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Do Spatial Qualities of A Play Space Influence The Intensity of Children's Outdoor Play? Evidence from Dhaka

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Abbreviations:
DNCC = Dhaka North City Corporation
DSCC = Dhaka South City Corporation
ICP = Intensity of Children's Play
MiSQ = Micro-spatial quality of a play space
RAJUK = Capital Development Authority, Dhaka

ABSTRACT

Outdoor play is important for children's physical, social, and mental health, as well as for their growth and intellectual development. However, there is limited empirical evidence of how outdoor play spaces and their qualities influence children's outdoor play. This study examines whether and how the spatial qualities of urban play spaces influence the intensity of children's outdoor play in Dhaka – a little researched urban context in South Asia. Twenty-one outdoor play spaces were systematically observed 168 times for 10 minutes to measure the intensity children's (7-18 years) outdoor play. Seventeen spatial qualities of those outdoor play spaces, termed as micro-spatial qualities, were evaluated to examine their statistical correlation with the intensity of children's outdoor play, followed by regression studies. Results reveal that 9 micro-spatial quality variables were significantly related to the intensity of children's outdoor play. Among them, the enclosure of a play space and the presence of small and informal retail business activities adjacent to a play space had stronger influences. Findings underscore the interconnected role of outdoor play spaces, their spatial qualities, and children's outdoor play activities. They suggest evidence-based planning and designing of outdoor play spaces in high-density cities.

1. Introduction

It is widely established that outdoor play is important for children's physical, social, and mental health (McGrath, Hopkins, and Hinckson 2015; Tremblay et al. 2015; Flôres et al. 2019; Janssen and LeBlanc 2010). Outdoor play is not only crucial for children's growth and development, it also facilitates quality times that children spend in their own way or with peers in the neighbourhood (Hart 2002; Wen, Kite, and Merom 2009). With the emergence of extra high-density urban neighbourhoods with the dominance of cars and vehicular streets, children's independent access to outdoor play spaces show declining trends in many cities in the world (Shaw et al. 2015). Although there are few research-based data, such trend is also noticeable in rapidly urbanising cities in South Asia (Bhuyan and Zhang 2020). In such context, international initiatives call for new policies and spatial plans for cities that encourage children to play outdoors more. For example, the UN Convention on the Rights of the Child (Article 31) and Global Designing Cities Initiative advocate for the creation of spaces for children of all ages to meet friends, go out, and exercise their 'right' to play (UNICEF 2018; UN Committee on the Rights of the Child 2013; Global Designing Cities Initiative and National Association of City Transportation Officials 2016).

However, discussions about children's right to play outdoors often overlook play spaces, particularly the link between children's outdoor play and play spaces (Freeman,

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Tranter, and Skelton 2017; Malone 2015; Carmona 2019). Spatial qualities of an outdoor play space are modifiable. Thus, recognising the role of play spaces and their physical qualities is crucial for improving children's opportunities to play outdoors. How the qualities of urban physical environment, specifically green and open spaces, affect children's outdoor play is little researched in urban studies including architecture, urban planning, and landscape architecture. Some scholarly attention has been given to the spatial affordances of children's play spaces in the developed world (Kyttä et al. 2014; Gill 2019; Broberg, Salminen, and Kytta 2013). Particularly in the South Asian cities, empirical evidence linking the spatial qualities of outdoor play spaces with the actual use of those spaces by children is very limited (Monsur, Mansur, and Islam 2017; Bhonsle 2016). Yet, understanding these links can help urban policy makers, planners and landscape architects to create outdoor play environments that attract more children to play outdoors, and consequently, help creating a city that is friendlier for children to play outdoors.

Dhaka, the capital city of Bangladesh, is projected to be the world's fourth largest urban agglomeration after Delhi, Tokyo, and Shanghai by 2030 (United Nations 2019). Characterised with extreme density, Dhaka's two city corporations - Dhaka South (DSCC) and Dhaka North (DNCC) have population densities of 39,406 and 30,531 persons per km2 respectably (BBS 2023). More than 2.75 million children under 18 years of age (28% of total population which is 10.2 million) live within the DSCC and DNCC areas. Planned provision of green spaces and children's outdoor play spaces are inadequate in the city – a concern for citizen groups often reported in the national news media (The Daily Star 2022). Due to rapid urbanisation, the amount of open fields and green spaces that children previously appropriated as their play spaces reduced significantly over the past few decades in Dhaka (Islam 2021). Ahmed (2011) identified only 4.1 km2 of play spaces (i.e., approximately 2.8% of total land area and approximately only 1m2 per child), including playgrounds/playfields, school playgrounds, urban parks, amusement parks, stadiums, and public green spaces, available within the DNCC and DSCC boundaries. Recently, although limited in its endeavour, DNCC and DSCC have undertaken several children's playground renovation projects where architects and landscape architects are engaged (Daily Sun 2023). Yet, such public endeavours require evidence-based understanding on which spatial qualities of outdoor play spaces children prefer and whether those spatial qualities influence them to use those spaces.

1.1. Urban Spatial Qualities and Children's Outdoor Play

Advances in children's urban environment design and outdoor play studies suggest that the spatial qualities of a play space matter for children's outdoor play (Gehl and Svarre 2017; Lynch 1977; Moore 1986; Kytta 2004). Affordance theory by Gibson (1986) recognizes the complementarity of people's behaviour and the modifiable properties of physical environments. Viewed as a process (Piaget, 1962), play behaviour has been described as having its own boundaries in space, time, and social settings (Gray 2013; Sutton-Smith 1997); yet play is a voluntary physical activity not linked with material gains (Huizinga, 1949). That implies that the discussions of play as behavioural and social phenomena must involve the discussions of the physical qualities of a play space. A review of 107 studies focusing on the correlates of children's outdoor play and time by Lee et al. (2021) suggest that the availability of recreational or physical activity facilities, including play spaces and playgrounds are positively associated with outdoor play.

In earlier studies, spatial qualities of urban spaces such as, comfort, availability of amenities, enclosure condition, and green cover within a public open space (Ewing and Clemente 2013; Mehta 2007; Karupannan and Sivam 2013), and size, designated fields or goal posts, fixed equipment, surface type, and presence of trees within a school playground (Caro et al. 2016), have been described in relation to children's play. However, empirical studies in different urban contexts have reported mixed and sometimes conflicting results on such impact. For example, Baran et al. (2014) reported significant association between park characteristics, such as park zone size, basketball court and playground settings with systematically observed park use by boys in central areas of North Carolina, USA. Whereas in Netherlands, Aarts et al. (2012) reported no significant correlation between the quality of outdoor play facilities and parent-reported outdoor play per week among children (aged 7-12). Such variability in results suggests a context-specific approach in the assessment of micro-spatial qualities of outdoor play spaces.

In Dhaka, Islam, Moore, and Cosco (2016) found that 9 to 14 years old children's outdoor time in Dhaka are influenced by the socio-economic profile of a child and the morphological qualities of urban neighborhoods. Sharmin, Kamruzzaman, and Haque (2020) explored connections between children's independent mobility, street connectivity, and land use mix. No study explored the spatial qualities of outdoor play spaces and their links with children's outdoor play in Dhaka. In practice, spatial qualities are key design elements that are modified by architects, urban designers and landscape architects, and city authorities, when provisions of outdoor play spaces are created for children (Ashik, Mim, and Neema 2020).

The people, place, and path framework developed earlier by Bhuyan and Zhang (2019) suggests that both social (people) and spatial (place and path) factors contribute to children's location preference for outdoor play in high-density urban built environments. Among the spatial factors, the spatial qualities of a play space and its immediate edge conditions are defined as place factors or micro-spatial qualities. The place factors of a play space

might both attract or detract children to use that space as a play space. This paper particularly focuses on the impact of the place factors or micro-spatial qualities on children's outdoor play. This study contributes to the built environment studies in urban contexts where there is a dearth of evidence-based literature that focuses on the spatial details of outdoor play spaces and their links with the actual usage of those spaces by children.

1.2. Research questions

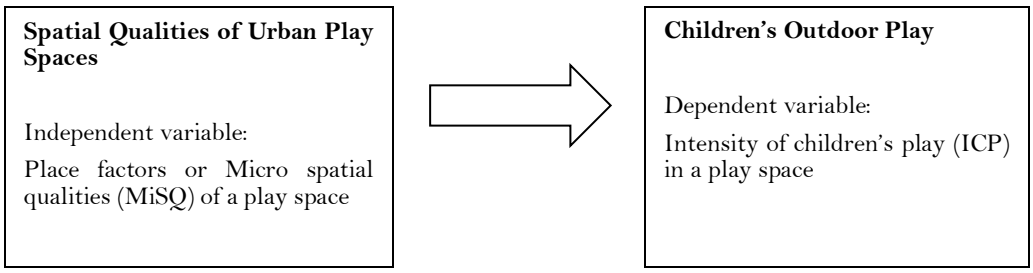
This study is guided by two questions: i) how to assess the spatial qualities of urban play spaces in Dhaka and, ii) to what degree these spatial qualities impact the children's outdoor play in those play spaces.

The correlation between the spatial qualities of play spaces (independent variable) and children's outdoor play (dependent variable) has been explored with reference to the following hypothesis: Children's (aged 7 and above) outdoor play in an urban play space is affected by the spatial qualities of a play space. Children's outdoor play is measured with reference to the intensity of children's play in this study. Intensity of children's play is defined as the number of children present within a unit time and a unit area of a play space.

2. Data and Methods

In this study we conducted systematic observation of children's play in the play spaces of three Dhaka neighbourhoods and modelled the relationship between the intensity of children's play and the spatial qualities of play spaces, including environments in their adjacent or front streets. Systematic observation and spatial modelling methods have been applied as part of a mixed methods research project that investigates the relationship between the configuration of urban built environments and children's outdoor play (Bhuyan and Zhang 2019) [reference masked to facilitate blind peer review. Similar for the rest]. Systematic observation was informed by our earlier studies that employed survey and interviews with children living in these study neighbourhoods (Bhuyan, 2022). Protocols used for the survey, interviews, and observations were approved by the institutional review board [NUS-IRB]. Figure 1 shows the process of data collection and analytical framework of this study.

Hypothesis



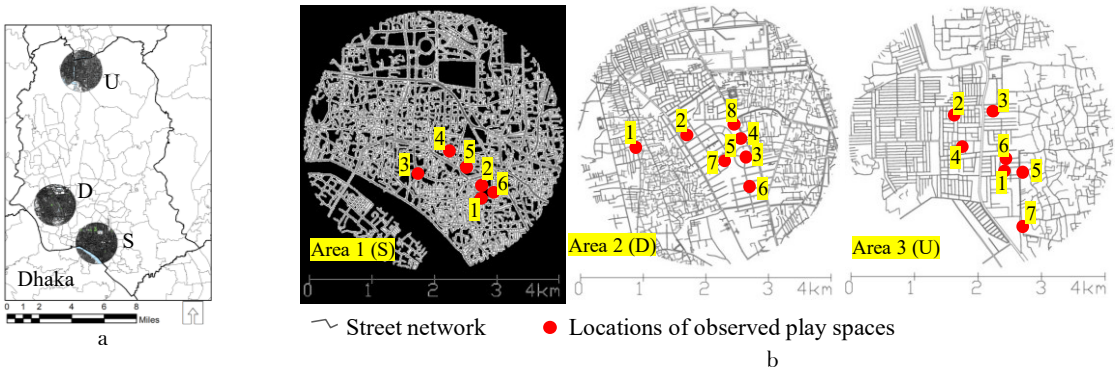
Methods	>>	>>	>>	>>	>>
Data Collection	Secondary Data	>Review of literature			
	Primary Data	>Selection of study areas and play spaces for observation	>Collection of available GIS maps of play spaces and audit of those spaces	>Preparation of observation tools	>Systematic observation of play activities in the play spaces in weekdays and weekend days
Data Analysis		>Mapping and spatial modelling Of MiSQ characteristics >Measurement of MiSQ indexes	>Measurement of ICP	>Statistical correlation studies between MiSQ and ICP	>Statistical regression studies to test overall predictive capacity of MiSQ indexes

Figure 1: Study framework and the process of data collection and data analysis

2.1. Selection of Study Areas and Play Spaces

Three study neighbourhoods, Sutrapur (S), Dhanmondi (D), and Uttara (U) –high-density areas located within the Dhaka South and North City Corporation boundary, were selected to conduct this study (Figure 2a). These three areas were selected based on their similarities and differences. The three areas were characterized with mixed residential environments (residential and commercial land uses) with low-to-mid-rise building types. They included urban development trajectories (S = oldest, D = mature, U = new). They are situated in three different parts in the city (S = southern Dhaka, D = central Dhaka, U = northern Dhaka). Population density of S, D, and U were 75,167; 33,652; and 41,914 persons per square kilometre respectively. As shown in Figure 2b, the ratios of parks and open playgrounds within S, D, and U, compared to total areas, were 0.51%, 3.88%, and 1.29% respectively (BBS 2015).

'Play space' refers to the places that were included in the



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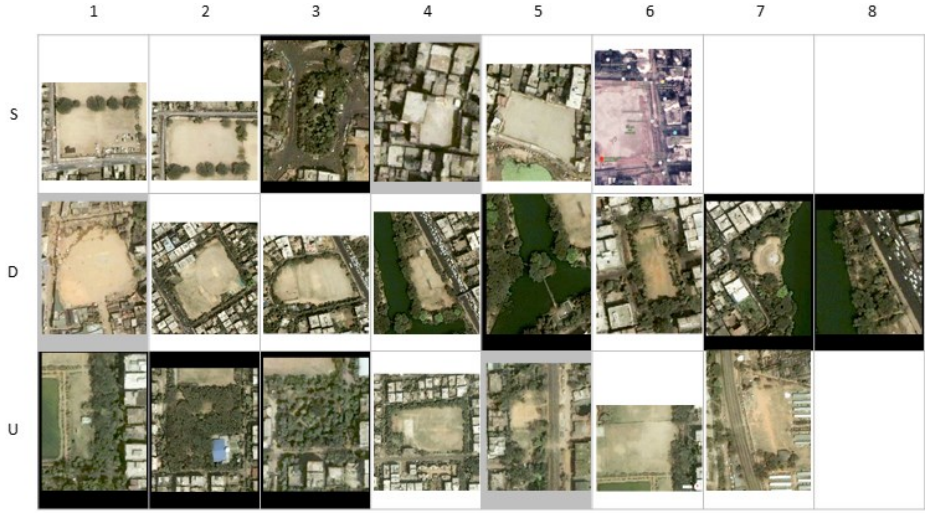


c

Study areas	Area (sq. km)	Household (N)	Population (N)	Population density [sq. km]	Children aged 6 to 14 (%)	Household income* / Month (USD)	Play space area compared to total Area
S	3.99	43,474	211,210	52,935	15.17%	396	0.51%
D	6.23	33,169	147,643	23,699	14.37%	574	3.88%
U	6.095	39,123	179,907	29,517	16.63%	281	1.29%

Data sources: BBS, 2015; *Field survey data
Map source: RAJUK (2015)

d

Figure 2: a) Location of study areas, b) location of study play spaces within the three study areas, c) Satellite images showing aerial maps of the study play spaces, d) Table reporting the area, population density, and the amount of available play spaces within administrative boundaries (Ward) of respective study areas.

both planned and unplanned neighbourhood developments. In terms of key differences, the three areas had different systematic observation of this study. We selected 21 play spaces located within the three study areas for systematic

observation. We reviewed available lists of playgrounds and parks reported on government agencies (e.g., Dhaka South and North City Corporations, RAJUK) and earlier studies (Ahmed 2011). Given available lists and maps did not provide updated data on public access to the play spaces, we conducted reconnaissance survey of the available green spaces including children's playgrounds, neighbourhood parks, open spaces, and vacant lands within the three study areas (Figure 2c). Key criteria for the selection of a play space for systematic observation were whether children were seen multiple times (during survey and interview studies) playing in that space, and whether children, irrespective of age, gender, and income, had limited (i.e., gates, if any, were not closed during the observation times) or full access to that space. Both 'formal' (e.g., play spaces provided by the city authority during residential area development) and 'informal' play spaces (e.g., parks and green spaces where children were seen engaged in play repeatedly during the reconnaissance survey) (Figure 3c). Although children were seen engaged in free play few times in the sidewalks and narrow streets adjacent to their houses, those spaces were excluded to avoid uncertainty of finding children in those spaces during systematic observation, which eventually might reduce the comparability of findings across play spaces (Umstattd Meyer et al. 2020).

2.2. Systematic observation

Studies and tools to observe and measure children's outdoor play as physical activity within urban settings have been evolving (Evenson et al. 2016; Smith 2012). Systematically observed physical activity levels (sedentary, walking, and mild to vigorous) are used to measure the frequency, degree, or intensity of children's use of outdoor play spaces (Ding and Gebel 2012).

Systematic observations of 21 play spaces and their front-streets were conducted by the first author on both weekdays (Monday-Thursday, when schools are typically open) and weekend days (Friday-Saturday, when schools are typically closed). Each space was observed 4 times a day, 7am-7pm with 3-hour interval. Duration of each observation was 10 minutes. Systematic observation is useful for collecting space-activity data, such as co-presence, use-pattern, and physical activities that often inform rejuvenation and (re)design of urban spaces (Gehl and Svarre 2013). Systematic observation is used in children behaviour and environments studies to learn about events as they occur naturally (Cosco, Moore, and Islam 2010). During our pilot studies, we found noticeable differences in the types of play and recreational activities (both structured and unstructured games) and play environments (ranging from bare earth surfaces to playgrounds with play equipment) in the study areas. Considering our study population, setting and study aims, we adapted the System for Observing Play and Recreation in Communities (SOPARC) tool, previously developed by Mckenzie et al. (2006). Adaptation resulted in two different instruments: System of Observing Children's Play in the Play spaces (SOCPP) and System of Observing Movements in Paths (SOMP). We applied SOCPP and SOMP to record play activities within play spaces, and pedestrian and vehicular movements in adjacent path segments respectively (See, Appendix I). SOCPP accounted for the presence of play activities and other co-existing activities of people of different age groups (younger children: 0 to 6 years, children: 7 to 16 years, 17 to 60 years, 61 years and above), gender (7 to 16 years old boys and girls) groups in a play space. The tool had provision for listing, note taking, and mapping of activities. SOMP counted pedestrian (aged 0 to 6, 7 to 18, 19 to 60, and 60 plus), non-motorised, and motorised vehicular movements through front-streets of the play spaces. A line map, representing pedestrian and vehicular movement lines on a street, was developed to define front-street segment. Subsequently, pedestrian and vehicular movements along a front-street segments were recorded by the observer. For vehicular roads with raised divider in the middle, movements through one side of the divider were considered for each observation.

Systematic observations were conducted throughout the year. School semester times were not considered in the analysis since semester timing varied for different schools surrounding the observed play spaces. A single observer (i.e., the first author who visited Dhaka three times, each spanning 1 to 3 months) collected all observation data for consistency. Each play space was systematically observed 8 times (4 times in a weekday and 4 times in a weekend day) asynchronously, i.e., the observer covered 1-2 time slots for 1-3 play spaces in a single day trip, considering proximity and convenience of traveling from one observation space to the other. Thus, fulfilling all 8 systematic observation slots for a particular play space involved 3-5 days' visitation. Rainy days and unusual circumstances such as hartals (political shutdown), EID holidays (when many Muslim people leave Dhaka to enjoy EID with families in their hometowns and villages) were excluded to reduce bias in space-activity observation data. Nighttime was excluded because, during pilot observation studies, children were seen playing outdoors mostly by the daytime when there was natural light (sunset time varies between 5:10pm to 6:50pm in Dhaka). The observer noted down the types of activities and mapped the locations of those activities within a play space between the intervals of counting. Photos were taken to record physical features and activities within the play spaces. Over the entire observation timeframe, daytime temperature varied from 18 degree Celsius to 31 degrees Celsius.

2.3. Modelling of spatial qualities

Digital copies of geographic information system (GIS) maps of Dhaka were collected from the Dhaka Capital Development Authority (RAJUK) to study and measure spatial qualities of the selected play spaces and their

adjacent street segments. Scaled maps of the observed spaces were drawn on AutoCAD based on the collected GIS maps, publicly available online maps (such as Google Earth and Google My Maps), physical environment audit, and photographic data collected during systematic observation. Spatial qualities of the play spaces and adjacent streets were then short-listed, defined, and measured subsequently for statistical analysis. For example, surface quality was defined with reference to green surface area and green foliage cover area index. Green surface area was measured by calculating non-paved, bare-earth, grass land, sandy, muddy areas within a play space. Similarly, green foliage cover area accounted for each tree-shaded area within a play space. Indexes of green surface area and green foliage cover were then developed as the relative proportion of green surface area and green foliage cover area within a play space compared to the total area of that play space, respectively.

2.4. Data analysis

To assess the influence of micro-spatial qualities of the play spaces on children's (aged 7 and above) outdoor play, we examined bivariate correlations between variables and conducted stepwise regression modelling using SPSS (Field 2013).

2.4.1. Dependent variable: Intensity of children's outdoor play

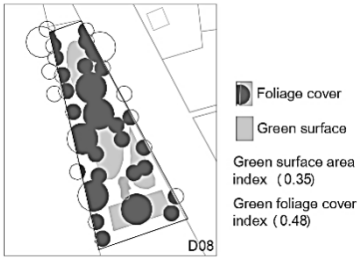
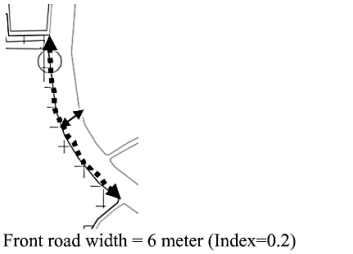
Intensity of use is often measured in terms of number of users within unit area and time (Umstattd Meyer et al. 2020). We measured the intensity of children's outdoor play (ICP) as the number of children (aged 7 and above and less than 18 years) systematically observed to be engaged in outdoor play activities, ranging from sedentary to vigorous activity levels, within 1 acre over a 10-minute period). This measure of the intensity of children's outdoor play is comparable across observation spaces and suitable for conducting statistical analysis.

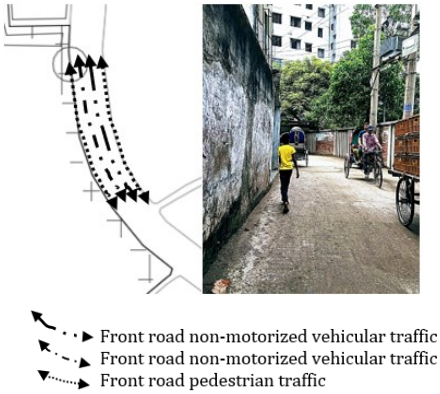
2.4.2. Independent variables: Micro-spatial qualities

The spatial qualities of a play space and its adjacent street segment are defined as place factors or micro-spatial qualities in this study. Based on extant literature in urban planning and landscape architecture (Caro et al. 2016; Monsur, Mansur, and Islam 2017) and a survey of children and their parents (conducted prior to systematic observations in the study areas), we developed and measured 17 micro-spatial qualities indexes grouped under 8 sub-categories. Micro-spatial quality indexes included co-presence of others (the presence of children aged 6 and younger, adults, and older adults) (Jacobs 1961); geometry of a play space (area, width, green surface and foliage cover area, diversity of amenities, enclosure); front-street characteristics (front-street width, street frontage length; small, medium and big business use intensity, motorised, non-motorised vehicular and pedestrian intensity). Definitions of the Micro-spatial quality indexes, respective data collection methods and analytical units are described in Table 1 and explained graphically with images and drawings in Appendix II.

Table 1: Description of the micro-spatial qualities

Indices	Definition	Data source*	Unit
1. Co-presence of younger children	Relative proportion of children aged under 7 years present concurrently within unit area of a systematically observed play space compared to total users of that space.	SO	%
2. Co-presence of adults	Relative proportion of adults aged 19 to 60 years, present concurrently within unit area of a systematically observed play space compared to total users of that space.	SO	%
3. Co-presence of older adults	Relative proportion of older adults aged 61 above years, present concurrently within unit area of a systematically observed play space compared to total users of that space.	SO	%
4. Area of play space	Relative area of an observed play space. Area was scaled from 0 to 1 with reference to the biggest observed play space.	SM, SO	Scale:0-1
5. Width of play space	Relative width of an observed play space. For a play space with variable widths, width refers to the average value measured at several equidistant points along the length of a play space.	SM, SO	m
6. Green foliage cover	Relative green foliage cover area (i.e., tree/foliage shaded area) within a play space as compared to total area. Each tree/foliage shaded area within a play space boundary was drawn, scaled, and measured using digital software (AutoCAD), overlaying direct observation data, satellite images, and GIS maps.	SM, SO	Scale:0-1

7. Green surface area	Relative green surface area (i.e., non-paved, bare-earth, grass land, sandy, muddy areas) within a play space compared to total area. Each green surface area within a play space boundary was drawn, scaled, and measured using digital software (AutoCAD), overlaying direct observation data, satellite images, and GIS maps. Example: 	SM, SO	Scale:0-1
8. Diversity of amenities	Relative number of different amenities (such as clubhouse, pavilions / monuments / sculptures, jogging track, seat/benches, goal posts, cricket practice pitch/nets, sea-saw, climbing bars/structure, slippers etc.) present within a play space. Diversity of amenities was measured as percentage with reference to the highest diversity of amenities (value=1) for all observed play spaces. Example: 	SO	Scale:0-1
9. Enclosure	Relative length of opaque walls across periphery of a play space as compared to the total perimeter of that play space. [1=most opaque, 0=most transparent.]	SO	Scale:0-1
10 .Front-street width	Width of the front street/road segment of a play space. For play spaces with more than one front road, average width is used.	SM, SO	m
11. Street frontage length	Relative length of the street frontage (with access point/gate) of a play space as compared to the total perimeter of that play space. For a play space with more than one access points from the streets, the sum of all lengths is considered. 	SM, SO	n/100m
12. Small business intensity	Number of small businesses (i.e., small tea stall, fruit-seller, ice-cream/candy van, vegetables seller etc. at ground level) located along both sides of the front street/road of a play space. Small businesses were counted through direct observation.	SO	n/100m
13. Medium business use intensity	Number of medium businesses (i.e., grocery shops, restaurants, tailoring shop, printing shop etc. at first two levels) located along both sides of the front street/road of a play space. Medium businesses were counted through direct observation.	SO	n/100m

14. Big business intensity	Number of big businesses (i.e., bank, big restaurant, shopping mall etc. at first two levels) located along both sides of the front street/road of a play space. Big businesses were counted through direct observation.	SO	n/100m
15. Motorised vehicle intensity	Average number of motorised vehicles (i.e., private cars, buses, taxis, motorbikes etc.) moving at unit time in the front streets of a play space. Front streets were observed systematically.	SO	n/ hour
16. Non-motorised vehicle intensity	Average number of non-motorised vehicles (i.e., rikshaws, tricycles, bicycles etc.) moving at unit time in the front streets of a play space. Front streets were observed systematically.	SO	n/ hour
17. Pedestrian intensity	Average number of pedestrians moving at unit time in the front streets of a play space. Front streets were observed systematically. Example:  	SO	n/ hour

*SO = Systematic observation. SM = Spatial modelling of play spaces. Spatial qualities were measured with reference to the boundary of a play space (Indices 1-9), or the street segment adjacent to a play space (Indices 10-17).

Principal Component Analysis has been conducted to identify patterned relationship, if any, between the Micro-spatial quality variables. Rotated Component Matrix was studied to estimate correlations between each micro-spatial quality variables. A Chi-square test of independence and a Kaiser-Meyer-Olkin Measure of Sampling Adequacy (KMO) test involving all micro-spatial quality variables have been conducted to evaluate the suitability of factor analysis for the collected micro-spatial quality data.

3. Results

3.1. Intensity of children's outdoor play in the study play spaces

Mean values of the intensity of children's outdoor play varied across observed play spaces, study area and time. The mean value of the intensity of children's outdoor play in all of the study play spaces was 22.8 children per acre per 10 minutes (SE = 34.9). Most of the times, children were seen playing various forms of football and cricket – the two most popular games among children in Bangladesh. Other play activities observed include flying kites, badminton, playing with marble, touch-and-go, playing with swings and slippers, jumping on the sand, and so on. The intensity of children's outdoor play for boys was almost 9 times higher than girls, showing gender disparity in children's outdoor play and mobility in Dhaka, reported earlier by Islam (2009) and Monsur, Mansur, and Islam (2017). Figure 3 shows the variation of the average intensity of children's outdoor play across play spaces in the three study areas. Observed intensity of children's outdoor play was highest in S, and lowest in D. Area S had the highest population density among the 3 study areas. In contrast to U and D, S is characterized with higher proportion of mixed-use developments (Khaleda, Mowla, and Murayama 2017).

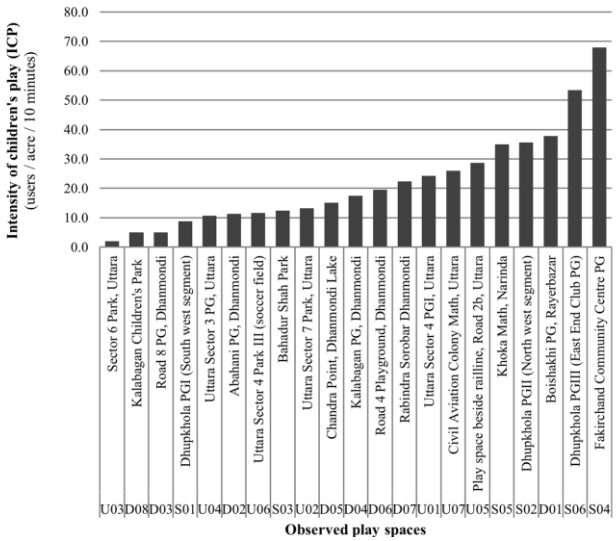


Figure 3: Average intensity of children's (aged 7 - 18 years) play in the study play spaces

Across times of day, as shown in Table 2, mean intensity of children's outdoor play was highest in the late afternoon (between 4pm to 6:59pm) with 37 children per acre per 10 minutes, and lowest in the early morning (between 7am to 9:59am) with about 14 children per acre per 10 minutes.

Table 2: Descriptive statistics of the intensity of children's play across time of day and weekday / weekend day

Intensity of children's play (children/acre/10 minutes)	Mean	SE	Min.	Max.
All observations	22.8	34.9	0	297.8
Time of day				
7am to 9:59am	14.2	3.1	0	123.6
10am to 12:59am	19.3	4.1	0	177.5
1pm to 3:59pm	18.7	4.6	0	221.4
4pm to 6:59pm	37.0	6.3	2.5	297.8
Weekday / Weekend day				
Weekday	22.2	3.9	0	297.8
Weekend day	23.0	3.0	0	177.5

This suggests that, as might be expected in subtropical monsoon climate, children's favourite time to play outdoors is late afternoon when the sun goes down. Unlike previous findings that reported significant variation of children's outdoor play across weekdays and weekend days (Monsur, Mansur, and Islam 2017; Marquet et al. 2019), variation of mean intensity of children's outdoor play across weekdays (mean = 22.2 children per acre per 10 minutes) and weekends (mean = 23.0 children per acre per 10 minutes) was low in this study.

3.2. Assessment of Micro-spatial qualities of the play spaces

Table 3 presents descriptive statistics of the 17 micro-spatial quality indexes measured for the study play spaces.

Micro-spatial quality indexes varied across play spaces and study areas. For example, while mean enclosure index for the 21 play spaces was 0.37 (fully opaque periphery of an observed play space = 1, fully transparent periphery of an observed play space = 0), play space D07 (with the lowest enclosure index = 0) was fully visible from surrounding streets, and play space S05 (with the highest enclosure index = 0.96) was surrounded with full-height boundary wall in all sides. Mean pedestrian traffic intensity (mean intensity = 559 persons per hour) in the front-street segments was higher than motorised traffic intensity (mean intensity = 240.7 vehicles per hour), suggesting active mobility adjacent to most of the study play spaces. Motorised traffic intensity in the front-streets however varied noticeably – highest for play space D04 and D08 (1,320 vehicles on an average per hour) and lowest for S04 (no movement of cars, credited to narrow front street, i.e., width = 2.4m only). Intensity of small businesses (such as small tea stall, fruit-seller, ice-cream van, and vegetables seller along unit length of a front-street) was relatively higher for play spaces in area S (19.2 per 100m), compared to area D (3.56 per 100m) and area U (3.6 per 100m), suggesting higher retail activities in local streets of organically grown Old Dhaka (S), compared to that of New Dhaka (D and U) which is characterised with more planned residential developments.

Table 1:Assessment Of The Micro Spatial Qualities Of The Studied Play Spaces. Values Are Comparable Across Columns.

Play Space ID	Co-presence of other children (%)	Co-presence of adults (%)	Co-presence of older adults (%)	Area (0-1)	Width (m)	Green foliage cover (0-1)	Green surface area (0-1)	Diversity of amenities (0-1)	Enclosure (0-1)	Street frontage length (0-1)	Front-street segment width (m)	Front-street small business intensity (n/100m)	Front-street medium business intensity (n/100m)	Front-street big business intensity (n/100m)	Front-street non-motorised vehicular traffic intensity (n/hour)	Front-street motorised vehicular traffic intensity (n/hour)	Front-street pedestrian traffic intensity (n/hour)
S01	3.57	25	7.14	0.20	75	0.03	1.00	0.2	0.42	0.3	8.6	29.2	49.7	0	258	48	1008
S02	3.09	27.3	2.06	0.20	74	0.15	1.00	0.4	0.50	0.282	7.5	23.5	38.6	0	222	24	960
S03	1.57	90.1	2.87	0.12	52	0.34	0.77	0.8	0.11	0.515	16	13.1	12.1	0	885	453	1059
S04	3.4	53.9	3.88	0.01	23	0.00	0.00	0.5	0.89	0.543	2.4	3.6	0.9	0	48	0	828
S05	6.25	25.9	0.67	0.08	45	0.00	0.86	0.5	0.96	0.315	5.5	3.2	19.4	0	96	24	840
S06	4.21	17.7	1.13	0.22	76	0.08	1.00	0.5	0.47	0.306	9	42.5	98.6	2.7	270	56	996
D01	11.6	34.1	2.02	0.15	72	0.06	0.89	0.6	0.94	0.161	6	10.3	2.6	0	288	40	1152
D02	2.09	40.3	1.12	0.98	191	0.10	0.96	0.7	0.17	0.188	8	0	0	0.4	168	144	296
D03	1.39	36.1	1.39	0.49	118	0.11	0.87	0.8	0.08	0.266	10	0.6	0	0.6	192	60	108
D04	2.38	45.9	1.56	0.23	67	0.14	0.90	0.7	0.22	0.342	30	1.4	0	0	102	1320	555
D05	12.3	60.5	5.13	0.03	29	0.53	0.59	0.3	0.00	0.569	2	0.7	0	0	24	48	306
D06	1.76	55.3	0	0.10	43	0.18	0.95	0.8	0.04	0.161	12	3.7	0	1.9	180	252	36
D07	4.06	85.2	1.4	0.06	46	0.16	0.74	0.4	0.00	1	6	10	7.9	0	228	288	318
D08	10.6	36.5	2.35	0.09	35	0.48	0.35	0.9	0.09	0.448	33	1.8	0	0	102	1320	555
U01	15.5	39.5	2.31	0.09	40	0.37	0.84	0.9	0.00	0.317	10	0.6	0	0	234	198	186
U02	7.84	55.8	2.58	0.30	93	0.37	0.88	0.7	0.48	0.52	9	2.5	0	0	240	216	480
U03	4.62	79.2	7.69	0.07	47	0.45	0.64	0.5	0.04	0.04	9.5	0	0	0	708	132	528
U04	4.39	44	2.77	0.39	110	0.13	0.86	1	0.14	0.256	9	2.3	5.4	0	264	108	204
U05	17.7	21.1	1.36	0.06	37	0.20	1.00	0.2	0.33	0.485	11.5	16.7	5.9	0	582	90	492
U06	4.45	29.1	1.21	0.15	67	0.14	1.00	0.3	0.21	0.176	9	1.5	0	0	234	198	186
U07	13.4	30.2	5.23	0.13	61	0.06	0.95	0.3	0.54	0.493	4	1.9	0.5	0	24	36	648
Mean	6.5	44.4	2.66	0.2	66.5	0.19	0.81	0.57	0.31	0.37	10.4	8.05	11.5	0.3	254.7	240.7	559
SE	1.08	4.5	0.4	0.21	37.7	0.16	0.24	0.24	0.3	0.2	1.7	2.0	5.0	0.1	47.6	81.9	75.5

3.3. Principal Component Analysis involving the micro-spatial quality variables

Principal Component Analysis, with a suppression of, r > =/- 0.4), is shown in (Table 4). Results suggest that seven micro-spatial quality variable groups (with Eigenvalue > 1) are capable of explaining 76% of variances within the

micro-spatial quality variables (cumulative percentage of rotation sums of squared loadings for seven components is 76%).

Table 4: Total variance explained for the MiSQ variables and rotated component matrix analysis

a) Comp.	Initial Eigenvalues			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cum. %	Total	% of Variance	Cumulative %
1	3.724	19.598	19.598	2.495	13.133	13.133
2	3.327	17.509	37.107	2.441	12.846	25.979
3	2.060	10.843	47.950	2.425	12.761	38.740
4	1.620	8.524	56.473	2.298	12.097	50.837
5	1.377	7.246	63.719	2.147	11.300	62.137
6	1.181	6.215	69.934	1.410	7.419	69.556
7	1.158	6.095	76.029	1.230	6.473	76.029
8	.991	5.218	81.247			
9	.896	4.717	85.964			

b) Rotated Component Matrix[a]							
	Component						
	1	2	3	4	5	6	7
Wk(1)_wknd (2)							-.452
Time of day							.685
Intensity_0_15 yrs							.597
Intensity_16_60 yrs					.870		
Intensity_61_ yrs					.760		
Area index	.944						
Width	.952						
Green foliage cover index				-.597			
Green surface area index					-.442		
Diversity of amenities index	.402		.579				
Enclosure				.891			
Street Frontage length index					.653		
Front road width index			.954				
Front road small business intensity		.840					
Front road medium business intensity		.885					
Front road big business intensity		.793					
Front road NMV traffic intensity						.921	
Front road MV traffic intensity			.942				
Front PED traffic intensity				.846			
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization. a. Rotation converged in 7 iterations.							

Significant Chi-square value ($\chi 2$ = 3310.13 (171), p < .000) suggests that the micro-spatial quality latent variables have patterned relationship amongst them. KMO value (0.447) shows that the micro-spatial quality variable sets are somehow suitable for exploratory factor analysis. Rotated Component loadings suggest clustering character of the micro-spatial quality variables and several variables, such as the diversity of amenities, enclosure etc., are highly correlated to each other (r > +/- .3). These results suggest correlation studies before predicting the overall predictive capacity of the micro-spatial quality variables through regression studies.

3.4. Relationship between micro-spatial quality indexes and the intensity of children's outdoor play

Table 5 presents the bivariate correlation co-efficient results (Pearson's r, 2-tailed) showing association between each micro-spatial quality index and the intensity of children's outdoor play. Nine out of seventeen micro-spatial quality indexes showed significant correlation with the intensity of children's outdoor play at p<0.05 with 95% confidence interval. Three of them – i.e., green foliage cover, enclosure, and medium businesses intensity – showed high significance at p<0.01. Enclosure (r = 0.33) showed highest correlation coefficient followed by green foliage cover (r = -0.23) and the presence of medium businesses along 100m length of the front-streets (r = 0.21). Co-presence of younger children aged 0 to 6 years (r = 0.15), diversity of available play amenities (r = -0.14), width of the front-street (r = -0.18), small business intensity along front-street (r = 0.22), volume of motorised vehicular traffic through front-street (r = -0.17) showed significance at p<0.05 with 95% confidence interval.

Table 5: Correlation of the intensity of children's play and the micro-spatial qualities of a play space

	Pearson's r
Intensity of children's play (ICP)	1
Co-presence of other children (%, aged < 7 years)	.149*
Co-presence of adults (%, aged 19-60 years)	.014
Co-presence of older adults (%, aged > 60 years)	-.026
Area	-.135
Width	-.130
Green foliage cover	-.231**
Green surface area	-.089
Diversity of amenities	-.143*
Enclosure	.326**
Street Frontage length	.063
Front-street width	-.179*
Front-street small business intensity	.215**
Front-street medium business intensity	.205**
Front-street big business intensity	.102
Front-street non-motorised vehicular traffic intensity	-.095
Front-street motorised vehicular traffic intensity	-.166*
Front-street pedestrian traffic intensity	.246**

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

However, strong correlation coefficient between several

independent variables, such as enclosure and green surface area (r = -0.61, P<0.01), medium and small business intensity (r = 0.95, P<0.01), pedestrian intensity and small business intensity (r = 0.60, P<0.01) were observed, suggesting a step-by-step and combined exploration of the dominant micro-spatial quality factors using multiple regression analysis.

3.5. Regression Results: Explanatory Power of the Micro-spatial Quality Model

Stepwise regression analysis (at 95% confidence interval) was conducted including all of the micro-spatial quality variables. All micro-spatial quality variables were included in the regression analysis since they were selected based on surveys and pilot observations conducted prior to this study as well as with reference to reported evidence in the literature. Stepwise regression analysis results yielded 3 models. As shown in Table 6, the first model (M1) that including all micro-spatial quality variables could explain 21.2% of the variance in the intensity of children's outdoor play with high level of confidence (R2=0.21, P < 0.0001, F=2.9).

Expectedly, variance inflation factor (VIF), that defines multicollinearity among variables, was high for several micro-spatial quality factors in M1 (VIF for area = 50.5, width = 56.0, front-street width = 58.9, front-street small business intensity = 21.38, and front-street motorised vehicular traffic volume = 60.84), reconfirming overlapping impact of the model variables on the intensity of children's outdoor play. Stepwise regression produced a second model (M2) that included 9 micro-spatial quality factors that could explain 20.01% of variance in intensity of children's outdoor play (R2=0.20, P < 0.0001, F=5.34). In M2, six variables – co-presence of older adults (aged > 60), area, width, enclosure, front-street width, and front-street small business intensity - showed significant (p < 0.05) correlation with intensity of children's outdoor play. However, high VIF values of 3 variables (area, width, and front-street width) in M2 indicate the presence of intercorrelations among the variables. Stepwise regression study stopped at the third model (M3) that yielded enclosure (β = 0.29, p<.001) and front-street small business intensity (β = 0.14, p<.05) as the two most significant micro-spatial quality indexes associated with the intensity of children's outdoor play and they could explain 12.6% of variance in the intensity of children's outdoor play with high level of confidence. M3 had low VIF (=1.06) and high F-value (R2=0.20, P < 0.0001, F=14.25).

Table 6: Relative strength of the micro-spatial quality models in explaining the intensity of children's play

	M1			M2			M3 (Stepwise)	
	β	t		β	t		β	t
(Constant)	67.16	2.657 (Sig. = 0.009)	VIF	42.641	3.045 (Sig. = 0.003)	VIF	8.529	2.425 (Sig. = 0.016)
Co-presence of other children (aged < 7)	.104 ~	1.479	1.15	0.426	3.045	1.10		
Co-presence of adults (aged 19-60)	.003	0.031	2.77					
Co-presence of older adults (aged > 60)	-.150 *	-1.831	1.50	-1.493**	1.485	1.17		
Area	.760 ~	1.630	50.50	0.831**	2.298	31.25		
Width	-.882 *	-1.796	56.00	-0.951***	-2.615	31.58		
Green foliage cover	-.080	-0.686	3.12					
Green surface area	-.090	-0.839	2.69					
Diversity of amenities	.166 ~	1.444	3.06	0.151*	1.719	1.85		
Enclosure	.333 *	1.651	9.44	0.287****	4.008	1.22	0.291****	4.250
Street Frontage length	-.096	-0.765	3.65					
Front-street width	-.868 *	-1.724	58.90	-0.562**	-2.128	16.66		
Front-street small business intensity	.566 *	1.865	21.38	0.289****	3.329	1.80	0.143**	2.091
Front-street medium business intensity	-.150	-0.665	11.80					
Front-street big business intensity	-.017	-0.139	3.34					
Front-street NMV traffic volume	.065	0.494	4.06					
Front-street MV traffic volume	.727 ~	1.421	60.84	0.382	1.502	15.50		
Front-street PED traffic volume	-.168	-0.711	13.01					
Note: Dependent Variable: ICP (Intensity of children's (7 and above) play (users/acre/10 minutes) Significance: ~p < 0.25, *p < 0.10, **p<0.05, ***p<0.01, ****=p<.001	R = 0. 461 R^2 = 0.212 F= 2.904 (p < 0.0001)			R = 0.448 R^2 = 0.201 F = 5.336 (p < 0.0001)			R = 0.355 R^2 = 0.126 F = 4.372 (p < 0.05)	

4. Discussion

Regression results of the 9 micro-spatial quality indexes are notable in a context where empirical evidence on the role of built environment on children's outdoor play activities are still very limited and evolving. For example, urban built environment variables such as net residential density, intersection density, public transport density, and number of parks within participant-reported buffers could explain only 0–11% of variations in mild to vigorous physical activities of people in 14 cities from five continents in a study by Sallis et al. (2016). Findings from this study reveals the potential for planning and design of outdoor play areas for children based on social, cultural, and climatic context of Dhaka, in contrast to relying on planning and design norms developed in other contexts.

Systematic observational results indicate that, on average, 2.28 children (aged 7 and above) occupy 1 acre of play space in 1 minute in Dhaka. This results is higher compared to findings in low-income neighbourhoods in New York (1.65 children aged 5 to 10 per scan, excluding scans of zero users) (Marquet et al. 2019). Relatively high value of mean intensity of children's outdoor play in Dhaka might be linked to high-density of population and buildings as well as inadequate provision of outdoor play spaces in general (Islam, Moore, and Cosco 2016).

Correlation results revealed significant relationship between several spatial qualities of play space and intensity of children's play. This highlights the need for a creative combination of multiple (re)design strategies, rather than single strategy in the planning and design of urban play spaces. For urban play space designers, our statistical results involving enclosure, for example, do not necessarily suggest fully enclosed and isolated urban play spaces. Rather, they encourages to achieve a balance between conflicting design considerations, such as transparency/openness and privacy/publicness (Fleury-Bahi, Pol, and Navarro 2017). Regarding significant positive association of small business intensity in front-street with the intensity of children's outdoor play, an increased presence of small retail business activities, e.g., small tea stall, fruit-seller, ice-cream/candy van, vegetables seller, in adjacent roads might increase children's play in an urban play space. As portrayed in Figure 4 and presented earlier in Table 4, small businesses and pedestrian traffic intensity values are higher for play spaces in study area S, compared to those in area D and area U. During field visits, we observed higher intensity of such activities in study area S (Old Dhaka, known for spontaneous, traditional and relatively older developments), compared to D and U (New Dhaka, characterised with planned, semi-planned and new developments) (Mowla 2012).

Stepwise regression study results in the model M2 identified front-street pedestrian and motorised vehicular traffic intensity, green foliage cover, front-street medium business intensity, front-street width, play space area, co-presence of children and older adults as important factors related to the intensity of children's outdoor play. Positive or negative values of correlation co-efficient brought forth both expected and unexpected results. Expectedly, front-street width and motorised vehicular traffic volume in the front-street showed negative correlation with the intensity of children's outdoor play, while pedestrian traffic volume in the front-street showed positive correlation. They indicate that high volume of pedestrian movements near a play space would attract, while high volume of motorised vehicular movements would detract children's outdoor play. These results add to the international body of evidence suggesting that children's outdoor play is alarmingly constrained by the presence of vehicular roads and high speed car movements (Carroll et al. 2019).

Correlation coefficients of area (positive) and width (negative) of a play space with the intensity of children's outdoor play, while they encourage further studies, might indicate that children are attracted to big play fields and parks with small pockets of spaces where they can engage in various forms of play. Quite unexpectedly, the green foliage cover index showed negative correlation with the intensity of children's outdoor play. Positive impacts of green cover and trees on youth's physical activities have been reported in earlier studies in Melbourne (Timperio et al. 2008) and western urban contexts (Gardsjord, Tveit, and Nordh 2014). In our study, the negative correlation of green foliage cover and the intensity of children's outdoor play might be linked to the forms of children's favourite outdoor games in Dhaka, i.e., cricket and football that require flat and uninterrupted ground surfaces (Bhuyan 2022). Interestingly, play amenity index correlated negatively with the intensity of children's outdoor play, suggesting that children might be less attracted to play spaces with unfamiliar play equipment (such as monkey bars, slippers, sea-saw bars etc.) and poor maintenance (for example, in D08). Reportedly, public authorities in Dhaka seldom engage local children and other stakeholders in the process of design and play equipment selection (Nahar 2019). Such practice might contribute to a reduced sense of place attachment and subsequently, a lower intensity of use by children. The capital development authority has developed the Dhaka Structure Plan 2016-2035 that recommends a provision for a children's park in every 400m (RAJUK 2015). Scholars argue that such plan, that seldom considers children's actual preferences for outdoor play, would be unrealistic within the dense building footprints of Dhaka and lacks context-sensitivity (Mowla 2015). Findings from this study suggest the exploration of the urban (re)design potentials of available urban spaces and streets considering their actual usage pattern and associated micro-spatial affordances of play, while setting realistic plans that consider rejuvenation of available spaces. In this direction, development of research-based database documenting and acknowledging the diverse range of children's outdoor play and play spaces can be a way forward towards evidence-based planning and

(re)design.

4.1. Limitations

This cross-sectional study is conducted using a small sample of play spaces and a limited dataset on the intensity of children's outdoor play. Future studies involving larger samples and data sets might test the external validity of reported findings in other contexts. While urban environments in developing countries in South Asia often show commonalities in terms of high-density and an inadequate provision of urban play spaces for children due to urbanisation, the unique context of Dhaka, e.g., children's preferred games and low maintenance and management of play spaces, need to be considered for the results to be applied in other urban contexts. This study particularly focused on the micro-spatial features of play spaces that are either internal or adjacent to an outdoor play space. The intensity of children's outdoor play would expectedly be affected by other spatial features external to a play space e.g., population and building density in the neighbourhood, distribution of amenities and open spaces (Islam, Moore, and Cosco 2016) and accessibility of surrounding areas (Sharmin and Kamruzzaman 2017). Future studies might consider combined impact of both internal and external spatial factors on the intensity of children's outdoor play. Children's gender as a strong individual and social factors are apparent in the disproportionately low value of the intensity of children's outdoor play for girls. The correlation study did not differentiate the intensity of children's outdoor play across age groups within 7 years and above children, primarily due to the limitation of identifying specific age only through systematic observation. Future studies might consider applying a combination of participatory and non-participatory methods to identify the variability of the impact of micro-spatial quality factors on the intensity of children's outdoor play across different age group of 7 years and above children.

5. Conclusion

It is widely acknowledged that children's outdoor play enhances their health and wellbeing. However, holistic and evidence-based spatial planning and (re)design of children's outdoor play spaces are often ignored amidst rapid urbanization in South Asian cities. Adequate provision of quality play spaces within the city would undoubtedly enhance affordances of play for children. One potential way to ensure efficient provision of play spaces, where urban designers and landscape architects are often involved, is to understand the use pattern and functionalities of available play spaces. Moreover, outdoor play spaces as urban infrastructure might act as both facilitators and barriers for children's play. In this direction, measurement, modelling and evaluation of the spatial qualities of play spaces on children's outdoor play is important. Within its scope, the study identified several micro-spatial quality factors, notably the enclosure of a play space and its front-street characteristics that significantly affect the intensity of children's outdoor play in the play spaces. Findings would inform landscape architecture and urban design practitioners in the study context and hopefully encourage further research on the spatial quality aspects of children's outdoor play environments amidst changing urban realities in South Asian cities.

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References

Aarts, M., S. I. D. Vries, H. A. Oers, and A. J. Schuit. 2012. "Outdoor play among children in relation to neighborhood characteristics: A cross-sectional neighborhood observation study." *International Journal of Behavioral Nutrition and Physical Activity* 9:98.

Ahmed, Afroza. 2011. "Factors and issues related to children's play and their implications on play and recreation provision in Dhaka City." PhD, Loughborough University.

Ashik, Fajle Rabbi, Sadia Alam Mim, and Meher Nigar Neema. 2020. "Towards vertical spatial equity of urban facilities: An integration of spatial and aspatial accessibility." *Journal of Urban Management* 9 (1):77-92. https://doi.org/https://doi.org/10.1016/j.jum.2019.11.004.

Baran, Perver K, William R Smith, Robin C Moore, Myron F Floyd, Jason N Bocarro, Nilda G Cosco, and Thomas M Danninger. 2014. "Park use among youth and adults: Examination of individual, social, and urban form factors." *Environment and behavior* 46 (6):768-800.

BBS. 2015. "Report on Bangladesh Sample Vital Statistics 2014." In.: Bangladesh Bureau Statistics, Ministry of Planning, Bangladesh.

BBS. 2023. "Population and Housing Census 2022: National Report, Vollume I." In. Dhaka: Bangladesh Bureau of Statistics.

Bhonsle, K. D. 2016. "Assessing the Play Provisions for Children in Urban Neighborhoods of India: Case Study Nagpur, Maharashtra." *Buildings* 6 (31). https://doi.org/doi:10.3390/buildings6030031.

Bhuyan, Md Rashed. 2022. "Geographies of outdoor play in Dhaka: an explorative study on children's location preference, usage pattern, and accessibility range of play spaces." *Children's Geographies* 20 (1):94-108. https://doi.org/10.1080/14733285.2021.1914823.

Bhuyan, Md Rashed, and Ye Zhang. 2019. "A mixed methods research strategy to study children's play and urban physical environments in Dhaka." *Journal of Mixed Methods Research* 14 (3):358–378. https://doi.org/10.1177/1558689819871820.

———. 2020. "Diversity of children's independent mobility in Dhaka." *Urbanisation* 4 (2):1-18. https://doi.org/10.1177/2455747119889915

Broberg, A., S. Salminen, and M. Kytta. 2013. "Physical environmental characteristics promoting independent and active transport to children's meaningful places." *Appl Georgr*.

Carmona, Matthew. 2019. "Principles for public space design, planning to do better." *Urban Design International* 24 (1):47-59. https://doi.org/10.1057/s41289-018-0070-3.

Caro, H. E., T. M. Altenburg, C. Dedding, and M. J. M. Chinapaw. 2016. "Dutch primary school children's perspectives of activity-friendly school playgrounds: A participatory study." *International journal of environmental research and public health* 13 (6):526. https://doi.org/10.3390/ijerph13060526.

Carroll, Penelope, Octavia Calder-Dawe, Karen Witten, and Lanuola Asiasiga. 2019. "A prefigurative politics of play in public places: Children claim their democratic right to the city through play." *Space and Culture* 22 (3):294-307.

Cosco, N. G., R. C. Moore, and M. Z. Islam. 2010. "Behavior mapping: A method for linking preschool physical activity and Outdoor design." *Medicine & Science In Sports & Exercise* 42 (3):513-519.

Daily Sun. 2023. "DSCC wards to get parks, playgrounds." In *Daily Sun*. Dhaka.

DAP. 2015. "The proposed 'Dhaka Structure Plan 2016-2035'." In *Daily Independent*, op-ed. Dhaka.

Ding, D., and K. Gebel. 2012. "Built environment, physical activity, and obesity: What have we learned from reviewing the literature?" *Health & Place* 18:100-105.

Evenson, K. R., S. A. Jones, K. M. Holliday, D. A. Cohen, and T. L. McKenzie. 2016. "Park characteristics, use, and physical activity: A review of studies using SOPARC (System for Observing Play and Recreation in Communities)." *Preventive Medicine* 86:153-166. https://doi.org/10.1016/j.ypmed.2016.02.029.

Ewing, R. H., and O. Clemente. 2013. *Measuring Urban Design: Metrics for Livable Places*. Washington, Covelo, London: Island Press.

Field, A. 2013. *Discovering Statistics Using IBM SPSS Statistics*. 4th ed. LA, London: Sage.

Fleury-Bahi, Ghozlane, Enric Pol, and Oscar Navarro. 2017. *Handbook of Environmental Psychology and Quality of Life Research*: Springer.

Flôres, Fábio Saraiva, Luis P. Rodrigues, Fernando Copetti, Frederico Lopes, and Rita Cordovil. 2019. "Affordances for motor skill development in home, school, and sport environments: A narrative review." *Perceptual and Motor Skills* 126 (3):366-388. https://doi.org/10.1177/0031512519829271.

Freeman, Claire, Paul Tranter, and Tracey Skelton. 2017. "Risk, protection, provision and policy." In. Singapore: Springer.

Gardsjord, H. S., M. S. Tveit, and H. Nordh. 2014. "Promoting Youth's Physical Activity through Park Design: Linking Theory and Practice in a Public Health Perspective." *Landscape Research* 39 (1):70-81. https://doi.org/10.1080/01426397.2013.793764.

Gehl, Jan, and Birgitte Svarre. 2013. *How to study public life*. Washington, DC: Island Press.

Gehl, Jan, and Birgitte Bundesen Svarre. 2017. "City planning for people." *Urban Solutions* 6:53-59.

Gibson, J. J. 1986. *The ecological approach to visual perception*. New York: Psychology Press.

Gill, Tim. 2019. "Widening the bandwidth of child-friendly urban planning in cities." *Cities & Health* 3 (1-2):59-67. https://doi.org/10.1080/23748834.2019.1660126.

Global Designing Cities Initiative, and National Association of City Transportation Officials. 2016. *Global street design guide*: Island Press.

Gray, P. 2013. "Definitions of play." In *Scholarpedia*, 30578.

Hart, Roger. 2002. "Containing children: some lessons on planning for play from New York City." *Environment and Urbanization* 14 (2):135-148. https://doi.org/10.1177/095624780201400211.

Islam, Jahidul Md. 2021. "No parks, playgrounds in Dhaka's 37 wards." In *The Business Standard*. Dhaka.

Islam, Md Zakiul. 2009. "Children and urban neighborhoods: Relationships between outdoor activities of children and neighborhood physical characteristics in Dhaka, Bangladesh." PhD, North Carolina State University.

Islam, Mohammed Zakiul, Robin Moore, and Nilda Cosco. 2016. "Child-friendly, active, healthy neighborhoods: Physical characteristics and children's time outdoors." *Environment and behavior* 48 (5):711-736. https://doi.org/10.1177/0013916514554694.

Jacobs, J. 1961. "The Uses of Sidewalks: Safety." In *The Death and Life of Great American Cities*. New York: Random House.

Janssen, I., and A. G. LeBlanc. 2010. "Systematic review of the health benefits of physical activity and fitness in school-aged children and youth." *Int J Behav Nutr Phys Act*.

Karupannan, S., and A. Sivam. 2013. "Comparative analysis of utilisation of open space at neighbourhood level in three Asian cities: Singapore, Delhi and Kuala Lumpur." *Urban Design International* 18:145–164.

Khaleda, Syeda, Qazi Azizul Mowla, and Yuji Murayama. 2017. "Dhaka Metropolitan Area." In *Urban Development in Asia and Africa: Geospatial Analysis of Metropolises*, edited by Yuji Murayama, Courage Kamusoko, Akio Yamashita and Ronald C. Estoque. Singapore: Springer.

Kytta, M. 2004. "The extent of children's independent mobility and the number of actualized affordances as criteria for child-friendly environments." *Journal of Environmental Psychology* 24 (2):179-198. https://doi.org/10.1016/S0272-4944(03)00073-2.

Kyttä, Marketta, Jenni Kuoppa, Jukka Hirvonen, Ehsan Ahmadi, and Tuija Tzoulas. 2014. "Perceived safety of the retrofit neighborhood: A location-based approach." *Urabn Design International* 19 (4):311–328.

Lee, Eun-Young, Ajaypal Bains, Stephen Hunter, Alyssa Ament, Javier Brazo-Sayavera, Valerie Carson, Shawn Hakimi, Wendy Y Huang, Ian Janssen, and Mikyung Lee. 2021. "Systematic review of the correlates of outdoor play and time among children aged 3-12 years." *International Journal of*

Behavioral Nutrition and Physical Activity 18 (1):1-46.

Lynch, K. 1977. *Growing Up in the Cities: Studies of the Spatial Environment of Adoloscence in Cracow, Melbourne, Mexico City, Salta, Toluca and Warszawa.* Paris: The MIT Press.

Malone, Karen. 2015. "Children's rights and the crisis of rapid urbanisation: Exploring the United Nations post 2015 Sustainable Development Agenda and the potential role for UNICEF's Child Friendly Cities initiative." *International Journal of Children's Rights* 23 (2):405-424. https://doi.org/doi:10.1163/15718182-02302007.

Marquet, Oriol, J Aaron Hipp, Claudia Alberico, Jing-Huei Huang, Dustin Fry, Elizabeth Mazak, Gina S Lovasi, and Myron F Floyd. 2019. "Park use preferences and physical activity among ethnic minority children in low-income neighborhoods in New York City." *Urban Forestry & Urban Greening* 38:346-353.

McGrath, Leslie J., Will G. Hopkins, and Erica A. Hinckson. 2015. "Associations of objectively measured built-environment attributes with youth moderate–vigorous physical activity: A systematic review and meta-analysis." *Sports Medicine* 45 (6):841-865. https://doi.org/10.1007/s40279-015-0301-3.

Mckenzie, T. L., D. A. Cohen, A. Sehgal, S. Williumson, and D. Golinelli. 2006. "System for observing play and recreation in communities (SOPARC): Reliability and feasibility measures." *Journal of Physical Activity & Health* 3 (1): 208–222.

Mehta, V. 2007. "Lively streets, determining environmental characteristics to support social behavior." *Journal of Planning Education and Research* 27 (2):165-187.

Monsur, Muntazar, Mohaimen Mansur, and Mohammed Zakiul Islam. 2017. "Are children living on dead-end streets more active? Near-home street patterns and school-going children's time spent outdoors in Dhaka, Bangladesh." *Preventive Medicine* 103:S73-S80. https://doi.org/10.1016/j.ypmed.2016.11.016.

Moore, R. C. 1986. *Childhoods domain: Play and place in childhood development.* London: Croom Helm.

Mowla, Q. A. 2012. "Dhaka: A mega city of persistence and change." In *Urbanisation in South Asia: Focus on mega cities*, edited by R. P. Mishra, 341-372. Foundation Books.

Nahar, Kamrun. 2019. "Park-playground project: DSCC revises up cost, extends tenure." In *The Financial Express.* Dhaka: International Publications Limited.

RAJUK. 2015. "Draft Structure Plan: 2016-2035." In, edited by Capital Development Authority. Dhaka: Capital Development Authority, Government of Bangladesh.

Sallis, J. F., E. Cerin, T. L. Conway, M. A. Adams, L. D. Frank, and M. Pratt. 2016. "Physical activity in relation to urban environments in 14 cities worldwide: A cross-sectional study." *Lancet* 387:DOI: 10.1016/S0140-6736(1015)01284-01282. https://doi.org/10.1016/S0140-6736(15)01284-2.

Sharmin, S., and M. Kamruzzaman. 2017. "Association between the built environment and children's independent mobility: A meta-analytic review." *Journal of Transport Geography* 61:104-117. https://doi.org/10.1016/j.jtrangeo.2017.04.004.

Sharmin, Samia, Md Kamruzzaman, and Md Mazharul Haque. 2020. "The impact of topological properties of built environment on children independent mobility: A comparative study between discretionary vs. nondiscretionary trips in Dhaka." *Journal of Transport Geography* 83:102660. https://doi.org/https://doi.org/10.1016/j.jtrangeo.2020.102660.

Shaw, B., M. Bicket, B. Elliott, B. Fagan-Watson, E. Mocca, and M. Hillmann. 2015. *Children's independent mobility. An international comparison and recommondation for action.* London: Policy Studies Institute.

Smith, P. 2012. "Observational methods in studying play." In *The Oxford handbook of the development of play*, edited by P. Nathan and A. D. Pelligrini. Permalink.

Sutton-Smith, B. 1997. *The ambiguity of Play.* Cambridge, MA: Harvard University Press.

The Daily Star. 2022. "Stop Kalabagan police station construction on Tetultala playground: Activists." In *The Daily Star.* Dhaka.

Timperio, Anna, Billie Giles-Corti, David Crawford, Nick Andrianopoulos, Kylie Ball, Jo Salmon, and Clare Hume. 2008. "Features of public open spaces and physical activity among children: Findings from the CLAN study." *Preventive Medicine* 47 (5):514–518. https://doi.org/https://doi.org/10.1016/j.ypmed.2008.07.015.

Tremblay, M. S., C. Gray, S. Babcock, L. Barnes, C.C. Bradstreet, D. Carr, C. Guylaine, et al. 2015. "Position statement on active outdoor play." *International journal of environmental research and public health* 12:6475-6505. https://doi.org/doi:10.3390/ijerph120606475.

Umstattd Meyer, M Renée, Tyler Prochnow, Christina N Bridges, Troy Carlton, Emily Wilkins, Kimberly T Arnold, Megan E McClendon, Thomas McKenzie, and Keshia M Pollack Porter. 2020. "Assessing physical activity in temporary spaces: Application of SOPARC/iSOPARC® for Play Streets." *Research Quarterly for Exercise and Sport* 91 (2):346-353.

UN Committee on the Rights of the Child. 2013. "General comment No. 17 (2013) on the right of the child to rest, leisure, play, recreational activities, cultural life and the arts (art. 31)." In. New York.

UNICEF. 2018. *Child friendly cities and communities handbook.* New York: United Nations Children's Fund (UNICEF).

United Nations. 2019. *World urbanization prospects: The 2018 revision.* New York: United Nations.

Wen, L. M., D. Kite, and C. R. Merom. 2009. "Time spent playing outdoors after school and its relationship with independent mobility: a cross-sectional survey of children aged 10–12 years in Sydney, Australia." *International Journal of Behavioral Nutrition and Physical Activity* 6 (15). https://doi.org/10.1186/1479-5868-6-15.