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Individual and environmental correlates of school-based recess engagement

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ABSTRACT

The purpose of this study was to examine individual variables associated with children's levels of recess physical activity (PA), as well as environmental influences that influence children's engagement during recess. Participants ($n = 146$) were 4–6th grade students across seven schools. PA data were collected using the Fitbit Flex. Psychological need satisfaction at recess data were collected with a basic psychological need satisfaction for recess PA survey. Observations of recess activity engagement and the quality of the recess environment were also collected at 134 recess periods ($n = 8340$ children) across nine schools. Results of multi-level regression analyses indicated that gender and recess time were significant predictors of physical activity during recess. In examination of the environmental level factors, multi-level regression analyses revealed that 'adult engagement and supervision' was the only significant predictor for recess engagement in boys and girls. These findings suggest the amount of time allocated, and the quality of the recess environment must be included in evaluation of the critical factors relevant to engagement of students in physically active recesses.

1. Introduction

Physical activity (PA) is important to help curb high obesity rates amongst today's children (Hills et al., 2011). In considering environmental contexts, the school day takes up a large quantity of waking hours for children, and is a prime opportunity to promote PA. Despite research that shows time spent engaging in PA may positively contribute to academic outcomes (Centers for Disease Control and Prevention, 2010; Jarrett et al., 1998; Wittberg et al., 2010; Zygmunt-Fillwalk and Bilello, 2005), and evidence which indicates that class time afforded to PA does not hinder academic performance (Centers for Disease Control and Prevention, 2010; Ahamed et al., 2007), time dedicated to PA opportunities such as school recess have decreased over the last two decades in the United States (U.S.) (Zygmunt-Fillwalk and Bilello, 2005). This trend disproportionally affects children who go to large, urban schools; schools with a high minority population; and schools with low-income levels (Robert Wood Johnson Foundation, 2007). These schools also report the fewest number of recess minutes allotted per day (Robert Wood Johnson Foundation, 2007). Children in urban communities also have less access to out of school opportunities to become physically active (Echeverria et al., 2014; Kottyan et al., 2014). Thus, opportunities during the school-day have become a more important, yet ever decreasing, mechanism for children to engage in PA that may help temper the current obesity epidemic.

In the U.S., recess has been shown to be a primary contributor to school-based PA (Robert Wood Johnson Foundation, 2007; Erwin et al., 2012). Despite this, 60% of U.S. school districts have no formal policy regarding daily recess, and only 22% of school districts require daily recess for children, with less than half of these requiring at least 20 min of recess per day (Centers for Disease Control and Prevention, 2014). While recess is an opportune time for PA during the school day, critical factors that allow schools to leverage this time period to promote PA are needed. In considering factors that might influence recess activity and engagement, data has consistently shown that boys are more active than girls during recess periods. For example, controlling for socioeconomic status (SES), Baquet et al. (2014) reported that boys participated significantly more in moderate-to-vigorous physical activity (MVPA), and that girls were significantly more likely to engage in sedentary behaviors during recess. Similar findings have been reported throughout the literature (Ishii et al., 2014; Martin et al., 2012; Saint-Maurice et al., 2011; Viciana et al., 2016). Aside from gender, weight status and perceived competence in sports are likely contributors to PA during discretionary periods such as recess (Martin et al., 2012). This finding is consistent with previous work that suggested satisfaction of

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basic psychological needs (e.g., perceived competence) is predictive of PA behavior (Kottyan et al., 2014; Haapala et al., 2014; Murillo Pardo et al., 2016; Stellino and Sinclair, 2013). Finally, in a systematic review of recess interventions, Erwin and colleagues (Erwin et al., 2012) reported that adding more playground equipment and providing a structured recess yielded the largest effect on PA during recess. Results showed the highest level of PA in younger children. Type of activity might also matter, as researchers have reported girls engage in similar levels of MVPA as boys when playing team sports (Saint-Maurice et al., 2011), and that providing an activity of the week intervention can yield gains in MVPA (Stellino et al., 2010).

As reported above, gender, age, SES, psychological needs and the playground environment can influence levels of PA during recess. Given that older elementary school children are less likely to be active than younger children, and that children in low SES schools are least likely to have opportunities for PA during school, we aimed to explore both individual, and environmental, correlates of PA in this specific population. The primary purpose of the current study was, therefore, to examine individual variables (i.e., gender, competence, autonomy, relatedness) that affect children's level of PA at recess; and to examine environmental factors (i.e., safety and structure, adult supervision and engagement, student behaviors, and transitions) that affect children's PA engagement at recess, in a sample of older elementary school students in an urban, low-income school district. Secondary purposes included an examination of how long students participated in PA during recess each day, the contribution of recess to school-based PA, and a description of what types of activities children choose to do at recess.

2. Materials and methods

2.1. Participants

Participants included 146 students (M_{age} = 9.85 years) in 4th, 5th and 6th grades across seven public schools in a large urban school district in the Midwestern portion of the U.S. Participants were 57.1% female, 43.5% African American, 34.8% Hispanic or Latino, and 12.9% Caucasian. Observational data of 8370 children, at 134 separate recess sessions were also collected across these nine schools. School district data reports showed that 85.07% of children in these nine schools were classified as economically disadvantaged and 12% were classified as English language learners.

2.2. Measures

2.2.1. Demographic data

Demographic data for each individual participant was collected by a trained data assessor. This information included participant age, grade, sex, and race (Table 1). Additionally, the percent of children classified as economically disadvantaged at each school was obtained from the department of public instructions' accountability report cards and used as an indicator of school level socio-economic status (SES).

2.2.2. Physical activity

The Fitbit Flex™ is a wrist worn triaxial accelerometer that uses proprietary algorithms to estimate steps counts and time spent in various activity levels. An anonymous account was created for each device accessible only by the research team. Data was housed by a third-party vendor (Fitabase LLC, San Diego, California). In child-based studies, both waist-worn (Hamari et al., 2017) and wrist worn (Voss et al., 2016) Fitbit devices (Fitbit One and Fitbit Charge, respectively) have been shown to have consistent levels of step counts with Actigraph accelerometers, yet may over-estimate absolute number of steps, as well as time spent in MVPA. Additional research in young adult populations has shown moderate validity between the wrist-worn Fitbit Flex and the wrist-worn Actigraph GT3X+ in free-living conditions (Sushames et al., 2016), yet the Fitbit flex showed higher levels of variability, and was more likely to under-estimated activity levels.

2.2.3. Activities for Daily Living–Playground Play (ADL-PP)

The different types of activities children engaged in during recess were measured using an observational form of the Activities for Daily Living–Playground Play (ADL-PP; Stellino and Sinclair, 2014). The ADL-PP is a single-page document that includes 38 squares with labeled illustrations (i.e., the words “bounce a ball” with a drawn picture of a child bouncing a ball) of playground-based activities (e.g., kickball, hopscotch, watch other kids) that children typically engage in during recess. An additional open square (Box 39) with no illustration and the phrase “play a different game” was included so observers could report any activities that were not included elsewhere on the instrument, but played during recess. Trained observers conducted observations at 5-minute intervals during a recess period, with frequency counts collected for all activities including the different games, activities, or sedentary behaviors. Counts were separated by gender, and a percent of children engaged in active play (as opposed to not-engaged) was calculated. Previous studies have suggested high levels of agreement between children self-report and observer reports (Watkinson et al., 2001) as well as between multiple raters (Stellino et al., 2018).

2.2.4. Great Recess Framework–Observational Tool (GRF-OT)

The GRF-OT is an observational measure that is used during live data collection periods. Previous research has shown support for the factorial validity of a four-factor model for the GRF-OT (Authors, blinded reference). Specifically, adult supervision and engagement, safety and structure of the playground, student behaviors, and transitions have all emerged as unique constructs within the tool. These constructs are measured through a series of questions pertaining to the context of recess and placed on a 4-point scale in which lower scores reflect a lower quality scores for each item. In the current study, the range of possible scores on the GRF-OT was 16 (i.e., “1” for each item) to 64 (i.e., “4” for each item). Previous data has also supported the inter-rater reliability, and the test-retest stability of the GRF-OT (Authors, blinded reference).

2.2.5. Basic Psychological Needs Satisfaction – Recess (BPNS)

Individual students completed a modified version (Sushames et al., 2016) of the basic psychological need satisfaction scale (BPNS: Deci et al., 2001), which measures autonomy (7-items), competence (6-items), and relatedness (8-items) for PA at recess. All responses corresponded to a 5-point Likert scale (5 = high need satisfaction) on items such as “I feel like I can say my ideas about what I want to do at recess” (autonomy), “Kids tell me I am good at things I do at recess” (competence) and “I really like the kids I play with at recess” (relatedness). Previous research consistently reported adequate reliability for each of the three areas of need satisfaction, including use of the measure adapted to physical education (Sushames et al., 2016; Stellino and Sinclair, 2014).

2.3. Procedures

All procedures were approved by the institutional review board of the first author's institution and the participating school district's research and evaluation office prior to school and participant recruitment. Schools were provided a $70 gift certificate to purchase recess equipment after data collection was completed. Parental consent forms were sent home in the weekly folders of fourth and fifth grade students at each school (note: one school had a combined classroom with 4–6th grade students, and thus these 6th grade students were included in the study). Signed parental consent and student assent was obtained to collect individual level data for 146 students. Prior to the start of the school day each participant was fitted with a Fitbit Flex on their non-dominant hand and was instructed to keep the device on throughout the day. Members from the research team were present at the beginning

Table 1
Participant demographic information.

	N	Sex	Race	Age (mean, SD)	School % economically disadvantaged
School 1	31	Female 71% Male 29%	African American 10% Hispanic/Latino 86.7% Multiracial 3.3%	9.48 (0.55)	92%
School 2	29	Female 55.2% Male 42.9%	African American 64.3% Hispanic/Latino 10.7% Caucasian 17.9% Multiracial 7.2%	9.57 (0.56)	62%
School 3	12	Female 75% Male 25%	African American 90.9% Hispanic/Latino 9.1%	10.15 (0.67)	85%
School 4	9	Female 44.4% Male 55.6%	African American 100%	10.22 (0.44)	97%
School 5	25	Female 64% Male 36%	African American 16.7% Hispanic/Latino 20.8% Caucasian 45.8% Hmong 4.2% Multiracial 12.5%	10.16 (0.37)	74%
School 6	24	Female 37.5% Male 62.5%	African American 95% Caucasian 5%	10.16 (0.45)	95%
School 7	16	Female 50% Male 50%	African American 6.3% Hispanic/Latino 81.3% Caucasian 12.5%	9.71 (0.62)	98%

and end of each day to ensure devices were properly placed on participants and were collected at the end of each day. Fitbits were worn over a two-week period, with the first week being used to decrease reactivity for users to the activity monitoring device and the second week being used for active data collection. Surveys used were available in Spanish and English and were administered by the research team. All data were collected in the fall of the 2016–2017 academic school year.

Group level observations using the GRF-OT and ADL-PP were also collected during the two-week study period. A passive consent protocol was approved for this portion of the study in which letters were sent home and parents were asked to sign and return the form if they wanted their child to be excluded from the study. No forms were returned which allowed the research team to conduct observations of all children at all recesses.

2.4. Data analysis

Prior to analysis, all data were screened for patterns of missingness. First, all PA data (as recorded with Fitbit Flex) were examined for all individual users at 60-second epochs, the most sensitive setting on the Fitbit Flex device. Participants with at least three valid school-days were included in the analysis (Heitzler et al., 2011). A valid day was defined by 6 h of wear time (approximately 30 min less than the entire school day). Non wear-time was defined by at least 60 consecutive minutes of 0 step counts (Borkhoff et al., 2015). In total, there were valid three-day averages for 104 participants (71.23% of the total sample). Data were collected for both step counts and minutes in MVPA across the school day. These data were then screened for normality, with all assumptions being met. Completed survey data were returned by 123 participants (84.25% of the total sample). The primary source of missing data was chronically absent students and those who were unavailable to complete the survey instrument during scheduled times. Survey data were also screened and met assumptions for normality. Prior to data analyses, missing data were tested and assumed to be missing at random (Little's MCAR test, $\chi^2 = 28.02$, $p = .993$). Given this, imputation of missing data was completed using expectation-maximization. Descriptive data for the sample can be found in Table 2.

To examine the relationships between recess PA satisfaction of autonomy, competence, and relatedness needs and measured levels of recess PA, multi-level linear regression analyses were conducted in which students were nested within schools. Gender, perceptions of autonomy competence, and relatedness for recess PA were entered as level 1 predictors, while overall recess length and school level SES were entered as level 2 predictors.

Following analysis of individual data, multi-level regression analyses were conducted on observational data in which engagement in play was nested within recess sessions, which were nested within schools. GRF-OT sub-scales of structure and safety, adult engagement and supervision, student behaviors, and transitions were used as level 2 predictors, while school level SES was used as a level 3 predictor. Separate analyses were conducted for male and female engagement rates.

3. Results

Overall, the length of recess varied between 20 and 30 min, with a mean recess session of 22.68 min (SD = 3.36 min). Participants averaged 41.70 steps per minute during recess (SD = 12.53 steps per minute) for a total average of 951 steps (SD = 355 steps) taken during each recess period. Students also averaged 8.31 min of MVPA during recess periods (SD = 4.98). Recess contributed 27.28% (daily step count average = 3695) to the overall steps taken during the school day (Range = 5.56%–64.88%).

Observational data collected with the ADL-PP of the activities participated in at recess were averaged across all recess sessions to include an aggregate summary of activities. At an average recess, 27.4% of children were classified in sedentary activities (e.g., talking with friends), 25.9% of children were classified as playing team sports (e.g., kickball, basketball), 19.6% of participants were classified as playing on fixed equipment or jungle gyms, 15.2% of participants were classified in aerobic type activities (e.g., running, jumping, playing tag), and 7.5% of students were classified in other activities (e.g., wrestling, dance).

3.1. Student level physical activity

To examine predictors of student level MVPA, an unconditional nested model was first tested to examine possible school-level effects. Results failed to detect statistically significant variability between schools ($p = .051$), however the random between school effect accounted for 56.7% of the variance in MVPA during recess. Level 1 predictors were entered into the model (gender, autonomy, competence, relatedness), and accounted for 17.2% of the variance in MVPA, with gender the only significant level 1 predictor ($p < .001$). The

Table 2
Descriptive statistics.

Individual level variables	All participants Mean (SD) range	Boys Mean (SD) Range, $n = 61$	Girls Mean (SD) Range, $n = 84$	p-Value
Psychological need satisfaction	78.10 (11.06) Range = 39–101	78.64 (10.17) Range = 58–101	77.48 (11.58) Range = 39–98	.530
Autonomy	25.41 (4.15) Range = 15–35	25.14 (4.26) Range = 17–33	25.55 (4.09) Range = 15–35	.563
Competence	21.47 (4.00) Range = 11–30	22.24 (3.78) Range = 15–30	20.81 (3.99) Range = 11–28	.031
Relatedness	31.23 (5.28) Range = 13–40	31.26 (4.96) Range = 13–40	31.12 (5.51) Range = 13–40	.876
Recess steps	950.65 (355.06) Range = 83–1974	1068.40 (369.88) Range = 145–1974	863.42 (321.25) Range = 83–1714	.001
Recess steps per minute	41.70 (12.53) Range = 4–86	47.19 (12.59) Range = 7–86	37.61 (10.94) Range = 4–75	< .001
Recess MVPA (minutes)	8.31 (4.98) Range = 0–23	10.09 (5.07) Range = 0–23	7.10 (4.50) Range = 0–20	< .001
% of school-day PA accumulated at recess	27.28 (11.33) Range = 5.56–64.88	29.53% (11.26) Range = 8.40–61.88	25.65 (11.22) Range = 5.56–64.88	.042

Recess environment-level variables	All participants Mean (SD) range, n	Boys Mean (SD) range, n	Girls Mean (SD) range, n	p-Value
% of children in active play	72.39% (0.15) Range = 40%–100% n = 134 sessions	82.76% (0.12) Range = 40%–100% n = 134 sessions	60.82% (0.20) Range = 10%–100% n = 134 sessions	< .001
Total recess quality score	55.72 (5.80) Range = 34.5–63.0 n = 134 sessions			
Safety and structure of environment	17.74 (2.26) Range = 12–21 n = 134 sessions			
Adult engagement and supervision	14.40 (1.78) Range = 8–16 n = 134 sessions			
Student behaviors	18.10 (2.44) Range = 9–20 n = 134 sessions			
Transitions	5.49 (1.19) Range = 2.5–8.0 n = 134 sessions			

Table 3
Estimates of effects on amount of MVPA during recess.

Estimation of covariance parameters

Parameter	Estimate	s.e.	Wald Z	p-Value	95% CI of the estimate
Residual	10.84	1.32	9.19	< .001	8.53, 13.77
Intercept variance (school)	2.65	2.16	1.22	.11	0.533, 13.14

Estimation of fixed effects

Parameter	Estimate	s.e.	t-Test statistic	p-Value	95% CI of the estimate
Intercept	−19.29	4.16	−4.64	< .001	−28.23, −10.36
Gender	2.92	0.588	4.97	< .001	1.76, 4.09
Autonomy	0.02	0.091	0.26	.79	−0.16, 0.20
Competence	0.07	0.084	0.85	.40	−0.09, 0.24
Relatedness	0.01	0.072	0.07	.94	−0.13, 0.15
Recess length	0.94	0.157	6.01	< .001	0.58, 1.30
School level SES	−0.55	5.40	−0.10	.92	−15.15, 14.05

addition of level 2 predictors (recess length, school SES) reduced the intercept variance at the school level by 85.37%. As shown in Table 3, recess length was the only significant level 2 predictor.

Following a similar procedure, the unconditional nested model to test steps per minute at recess failed to detect statistically significant variability between schools ($p = .091$), however the random between school effect accounted for 14.7% of the variance in steps per minute during recess. Level one predictors were then entered into the model (gender, autonomy, competence, relatedness) and accounted for 16.3% of the variance in steps per minute. As with MVPA, gender was the only significant predictor ($p < .001$). The addition of level 2 predictors (recess length, school SES) reduced the intercept variance at the school level by 98.73%. As shown in Table 4, recess length was the only significant level 2 predictor.

Table 4
Estimates of effects on steps per minute during recess.

Estimation of covariance parameters					
Parameter	Estimate	s.e.	Wald Z	*p*-Value	95% CI of the estimate
Residual	110.81	13.54	8.18	< .001	87.20, 140.79
Intercept variance (school)	0.36	4.38	0.08	.47	0.00, > 954

Estimation of fixed effects					
Parameter	Estimate	s.e.	*t*-Test statistic	*p*-Value	95% CI of the estimate
Intercept	−10.05	8.90	−1.13	.27	−28.34, 8.25
Gender	10.17	1.83	5.57	< .001	6.66, 13.79
Autonomy	0.47	0.28	1.69	.09	−0.08, 1.03
Competence	0.22	0.26	0.85	.40	−0.30, 0.75
Relatedness	−0.17	0.22	−0.77	.44	−0.62, 2.70
Recess length	1.15	0.27	4.25	.003	0.52, 1.76
School level SES	−19.83	7.04	−2.82	.07	−43.12, 3.46

3.2. Recess level engagement

To examine predictors of engagement levels at recess, an unconditional nested model was first tested to examine possible recess-level and school-level effects. For boys, statistically significant variability between schools ($p = .043$; 46.7% of the variance in engagement levels), and between recesses within schools ($p = .034$; 13.6% of the variance in engagement levels) was observed. For girls, statistically significant variability between recesses within schools ($p = .004$; 36.8% of the variance in engagement levels) was observed, however results failed to detect statistically significant variability between schools ($p = .087$; 29.5% of the variance in engagement levels). For boys the addition of level 2 predictors (safety and structure, adult engagement and supervision, student behaviors, transitions) reduced the intercept variance at the recess level by 98.5%, while the addition of level 3 predictors made a negligible contribution (< 1%). As shown in Table 5, adult engagement and supervision was the only significant predictor variable in the model. For girls, the addition of level 2 predictors (safety and structure, adult engagement and supervision, student behaviors, transitions) reduced the intercept variance at the recess level by 13.9% and the addition of level 3 predictors reduced the intercept variance at the school level by 40.8%. As shown in Table 6, adult engagement and supervision was the only significant predictor variable in the model.

4. Conclusions

The current study contributes a multi-faceted examination of individual, as well as environmental, factors associated with PA during school-based recess at urban elementary schools. Consistent with previous research, data suggest that recess makes a meaningful contribution to student's accumulation of school-based PA. While recess was short in duration, accounting for approximately 5.6% of the school day, roughly 27% of school-day PA was recorded during this time period. From a policy standpoint, it appears that children in urban and low-income schools continue to receive less than optimal opportunities for PA throughout the school-day (Centers for Disease Control and Prevention, 2010). Interestingly, recess length was a significant predictor of both MVPA, and steps per minute taken during recess. This finding suggests that providing students with extra recess time not only increases opportunities for physical activity, but that children are more active with the time they have when this time is increased.

In examining individual level predictors, findings that gender was a significant predictor of PA outcomes is consistent with previous research (Baquet et al., 2014; Ishii et al., 2014; Martin et al., 2012; Saint-Maurice et al., 2011; Viciana et al., 2016). The lack of finding significant predictive relationships between satisfaction of any of the basic psychological needs for recess PA and actual PA levels was surprising, but could have been due a variety moderating variables including, but not limited to, the specific nature of the recess environment in urban and under-resourced settings, or the limited time frame available for PA during recess. Extant research that indicated significant associations between autonomy, competence and relatedness needs satisfaction for recess PA and actual PA levels was conducted in a suburban, middle socioeconomic context where the average recess period available for PA

Table 5
Estimates of effects on boys' engagement level during recess.

Estimation of covariance parameters					
Parameter	Estimate	s.e.	Wald Z	*p*-Value	95% CI of the estimate
Residual	0.006	0.001	7.25	< 0.001	0.005, 0.008
Intercept variance (recess group)	0.002	0.001	1.85	0.03	0.001, 0.006
Intercept variance (school)	0.002	0.001	1.21	0.11	0.0004, 0.010

Estimation of fixed effects					
Parameter	Estimate	s.e.	*t*-Test statistic	*p*-Value	95% CI of the estimate
Intercept	0.30	0.13	2.27	.03	0.03, 0.57
Safety and structure	0.005	0.007	0.66	.52	−0.009, 0.02
Adult engagement and supervision	0.03	0.007	3.83	< .001	0.01, 0.04
Student behaviors	0.002	0.004	0.46	.65	−0.006, 0.009
Transitions	0.01	0.01	0.92	.36	−0.02, 0.03
School level SES	0.02	0.16	0.12	.90	−0.35, 0.39

Table 6
Estimates of effects on girls' engagement level during recess.

Estimation of covariance parameters					
Parameter	Estimate	s.e.	Wald Z	*p*-Value	95% CI of the estimate
Residual	0.02	0.002	7.04	< .001	0.01, 0.02
Intercept variance (recess group)	0.01	0.005	2.49	.007	0.006, 0.03
Intercept variance (school)	0.005	0.006	0.87	.19	0.005, 0.05

Estimation of fixed effects					
Parameter	Estimate	s.e.	*t*-Test statistic	*p*-Value	95% CI of the estimate
Intercept	0.53	0.23	2.33	.03	0.06, 0.99
Safety and structure	−0.10	0.01	−1.43	.16	−0.04, 0.007
Adult engagement and supervision	0.02	0.01	2.11	.04	0.001, 0.05
Student behaviors	0.001	0.006	0.19	.85	−0.01, 0.01
Transitions	0.005	0.02	0.25	.80	−0.03, 0.04
School level SES	−0.47	0.29	−1.64	.15	−1.16, 0.22

opportunities was approximately 30 min long (Stellino and Sinclair, 2013; Stellino et al., 2010). While inconsistent with previous research, these findings may point to the salience of examining the social and environmental context of recess. Moreover, results suggest a significant portion of unaccounted for variance at the individual level, and thus future researchers should consider identifying barriers and facilitators to recess physical activity that are unique to urban and low-income populations. Finally, it is possible that the current study was not powered enough to detect a significant relationship that otherwise exists, and future studies examining school based recess should aim to adequately power their analyses for the clustered nature of recess level data.

Perhaps the most novel finding in the current study pertains to the results of examinations of the environmental context of recess, and the activities in which students choose to engage. To date, no study has concurrently examined the contextual features of the environment and what students choose to do during recess in a systematic way. Our results indicate that the quality of the recess environment is a variable warranting attention in the literature. Indeed, previous research has examined environmental interventions and their impact on PA, yielding findings to suggest that the environment is important in promoting PA during recess (Erwin et al., 2012). However, in the current study, adult engagement and supervision was identified as the most salient recess level predictor of engagement for boys and girls. Thus, in considering how to take advantage of limited time for PA, results of the current study suggest that adults can be more than passive observers assigned to monitor recess, but can also be active participants, and even beneficial role models, for children on and around the playground. In doing so, adults may help to optimize the relatively short periods of time children have during recess by ensuring equipment is out and ready for use, games and play can be started in a timely and efficient manner, and conflicts on the playground can be mediated in an expedited fashion, as well as with a focus on ensuring play is not disrupted. While the environmental constraints associated with recess PA remain understudied, qualitative investigations examining children's own perceptions of recess time are congruent with the observations in the current study (Watkinson et al., 2005; Hyndman, 2016; Pawlowski et al., 2016). However, analyses in the current study also suggest there may be additional recess level, and school level, predictors of student engagement during recess which is a topic that should be explored in future research.

The strengths of this study include the examination of children's PA behaviors at recess according to a variety of factors simultaneously, particularly within a sample from an under-researched and under-represented population. That said, several limitations should be noted in considering the findings in the current study. First, due to difficulties in obtaining parental consent, there were lower than expected individual participation rates, thereby diminishing the sample, reducing statistical power, and introducing a possible selection bias. An additional limitation is the use of the Fitbit Flex, which is a commercial device with proprietary algorithms for estimated activity levels. Given difficulties with both feasibility and validity in child-based PA measurement (Muller et al., 2018) future researchers are encouraged to develop child-centered devices for use in future studies. Finally, the cross-sectional nature of the data collection precludes any inferences of causality being made within the current study. Thus, future studies should examine if interventions aimed at the maximizing adult supervision and engagement, and student behaviors (i.e., inclusion, conflict resolution, initiative) can increase PA during recess. Despite these limitations this study provides important evidence-based insights into possible environmental variables that are important to PA promotion during recess in low-income urban schools, adds to the knowledge base on levels of recess PA behavior, and ultimately provides a starting point for better understanding how factors about the environment may shape PA behavior during school recess.

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Data availability

Our participants and their parents were not asked to consent to data-sharing outside of our research group. A desensitized aggregated dataset can be requested by contacting the primary investigator of the study.

Conflicts of interest

None.

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References

Ahamed, Y., Macdonald, H., Reed, K., Naylor, P.J., Liu-Ambrose, T., McKay, H., 2007. School-based physical activity does not compromise children's academic performance. Med. Sci. Sports Exerc. 39 (2), 371–376.
Baquet, G., Ridgers, N.D., Blaes, A., Aucouturier, J., Van Praagh, E., Berthoin, S., 2014.

Objectively assessed recess physical activity in girls and boys from high and low socioeconomic backgrounds. BMC Public Health 14, 192. https://doi.org/10.1186/1471-2458-14-192. (Feb 21).
Borkhoff, C.M., Heale, L.D., Anderson, L.N., et al., 2015. Objectively measured physical activity of young Canadian children using accelerometry. Appl. Physiol. Nutr. Metab. 40, 1302–1308.
Centers for Disease Control and Prevention, 2010. The association between school-based physical activity, including physical education, and academic performance. http://www.cdc.gov/healthyyouth/health_and_academics/pdf/pa-pe_paper.pdf.
Centers for Disease Control and Prevention, 2014. Supporting recess in elementary schools. http://www.bridgingthegapresearch.org/_asset/1d74y4/Supporting_Recess_Elementary_Schools_Oct_2014.pdf.
Deci, E.L., Koestner, R., Ryan, R.M., Cameron, J., 2001. Extrinsic rewards and intrinsic motivation in education: reconsidered once again: comment/reply. Rev. Educ. Res. 71 (1), 1–51.
Echeverria, S.E., Luan Kang, A., Isasi, C.R., Johnson-Dias, J., Pacquiao, D., 2014. A community survey on neighborhood violence, park use, and physical activity among urban youth. J. Phys. Act. Health 11 (1), 186–194.
Erwin, H., Abel, M., Beagle, A., Noland, M.P., Worley, B., Riggs, R., 2012. The contribution of recess to children's school-day physical activity. J. Phys. Act. Health 9, 442–448.
Haapala, H.L., Hirvensalo, M.H., Laine, K., et al., 2014. Recess physical activity and school-related social factors in Finnish primary and lower secondary schools: cross-sectional associations. BCM Public Health 14 (1114). https://doi.org/10.1186/1471-2458-14-1114.
Hamari, L., Kullberg, T., Ruohonen, J., et al., 2017. Physical activity among children: objective measurements using Fitbit One® and Actigraph. BMC Res Notes 10 (161).
Heitzler, C., Lytle, L., Erickson, D., Sirard, J., Barr-Anderson, D., Story, M., 2011. Physical activity and sedentary activity patterns among children and adolescents: a latent class analysis approach. J. Phys. Act. Health 8 (4), 457–467.
Hills, A.P., Andersen, L.B., Byrne, N.M., 2011. Physical activity and obesity in children. Br. J. Sports Med. 45, 866–870.
Hyndman, B., 2016. A qualitative investigation of Australian youth perceptions to enhance physical activity: the environment perceptions investigation of children's physical activity (EPIC-PA) study. J. Phys. Act. Health 13, 543–550.
Ishii, K., Shibata, A., Sato, M., Oka, K., 2014. Recess physical activity and perceived school environment among elementary school children. Int. J. Environ. Res. Public Health 11 (7), 7195–7206. https://doi.org/10.3390/ijerph110707195.
Jarrett, O.S., Maxwell, D.M., Dickerson, C., Hoge, P., Davies, G., Yetley, A., 1998. The impact of recess on classroom behavior: group effects and individual differences. J. Educ. Res. 92 (2), 121–126.
Kottyan, G., Kottyan, L., Edwards, N.M., Unaka, N.I., 2014. Assessment of active play, inactivity and perceived barriers in an inner city neighborhood. J. Community Health 39 (3), 538–544.
Martin, K., Bremner, A., Salmon, J., Rosenberg, M., Giles-Corti, B., 2012. School and individual-level characteristics are associated with children's moderate to vigorous-intensity physical activity during school recess. Aust. N. Z. J. Public Health 36, 469–477.
Muller, J., Hoch, A.M., Zoller, V., Oberhoffer, R., 2018. Feasibility of physical activity assessment with wearable devices in children aged 4–10 years – a pilot study. Front Pediatr. https://doi.org/10.3389/fped.2018.00005.
Murillo Pardo, B., García Bengoechea, E., Julián Clemente, J.A., Generelo Lanaspa, E., 2016. Motivational outcomes and predictors of moderate-to-vigorous physical activity and sedentary time for adolescents in the sigue la huella intervention. Int. J. Behav. Med. 23 (2), 135–142.
Pawlowski, C.S., Schipperijn, J., Tjornhoj-Thomsen, T., Troelsen, J., 2016. Giving children voice: exploring qualitative perspectives on factors influencing recess physical activity. Eur. Phys. Educ. Rev. https://doi.org/10.1177/1356336X1664748.
Robert Wood Johnson Foundation, 2007. Recess Rules: Why the Undervalued Playtime May Be America's Best Investment for Healthy Kids and Healthy Schools Report. RWJF, Princeton, NJ. http://www.rwjf.org/content/dam/web-assets/2007/09/recess-rules.
Saint-Maurice, P.F., Welk, G.J., Silva, P., Siahpush, M., Huberty, J., 2011. Assessing children's physical activity behaviors at recess: a multi-method approach. Pediatr. Exerc. Sci. 23 (4), 585–599 (Nov).
Stellino, M.B., Sinclair, C.D., 2013. Psychological predictors of children's recess physical activity motivation and behavior. Res. Q. Exerc. Sport 84 (2), 167–176.
Stellino, M.B., Sinclair, C.D., 2014. Examination of recess physical activity patterns using the activities for daily living-playground participation (ADL-PP) instrument. J. Teach. Phys. Educ. 33 (2), 282–296.
Stellino, M.B., Sinclair, C.D., Partridge, J.A., King, K.M., 2010. Differences in children's recess physical activity: recess activity of the week intervention. J. Sch. Health 80 (9), 436–444 (Sep).
Stellino, M.B., Massey, W.V., Ross, A., Dykema, K., Magnuson, S., 2018. What Children Do at Recess? An Examination of Activity Engagement and Implications for Recess Quality. Paper Presented at Active Living Research, Banff, Alberta, Canada. (February).
Sushames, A., Edwards, A., Thompson, F., McDermott, R., Gebel, K., 2016. Validity and reliability of the Fitbit Flex for step count, moderate to vigorous physical activity and activity energy expenditure. PLoS One. https://doi.org/10.1371/journal.pone.0161224.
Viciana, J., Mayorga-Vega, D., Martínez-Baena, A., 2016. Moderate-to-vigorous physical activity levels in physical education, school recess, and after-school time: influence of gender, age, and weight status. J. Phys. Act. Health 13 (10), 1117–1123 (Oct).
Voss, C., Gardner, R., Dean, P.H., Harris, K.C., 2016. Validity of commercial activity trackers in children with congenital heart disease. Can. J. Cardiol. 33 (6), 799–805. https://doi.org/10.1016/j.cjca.2016.11.024.
Watkinson, E.J., Dunn, J.C., Cavaliere, N., Calzonetti, K., Wilhelm, L., Dwyer, S., 2001. Engagement in playground activities as a criterion for diagnosing developmental coordination disorder. Adapt. Phys. Act. Q. 18 (1), 18–34. https://doi.org/10.1123/apaq.18.1.18.
Watkinson, E.J., Dwyer, S.A., Nielsen, A.B., 2005. Chilidren theorize about reasons for recess engagement: does expectancy-value theory apply? Adapt. Phys. Act. Q. 22, 179–197.
Wittberg, R., Cottrell, L.A., Davis, C.L., Northrup, K.L., 2010. Aerobic fitness thresholds associated with fifth grade academic achievement. Am. J. Health Educ. 41 (5), 284–291.
Zygmunt-Fillwalk, E., Bilello, T.E., 2005. Parents' victory in reclaiming recess for their children. Child. Educ. 82, 19–23.