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Accelerated Evidence Snapshot

Physical activity in school playgrounds

A Rapid Evidence Check produced by the Sax Institute for the Northern Sydney Local Health District—December 2025

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Disclaimer:

This Accelerated Evidence Snapshot was produced using a rapid evidence review methodology in response to specific questions from the commissioning agency.

It is not necessarily a comprehensive review of all literature relating to the topic area. It was current at the time of production (but not necessarily at the time of publication). It is reproduced for general information, and third parties rely upon it at their own risk.

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Introduction

This Accelerated Evidence Snapshot was commissioned by Northern Sydney Local Health District (NSLHD) and prepared by the Sax Institute.

NSLHD supports local schools in promoting health and wellbeing among school-aged children in the district as part of the NSW Health *Live Life Well at School Program*. The primary school population in seven of the nine Local Government Areas within NSLHD is predicted to grow in the decade ahead. In addition, many schools within NSLHD have a limited amount of play space available per student, and the anticipated increase in student populations over time is expected to impede access to these spaces further as more classrooms are incorporated on school campuses.

The NSLHD Population Health Promotion team is interested in the evidence on strategies to support children's physical activity in primary schools. This review does not consider strategies or interventions to increase structured or teacher-led physical activity in primary schools.

Review aim

This review aims to identify evaluative studies of primary school play space interventions that have the intention to improve the physical activity levels of children aged 5-12 years, summarise their effectiveness, describe their implementation characteristics, and identify the features that enable or are a barrier to supporting children's physical activity.

Methods

A systematic approach was employed as follows:

1. Conduct a comprehensive literature search.
2. Remove duplicate entries from the search results.
3. Screen the results according to the predetermined eligibility criteria.
4. Extract relevant data from eligible studies and organise it into tabular format.
5. Present concise narrative syntheses of the eligible studies, drawing from the available peer-reviewed literature.

The search focused on peer-reviewed literature published since 2022. To ensure this review included information about the effectiveness of interventions that improved physical activity levels, the search strategy was designed to capture studies reporting on outcomes (intervention studies). Given the rapid nature of this Accelerated Evidence Snapshot, grey literature was not included. Intervention

studies (defined as levels II to IV on the National Health and Medical Research Council (NHMRC) levels of evidence hierarchy) assessing the effectiveness of interventions delivered in primary school playground settings were included.

A search strategy was developed utilising a three-step methodological approach originally proposed by Arksey and O'Malley and further outlined by the JBI.[1,2] First, a pilot search of PubMed and Google Scholar was undertaken on 31/10/2024. Second, results were reviewed to identify additional search terms, with the final search strategy being translated for additional search engines with the assistance of the following validated search engine translation software and automation tools: Systematic Review Accelerator [SRA], Polyglot Search Translator, Word Frequency Analyser, SearchRefinery and Spidercite.[3–6] The search strategy and search strings are available in Appendices 1 and 2, respectively. Three electronic databases were searched on 5/11/2024: Scopus, Proquest, and Web of Science. An additional search of PubMed for peer-reviewed literature associated with the studies found was undertaken using the automation tool TERA Farmer on 11/11/2024.[5] Results were imported into Covidence systematic review workflow management software and deduplicated.[7] We reviewed the title and abstracts of 1693 peer-reviewed papers. Study selection involved independent screening by two reviewers (EG and CvK), and any discrepancies were resolved through discussion. Full-text screening was undertaken by three reviewers (CvK, AS, EW). Discrepancies were resolved by a fourth author (EG). A PRISMA diagram outlining the studies included and excluded at each stage is available in Appendix 3. Data extraction was undertaken by three authors (CvK, AS, EW) and checked by a fourth author (EG). Studies were categorised by a fifth author (NP) as Effectiveness, Impact or Observation based on the study design and methods used. A quality assessment was also undertaken to highlight higher-quality evidence.[8] The quality ratings and data extraction tables are presented in Appendix 4.

Summary of findings

We identified 16 peer-reviewed studies. The studies included in this review varied widely in quality, with three studies rated as **high or high-medium quality** due to their robust study designs, methods, measurement tools, sample size and/or duration.[9–11] Two studies received **medium-high quality** ratings due to their large sample sizes and the use of validated measurement instruments, providing valuable but less generalisable findings.[12,13] Four studies fell into the **medium quality** category.[14–17] These studies used robust study designs but fell short on various aspects such as subjective measures, short duration, or limited sample size. Five studies were rated as **medium-low quality**, reflecting challenges such as small sample sizes, subjective measures, or limited generalisability.[18–22] Two studies were rated **low quality** due to short durations, reliance on subjective measures, and lack of methodological rigour.[23,24]

Six studies utilised quasi-experimental approaches in **study design**, offering moderate evidence.[11,14,16,19,20,24] Other designs included one randomised controlled trial[15], two pre-post studies[21,23], three cross-sectional studies[10,12,22], one observational study[13], one post-test only design[16], and one mixed-methods study.[17]

Policies and procedures, such as active breaks, recess durations, uniforms or school-level determinants impacting physical activity, were the subject of nine studies.[9–12,14,16,18,19,22] **Design modifications to the physical environment** were implemented in four studies, including playground improvements, activity zones, and green space enhancements.[15,17,20,21] Three studies focused on the **built environment** through observational approaches, analysing aspects like schoolyard design and the impact of playground equipment installations and outdoor play structures.[13,23,24]

Participants ranged from 5 to 19 years and included primary and middle school students. We report findings for primary school-age participants. Gender representation was generally mixed, and ethnic diversity was highlighted in some studies that included CALD and Aboriginal students.[9,16] One study included students with disabilities.[17] Socioeconomic status (SES) was noted in several studies.[9,10,13,15] **Geographically**, the studies included inner-city schools[12,13,17,19,21,24], suburban schools[9,10,16,23] and regional or rural schools.[22] The United States accounted for the majority of studies included (n=6), and Australia followed with two studies. There were also single studies from Brazil, Chile, Spain, The Netherlands, Türkiye, Estonia, India, Italy, and Canada.

Key messages

School policies and procedures

- Active breaks of 10 minutes duration, 3 times per day, and co-designed by teachers and students resulted in an additional 15.4 minutes of moderate to vigorous physical activity (MVPA) per day, emphasising the importance of tailored and minimal-resource activities.[11] Fun and structured

activities (running, skipping, circuit training and games such as ‘bullrush’ and ‘stuck in the mud’ reduced off-task behaviour and promoted positive attitudes but had no effect on cognitive function or math performance (high-medium quality).[11]
- Extended recess duration (e.g., 60 minutes for third graders) led to significant increases in steps and MVPA (medium quality).[16]
- Outdoor recess fostered improved concentration and lightened perceptions of the school day, supported by parental agreement on its benefits (medium-low quality).[22]
- Supervised recess zones[14] (medium quality) and unstructured access to play structures[20] (medium-low quality) did not significantly increase PA levels.
- Allowing sports uniforms contributed to better academic outcomes through improved functionality and comfort (medium-low quality).[19]

Influence of playground design

- Properly designed spaces, such as nature-based zones or shaded grass fields, facilitated creative, imaginative, and prosocial play.[13] A mix of motor skill opportunities (balance, agility) and unique challenges (e.g., climbing structures) increased MVPA. Areas with clear purposes may reduce sedentary behaviour (medium-high quality).[13]
- Overcrowding reduced active participation, emphasising the need for better student dispersion (medium-high quality).[13] Limited space and outdated or unsafe play structures reduced activity opportunities (medium-low, low quality).[20,23]
- Creative play opportunities, e.g. with loose parts, enhanced engagement but increased solitary play among children with disabilities (medium-high quality).[17]
- Older students, particularly girls, were less engaged by traditional schoolyard designs, which limited developmental and preference-appropriate options (medium-high quality).[13]
- Playgrounds with painted line markings and designated zones significantly influenced active play positively[15] while built environments promoted structured games like ball play (medium-low quality).[24] Designated play areas with specific features (e.g., basketball courts) also increased physical activity (high quality).[10] Increased physical activity during recess was positively correlated with academic performance (medium-low quality).[18]
- Schools with larger, well-maintained green areas relieved stress and promoted better mental health (low quality).[23]

Implementation considerations

- The PACE intervention* cost $1,151 per school ($5.75 per child), highlighting the need for economic considerations in scaling interventions (high quality).[9]
- Interventions driven by proactive principals and classroom teachers acting as champions were more effectively implemented, as leadership and advocacy facilitated staff and student engagement.[9] This may help counteract staff resistance to interventions in situations where they are perceived as disruptive to existing routines (high quality).[9]
- Structured activities such as active breaks required minimal resources and infrastructure, making them cost-effective (high-medium quality).[11]

* Physically Active Children in Education (PACE) is a multi-strategy implementation intervention that supports teachers to increase their scheduling of physical activity and energiser breaks throughout the school day.

- Positive student engagement, as seen in active break sessions, sustained participation and contributed to increased MVPA (high-medium quality).[11]
- Ongoing teacher training and consultation helped schools integrate physical activity into routines, enhancing implementation success (high- and medium-low quality).[9,18] However, allocating time for additional activities amidst packed schedules and competing academic demands is a challenge (high quality).[9]
- Expensive infrastructure like outdoor play structures was often excluded from school budgets, limiting feasibility (medium-low quality).[20]

Conclusion

The findings highlight the multifaceted impact of school policies, playground design, and implementation strategies on physical activity, student engagement, and academic outcomes.

When tailored and co-designed with teachers and students, policies such as active breaks increased MVPA and positively influenced classroom behaviour and student attitudes, though they had no effect on academic performance (high-medium quality evidence).[11] Interventions that included supervised recess zones and unstructured access to play structures did not yield significant gains in physical activity (medium-low quality evidence).[14,20] However, extending recess duration demonstrated clear benefits for physical activity, particularly in younger students (medium quality evidence)[16], while outdoor recess fostered improved concentration and lighter perceptions of the school day (medium-low quality evidence).[22] School uniform policies promoting functionality were linked to better academic outcomes, highlighting the interplay between physical activity opportunities and academic success (medium-low quality evidence).[19]

The design of playgrounds and outdoor environments played a critical role in shaping physical activity and engagement outcomes. Well-designed spaces, such as those incorporating nature-based zones, shaded areas, and motor skill opportunities, supported active and imaginative play while reducing sedentary behaviour (medium-high quality evidence).[13] On the other hand, traditional schoolyard designs failed to address developmental needs and activity preferences, particularly for older students and girls, underscoring the need for diverse and inclusive playground features (medium-high quality evidence).[13] Barriers such as overcrowding and outdated infrastructure further limited the effectiveness of playgrounds in promoting physical activity (medium quality evidence).[13,20] Built environments with painted markings or designated zones promoted structured games and increased physical activity (medium-low quality evidence).[15,24] Green spaces also enhanced mental health outcomes but required adequate maintenance and size to meet students' needs (low quality evidence).[23]

Implementation strategies and costs are critical considerations in scaling up interventions. Leadership from principals and in-school champions played a pivotal role in driving intervention success and fostering staff and student engagement (high-quality evidence).[9] However, resistance to change, time constraints, and competing academic priorities often hindered implementation efforts (high quality evidence).[9] Teacher training and ongoing consultation emerged as key enablers, helping schools integrate physical activity into their routines and sustain participation over time (medium quality evidence).[9,18] Low-cost initiatives like active breaks proved both effective and feasible (high-medium

quality evidence)[11], while expensive infrastructure, such as outdoor play structures, posed challenges for school budgets (medium quality evidence).[20]

Overall, the findings underscore the importance of tailoring interventions to school-specific needs and contexts, prioritising inclusive design, and addressing systemic barriers to ensure sustained success. Strategic leadership, cost-effective approaches, and adaptive planning are essential to optimising physical activity interventions in schools.

Appendices

Appendix 1 – Search Strategy

Step	Domain	Query syntax (OVID Medline)
1	Population (and setting)	1 ("primary school" or "school aged" or "school-age" or "elementary school" or "day school" or "school*" or "school children" or child* or "5-12 years old" or "5-12 years" or "aged 5-12" or "ages 5-12" or "kindergarten - grade 6" or "kindergarten - year 6" or "years K-6" or "K-6" or (school adj3 student*)).mp. or exp Child/ 3114536
2	Intervention	2 ("play space" or "outdoor area" or "outdoor space" or playground* or "playtime" or "outdoor play" or "recreation area" or "recreation space" or "play area" or "recess area" or "playground equipment" or "play equipment" or "built environment" or "loose play" or "fixed equipment" or "shared public spaces" or "shared space*" or "nature play" or "open space" or "pop up play" or "play surfaces" or "playground marking*" or "line marking*" or (play adj3 area) or (play adj3 space) or (school adj3 play*) or (school adj3 ground*)).mp. or exp "Play and Playthings"/ 31272 3 (design or redesign or revitalis* or access* or weather or climat* or polic* or procedur* or stagger* or roster* or uniform or "break length" or "break time" or supervis* or consult* or time or timing or area or space or equipment or marking*).mp. 10652116
3	Comparison	Not required
4	Outcomes	4 ("physical activity levels" or "physical* activ*" or exercise* or "incidental activity" or "recreation*" or "non-exercise physical activity" or "leisure time" or fitness or "movement levels" or "activity level*" or "active play" or "play time" or "sedentary behaviour" or inactiv* or "passive play" or "area per child" or "area child ratio" or "square feet" or "square metres" or "square meters" or "meters squared" or "metres squared" or "school engag*" or engag* or "mental health" or wellbeing or "economic outcomes" or "academic performance" or "educational outcomes" or injur* or (play adj3 area)).mp. or exp Exercise/ or exp Educational Measurement/ 3283438
5	Study types	5 ("experimental study" or evaluat* or "randomi* controlled trial" or RCT or "nonrandomi* controlled trial" or "cluster randomi* trial" or "cluster RCT" or "crossover study" or "stepped wedge" or "multiple baseline" or "quasi-experimental" or "pre post" or "interrupted time series" or "before after" or "evaluation study" or "intervention study" or "repeat cross-section" or intervention or cohort or impact* or effectiveness or effect* or Evaluation Study).mp. or exp Evaluation Study/ 16352580
6	Combined	1 and 2 and 3 and 4 and 5 2612
7	Limits	limit 6 to (English language and yr="2022") 171
8	Limits	limit 6 to (English language and yr="2019 -Current") 979

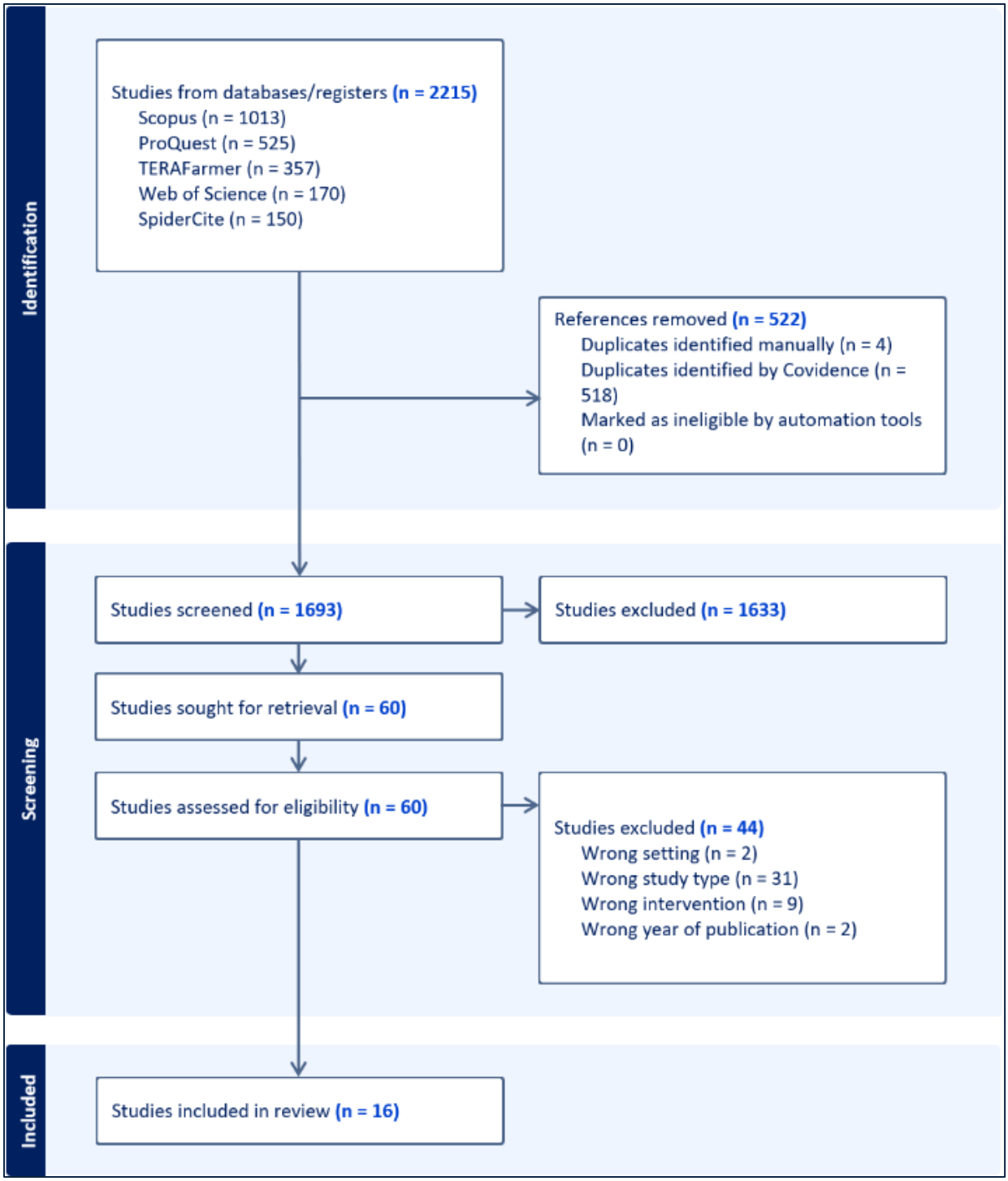
Appendix 2 – Search Strings†

Database	Search string	Date searched	Output
Scopus (adv)	(TITLE-ABS-KEY ("primary school" OR "school aged" OR school-age OR "elementary school" OR "day school" OR school* OR "school children" OR child* OR "5-12 years old" OR "5-12 years" OR "aged 5-12" OR "ages 5-12" OR "kindergarten - grade 6" OR "kindergarten - year 6" OR "years K-6" OR k-6 OR (school W/3 student*)) OR INDEXTERMS (child)) AND (TITLE-ABS-KEY ("play space" OR "outdoor area" OR "outdoor space" OR playground* OR playtime OR "outdoor play" OR "recreation area" OR "recreation space" OR "play area" OR "recess area" OR "playground equipment" OR "play equipment" OR "built environment" OR "loose play" OR "fixed equipment" OR "shared public spaces" OR "shared space*" OR "nature play" OR "open space" OR "pop up play" OR "play surfaces" OR "playground marking*" OR "line marking*" OR (play W/3 area) OR (play W/3 space) OR (school W/3 play*) OR (school W/3 ground*)) OR INDEXTERMS ("Play and Playthings")) AND (TITLE-ABS-KEY (design OR redesign OR revitalis* OR access* OR weather OR climat* OR polic* OR procedur* OR stagger* OR roster* OR uniform OR "break length" OR "break time" OR supervis* OR consult* OR time OR timing OR area OR space OR equipment OR marking*)) AND (TITLE-ABS-KEY ("physical activity levels" OR "physical* activ*" OR exercise* OR "incidental activity" OR recreation* OR "non-exercise physical activity" OR "leisure time" OR fitness OR "movement levels" OR "activity level*" OR "active play" OR "play time" OR "sedentary behaviour" OR inactiv* OR "passive play" OR "area per child" OR "area child ratio" OR "square feet" OR "square metres" OR "square meters" OR "meters squared" OR "metres squared" OR "school engag*" OR engag* OR "mental health" OR wellbeing OR "economic outcomes" OR "academic performance" OR "educational outcomes" OR injur* OR (play W/3 area)) OR INDEXTERMS (exercise) OR INDEXTERMS ("Educational Measurement")) AND (TITLE-ABS-KEY ("experimental study" OR evaluat* OR "randomi* controlled trial" OR rct OR "nonrandomi* controlled trial" OR "cluster randomi* trial" OR "cluster RCT" OR "crossover study" OR "stepped wedge" OR "multiple baseline" OR quasi-experimental OR "pre post" OR "interrupted time series" OR "before after" OR "evaluation study" OR "intervention study" OR "repeat cross-section" OR intervention OR cohort OR impact* OR effectiveness OR effect* OR "Evaluation Study") OR INDEXTERMS ("Evaluation Study")) AND PUBYEAR > 2021 AND PUBYEAR < 2026 AND (LIMIT-TO (LANGUAGE , "English"))	6/11/2024	Limiting to English 2022-present = 1013 papers
Proquest Central	((TI,AB,IF("primary school") OR TI,AB,IF("school aged") OR TI,AB,IF(school-age) OR TI,AB,IF("elementary school") OR TI,AB,IF("day school") OR TI,AB,IF(school*) OR TI,AB,IF("school children") OR TI,AB,IF(child*) OR TI,AB,IF("5-12 years old") OR TI,AB,IF("5-12 years") OR TI,AB,IF("aged 5-12") OR TI,AB,IF("ages 5-12") OR TI,AB,IF("kindergarten - grade 6") OR TI,AB,IF("kindergarten - year 6") OR TI,AB,IF("years K-6") OR TI,AB,IF(K-6) OR (TI,AB,IF(school) NEAR/3 TI,AB,IF(student*))) OR SUBJECT(Child)) AND (TI,AB,IF("play space") OR TI,AB,IF("outdoor area") OR TI,AB,IF("outdoor space") OR TI,AB,IF(playground*) OR TI,AB,IF(playtime) OR TI,AB,IF("outdoor play") OR TI,AB,IF("recreation area") OR TI,AB,IF("recreation space") OR TI,AB,IF("play area") OR TI,AB,IF("recess area") OR TI,AB,IF("playground equipment") OR TI,AB,IF("play equipment") OR TI,AB,IF("built environment") OR TI,AB,IF("loose play") OR TI,AB,IF("fixed equipment") OR TI,AB,IF("shared public spaces") OR TI,AB,IF("shared space*") OR TI,AB,IF("nature play") OR TI,AB,IF("open space") OR TI,AB,IF("pop up play") OR TI,AB,IF("play surfaces") OR TI,AB,IF("playground marking*") OR TI,AB,IF("line marking*") OR (TI,AB,IF(play) NEAR/3 TI,AB,IF(area)) OR (TI,AB,IF(play) NEAR/3 TI,AB,IF(space)) OR (TI,AB,IF(school) NEAR/3 TI,AB,IF(play*)) OR (TI,AB,IF(school) NEAR/3 TI,AB,IF(ground*))) OR SUBJECT("Play and Playthings") AND ((TI,AB,IF(design) OR TI,AB,IF(redesign) OR TI,AB,IF(revitalis*) OR TI,AB,IF(access*) OR TI,AB,IF(weather) OR TI,AB,IF(climat*) OR TI,AB,IF(polic*) OR TI,AB,IF(procedur*) OR TI,AB,IF(stagger*) OR	6/11/2024	Limiting to English 2022-present, scholarly journals = 525 papers

† Note all searches were limited to 2022 - current

	TI,AB,IF(roster*) OR TI,AB,IF(uniform) OR TI,AB,IF("break length") OR TI,AB,IF("break time") OR TI,AB,IF(supervis*) OR TI,AB,IF(consult*) OR TI,AB,IF(time) OR TI,AB,IF(timing) OR TI,AB,IF(area) OR TI,AB,IF(space) OR TI,AB,IF(equipment) OR TI,AB,IF(marking*))) AND ((TI,AB,IF("physical activity levels") OR TI,AB,IF("physical* activ*") OR TI,AB,IF(exercise*) OR TI,AB,IF("incidental activity") OR TI,AB,IF(recreation*) OR TI,AB,IF("non-exercise physical activity") OR TI,AB,IF("leisure time") OR TI,AB,IF(fitness) OR TI,AB,IF("movement levels") OR TI,AB,IF("activity level*") OR TI,AB,IF("active play") OR TI,AB,IF("play time") OR TI,AB,IF("sedentary behaviour") OR TI,AB,IF(inactiv*) OR TI,AB,IF("passive play") OR TI,AB,IF("area per child") OR TI,AB,IF("area child ratio") OR TI,AB,IF("square feet") OR TI,AB,IF("square metres") OR TI,AB,IF("square meters") OR TI,AB,IF("meters squared") OR TI,AB,IF("metres squared") OR TI,AB,IF("school engag*") OR TI,AB,IF(engag*) OR TI,AB,IF("mental health") OR TI,AB,IF(wellbeing) OR TI,AB,IF("economic outcomes") OR TI,AB,IF("academic performance") OR TI,AB,IF("educational outcomes") OR TI,AB,IF(injur*) OR (TI,AB,IF(play) NEAR/3 TI,AB,IF(area))) OR SUBJECT(Exercise) OR SUBJECT("Educational Measurement")) AND ((TI,AB,IF("experimental study") OR TI,AB,IF(evaluat*) OR TI,AB,IF("randomi* controlled trial") OR TI,AB,IF(RCT) OR TI,AB,IF("nonrandomi* controlled trial") OR TI,AB,IF("cluster randomi* trial") OR TI,AB,IF("cluster RCT") OR TI,AB,IF("crossover study") OR TI,AB,IF("stepped wedge") OR TI,AB,IF("multiple baseline") OR TI,AB,IF(quasi-experimental) OR TI,AB,IF("pre post") OR TI,AB,IF("interrupted time series") OR TI,AB,IF("before after") OR TI,AB,IF("evaluation study") OR TI,AB,IF("intervention study") OR TI,AB,IF("repeat cross-section") OR TI,AB,IF(intervention) OR TI,AB,IF(cohort) OR TI,AB,IF(impact*) OR TI,AB,IF(effectiveness) OR TI,AB,IF(effect*) OR TI,AB,IF("Evaluation Study")) OR SUBJECT("Evaluation Study"))		
Web of Science (ADV)	(ALL=(("primary school" OR "school aged" OR school-age OR "elementary school" OR "day school" OR school* OR "school children" OR child* OR "5-12 years old" OR "5-12 years" OR "aged 5-12" OR "ages 5-12" OR "kindergarten - grade 6" OR "kindergarten - year 6" OR "years K-6" OR K-6))) OR KP=((school NEAR/3 student*)) (ALL=(("play space" OR "outdoor area" OR "outdoor space" OR playground* OR playtime OR "outdoor play" OR "recreation area" OR "recreation space" OR "play area" OR "recess area" OR "playground equipment" OR "play equipment" OR "built environment" OR "loose play" OR "fixed equipment" OR "shared public spaces" OR "shared space*" OR "nature play" OR "open space" OR "pop up play" OR "play surfaces" OR "playground marking*" OR "line marking*"))) OR KP=((play near/3 area) OR (play near/3 space) OR (school near/3 play*) OR (school near/3 ground*)) AND (ALL=(design OR redesign OR revitalis* OR access* OR weather OR climat* OR polic* OR procedur* OR stagger* OR roster* OR uniform OR "break length" OR "break time" OR supervis* OR consult* OR time OR timing OR area OR space OR equipment OR marking*)) AND (ALL=(("physical activity levels" OR "physical* activ*" OR exercis* OR "incidental activity" OR recreation* OR "non-exercise physical activity" OR "leisure time" OR fitness OR "movement levels" OR "activity level*" OR "active play" OR "play time" OR "sedentary behaviour" OR inactiv* OR "passive play" OR "area per child" OR "area child ratio" OR "square feet" OR "square metres" OR "square meters" OR "meters squared" OR "metres squared" OR "school engag*" OR engag* OR "mental health" OR wellbeing OR "economic outcomes" OR "academic performance" OR "educational outcomes" OR "Educational Measurement" OR injur*))) OR KP=((play NEAR/3 area)) AND KP=(("experimental study" OR evaluat* OR "randomi* controlled trial" OR RCT OR "nonrandomi* controlled trial" OR "cluster randomi* trial" OR "cluster RCT" OR "crossover study" OR "stepped wedge" OR "multiple baseline" OR quasi-experimental OR "pre post" OR "interrupted time series" OR "before after" OR "evaluation study" OR "intervention study" OR "repeat cross-section" OR intervention OR cohort OR impact* OR effectiveness OR effect* OR "Evaluation Study"))	6/11/2024	Limiting to English 2022-present = 170 paper

Appendix 3 – Prisma Diagram



Appendix 4 – Data Extraction Tables

Table 4.1: Assessment of study quality

Study	Study design	Notes on study quality	Rank
Effectiveness studies			
Zask 2023[11]	Quasi-experiment	• 6 weeks • N (I) = 101 children from six classrooms; N (C) = 89 from five classrooms • Objective measure of PA (accelerometer)	High-Med
Barnas 2024[14]	Quasi-experiment	• Objective measures – accelerometer and SOPLAY observation tool • Only short study duration • N = 380, but sub-set of N = 169 wore accelerometers • Do not state the n in each analysis and no power calculations, therefore may have been an inadequate sample to detect effects • Student participant characteristics not described in findings	Med
Benthroldo 2022[15]	Randomised controlled trial	• Sample size calculated to ensure adequate power to detect an effect • Subjective self-report questionnaire to measure PA • N (I) = 615; N (C) = 360 • Intervention duration short - one month • Analysis GLM	Med

Study	Study design	Notes on study quality	Rank
Farbo 2024[16]	Post-test (with control group)	• The intervention children comprised 90 third graders and 100 fourth graders, and the control children comprised 101 third graders and 92 fourth graders • Only post-test measures	Med
Carriedo 2023[18]	Longitudinal study (using a natural experiment)	• Only 23 participants per classroom for I and C classrooms • PA levels measured for six weeks • Objective physical activity (PA) measures	Med-Low
Cristi-Montero 2022[19]	Quasi-experiment	• Subjective PA measure • N (C) = 854; N (I) = 134 • Chile – may not be generalisable	Med-Low
Fuentes Diaz 2024[20]	Quasi-experiment	• N = 41, two schools. • 82 wore Fitbit. • One week duration of observations	Med-Low
Amicone 2024[24]	Quasi-experiment	• Single day duration and 30 min exposure • Measure is the children's subjective description of their social play, cognitive play and non-play behaviours • Analysis chi-square (categorical data) and ANOVA (continuous count data) with no adjustment for confounders or tests of interaction (regression analysis adjusting for potential confounders would have been a superior method for this analysis)	Low
Impact studies			

Study	Study design	Notes on study quality	Rank
Lane 2022[9]	Economic evaluation	• Duration = 12 months • Validated weekly PA implemented by teachers recorded in an activity logbook	Very High
Eichengreen 2024[17]	Mixed methods	• N = 42 students, some with disabilities • Some objective measures and qualitative insight	Med
Lateef 2024[21]	Pre-post	• N = 148, subjective surveys • Duration interrupted by pandemic – around one year of exposure, but measures were three years apart • Intervention relevant, but outcomes don't include PA	Med-Low
Observational studies			
Bartholemew 2022[10]	Cross-sectional	• N = 1049, 14 schools • Objective measures – accelerometer and SOPLAY	High
Craig et al 2024[12]	Cross-sectional	• N = 38 schools • Objective measures, large sample, regression analysis	Med-High
Raney 2023[13]	Observational	• N = 2275 • Objective – validated observational tools (SOPLAY, SOCARP)	Med-High
Lemberg 2024[22]	Cross-sectional	• N = 792 students and N = 759 legal guardians	Med-Low

Study	Study design	Notes on study quality	Rank
		• Subjective measures	
Akpinar 2024[23]	Pre-post	• Subjective measures • Single exposure to green space for 50 min • N = 381 • Repeat cross-sectional measures with one point not in green space and next point two weeks later straight after 50 mins in green space	Low

Notes on Table 4.1:

In our assessment of the quality of evidence, we rated studies Low, Med and High based on the 'Study design', dividing them into categories of Effectiveness, Impact, or Observational study. The sampling methods, sample size, whether the measures were objective/subjective (or a well-accepted validated instrument like SOPLAY [e.g. Barnas 2024] vs subjective and innovative like children's own descriptions and drawings of their play [e.g. Amicone 2024]) and study duration were considered. The methods of analysis and issues of generalisability of the findings have been noted in some instances where they were manifestly not ideal, e.g. using the chi-squared statistic, which does not allow for any adjustments of factors that may impact/confound the results.

This pragmatic method of ranking has been done to highlight higher-quality evidence. Note that for studies ranked Med or High, this does not necessarily consider the generalisability of findings from countries with very different study populations, nor does it consider the transferability and relevance of the types of interventions or exposures to the NSLHD context. Although stronger study designs for testing effectiveness appear first, some high-quality observational insights, which can't provide information on effects nor allow for causal inferences, do provide clues from associations of exposure with outcomes, which may be tested as components of interventions in future innovative studies.

Table 4.2: Study characteristics by intervention type

First author, year, country	Intervention type	Study aim	Sample population/ setting
Effectiveness studies			
Zask 2023 Australia[11]	Policies and procedures	To evaluate whether physically active breaks increased students' overall MVPA, increased the proportion of children meeting MVPA guidelines, and determine the effect on classroom behaviour, students' wellbeing, cognitive function and maths performance.	N = 190 Student characteristics: Age: 5-12 years Years K, 1, 3, 5 and 6 School characteristics: One Catholic school in Northern NSW
Barnas 2024 United States[14]	Non-randomised experimental study (quasi-experiment)	To assess changes in PA of elementary-aged children during recess by implementing an activity-zoned playground using SOPLAY and accelerometry. Specifically, this study aims to (1) investigate changes in PA between active and inactive children and (2) determine if supervision with activity zones influences PA engagement.	N = 280 Student characteristics: Grade 3,4,5; mixed gender School characteristics: 2 public elementary schools, matched in size, playground layout, and socioeconomic status
Benthroldo 2022 Brazil[15]	Design modifications to physical environment	To assess the effect of modifications of the school environment on physical activity in Brazilian adolescent students.	N = 975 Student characteristics: Low SES, mean age 11.5 years (Grade 5/6), 56.7% boys School characteristics: 7 schools, mixed gender

First author, year, country	Intervention type	Study aim	Sample population/ setting
Farbo 2024 United States[16]	Non-randomised experimental study (quasi-experiment)	To compare the physical activity intensity and obesity rates of third- and fourth-grade children participating in the LiiNK intervention, which provides 60 min of recess for third graders and 45 min for fourth graders, to those in a control group allowed 30 min of daily recess.	N = 383 Student characteristics: mixed gender, years 3-4 School characteristics: Schools from two districts in North Texas and South Central Texas, type not specified. Districts 1 and 2 are public school districts (funded by the government). District 1: 40% white, 40% Hispanic, 15% black, and 5% other. District 2: Primarily Hispanic (70%), with smaller proportions of White (20%) and Black (5%) children, and 5% in the "other" category
Carriedo 2023 Spain[18]	Policies and procedures	This study aimed to examine the impact of such practices on children's physical activity (PA) and the relationships between PA, gender, body mass index (BMI), and academic achievement.	N = 46 Student characteristics: 19 boys and 27 girls in two first grade classes from one school. All were Caucasian. School characteristics: 1 school in Northern Spain
Cristi-Montero 2022 Chile[19]	Observational study of uniform policy	To compare academic achievement, cognitive performance, playtime, bullying, and discrimination in adolescents according to traditional uniforms (TUs) and sports uniforms (SUs) worn at school.	N = 998 Student characteristics: Mixed-gender schools (52.6% boys), 10-14 years; 86.4% wore a TU. School characteristics: Public, subsidised and private schools, Valparaiso region of Chile includes urban, suburban and rural areas. Total of 15 schools (12 TU and 3 SU). TU schools were public (n=7), subsidised (n=4), private (n=1), high SVI (n=9), middle-SVI (n=2),

First author, year, country	Intervention type	Study aim	Sample population/ setting
			and low-SVI (n=1). SU schools were subsidised (n=2) and private (n=1), middle-SVI (n=2) and low-SVI (n=1).
Fuentes Diaz 2024 Canada[20]	Non-randomised experimental study (quasi-experiment)	To explore whether access to outdoor play structures during recess interferes with children's physical activity levels.	N = 59 Student characteristics: mixed gender, aged 8-10 School characteristics: 2 public schools
Amicone 2024 Italy[24]	Observational study of the built environment	To investigate the perceptions of the physical environment and children-environment interactions during recess time in natural (vs. built) schoolyards.	N = 298 Student characteristics: 154 girls and 144 boys, 3rd, 4th and 5th grades (average age 9.6 years) School characteristics: Two primary schools located in urban areas of two cities (Rome and Catania)
Impact studies			
Lane 2022 Australia[9]	Policies and procedures	To evaluate the value of investment by health service providers tasked with delivering the intervention to provide information for decision-makers interested in scaling up policy implementation and identify cost-heavy components of the intervention to target adaptations for reducing delivery costs at scale.	N = 403 Student characteristics: ages 5-12 CALD and ATSI students included SES captured using ICSEA and SEIFA School characteristics: Mixed gender public, catholic, and independent schools located in inner, suburban, and outer suburban areas

First author, year, country	Intervention type	Study aim	Sample population/ setting
Eichengreen 2024 The Netherlands[17]	Design modifications to physical environment	To examine whether loose-parts-play (LPP) can promote social participation for children with and without disabilities.	N = 42 Student characteristics: Two primary school-aged classes, mixed gender. Two of the children had autism spectrum disorder (ASD), and one had hearing loss. School characteristics: Primary schools in the Netherlands
Lateef 2024 India[21]	Case studies with either post-test or pre-test/post-test outcomes	To examine the impact of installing playground equipment in the schoolyard on students' attitudes toward school, peers, and the capacity to play of elementary-school children	N = 148 Student characteristics: girls, low-income School characteristics: elementary school, inner city, 4 storey building
Observational studies			
Bartholomew 2022 United States[10]	Secondary analysis (observational) of the Texas I-CAN! Study. This analysis is limited to intervention schools only.	To elucidate how school-level variables (i.e., duration of recess, recess before or after lunch, the recess environment, playground spaces available, playground space per student, bad weather days) and individual-level variables (i.e., age, gender, SES, ethnicity, fitness) affect children's physical activity and sedentary time during recess.	N = 1049 Student characteristics: 546 boys and 503 girls, 100% fourth grade (stage 2), 56.7% white and 43.3% not white, 76.3% no lunch support and 23.7% eligible for lunch (SES status) School characteristics: 14 schools from 4 suburban school districts

First author, year, country	Intervention type	Study aim	Sample population/ setting
Craig 2024 United States[12]	Policies and procedures	To examine the associations between school-level determinants and the implementation of school-based PA opportunities (number and success).	N = 48 Student characteristics: NR School characteristics: elementary schools in Texas
Raney 2023 United States[13]	Observational	To examine the impact of various schoolyard design features and green space on unstructured recess play behaviours according to gender and age	N = 2275 Student characteristics: Not described School characteristics: Four Title I (>50% of students eligible for free or reduced lunch based on family income) urban elementary schools in the Los Angeles and Pasadena Unified School Districts with variation in schoolyard design and differing levels of green space square footage were selected for this study.
Lemberg 2024 Estonia[22]	Cross-sectional study	To investigate students' and their parents' perceptions of outdoor recess, its benefits, and PA opportunities in schools with different recess opportunities.	N = 792 students, 759 legal guardians Student characteristics: Students from grades 3 to 6 (9-13-years-olds) School characteristics: All 15 schools were part of the Schools in Motion program, location and size of school varied. Grouped as follows:: (1) "outdoor recess"- (6 schools; students n = 320; parents n = 309) had a daily outdoor recess in the school schedule, and it was obligatory to go outside during this time (2) "outdoor recess on some days" - (4 schools; students

First author, year, country	Intervention type	Study aim	Sample population/ setting
			n = 229; parents n = 222) had one longer active recess every day. On some days of the school week, it was an outdoor recess; on other days, it was an active indoor recess where students could access the gym or engage in other physically active activities. (3) "indoor recess" - (5 schools, students n = 243; parents n = 228) did not have outdoor recess as part of the school schedule; however, students were not forbidden to go outside during any recess.
Akpinar 2024 Türkiye[23]	Observational study of the built environment	To investigate (a) how school green spaces are associated with students' perceived stress, mental health, and general health, (b) whether school green spaces address students' perceived mental and physical needs, and (c) what students' experience and expectations about school green spaces are.	n = 381, aged 10-19, mixed gender. 4 middle and high schools (1 private and 3 public). Total school area varied, as did the proportion of the school area dedicated to green space and open space. Facilities differed between schools, though all included a basketball court.

Table 4.3: Intervention implementation characteristics

First author, year	Intervention aim/objective	Brief description	Critical resources
Effectiveness studies			
Zask 2023[11]	To increase students' MVPA by incorporating 3 x 10-minute breaks into the school day. Classroom behaviour, students' wellbeing, cognitive function and maths performance were also measured.	Students in the intervention group participated in active breaks during class time (3 10-minute active breaks per weekday) for six weeks. Active breaks were implemented outdoors, at 9 am, 10 am, and 12.30 pm (during class time) for 6 weeks in Term 3, 2020. The times were selected by school staff to ensure that students did not sit for longer than 1 hour. Students in the control group attended class as usual. All measures were administered at baseline and after the intervention, with physical activity measurement and classroom behaviour observations also taking place mid-intervention.	The active break activities required minimal or no equipment or set-up. They were set up by the classroom teacher. The active break activities were codesigned by the students and teachers and aimed to elicit MVPA. Activities included running, skipping, circuit training, and other moderate to vigorous intensity options, such as games, for example, "bull-rush" and "stuck in the mud".
Barnas 2024[14]	To: (1) investigate changes in PA between active and inactive children in activity-zoned playgrounds and (2) determine if supervision with activity zones influences PA engagement.	The existing playground space was divided into 6 different activity zones for 10 successive days (2 school weeks). Activities within the zones included small team sports, obstacle courses using the existing playground structure with the addition of foam apparatuses, and variations of recess games such as 4-square. Activities were	Set up of activity zones within the existing playground. Staff supervision of playground, as usual.

First author, year	Intervention aim/objective	Brief description	Critical resources
		selected based on adult supervisor facilitation, ability to improve MVPA, popular recess games, and emphasis on skills such as teamwork, cooperation, and student inclusion. One institution had supervised (interactive) activity zones whereas the second had unsupervised ones.	
Benthroldo 2022[15]	To increase the physical activity of students through playground modifications.	Design modification 4 schools received modifications to the school environment, which included: - painting line markings - providing sports equipment - a superhero character named "Super Active" 3 control schools received no modifications. The changes were implemented during the school's mid-year vacation. The intervention lasted for one month. Measurements were taken before and after the intervention using a validated self-reported questionnaire which included six questions about the duration and frequency of various physical	Sports equipment (soccer balls, basketballs, volleyballs, hula hoops, shuttlecocks, jump ropes, and volleyball nets). Researchers replaced this weekly if worn out. Playground modifications: painted line markings for hopscotch and designated areas for sports activities, footsteps painted throughout the school grounds, guiding students towards these activity areas and equipment. Superhero mascot: "Super Active" was introduced to the school environment. This superhero character was depicted on a banner

First author, year	Intervention aim/objective	Brief description	Critical resources
		activity domains in the seven days prior to the survey.	displayed in the schoolyard to encourage students to participate in physical activities.
Farbo 2024[16]	To increase physical activity levels, particularly moderate-to-vigorous activity of third- and fourth-grade children by providing 60 min of recess for third graders and 45 min for fourth graders, and to assess the impact on body composition.	The intervention involved extending recess time for third and fourth graders in the intervention schools to 45-60 minutes of unstructured outdoor play, compared to 30 minutes in control schools. The children were given a variety of play environments, including traditional playgrounds, bus loops, and blacktop areas. The control group consisted of third and fourth-grade children from schools with standard recess times of 30 minutes daily. These students had access to traditional playground equipment, grassy areas, and climbing structures, but no additional modifications or interventions were made to their physical activity schedule. Physical activity levels and body composition were compared between groups.	Play equipment: Various play environments (traditional playgrounds, bus loops, blacktops) for unstructured outdoor play during extended recess
Carriedo 2023[18]	To increase students' PA by allowing them to use their entire recess period (30 min) to play freely in the playground.	The study compared two groups of first-grade children: Group A: Students had intermittent recess, spending some time in the classroom and other	Supervision of students in the playground.

First author, year	Intervention aim/objective	Brief description	Critical resources
		times in the playground. Group B: Students used the entire recess time (30 minutes) freely in the playground. Recess observation was conducted over 23 school days across 6 weeks to assess physical activity patterns.	
Cristi-Montero 2022[19]	To determine the impact of uniform type (traditional vs sports) on PA.	n/a - observational study	n/a -observational study
Fuentes Diaz 2024[20]	To explore whether access to play structures increased MVPA during recess.	The intervention involved providing children in the experimental school with access to outdoor play structures during afternoon recess. The control school had no access to these structures at any time.	Playground equipment
Amicone 2024[24]	This study examined how two different outdoor environments during recess, a natural environment (school garden) and a built environment (basketball court), influenced children's play behaviours, social interactions, and overall experience during recess.	Children were randomly assigned by class to spend recess in either: Natural environment (school garden) - 7 classes, 152 students. Built environment (basketball court) - 7 classes, 146 students. During recess, children played in their assigned environment (natural or built) under supervision.	A team of expert child development and education psychology researchers carried out the intervention. The team had a background in developmental psychology, environmental design, and education,

First author, year	Intervention aim/objective	Brief description	Critical resources
		Immediately after the break, children drew a picture of their playtime in the assigned environment. Children also wrote about the activities they did during recess. Cognitive, emotional, and social assessments were also conducted before and after recess but were not the focus of this paper. Study conducted in Spring to ensure suitable weather conditions for outdoor play.	with experience in conducting field-based studies involving children. Researchers were responsible for designing the study, implementing the procedures, ensuring ethical standards were met, and collecting data. They also supervised the children during recess to ensure compliance with the environmental conditions (natural vs. built). Teachers were involved in the study by facilitating the daily school activities and ensuring students followed the school norms during break time. They were also responsible for coordinating with researchers and ensuring the proper conditions for the experiment.
Impact studies			
Lane 2022[9]	The PACE intervention aimed to increase PA by supporting schools to implement a physical activity policy. This study is an	The PACE intervention was delivered over 12 months.	Training: teachers and in-school champions received full-day training to develop implementation plans and

First author, year	Intervention aim/objective	Brief description	Critical resources
	economic evaluation of the PACE intervention to inform scaling up and targeted adaptations of the program.	The intervention included training in-school champions (teachers), engaging principals to lead change, conducting teacher training sessions, providing educational materials and activity equipment, and optimising school environments for physical activity. The control group in the study received usual care, which consisted of access to general resources and information about physical activity policies, available to all schools. Measures were taken before the intervention began, at the start of the school year. The primary measure was the mean weekly minutes of physical activity implemented by teachers, recorded in a daily logbook. Data were collected 12 months after the intervention began to assess changes in physical activity levels.	strategies for integrating physical activity into their classrooms. Support activities: project officers from the LHD provided ongoing consultation and coaching, offering tailored guidance to schools throughout the intervention. This included school-wide promotion of physical activity and policy development led by principals. In-school champions (classroom teachers) played a key role in delivering the intervention within their schools.
Eichengreen 2024[17]	To promote social participation in students with/without disabilities through loose-parts play.	Children were provided with loose parts to play with in the playground. Playground assessments took place during one recess per week, always on the same day and time, and lasted about 30 min each. Children were assessed by wearable	300 parts, including crates, tyres, old furniture, buggies, sunshades, tree trunks, pipes and cable reels. The playground teachers were

First author, year	Intervention aim/objective	Brief description	Critical resources
		sensors and observations at the playground six times.	instructed on how to adapt their supervision to the intervention.
Lateef 2024[21]	To examine whether installing playground equipment would impact students' attitudes towards school, peers and their capacity to play.	Surveys were administered before and after the installation of school playground equipment.	Installation of a schoolyard play structure, including slides, ropes, seesaws, and ladders.
Observational studies			
Bartholomew 2022[10]	Secondary analysis (observational) of the Texas I-CAN! Study, limited to intervention schools only. Examined the relationship between school-level variables (i.e., duration of recess, recess before or after lunch, the recess environment, playground spaces available, playground space per student, bad weather days) and individual-level variables (i.e., age, gender, SES, ethnicity, fitness) affect children's physical activity and sedentary time during recess.	n/a - observational study	n/a - observational study
Craig 2024[12]	This was a secondary analysis of the HZPA study, examining the associations between	n/a - observational study	n/a - observational study

First author, year	Intervention aim/objective	Brief description	Critical resources
	school-level use of PA programs and activities implemented.		
Raney 2023[13]	To examine the impact of various schoolyard design features and green space on unstructured recess play behaviours according to gender and age.	n/a - observational study	n/a - observational study
Lemberg 2024[22]	To investigate whether policies around indoor vs outdoor recess had an impact on students' PA.	n/a - observational study	n/a - observational study
Akpinar 2024[23]	This observational study examined the impact of spending time in school green spaces on student health.	n/a - observational study	n/a - observational study

Table 4.4: Outcomes

First author, year	Physical activity	Available play space	School engagement	Economic	Other
Effectiveness studies					
Zask 2023[11]	Children in the intervention group engaged in 15.4 and 10.9 minutes more MVPA per day at 3 and 6 weeks, respectively ($p < .001$). Participation significantly increased the proportion of children who met the Australian 24-Hour Movement Guidelines ($p < .001$). There was no significant intervention effect on full day sedentary behaviour.		Significantly fewer students engaged in off-task behaviour in the intervention classes at the mid-point and final weeks of intervention (1.4 students, $p = .003$).		No significant intervention effects were found for wellbeing, cognitive and maths performance.
Barnas 2024[14]	Supervision had no statistically significant effect on sedentary, light, and MVPA engagement across all weeks of the study. Supervision did not significantly affect step counts, peak cadence, or average cadence. Supervision decreased moderate PA engagement during AZP				

First author, year	Physical activity	Available play space	School engagement	Economic	Other
	implementation, compared to unsupervised conditions (p = .001).				
Benthroldo 2022[15]	Increase in PA in both intervention and control groups (ns). No change in the proportion of students meeting the physical activity guideline (300 minutes per week) (ns).				
Farbo 2024[16]	For third graders, the intervention group had significantly more steps, more MVPA minutes and fewer sedentary minutes than the control group (p < 0.001 for both), supporting the hypothesis that 60 minutes of recess led to increased PA. For fourth graders, the intervention group showed fewer steps and lower MVPA minutes than the control group (p < 0.001 for steps and MVPA). The sedentary				Both intervention and control groups showed similar body fat shifts, regardless of the amount of recess (no significant differences between the groups for shifts in body fat categories, p = 0.7).

First author, year	Physical activity	Available play space	School engagement	Economic	Other
	behaviour was also higher in the intervention group (p = 0.001).				
Carriedo 2023[18]	At the end of the study, Group B (full recess) had significantly higher MET (Metabolic Equivalent of Tasks) than Group A (intermittent recess) (p < 0.001). Group A (intermittent recess) spent significantly more time in sedentary behaviour than Group B (p < 0.001).				Gender: Girls spent significantly more time in sedentary behaviour than boys (p < 0.001). Academic performance: A positive relationship between METs and academic achievement was observed p < 0.001.
Cristi-Montero 2022[19]	At the end of the study, no statistically significant difference in playtime was observed between the adolescents who wore TUs versus those who wore SUs (p = 0.739) Perceived PA: 64.1% of adolescents believe the traditional uniform affects their physical activity (proportion test, p < 0.01). Adolescents who believed that wearing traditional uniforms (TUs) affected their physical activity				Academic performance: Adolescents who wore SUs had slightly higher academic achievement scores than those who wore TUs (p = 0.022). Cognitive ability: Adolescents wearing sports uniforms (SUs) had slightly higher cognitive performance scores than those

First author, year	Physical activity	Available play space	School engagement	Economic	Other
	played 14.5 minutes more on average compared to those who believed that wearing the uniform did not affect their physical activity (p = 0.012).				wearing traditional uniforms (TUs). The p-value for this difference was 0.003. Bullying: no significant difference between groups at the end of the study Feelings of discrimination: Adolescents wearing traditional uniforms (TUs) reported higher levels of discrimination compared to those wearing sports uniforms (SUs) (p = 0.041).
Fuentes Diaz 2024[20]	No significant difference was observed in MVPA between groups (e.g., morning vs. afternoon recess with and without access to play structures) (p-values all >0.05).				

First author, year	Physical activity	Available play space	School engagement	Economic	Other
Amicone 2024[24]	A higher percentage of children in the natural environment were inactive during recess compared to those in the built environment, $p < 0.05$. A higher percentage of children played with a ball ($p < 0.001$) or engaged in play with rules ($p < 0.001$) in the built environment compared to the natural environment.				A higher percentage of children engaged in interactions with others in the built environment compared to the natural environment ($p < 0.05$).
Impact studies					
Lane 2022[9]	There was a mean increase of 44.2 mins PA per week in the intervention group and no change in the control group ($p < 0.001$).			PACE intervention cost: $35,692 total, $1,151 per school, or approximately $5.75 per child (estimated). Control group cost (usual care): Approximately $700 per school, or $3.50	

First author, year	Physical activity	Available play space	School engagement	Economic	Other
				per child (estimated).	
Eichengreen 2024[17]					Group observations indicated high involvement with LPP during the intervention sessions, with most of the play activities (84%) observed with loose parts. Individual-level sensor data at T2 showed a wider variety of interaction partners and a shrinkage in the proportions of same-sex interaction time compared with T1. 1. Findings indicated for all children a decrease during the intervention in the proportions of social interactions and social play and an increase in

First author, year	Physical activity	Available play space	School engagement	Economic	Other
					solitary play activities, based on group-level observations and no change in network centrality. 2. Enjoyment of LPP was high for all children, yet children with disabilities did not benefit socially from the intervention and became even more isolated compared with baseline level.
Lateef 2024[21]					Higher proportion of students with a positive attachment (p = .019).
Observational studies					
Bartholomew 2022[10]	The amount of time spent in MVPA and sedentary(mins/day) were directly associated with recess length (P=0.009).	No effect for the size of the recess area and time spent in either			

First author, year	Physical activity	Available play space	School engagement	Economic	Other
	The number of environmental supports for activity was associated with MVPA (1.2% increased MVPA per item) and sedentary behaviour (1.7% decreased sedentary behaviour per item). In contrast, sedentary/seating areas showed the opposite pattern of effects with per cent MVPA (2.0% decreased MVPA per item) and sedentary behaviour (2.8% increased sedentary behaviour per item).	MVPA or sedentary behaviour was found.			
Craig 2024[12]	NR - this study reported implementation characteristics.				
Raney 2023[13]	A greater percentage of students at schoolyards with fewer play zones and no green space were observed to be sedentary at one time during recess. Individual students' time spent in MVPA was highly dependent on where students played during recess. Across schoolyards, students spent the	A direct relationship was found between play zone density (number of students per zone square foot) and the percentage of students observed sedentary within that zone $p < .05$). Zone		A greater number of unique play zones was associated with a greater number of prosocial (verbal and physical) interactions during playtime.	

First author, year	Physical activity	Available play space	School engagement	Economic	Other
	most time active when located in the basketball courts and on the play structure available and the least time active when located in 4- 4-square/dodgeball, kickball, and non-designated areas lacking markings or specific play purpose and frequently containing plastic or metal benches. More MVPA minutes were accumulated in the play structure than in kickball, handball, 4-square/dodgeball, volleyball, and non-designated play zones (p <.05). There was no difference in the MVPA minutes accumulated in the play structure and the basketball, tetherball, open field, or outdoor classroom play zones (p >.05).	popularity differed according to age group, gender, and location, p <.05.			
Lemberg 2024[22]	The "outdoor recess" group stated being significantly more active outdoors during their leisure time compared to "outdoor recess on		The "outdoor recess on some days" group had more positive attitudes about concentration after outdoor recess		The "outdoor recess" group had more positive attitudes about outdoor recess compared to "outdoor recess on some

First author, year	Physical activity	Available play space	School engagement	Economic	Other
	some days" and "indoor recess" groups ($p < 0.05$).		and outdoor recess, making the rest of the school day lighter when compared with the "indoor recess" group ($p < 0.05$).		days" and "indoor recess" groups ($p < 0.05$).
Akpinar 2024[23]					Improvements were reported for stress, mental health and general health (all $p < 0.05$).

Table 4.5: Program features that enable or are barriers to participation

Author, Year	Enablers	Barriers	Cost information
Effectiveness studies			
Zask 2023[11]	Having a routine Students enjoyed the sessions Staff found the experience positive	Challenging to motivate some students The weather can impact outdoor active breaks Children in Kindergarten found it difficult to control their emotions at times. Children in Kindergarten tripped or bumped into each other in the beginning.	NR
Barnas 2024[14]	Staff training	AZP created more structure and rules to be followed, decreasing PA engagement in students who were already active The activities chosen may not have been as physically engaging for active children as anticipated.	NR
Benthroldo 2022[15]	NR	NR	NR
Farbo 2024[16]	NR	NR	NR

Author, Year	Enablers	Barriers	Cost information
Carriedo 2023[18]	Teacher training on the importance of recess and PA could help promote the full use of recess for physical activity. School policies that limit or prohibit withholding recess for punitive or academic reasons	Withholding recess as a form of punishment or to allow students to finish classwork.	NR
Cristi-Montero 2022[19]	Institutional changes, including policies backed by the government, could create the conditions needed to change school uniform policies. School type	School principals seem to be a key barrier related to attitudes to changing school uniform policies, allowing students to wear SUs every day, but not teachers, parents, and students. School type - schools where SUs are worn tend to be private rather than public	"Low-cost", but not specified
Fuentes Diaz 2024[20]	Free-play environments (without structures) were highlighted as suitable for physical activity. Outdoor environments and space availability facilitated engagement	Concerns about safety, supervision needs, and cost of play structures Limited infrastructure and potential design inadequacies of the structures	The study notes that outdoor play structures are costly and often not included in school budgets when built or renovated. No specific cost data reported
Amicone 2024[24]	NR	NR	NR

Author, Year	Enablers	Barriers	Cost information
Impact studies			
Lane 2022[9]	Principals played a critical role in mandating change, promoting physical activity within their schools, and encouraging teachers to participate in the intervention. Nominating in-school champions (typically classroom teachers) helped drive the intervention at the school level. Training and ongoing consultation from project officers ensured schools received continuous support, which facilitated the effective implementation of the intervention. Collaboration with local government areas and engaging the broader community helped schools feel supported and encouraged to adopt physical activity practices.	Teachers and school staff often faced time constraints, which made it challenging to fit additional activities or policy changes into already packed schedules. Some schools reported a lack of resources (e.g., space, equipment) to effectively implement the physical activity strategies. Schools often had competing priorities, such as academic performance and other health initiatives. There was some resistance to change, particularly among staff who were not convinced of the benefits of the intervention or who felt the physical activity strategies would disrupt existing routines.	Total cost of PACE intervention = $35,692 for 31 schools. Average cost per school = $1,151
Eichengreen 2024[17]	NR	NR	NR

Author, Year	Enablers	Barriers	Cost information
Lateef 2024[21]	Funding		
Observational studies			
Bartholomew 2022[10]	NR	NR	NR
Craig 2024[12]	Implementation climate - "The absorptive capacity for change, shared receptivity of involved individuals to an intervention, and the extent to which use of that intervention will be rewarded, supported, and expected within their organisation." Access to knowledge and information - "Ease of access to digestible information and knowledge about the intervention and how to incorporate it into work tasks."	NR	NR
Raney 2023[13]	The greater the variety and flexibility of the play structure equipment, the greater the sociability associated with the space.	Traditional schoolyards that devote a large percentage of the overall schoolyard square footage to courts or fields designed for ball games and sports do not optimise the utilisation of the schoolyard. They may	NR

Author, Year	Enablers	Barriers	Cost information
	Grass field popularity and activity levels are higher when the grass field is more parklike in design, with trees (and resulting shade) interspersed throughout a non-linear-shaped field, compared to a rectangular open grass field with no trees designed for sport. A greater number of unique play zones that are nature-based are related to creative/imaginative and collaborative/ prosocial play, e.g. digging, building, jumping from log to log, and playing hide and seek. When properly designed, play structures and vertical features are highly effective at promoting physical activity, even without green space. Structures with unique balance and climbing challenges were associated with more MVPA minutes. When individual play zones are less crowded due to better dispersion of students across the schoolyard, more students are active at once. When play zones include opportunities to perform motor skills such as balance, agility, and	also contribute to fewer physical activity options for girls due to gender differences in activity preferences. As students get older, activity preferences evolve, and painted lines on asphalt (e.g. 4-square, hopscotch) no longer serve as an appealing place to play. While sports fields and basketball courts continue to cater to boys as they age, these design features are not sufficient to fulfil the developmental changes in girls who, when active, were observed engaging in activities such as gymnastics and dance. Green space alone is insufficient to attract or promote student engagement in MVPA.	

Author, Year	Enablers	Barriers	Cost information
	coordination, a higher percentage of children are active		
Lemberg 2024[22]	Parental agreement about the benefits of going outdoors during recess	NR	NR
Akpinar 2024[23]	NR	Students stated that the school campus green spaces do not meet their perceived mental and physical needs because the school campus green spaces are not large enough, the size of green spaces is too small, and they are neglected.	NR

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