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Designing movement-rich environments: evaluating the Skills Garden for physical activity promotion

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HIGHLIGHTS

- The Skills Garden attracted 3 x more users than traditional spaces.
- There was an 18% rise in female participation at the Skills Garden.
- The Skills Garden offers a rich location of affordances encouraging varied movement.
- The study used a unique free-play movement analysis to evaluate movement variety.

ABBREVIATIONS

BF	Balancing & Falling
BMS	Basic Movement Skills
CI	Confidence Interval
GEE	Generalised Estimating Equation
ICC	Intraclass Correlations
JL	Jumping & Landing
KSA	Kicking, Shooting & Aiming
MIM	Music in Motion
ML	Moving & Locomotion
MVPA	Moderate-to-vigorous physical activity
PA	Physical Activity
PARA	Physical Activity Resource Assessment
PD	Population Density
QGIS	Quantum Geographic Information System
RF	Romping & Fighting
RTT	Rolling, Turning & Tumbling
S	Swinging
SG	Skills Gardens
SOPARC	System for Observing Physical Activity and Recreation Communities
TCHA	Throwing, Catching, Hitting & Aiming
z	Standardized residuals

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BACKGROUND: Publicly accessible built environments such as sports courts, playgrounds, and outdoor gyms are often underutilised. Innovative built environments provide an alternative approach, promoting free play and diverse movement experiences.
AIM: This study examined the user demographics, physical activity (PA) levels, and movement patterns observed at Skills Gardens (SGs) – innovative built environments designed to promote activity and movement - and compared them to traditional public spaces.
METHODS: Direct observations were conducted at two SGs and two traditional sites matched for area and population density. Observers recorded user counts by assumed sex and perceived age, along with engagement in moderate-to-vigorous physical activity (MVPA) and movement patterns.
RESULTS: SGs attracted approximately three times more users than traditional spaces (257.5 vs. 84.5, $p < .001$), with over twice as many engaging in MVPA (142 vs. 65.5, $p = .008$) and an 18% increase in female participation (39% vs. 21%, $p = .029$). Movement patterns also varied by setting: SGs facilitated more Balancing & Falling, Moving & Locomotion, and Music in Motion ($p < .05$), whereas traditional spaces saw higher frequencies of Romping & Fighting, Rolling ($p < .05$), Turning & Tumbling ($p < .01$), and object control movements such as Throwing, Catching, Hitting & Aiming, and Kicking, Shooting & Aiming ($p < .001$).
INTERPRETATION: These findings suggest that the SGs can attract more diverse users and encourage varied movement patterns, informing the design of inclusive public spaces that promote physical activity through an innovative design approach.

KEYWORDS: Physical Activity | Built Environment | Innovative Spaces | Urban Design | Affordances

INTRODUCTION

Publicly accessible built environments for sports, play, and exercise, such as sports courts, playgrounds, and outdoor gyms, provide dedicated spaces for physical activity (PA). Many countries, including New Zealand, Denmark, and the US, have developed such spaces, particularly within parks [1,2] to promote PA. Nevertheless, research indicates that these spaces are largely underutilised, with parks remaining empty 75–92% of the time [3], and users typically spending only 15–30 minutes per visit in outdoor gyms [4]. Factors influencing park usage (i.e., length of stay or attendance) and consequently design include size [2], population density [5] and the number of structure and play elements [5,6].

Recent efforts to increase user engagement have led to the development of 'innovative' built environments for PA. These spaces aim to provide users with a more attractive space to spend more time outdoors, participate in free play (i.e., unstructured, enjoyment-driven activity) [7], and facilitate varied movement experiences (e.g., swinging & climbing) [8]. Characterised by features including diverse surface types, naturalised play areas, open-ended structures, movable equipment, and non-traditional designs, catering to multiple age groups, including adults and seniors, innovative environments attract more users and result in approximately three times greater moderate-to-vigorous physical activity (MVPA) than traditional spaces [5,8]. This increased engagement is attributed to the presence of open function elements that do not determine the movements to be performed, which stimulate creativity [9] and provide an enriched neutral landscape of affordances [10]. According to Gibson [11], affordances are opportunities for action provided by the environment, whereas the perception and realisation of these affordances are influenced by individuals' capabilities. In built environments for PA, an enriched neutral landscape of affordances are environments that offer a range of potential actions without imposing specific uses of its features whilst encouraging users to search, discover and explore action possibilities.

More recently, the theory of affordances has been informing the development of frameworks to design spaces for PA [12], including the Skills Garden (SG) and PLAYCE approach [10,13] (Skillsgarden.nl, PLAYCE.nl). With more than 60 indoor and outdoor movement spaces ranging from physical education halls, parks, and sports centres to rehabilitation centres, the SG and PLAYCE is an affordance-based and movement-focused design framework. That is, these built facilities focus on creating spaces that invite users to explore and perform a wider range of movements. Heft [14] [p. 28] had previously stated that *"Because affordances are action-related properties of environments, they are particularly well suited for considering the implications of environmental design for health promotion and "active living"*. Therefore, to create an enriched neutral landscape of affordance, the SG and PLAYCE framework adopts five design principles: 1) Affordances, 2) Fundamental Movements, 3) Scaling, 4) Asymmetry, and 5) Monitoring/Testing [15]. More specifically, the design of these spaces affords users opportunities to perform fundamental movements (e.g. climbing and scrambling, jumping and landing, balancing and falling - based on [13], which extends traditional categories of locomotion, object control, and stability [16] by promoting a more diverse and integrated set of movement patterns across the lifespan) according to their action capabilities. For example, stepping stones of different heights arranged apart at different distances can afford seating, jumping, leaping, or even climbing depending on users' capabilities. Similarly, a large slide with an adequate inclination angle affords not only siting-sliding but also standing-sliding when going down, as well as climbing and running when going up. This approach thoughtfully considers different features that can be configured in different ways to offer children and adults opportunities for action scaled to their abilities. This process of scaling (i.e., offering opportunities for actions to users of different action capabilities [17]) is complemented by the development of asymmetrical features which include different sizes and heights for sports equipment (e.g. basketball hoops, football goals) and other movement features (e.g. stepping stones and bars) [17] as well as asymmetrical painted lines and targets on the floor and walls. Asymmetrical features invite users to adapt their activity within their boundaries (e.g. smaller fields to play football for smaller children), enabling the space to be versatile and multifunctional from a movement perspective (i.e., opportunities to perform as many different movements as possible, in a variety of ways by engaging in different activities, games or sports on the same space). Finally, additional markers on the floor or wall are also included to facilitate practitioners to monitor users, which may be particularly useful for movement programmes or organisations [13] [p.251].

The inclusion of specific features to promote the development of fundamental movement skills such as balance, climbing, throwing, and catching appears to be important in developing motor competence [18]. Despite efforts to reduce physical inactivity, most of the population remains insufficiently active [19]. Early development of motor competence is essential for long-term PA engagement [16], with research showing strong positive correlations between motor competence, PA levels, and cardiorespiratory and musculoskeletal fitness outcomes [20]. Hence, built environments with affordances and movement-focused design such as the SG and PLAYCE approach, might support the development of motor competence in addition to high levels of PA. Nevertheless, so far no studies have evaluated the impact of the innovative SG approach on users' engagement patterns, including the number of users and movements performed on the sites. Therefore, the current study aimed to evaluate the impact of the SG and PLAYCE approach to designing built environments for PA on users' engagement patterns. Based on the rationale provided, we hypothesised that more users would use the selected SGs, performing different movement patterns at higher levels of PA intensity compared to match-controlled traditional designed sites.

METHODS

Study Design

The current study adopted a naturalistic observational, cross-sectional design to examine the number of users and their movement behaviours at four different built environments for PA. The current study was approved by the University of Portsmouth Science and Health Faculty Ethics Committee (SHFEC 2023-067). A week prior to data collection, local authorities informed residents within a 1 km radius about the study schedule, and additional signs were placed at the site entrances on data collection days.

Participation in activities during time slots inferred consent.

Investigation Area

Prior to data collection, four sites were selected including two publicly accessible SGs located in the Netherlands, the SG Learn and Sportpark Veendam located in the city of Veendam (Fig. 1) and the SG Almere Haven located in the city of Almere (Figure 1). Two other publicly accessible sites, one in each city, were included to act as control sites. To select these two additional sites, a list of the publicly available spaces for PA in both cities were received from the respective local authorities (seven sites in Veendam and three sites in Almere, Table S1). The control sites were selected based on similar area and population density in comparison to the SGs in each location (SG Veendam, area = 32,840 square meters, population density = 773 1-km radius; SG Almere, area = 6502 square meters, population density = 2867 1-km radius). In Veendam, the Sportpark Wildervank (Fig. 1, area = 56,792 square meters, population density = 843 1-km radius) was selected as the control site for the SG Learn and Sportpark whilst in Almere, the Clarence Seedorf Playground Stedenwijk (Fig. 1, area = 6204 square meters, population density = 3132 1-km radius) was selected as the control site for the SG Haven Almere. Site area (m²) and population density (PD), within a 1 km radius from the centre of the target site were calculated [21] for each site using Quantum Geographic Information System (QGIS) (3.32 version, PDOK plugin, Ortophotos 8 cm RGB) in conjunction with the latest available Dutch census data (Table S1, supplementary data).

Figure 1. Images of sites included in the study. Top left SG Learn and Sportpark Veendam ASM©, top right SG Almere Haven ASM©, bottom left Sportpark Wildervank Veendam image obtained from Google Sattelite, and bottom right Clarence Seedorf Playground Stedenwijk, Almere image obtained from Google Sattelite. Note that access to the aerial view of the latter two sites was not possible to obtain.

Procedures

Two independent observers conducted and coded all observations. Before data collection, observers were trained in using all observational tools and completed pilot testing in the United Kingdom under the supervision of an experienced researcher. Observers observed the same site simultaneously but recorded data independently. Data collection took place over two weeks (one week per city, Table S2 for planned visits scheduling and Table S3 for completed visits) in June (mean = 21.61 °C, range = 17 °C to 32 °C) [22] and August 2023 (mean = 21.29 °C, range = 17 °C to 27 °C) [22], from Saturday through to Thursday, with observations being completed at 09:30, 15:00 and 18:30 (each observation was allocated one hour depending on number of users). Visits were cancelled in the event of substantial rainfall (i.e., rainfall ≥ 4mm/hour). Observations times were based on previous research suggesting that increased PA engagement occurs during the morning for adults [23] and older adults [24], the afternoon and late afternoon for children [25], and the late afternoon for adolescents [26]. During the first visit of each site, observers independently completed a site audit using the Physical Activity

Resource Assessment (PARA, detail below). For each subsequent visit, observers used the System for Observing Physical Activity and Recreation Communities (SOPARC, details below) and performed an activities and movement analysis.

Site audits

A site audit was used to assess each park's potential to promote PA. The PARA [27], is a brief one-page tool used to assess PA resources. Assessments took between 10 and 30 minutes, depending on the size of the resource. PARA assessed park type, features, amenities, and incivilities with a simple rating scale. Features and amenities were coded as 3 "good", 2 "mediocre", 1 "poor" and 0 "not present" for a maximum total score of 39 and 36 respectively. Incivilities were reverse coded as 4 "not present", 3 "a little", 2 "a medium amount", and 1 "a lot" for a maximum score of 48 and a minimum score of 12. The tool demonstrates strong inter-rater reliability (rs > .77) [27].

Users' count

The System for Observing Physical Activity and Recreation Communities (SOPARC) was used [28] to count the number of users per visit including assumed sex, perceived age group (child, teen, adult, and senior adult), and observed PA intensity (i.e., sedentary, light and moderate-to-vigorous). SOPARC is based on momentary time sampling techniques in which observers complete scans of predetermined target areas of each site. As per the SOPARC protocol, the sites were subdivided into sections to allow for scans of specific areas. While SOPARC is based on visual estimation and thus involves a degree of subjectivity, it has been widely validated and applied in over 30 peer-reviewed studies [29]. The PA intensity categories used by SOPARC have been supported through validation studies involving heart rate monitoring, showing clear differentiation in physiological responses for sedentary, walking, and vigorous activity [30]. Therefore, although not equivalent to device-based tracking, SOPARC provides a reliable and practical method for assessing observable trends in activity intensity across public spaces.

Movement Analysis

In addition to the record of activities, a movement analysis was conducted by tallying the number of basic movement skills (BMS, an extension of the traditional categories of locomotion, object control, and stability [19]) performed in each identified area (Table 1) [13]. As per previous research, each area was observed for 3 minutes with the number of individual movements being recorded [31]. If users were still performing the observed activity from the SOPARC scan, observers recorded the BMS for that activity multiplied by the number of users. Additional BMS performed by either separate users or those skills not included in the observed activities were also recorded.

Table 1. Ten basic movement skills and their representations (reproduced with permission from 13).

Basic Movement Skills	Representation
Balancing and falling (B&F)	Representations of balance: supporting, gliding, rolling, rotational, air, hanging, and all combinations of, balance; acrobatics; the art of falling.
Romping and fighting (R&F)	Pulling and pushing, lifting, raising, and carrying, duelling.
Moving and locomotion (M&L)	Swimming and cycling, walking, running, sprinting, frolicking, galloping, hopping, crawling, and turn, stop and go.
Jumping and landing (J&L)	Flight, height, and rotation.
Rolling, tumbling, and turning (RT&T)	Rotating in different axes and planes.
Throwing, catching, hitting, and aiming (TCH&A)	Moving or hitting objects with the upper extremities, dribbling, bouncing, all types of throwing, pitching, hitting, catching, heading, and juggling.
Kicking, shooting, and aiming (KS&A)	Moving or hitting objects with the lower extremities: dribbling, passing and kicking.
Climbing and scrambling (C&S)	Leaning and hanging in multiple positions.
Swinging (S)	Swinging: swinging while hanging. Swinging while leaning and swaying.
Music in motion (MIM)	Moving to music and making music.

Statistical Analysis

Intraclass correlations (ICC) and pairwise comparisons were conducted in JASP (0.17.2.1) and generalised estimating equation (GEE) and Chi-Square analyses were conducted in SPSS (27.0). The value alpha was set at .05. Effect sizes for GEE were calculated using Partial Eta Squared [32] with 0.02 or less, 0.15, and 0.35 or more, representing small, medium, and large effect sizes, respectively whilst effect sizes for Chi-Square were calculated using Cramér's V, with 0.1 or less, 0.3, and 0.5 or more, representing small, medium, and large effect sizes, respectively [33].

Analysis of rater reliability

ICC, reported with 95% confidence interval (CI), were used to evaluate the level of agreement in the data across visits between the two observers during observations. The assessed variables included the results of the PARA audit, total number of users, assumed sex, perceived age group, PA level, and BMS recorded. PARA, SOPARC and BMS observational data were aggregated between observers for the count of users observed, assumed sex, perceived age, PA level, and BMS performed per visit if ICC was deemed to be at least moderate (≥0.5) [34].

Site audits

PARA scoring for each observer's audit was completed according to previous research [27]. Using the aggregated ratings, scores for features, amenities, and incivilities were calculated by summing the scores for each set of items and then divided by the total number of items (features = 13, amenity and incivilities = 12) to obtain an average score for further comparison between sites at the same location (i.e., Veendam, Almere) and between site types (Control, SG).

User count

For each observer's collected data, the total number of users was calculated for assumed sex (male and female), perceived age group (child, teen, adult and senior adult), and observed PA intensity (sedentary, light, and moderate-to-vigorous). Each observer's data was then averaged and percentage values were calculated where appropriate for SOPARC categories (sex, age group and PA level). GEE modelling was conducted with location (Veendam, Almere) and site type (Control, SG) as factorial effects on all dependent variables except for sedentary and light PA intensities.

Movement analysis

For the movement analysis, the frequency of each BMS per site was calculated and submitted to a chi-square analysis to examine whether the distribution of BMS observed differed between sites. Analysis for the Veendam sites was not included due to the low number of users across visits for the control site.

RESULTS

Intraclass correlations for reliability

ICC for PARA scores of each site ranged from 0.810 (95% CI, 0.661 to 0.897) to 0.864 (95% CI, 0.752 to 0.928) (Table S2). ICC for each SOPARC category ranged from 0.637 (95% CI, 0.345 to 0.816) to 0.963 (95% CI, 0.921 to 0.983) (Table S4). ICC for the BMS for all visits ranged from 0.468 (95% CI, 0.417 to 0.515) to 0.934 (95% CI, 0.926 to 0.942) (Table S5).

Park audits

The results from the PARA indicated that the results were mixed between the control sites and the SGs (Table 2). The SGs appeared to be more equipped regarding features, however scored worse when examining incivilities. The results when examining amenities were mixed and dependent on city location.

Table 2. PARA audit total scores (average score for each category) for each site. Scores have been aggregated from both observers.

	Veendam		Almere	
Site	Control	Skills Garden	Control	Skills Garden
Feature	12.5 (0.96)	17.5 (1.35)	13 (1.00)	17 (1.31)
Amenity	19 (1.58)	25.5 (2.13)	20 (1.67)	18.5 (1.54)
Incivilities	45 (3.75)	42.5 (3.54)	45 (3.75)	39 (3.25)

Users count

Table 3 shows the aggregated data between observers for the number of users (%) observed at each site across all visits.

Table 3. Total users (%) observed across all sites. Results are presented as the average between the two observers.

	Match controls All Users	Skills Gardens All Users
Users observed	84.5	257.5
Male users	67 (79.29%)	156 (60.58%)
Female users	17.5 (20.71%)	101.5 (39.42%)
Child	38.5 (45.56%)	108 (41.94%)
Teen	20.5 (24.26%)	84 (32.62%)
Adult	22.5 (26.63%)	48.5 (18.83%)
Seniors	3 (3.55%)	17 (6.6%)
Sedentary	19 (22.49%)	115.5 (44.85%)
Moderate-to-Vigorous users	65.5 (77.51%)	142 (55.15%)

Figure 2 shows the average number of all users and active users observed per visit split into location, site type and age group. GEE revealed a main effect for site location and site type for total user count, and numbers of male and female, and child, teen, adult and senior users with a greater number of users observed in the city of Almere and at the SG sites ($p < .001$ to .041, $f^2 = 0.001$ to 0.516 for city location and $f^2 = 0.106$ to 0.948 for site type) (Table S7).

For activity levels, GEE revealed a main effect of location ($\chi2 = 13.435$, $p <.001$, $f^2 = 0.52$) and site type for users in MVPA ($\chi2 = 7.092$, $p < .008$, $f^2 = 0.27$) indicating more users displayed a higher level of energy expenditure in Almere (12.333 ± 1.763 users) compared to Veendam (3.652 ± .765 users) and at the Skills Garden sites (10.589 ± 1.102 users) compared to control sites (5.396 ± 1.254 users). There was no significant interaction effect for any of the variables submitted to GEE ($p > .05$).

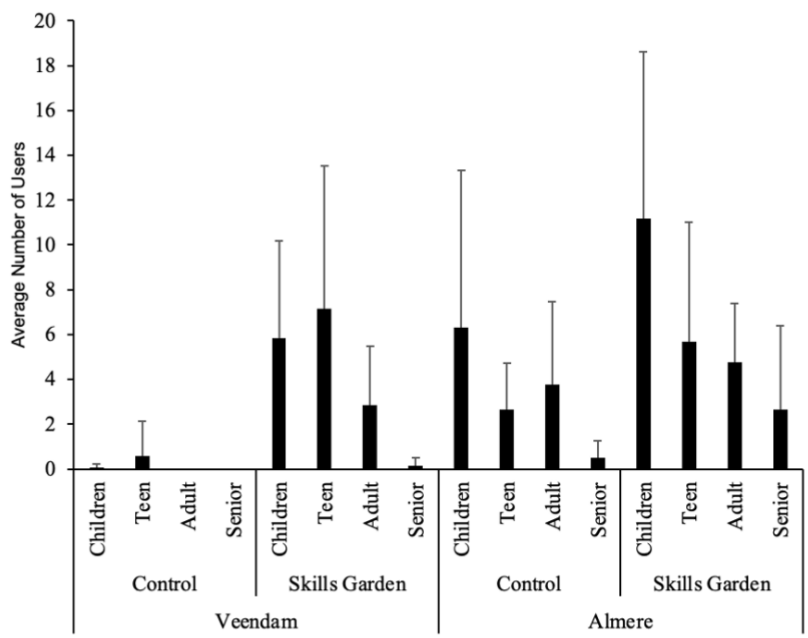

Figure 2. Average number of all users observed per visit at each of the four sites. Users are split into the four age brackets used by the SOPARC tool.

Movement analysis

Chi-square analysis showed a significant association between the site type and the distribution of BMS observed, $\chi2$ (9, 870) = 101.507, $p < .001$, V = 0.34 (Table S8). Standardized residuals (z) showed significantly greater distribution of Balancing & Falling (BF) ($p < .05$), Moving & Locomotion (ML) ($p < .05$), C&S (CS) ($p < .05$) and Music in Motion (MIM) ($p < .05$) at the SGs, whereas there was a significant greater distribution of Romping & Fighting (RF) ($p < .05$), Rolling, Turning & Tumbling (RTT) ($p < .01$), Throwing, Catching, Hitting & Aiming (TCHA) ($p < .001$), and Kicking, Shooting & Aiming (KSA) ($p < .001$) at the control site. There was no significant difference in the distribution of Jumping & Landing (JL) and Swinging (S) between the sites.

DISCUSSION

This is the first study to evaluate the use of the SG, a movement-focused built environment for PA, designed according to the theory of affordances [11]. Providing a neutral landscape of affordances with a wider range of opportunities for action, we can accept our hypotheses that SG sites would attract more users and lead to higher levels of PA intensity than control sites, with movement patterns varying between site types.

Consistent with previous research indicating innovative spaces as more popular [8], SG sites attracted a significant total ~3 times more users than their respective control sites. Previous research suggests that people often gravitate towards environments that offer a richer array of opportunities for action, particularly if these affordances align with their needs, goals, or capacities [35]. Environments with more complex affordances, such as areas with varied textures, and diverse materials, encourage engagement and exploration, particularly among children, but also extending to adults seeking versatile spaces [14]. In addition, the inclusion of innovative features (e.g. different surface types, open-ended structures) attracted a more diverse population of users. Subgroups analysis revealed a significant increase in users across all groups (males, females and children, teenagers and adults), except seniors, at the SG sites. Importantly, SG sites showed a more balanced assumed sex distribution, with 39% female and 61% male users, compared to 21% female and 79% male at traditional sites. Research suggests that traditional ball courts and skate parks, such as those in Sweden, have a predominantly male user base [36]. Our findings indicate an 18% increase in female representation in SG spaces, suggesting this design might be more inclusive. Females reported a preference for spaces that allow flexible and varied activities as well as opportunities for more playful and social activities (e.g. a set of bars for climbing and gymnastics) [36]. SG's affordance-rich landscape may provide a more appealing space for these preferences, supporting greater female participation.

A significantly greater number of users (over x 2) engaging in MVPA were also observed at the SG compared to the control sites, which suggests that innovative spaces for PA may provide greater opportunities for users to engage in higher-intensity physical activity. The PARA audits confirmed that SG sites scored higher in facility offerings, aligning with previous findings that innovative spaces for PA promote MVPA [19]. The array of affordances presented at SG sites allowed users diverse ways to engage in MVPA. In fact, research on children's playscapes shows that varied movement options, even in simple settings, can lead to higher activity intensities [16]. That is, children prefer to jump between blocks instead of stepping, subsequently engaging in a higher-intensity activity [16]. Adults also display similar challenge-seeking behaviours. When asked to choose between a more varied, challenging walking route and a simpler one, most participants preferred the route offering more affordances [37]. This aligns with previous research trends, which associate innovative playgrounds with higher levels of MVPA. Importantly, the statistical effects observed in this study were not only significant but also suggest potential practical relevance. For example, the effect size of design on total user count was large, indicating that affordance-rich environments may meaningfully influence how many people choose to use a space. Similarly, relatively strong effects were observed for female users and for users engaging in MVPA, with design showing a medium-to-large effect and location a large one. While these findings do not confirm causality, they support the possibility that site design characteristics contribute to differences in both the volume and diversity of use. In particular, SG sites may offer features that are more appealing to a broader demographic, including populations often underrepresented in traditional recreational environments. These results highlight the potential for thoughtful design to play a role in promoting greater inclusivity and engagement in physical activity.

This was the first study to perform a movement analysis in a free-play setting across different sites. Traditionally, research describes the types of activities performed (e.g. structured activities such as football, or unstructured activities such as play), however, from a motor development perspective, PA and motor skill competence have strong positive relationships (i.e., higher levels of motor competence are associated with higher levels of PA) [19], suggesting that it may be more informative to examine the quality of movement patterns underlying these activities, rather than simply categorising the activities themselves. The current findings indicated that specific BMS (i.e., BF, CS, ML and MIM) were more prevalent in the SGs, while other movement patterns (i.e., KSA, TCHA, RF and RTT) were more common at the control sites. Although the type of activities was not examined in the current study, traditional post and platform spaces may predetermine users' activities depending on the site design (e.g., football or basketball courts), possibly explaining the higher prevalence of KSA, RF, RTT and TCHA in the control sites (e.g., users may perceive the control site as better suited for football, while the SG accommodates a broader range of activities). Additionally, the higher number of female users at the SG compared to the male-dominated control site may also help explain the observed differences in movement patterns. Research has shown that in public spaces females often prefer to engage in different types of activities (e.g., dance rather than playing traditional sports such as football) [36]. Therefore, designing spaces for PA should consider providing diverse movement opportunities to support a more inclusive approach. Previous research observed that climbing and swinging were the most popular activities in innovative playgrounds [8], yet such movements are limited in traditional post-and-platform spaces. Innovative design should therefore offer users greater opportunities for movement scaled to a wide range of users' skill levels. For example, a set of monkey bars over stepping stones allow users of all ages to select the most functional action based on their capabilities choosing to move through the path either on the steps, swinging on the bars or a combination of both. This approach ultimately can foster motor learning and more creative movement solutions [13,38].

Limitations

Although the SOPARC tool has been previously validated, the limitation arises from the duration of observations which provides only a snapshot of the site usage during the scheduled observations. While observation timing was based on previous research and spread over numerous days to achieve a total of 27 observations, this approach may not have captured peak site usage. Conducting preliminary visits to assess the sites' busiest time might have been more prudent. Previous research has adopted video photography [8] to capture users' engagement over extended periods, however, different countries impose restrictions on naturalistic observational research involving images of the general public.

Site selection focused on two pre-selected, publicly accessible SG in the Netherlands, with control sites chosen based on population density and area at similar demographic areas. The Veendam control site was sparsely visited, with only one observed visit involving users, while the Almere control site resembled a traditional space but incorporated some innovative features, which may not have been the most appropriate comparison site[a]. Due to logistical constraints, preliminary site visits were not conducted; future research should include pre-data collection site assessments to ensure comparability.

Finally, in retrospect, we should have accounted for the types of activities (e.g. football, parkour, gymnastics) by gender alongside movement patterns, allowing for a deeper analysis of movement versatility (e.g., similar movements in different contexts, such as kicking in football versus martial arts [13]). This information could be particularly relevant when considering the development of a broader motor repertoire and consequently movement competency [17].

CONCLUSION AND PRATICAL APPLICATIONS

This study underscores the significance of designing built environments, particularly innovative spaces such as the SG, to facilitate physical activity. The findings corroborate existing literature, suggesting that environments offering diverse affordances not only promote a wider range of movement patterns but also increase user engagement. Specifically, the SG design demonstrated its effectiveness in enhancing participation, supporting higher energy expenditure, and fostering movement diversity. Future research should investigate prolonged user engagement in SG, with a focus on movement versatility and potential variations across demographic groups to deepen understanding of their impact on physical activity behaviours.

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[a] To address concerns regarding the suitability of the Veendam control site, a supplementary analysis was conducted excluding data from both Veendam sites. Most results remained consistent, with site type (SG vs. control) continuing to show significant effects on key outcome variables. For example, when analyzing the total number of users using a GEE model, site type remained a significant predictor: $\chi^2 = 9.626$, $p = .002$. Similar results were observed for female users: $\chi^2 = 22.375$, $p < .001$. Although the effect on MVPA was no longer statistically significant ($\chi^2 = 2.343$, $p = .126$), the direction of the effect remained consistent. No significant effect was observed for male users ($\chi^2 = 0.888$, $p = .346$). These findings suggest that the inclusion of the Veendam data did not materially affect the overall conclusions of the study.

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