated that there was no significant difference between the effects of the 2 socioeconomic school groupings on playground activity levels of the children involved in the study. The deviance ratio (on 1 and 11 degrees of freedom) equaled 0.48 ($P = .503$; refer to Table 2 for school SES status).

Time Spent in School Playground. Spearman's correlation coefficients indicate the proportion of active children at each school and the actual number of minutes the children spent in the playground during the observational data collection showed a positive correlation $r = .318$ ($P = .289$). The relationship is significant if a Spearman's correlation is run with all schools except 1 outlier $r = .603$, ($P = .038$).

Discussion

CAST2 was used to determine whether there were significant differences between the playground physical activity levels of children at 13 primary schools. There is a dearth of knowledge regarding the school environmental variables which contribute to children's playground activity levels. One method of exploring possible variables is to compare different school environments. However, first there must be evidence that a difference exists between the proportions of active children in school playgrounds. This study found significant differences between the proportions of active children ranging from 40 to 70% at 13 primary schools, confirming that comparing school environments is an appropriate method of ascertaining reasons for variability in physical activity. Notably it is important to find ways of increasing playground activity in schools where the recess period is clearly underutilized and activity levels are as low as 40%.

It was not possible to record the specific age of the children involved in scans. However observers rotated through all playground areas to include all age groupings in the data set and there were similar proportions of older and younger children at all of the schools in the study. A challenge for future research is to consider ways to segment younger and older children during observation to ascertain the effect of this variable.

Previous research has acknowledged the complexity of gathering observational data in the chaotic environment of school playgrounds.[2,19] One consequence of this is the possibility of counting children more than once during 1 observational scan. It is a limitation of collecting data in a real world environment of the school playground (as in CAST2).

The 75 second scanning periods for observational data collection (CAST2) used in this study reflected the protocol used in previous research.[2,26] Observers were trained to segment the playground for scanning, allowing for adequate data collection during the 75 second interval. This time interval was found to be satisfactory during this research. No problems were reported by the observers in recording the required data in this time frame.

The time available for children to be active during school break times may be important in achieving children's recommended daily physical activity. At school, children have been shown to be MVPA during physical education (PE) for only 18% of class time and PE classes are sometimes replaced by other academic curriculum.[29,30] Opportunities for children to be active at home participation are limited by their sedentary activities (ie, TV, computers, and PlayStations). Modern home environments also often lack space for adequate outdoor activity. Thus school break times give children a daily opportunity to be active, in a secure spacious environment, devoid of sedentary screen pastimes. There were noticeable disparities between total breaks times at the 13 schools (55 to 130 minutes; mean 97.5 mins). Restricted school break times may remove one of the few outdoor opportunities available for children to be active.

Undertaking research in school environments makes it difficult to compare like variables, as schools are so diverse. Disparities were found between break times and student numbers at the 13 schools. To reduce confounding, data analysis involved comparing proportions of active children, rather than actual student numbers. The overall proportion of children who were moderately or highly active at the observed schools were 56%, which is similar to previous research.[15–17,31] However there were significant differences between the most and least active schools (40% to 70%). Closer examination of the school environments may disclose the reasons for this discrepancy.

The results of this study confirm a need to address gender differences in physical activity, particularly as previous studies have found that girls partake in most of their activity during school hours.[21] Outdoor play is ball based and therefore more conducive to male activity.

Table 4 Instrument Calibration: 95% Confidence Intervals (CI) of Moderate Physical Activity (MVPA) for Recess Playground Activity

School	No of pupils	No of scans in break	When surveyed (out of 13)	Observers	Correlation coefficient	95% CI
M	295	32	1st	1 & 2	0.966	0.930–0.983
				2 & 3	0.853	0.718–0.926
				3 & 1	0.900	0.804–0.950
A	380	19	4th	1 & 2	0.967	0.915–0.988
				2 & 3	0.987	0.966–0.995
				3 & 1	0.979	0.946–0.992
C	140	40	5th	1 & 2	0.993	0.987–0.996
				2 & 3	0.973	0.949–0.986
				3 & 1	0.978	0.959–0.988
I	165	66	6th	1 & 2	0.963	0.941–0.977
				2 & 3	0.969	0.949–0.981
				3 & 1	0.997	0.995–0.998
H	588	40	8th	1 & 2	0.996	0.991–0.998
				2 & 3	0.996	0.991–0.998
				3 & 1	1.000	1.000
K	27	27	10th	1 & 2	0.981	0.959–0.991
B	97	40	11th	1 & 2	0.945	0.899–0.971
				2 & 3	0.986	0.974–0.993
				3 & 1	0.973	0.950–0.986
L	200	14	12th	1 & 2	0.980	0.935–0.993
				2 & 3	0.997	0.990–0.999
				3 & 1	0.978	0.931–0.993
E	156	40	13th	1 & 2	0.994	0.989–0.997
				2 & 3	0.988	0.978–0.994
				3 & 1	0.995	0.991–0.998

Note. Only 2 observers were used during reliability testing for one recess at School K.

Altering outdoor environments may make active play more attractive to girls. If appropriate equipment and space were available, girls may prefer activities such as dance. It is also possible that boys may be more aggressive or in their play intimidate girls.[32] Designated play areas for girls might increase their opportunities to be active. In Australia, uniforms worn by girls in primary school (ie, dresses, skirts, tights) may restrict them and discourage active play. Raising school and parent boards' awareness of gender differences in activity may influence decision making about girls' uniforms. There are many unanswered questions regarding gender discrepancy in playground physical activity, warranting further investigation.

In this study, an analysis of variance of the mean proportions of 3 days of observed activity indicated that 1 day of activity data did not adequately represent 3 days of activity data. It is recommended that a minimum of 3 days of data collection is required for observational data.

This study was unique in testing CAST2 under a wide range of circumstances, in different sized schools and playgrounds.[2] CAST2 instrument calibration indicated that correlations between observers were consistently high, strengthening previous reliability analysis of the instrument.[2,26] The findings thus confirm that the CAST2 instrument is a suitable observational tool for physical activity analysis of Australian primary school playgrounds. However instrument calibration may have been limited by having only 2 of the 3 observers calibrate the CAST2 instrument at 1 small school in the study (N = 27). This was not in keeping with the instrument design, but unavoidable due to staffing issues. Furthermore, future reliability analysis may be improved by having observers calibrate all 3 activity categories (low, moderate, and high) instead of moderate alone.

This study was designed to focus on physical activity in schools in low and average SES areas as previous studies have found an association between lower socioeconomic status and lower levels of primary aged children's physical activity.[18] An Australian study, Spinks et al,[33] found no association between children's daily physical activity and SES. It is interesting to note that of the 13 schools in this study 2 of the 3 most active and 4 of the 5 least active schools were rated lower SES. However, a logistic regression indicated no significant difference between the socioeconomic school groupings in terms of levels of physical activity.

This research found positive associations between the proportion of active children at each school and the number of minutes they were allowed to play during break time. Notably total time available for play ranged from 55 to 130 mins at the 13 schools (3 day period). Ensuring children have adequate time to play in break times may increase their overall activity levels.

Conclusion

In this study, a significant difference was found between the proportions of active children at 13 schools in 1 region, providing support for the need to examine school environment variables to ascertain reasons for variability in children's playground physical activity levels. The association between activity and length of break time indicates that restricted break times may remove 1 of the few outdoor opportunities available for children to be active. The findings indicate that a minimum of 3 days of observation are required for adequate sampling of observational data. Interrater reliability for observer instrument calibration (CAST2) was confirmed by findings of consistently high correlations between observers. Discrepancies between the activity levels of males and females foster unanswered questions related to gender, warranting further investigation. Finally the study found no significant difference between the effects of lower or average SES on children's playground activity levels.

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