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Urban park design and children's physical activity levels: an investigation of design characteristics of green areas and playgrounds

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Abstract

Physical activity has a great impact on the development and overall health of children. Urban parks, which generally feature both green areas and playgrounds, offer children a wide range of opportunities to be physically active. However, previous studies have shown that a significant number of children are sedentary during park visits, rather than engaging in vigorous activities. In addition, children's physical activities in urban parks have not been sufficiently studied in the Egyptian context. Accordingly, the main objective of this study is to investigate the relationship between the design characteristics of urban parks and children's physical activity in the Egyptian context. To achieve its objective, the study relied on a mixed qualitative-quantitative approach to investigate six settings in a large urban park east of Cairo, three green areas, and three playgrounds. Methods of data collection included field documentation of the design characteristics of the six settings investigated, structured observations, behavioral mapping, and semi-structured interviews with 16 children. Study results show that the presence of both green areas and playgrounds is important in the design of parks. The study also identifies the design features that need to be considered in the design of parks to promote children's vigorous activity. These features are the presence of wide-open green spaces, the presence and variety of vegetation, the presence of water bodies, the presence of challenging age-appropriate play equipment in playgrounds, the availability of pathways, the availability of shading, the variety and appropriate use of ground surface materials, and the variety in topography. Findings of the study can help designers and decision-makers in efforts to create urban parks that promote the active play of children.

Keywords: Urban park design, Playground design, Children's physical activity, Play behavior, Affordance theory, SOPARC Observation Tool, Behavioral mapping, Semi-structured interviews

Introduction

Physical activity is important for children's development and various aspects of their health [1]. Higher levels of physical activity during childhood are associated with significant short- and long-term health benefits [2]. Today, with the increasing time children spend watching television and playing on computers and mobile phones, there is

a decrease in physical activity in favor of more passive forms of activities which do not have the same benefits as physical activities for the overall development and health of children [3]. Urban parks are certainly among the most important public places in cities that provide children with opportunities to engage in physical activity [4]. Urban parks, which generally feature both green areas and playgrounds, offer children a wide range of opportunities to be physically active. Previous studies have shown positive correlations between access to green areas and children's levels of physical activity, mental health, and cognitive development [5, 6]. Similarly, studies have related play on playgrounds to positive impacts on children's physical, social, emotional, and cognitive development [7]. A large amount of research has investigated children's play activities in urban parks, green areas, and/or playgrounds (for a recent literature review, see [8]). However, previous research has shown that a significant percentage of children are sedentary during park visits [9, 10]. Moreover, a previous study in Australia showed that even parks with play equipment remain underutilized by children [11]. Therefore, there is a need to better understand how urban parks can be designed to provide increased physical activity opportunities for children and further encourage active play. Accordingly, the main objective of this study is to investigate the relationship between the design characteristics of urban parks and children's physical activity. More specifically, the study investigates, in the Egyptian context, the design characteristics of both green areas and playgrounds that promote different levels of children's physical activity.

Significance of physical activity for children

Physical activity can be defined as any bodily movement produced by skeletal muscles that requires energy expenditure, including exercise, active games, and sports programs [2]. According to Hancox and Poulton, 3 to 4 h of daily physical activity is needed for the healthy development of children [12]. Previous studies found that increased physical activity has a significant effect on the health and various aspects of the development of children, including cognitive, social, emotional, and physical development. For example, studies by Fedewa and Ahn [13] and Carson et al. [14] suggest that physical activity has beneficial effects on cognitive development in children, such as attention, working memory, classroom behavior, and academic achievement. Regular physical activity also helps in reducing health risks including childhood obesity and other chronic diseases such as diabetes, osteoporosis, and cardiovascular diseases [15, 16]. Moreover, physical activity exposes children to opportunities to enhance their social and emotional skills through developing new friendships and learning socially accepted behaviors which assist in developing positive self-esteem, pro-social attitudes and behaviors, problem-solving skills, and discipline [17]. A study by Zeng et al. [18] also suggests that physical activity develops motor skills functioning in children. According to Hennessy et al. [19] and Gallahue and Donnely [20], between the ages of two and seven, children go through a "Fundamental Motor Phase" which is considered to be the 'sensitive learning period' for the development of fundamental motor skills including running, jumping, throwing, catching, rolling and bouncing a ball. Moreover, between the ages of 7 to 11, the child learns how to adaptively apply these fundamental skills to a variety of constrained situations [21].

Urban parks as settings for children's physical activity

Research shows a positive correlation between access to urban parks and levels of children's physical activity [9]. Therefore, the appropriate design of parks and the provision of amenities that encourage children to visit them and engage in park-based physical activity is potentially a long-term and sustainable approach to increase levels of physical activity [22]. According to Baek et al. [23], variables that influence the degree to which parks enable children's physical activity can be grouped into three broad categories: (1) the proximity of parks to children's life spaces including homes and schools, (2) the level of safety around and within the parks; and (3) the design features within park boundaries. Linking park design characteristics and level of physical activity is essential for understanding the impact of design on children's behavior and for guiding future park design interventions [24]. An extensive review of the relevant research literature was conducted to identify the different design characteristics of parks that could impact children's physical activity. For the purpose of this study, these different design characteristics were categorized into eight features: (1) presence of open spaces [23, 25], (2) presence of playgrounds/sports courts [23, 26, 27], (3) availability of pathways/park trails [25, 28], (4) presence and variety of vegetation [26, 29], (5) presence of water bodies [23, 27], (6) availability of shading [30, 31], (7) variety of appropriate ground surface materials [23, 25, 26], and (8) variety in topography [23].

According to Gibson [32], children's environments should not be described in terms of forms, but in terms of "affordances". For the playing children, it is not the form of the environmental feature that counts but rather, what behaviors it affords [32, 33]. Urban parks provide settings that afford children the opportunity to be physically active; grassy areas provide space to run and throw, courts mark the boundary for sports, and playground equipment facilitate climbing, sliding, and swinging [9]. Urban parks also afford opportunities for outdoor "risky play". According to Sandseter [34] and Sandseter and Kennair [35], risky play is a subcategory of physical play described as active, exciting, and having elements of risk. Based on the literature, types of risky play include: play that has a probability of resulting in harm or injury, play that offers children opportunities for testing boundaries and exploring risk, play on the borderline of "out of control" (often because of height and speed), play involving overcoming fear, and play attempting something never done before [36, 37]. According to Sandseter [38], the most frequent forms of risky play are climbing and jumping down from high places.

Green areas and children's physical activity

Research has shown that children's access to green areas is associated with increased physical activity, better general health, improved psychological well-being and cognitive development, and decreased emotional and behavioral problems [6, 39]. In green areas, it is typically through play that children engage in physical activity. Green areas provide children with a sense of freedom and play in green areas tends to be more creative and more fun than play in indoor areas [40, 41]. Fjørtoft and Segeie [29] suggest that green areas and natural environments provide a limitless amount of affordances for play. Accordingly, in green areas, children perceive a multitude of play opportunities. As a result, play in green areas tends to be associated with a greater diversity in play behavior and in physical activity levels. In turn, this increases opportunities for learning

and development through the increased challenge to the child's abilities, curiosity, and judgment [42]. According to Sandseter [34], it is the complexity and diversity of natural elements in green areas that afford children immeasurable opportunities to play with risk-seeking and risk-avoiding behaviors. For example, natural elements such as trees afford children more play opportunities than a set of monkey bars which, although safer, limits children in what they can do due to their equal-distance spacing, stable height, and identified start and finish points [43].

Playgrounds and children's physical activity

The availability of a variety of play areas and equipment that allow both structured and unstructured activities, such as climbing, swinging, and games such as tag, and "make believe" activities, adds quality to parks [44]. Floyd et al. [10] reported that within parks, the physical activity levels of girls are generally lower than those of boys. However, according to Korca et al. [45], playgrounds are the only activity setting in parks that attracts both boys and girls equally. Smith [46] also suggested that boys are more willing to take risks than girls during play, particularly in playgrounds. Previous research shows that the type of playground and the equipment provided influence children's creativity and physical activity levels [47, 48]. According to the literature [49–51], playgrounds can be classified into three main types: traditional playgrounds (categorized by the presence of unconnected play equipment such as slides, swings, seesaws, and climbers), contemporary playgrounds (in which the different pieces of play equipment are typically connected together to form multi-purpose continuous structures with multiple entry and exit points and that are usually aesthetically pleasing), and adventure playgrounds (which incorporate various types of loose materials—old tires, large building blocks, ropes, logs and various pieces of wood, buckets and water containers, sand and sand toys, and a variety of natural materials—that allow children to create their own environment or play equipment). Outdoor playgrounds are intended to enhance children's physical, social, emotional, and cognitive development through play and are typically designed to provide a relatively safe playing environment [52]. However, several researchers have argued for the developmental benefits of the less predictable and more dynamic play spaces for children over those designed for safety [53, 54]. According to Withagen et al. [55], one of the factors determining the attractiveness of a playground to children is the effort needed to actualize an affordance in that playground, as it has been suggested that children are attracted to challenging opportunities that imply risky behavior [34].

Methods

Research design

As previously mentioned, the objective of the study is to investigate, in the Egyptian context, the design characteristics of the green areas and playgrounds of urban parks that promote different levels of children's physical activity. To achieve this objective, the study investigated six settings—three green areas and three playgrounds—in a large urban park east of Cairo, namely "Family Park". Family Park is a relatively new urban park in New Cairo with a total area of about 283,000 sqm. This park was selected for the study because it features several green areas and several playgrounds. In addition, the different green areas and the different playgrounds differ in terms of design characteristics.

The study relied on a mixed qualitative-quantitative approach and several methods of data collection, including the field documentation of the design characteristics of the six settings investigated, structured observations, behavioral mapping, and semi-structured interviews with 16 children. The purpose of the structured observations was to quantitatively assess levels of children's physical activity in the different settings investigated. Behavioral mapping was used to document the different activities children undertake in relation to the design features of the six settings. Finally, the purpose of the semi-structured interviews was to investigate children's perceptions, opinions, and preferences about the different settings studied.

Based on the literature discussing the age range for fundamental motor skills development, the target age group for this study was 5- to 11-year-old children [19–21]. Children under the age of 5 were not included because it is only from the age of five that children can interpret their experiences and feelings in relation to their environments and can express their preferences about the places they use and the activities they undertake in those places [56]. Moreover, children under the age of five are often unable to use the playground on their own and are usually accompanied by a parent or guardian. Accordingly, only 5- to 11-year-old children were interviewed. For observations and behavior mapping, the determination of children's age had to rely on judgment and only children who appeared within the targeted age group were considered.

The settings selected for the study

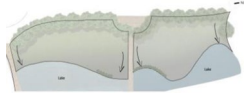

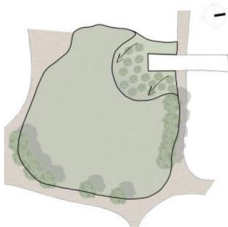
Six settings within family park were selected for the study, three green areas and three playgrounds. Family park features several relatively well spatially defined green areas and a total of four playgrounds. Some of the green areas border a large artificial lake at the center of the park. The park also features a petting zoo, an outdoor theater, a small amusement park, and several buildings housing a museum, workshop spaces for children, indoor games, and restaurants. A main circular pathway connects the different areas and facilities of the park together.

The three green areas selected for the study—GA1, GA2, and GA3 (see Fig. 1)—were determined during pilot visits to be the green areas most used by children. These three green areas were also selected because, as detailed in Table 1, they differ in terms of physical characteristics such as area, topography, and types and diversity of vegetation. They also differ in their relation to the park's central lake. GA1 overlooks the lake. GA2 surrounds the southern end of the lake. However, GA3 does not border the lake at all. Other large green areas in the park were not considered because they are often reserved for private events and are thus not always available for public use. Similarly, the three playgrounds selected for the study—PG1, PG2, and PG3 (see Fig. 1)—differ in terms of design characteristics. As detailed in Table 2, they differ particularly in area, ground surface material, presence of shaded area, and nature of the elements defining the boundaries of the playground. They differ also in terms of types of play equipment. Both PG1 and PG3 feature a mix of traditional and contemporary play equipment. On the other hand, PG2 features climbable military equipment—such as a tank, a plane, and a small ship—intended for children to play on. The fourth playground of the park was excluded because its play equipment is intended for children under the age of 5, younger than the study's target age range.



Fig. 1 Green areas and playgrounds selected for the study (Google Earth)

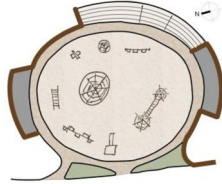
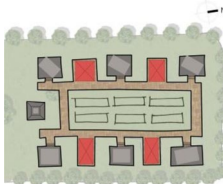
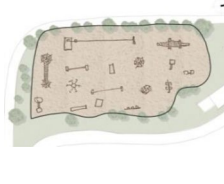
Table 1 Difference in physical characteristics of the three investigated green areas

	Green Area 1 (GA1)	Green Area 2 (GA2)	Green Area 3 (GA3)
Layout			
Approx. area (SQM)	3700	10,000	4000
Topography	Sloped in one direction towards the lake	Leveled ground in the southwest with the rest of the green area sloped inwards towards the lake	One flat green space with an elevated area in the northwest sloped inwards
Types and diversity of vegetation	Dense trees on the western edge opposite the lake	Scattered trees on the edges with dense palm trees on both sides of the lake and scattered small trees on one side of the lake	Dense trees on the northern edge with scattered trees on the rest of the edges and small dense trees on the sloped area
Water feature	Overlooking the lake	A large lake in the center	NA

Data collection

The repeated pilot visits to the park in August and September 2021 helped in the selection of the six settings investigated. During these visits, the different methods of data collection used, detailed in the following paragraphs, were pilot-tested. In particular, the reliability of the systematic observations was calculated several times through the use of two independent observers and considered to be appropriate above 85%. Through these visits, it was determined that the park is busiest on Fridays, particularly after 1:00 pm. Accordingly, it was decided to conduct all data collection on Fridays between 1:00 pm and 6:00 pm, the time at which it was beginning to be too dark to conduct observations. The actual data was collected on four different Fridays in September and October 2021. Accordingly, data collection was performed before

Table 2 Difference in physical characteristics of the three investigated playgrounds

	Playground 1 (PG1)	Playground 2 (PG2)	Playground 3 (PG3)
Layout			
Approx. area (SQM)	1500	2700	3300
Ground surface material	Sand	Grass with a paved pathway and concrete bases for the equipment	Sand
Types of play equipment	A mix between traditional and contemporary	Climbable military equipment (Tank, plane, ship, ...)	A mix between traditional and contemporary
Presence of shaded areas	Only above benches on the sides	Shelters above empty spaces	Trees on the periphery providing shade
Area boundaries	Short stone walls defining the boundaries of the playground	Green area	Green area and pathway surrounding the area

the start of the school year and in a period during which the weather in Cairo is typically appropriate for outdoor activities. During data collection sessions, the weather was mostly sunny with no rainfall and temperatures ranged between 31 °C and 24 °C.

For the systematic observations, a modified version of the SOPARC observation tool—System for Observing Play and Recreation in Communities [57]—was used to capture the physical activity levels of children in the six settings investigated. This observation tool is particularly suited to quantitatively compare physical activity levels in different settings or in the same setting at different times. The SOPARC manual [57] was used to guide observation procedures. According to the SOPARC manual, physical activity is categorized in terms of three levels: (1) sedentary (individuals are lying down, sitting, or standing in place), (2) walking, and (3) vigorous (individuals are engaged in an activity more vigorous than an ordinary walk—with an increase in heart rate causing them to sweat—such as running, jumping, swinging, and doing cartwheels). On each of the data collection days, for each of the six settings investigated, observations were repeated three times at 10 min intervals. Each observation consisted of a quick “scan” of the setting to record the number of children engaged in each of the three levels of physical activity. The numbers of girls and boys were recorded separately. As per the SOPARC manual guidelines [57], a child who was engaged in a vigorous activity but was standing still at the exact moment of the observation was recorded as sedentary.

For the behavioral mapping, a base map was initially created for each of the settings investigated, clearly identifying the physical features of the setting that could affect children’s physical behavior. Based on the different activities of children observed during the pilot visits, several behavioral categories were defined and a coding system was developed. For each of the days of data collection, a behavioral map was created for each of the settings investigated. On the map, for each child present in the setting

at the time, the particular type of activity engaged in and its specific location were recorded. To avoid the interruption of children's behavior, direct interaction with the children during behavioral mapping was avoided.

Semi-structured interviews were carried out with nine boys and seven girls. These 16 interviews were considered sufficient for the purpose of the study as no new information appeared to emerge from the last interviews (data saturation). For these interviews, children whose parents could be identified were randomly picked. Parents or legal guardians were first approached to obtain consent for the participation of their child after they were explained the objective of the study. Parents were also asked to confirm the age of the child. Only two of the parents who were approached refused to have their children interviewed. Interview questions focused on whether the children had visited the park before, where did they like to play in the park and why, whether they prefer to play in the green areas or the playgrounds and why, and what games or activities they liked to engage in. Children were also shown photographs of the six settings investigated and were asked to indicate what they liked most about each photograph and pick the one they considered the best place to play. To facilitate the transcribing of the answers, all interviews were recorded with the parents' permission. Interviews lasted around 10 min.

Data analysis

For each of the six settings investigated, SOPARC observation data collected on the 4 days of data collection were combined into a single schedule. Comparisons between the different settings were then conducted through the use of graphs. Also, for each of the settings, the four behavioral maps were combined into one aggregate map on which each child observed is represented by the symbol of the activity he or she was engaged in. The combined behavioral maps of the different settings were analyzed to identify relations between the physical features of the settings and the types of behavior they appeared to promote. Interviews were fully transcribed. Transcripts were then analyzed to identify emerging themes for each of the green areas and playgrounds.

Results

Children's physical activity: green areas vs. playgrounds

The SOPARC observation data suggests that playgrounds were more attractive to children than green areas. Although the area of the playgrounds investigated is smaller than that of the green areas investigated, a total of 1052 children were recorded in the playgrounds compared to a total of 737 children in the green areas. In PG1, the smallest of the three playgrounds in area and the closest to the main entrance of the park, the high number of children sometimes appeared to cause overcrowding. Some of the children interviewed expressed a clear preference for playgrounds as a place to play. For example, one of the girls indicated "I prefer to play in the playgrounds because there are a lot of games that I can play and I don't get bored" (Ch. 3). However, other children expressed a preference for green areas. One of the boys interviewed explained his preference for green areas "I like large open spaces where I can run and play with the ball" (Ch. 11). Also, some of the children could not express a preference for either playgrounds or green areas suggesting that it could depend on how they would like to play at a particular time.

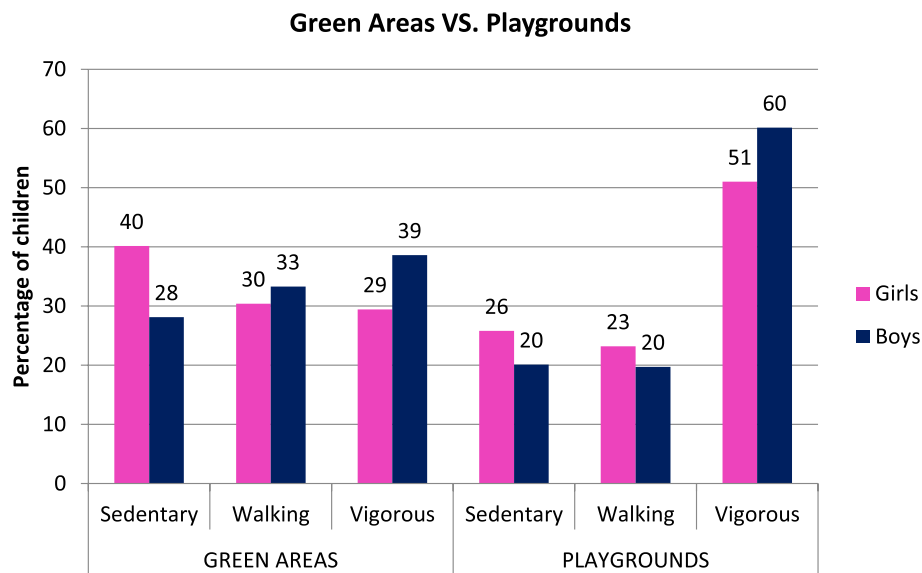


Fig. 2 Children's physical activity levels in green areas and playgrounds

As shown in Fig. 2, children in the playgrounds, both girls and boys, were more likely to be engaged in vigorous activities than children in green areas. In both playgrounds and green areas, boys were more likely to be engaged in vigorous activities than girls. For boys, vigorous activity was the highest level of physical activity recorded in both playgrounds and green areas. On the other hand, for girls, vigorous activity was the lowest level of physical activity recorded in green areas, below sedentary and walking activities.

Types of sedentary activities observed in green areas and playgrounds were very similar and mainly included sitting and standing still. However, for types of vigorous activities, differences were found between green areas and playgrounds except for running, which was found to be the highest vigorous activity children undertook in both green areas and playgrounds (see Fig. 3).

Running was the highest type of vigorous activity (in terms of the percentage of children engaged in vigorous activity) observed in both types of settings (61.2% for green areas and 40.7% for playgrounds). In green areas, the presence of large open spaces permitted children to run around freely. In playgrounds, most of the running observed was the running of children from one play equipment to another. In green areas, the second most frequently observed vigorous activity was ball playing. Eighty-seven percent of all the children engaged in vigorous activity in green areas were recorded as either running or ball playing. Other types of vigorous activity observed in green areas included rolling over and gymnastics. Interestingly, ball playing, rolling over, and gymnastics were not observed at all in playgrounds. These particular types of vigorous activity were facilitated by the physical characteristics of green areas. In contrast, the play equipment in the playgrounds promoted such vigorous activities as climbing, swinging, jumping, and sliding. These types of vigorous activities were not observed in green areas. Only climbing and swinging were rarely observed (see Fig. 3).

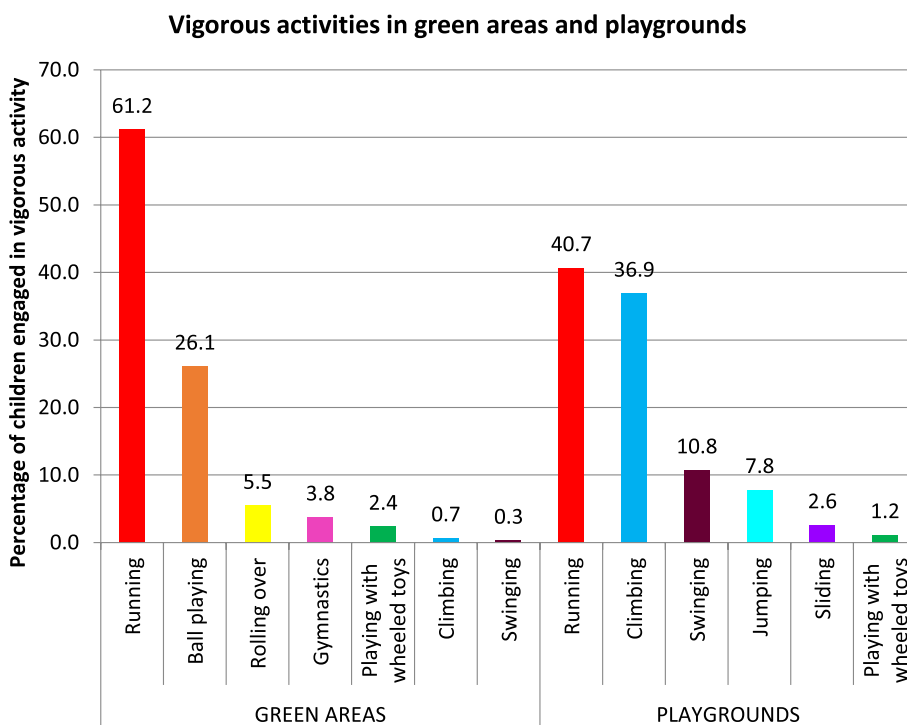


Fig. 3 Types of vigorous activities observed in green areas and playgrounds

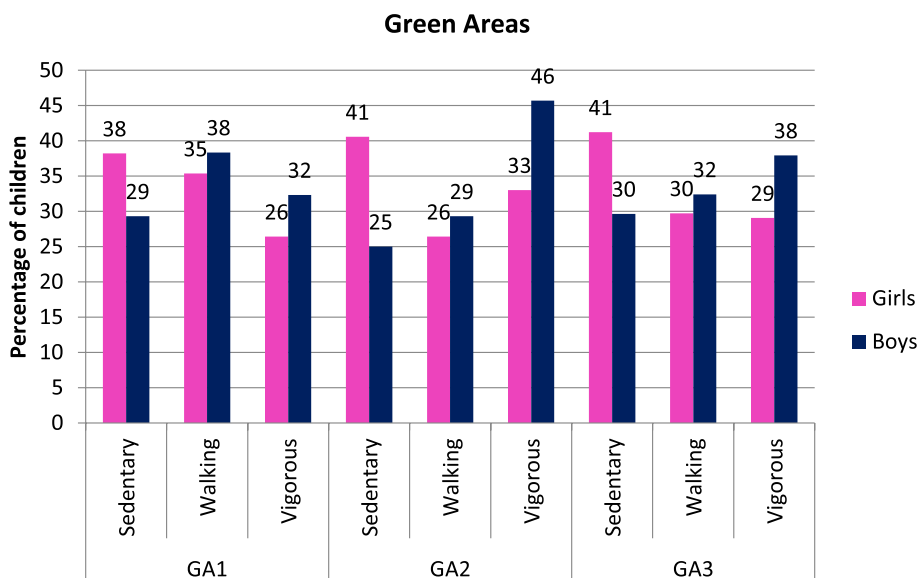


Fig. 4 Physical activity levels of children in green areas

Design features of green areas and children’s physical activity

The SOPARC observation data show that for girls, in the three green areas investigated, sedentary activity was the highest level of physical activity recorded (see Fig. 4). On the other hand, for boys, vigorous activity was the highest level of physical

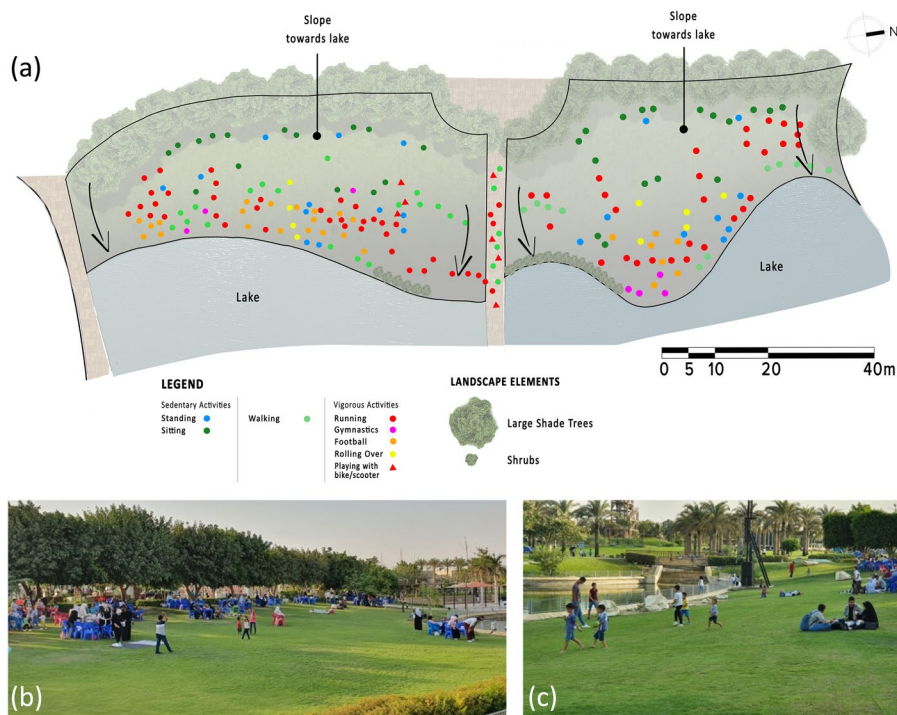


Fig. 5 GA1, combined behavior map and photographs

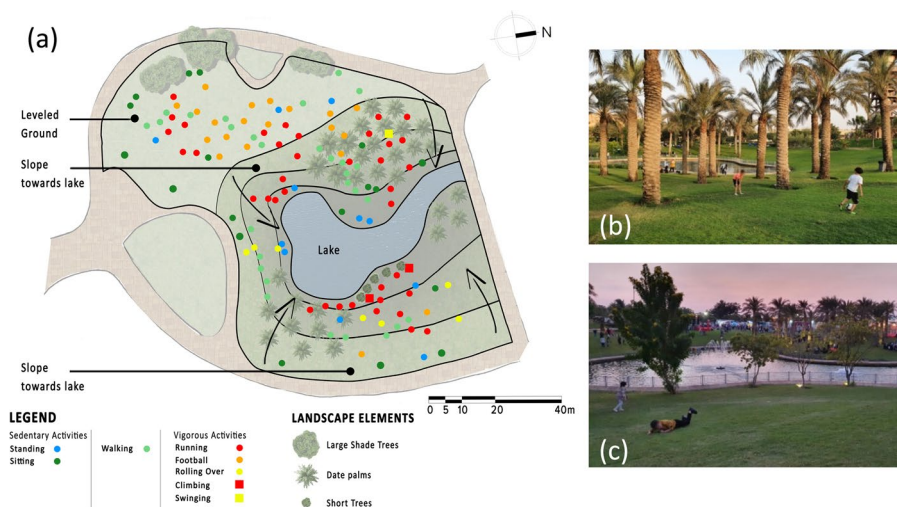


Fig. 6 GA2, combined behavior map and photographs

activity recorded in two of the green areas (GA2 and GA3). In GA1, the highest level of physical activity recorded for boys was walking followed by vigorous activity. While there were clear differences between girls and boys in terms of percentages of children engaged in the different levels of physical activity, the specific types of activities that both girls and boys were observed to be engaged in were very similar.

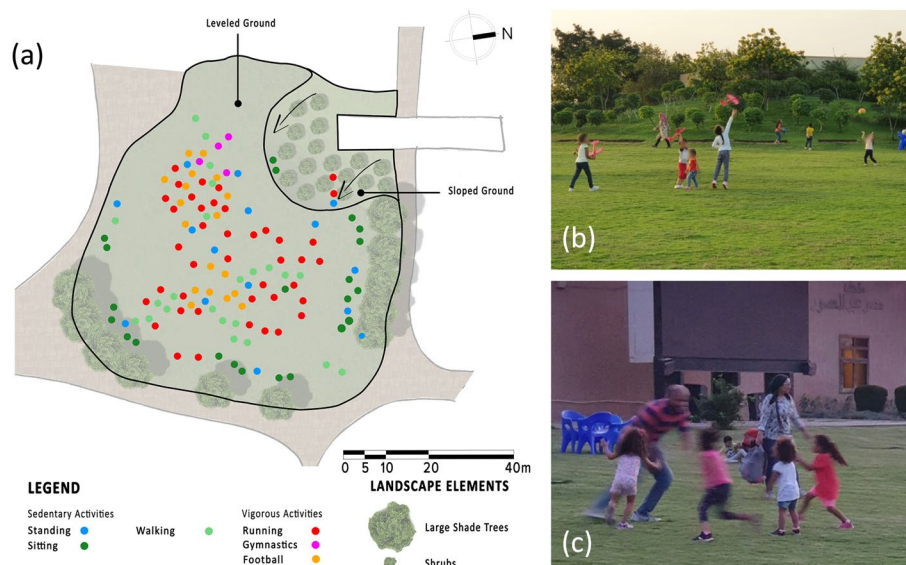


Fig. 7 GA3, combined behavior map and photographs

The analysis of observational data and of the behavior maps created (Figs. 5, 6, and 7) strongly suggests that the different physical features of the green areas afford and promote different types of vigorous activities. For example, the presence of open spaces appeared to encourage such activities as running freely while playing with toys, group game playing with adults, ball playing, or playing gymnastics. This was emphasized by some of the children interviewed. One of the boys indicated “It’s nice and wide [GA1] and I can play a lot of games here” (Ch. 1). Another one explained, “We came here [GA2] to play football with our father” (Ch. 5). The presence and diversity of vegetation in green areas also afforded several activities. For example, observations showed that large trees were used as hiding spots when playing such games as hide and seek or as goal posts while playing football (see Fig. 6b). A boy reported “I like to play as a goalkeeper so I stand here and use the trees as goal posts” (Ch. 6). It was also observed that trees with reachable branches afforded climbing. And, one of the interviewees indicated “I like climbing on these trees as I see in cartoons” (Ch. 14). Date palms in GA2 promoted other activities such as swinging from their leaves and throwing small stones to collect dates. The particular nature of the ground surface in green areas, mainly grass, afforded certain types of activity not observed in the playgrounds such as ball playing, rolling over, and gymnastics. In contrast, the presence of a pathway with a harder ground surface in GA1 permitted other activities including bike riding, skating, and other forms of wheeled toy playing. Actually, one of the children reported “I tried to play with my bike over there [large grassy area] but the wheels didn’t move well so I came to ride it here [on the pathway]” (Ch. 8). To a large extent, it is the presence of the pathway cutting through GA1 that explains the higher incidence of walking activities observed in GA1 compared to GA2 and GA3 (see Fig. 4). The nature of the topography in green areas also has an important impact on the particular types of activities afforded. While leveled areas were observed to promote playing football, sloped areas were observed to promote such activities as rolling over (see Fig. 6c) or racing up and down. One of the

interviewees indicated: “There [in GA3], there’s a hill that I like to climb up and down” (Ch. 8). The presence of a water feature in GA1 and GA2 attracted vigorous as well as sedentary activities. Vigorous activities that children were observed engaging in by the side of the lake included running, playing with a ball, and playing gymnastics, while sedentary activities included sitting down or standing next to the lake. One of the girls stated “I like to sit here [GA2] because it’s next to the lake and there are a lot of trees and it looks nice” (Ch. 2). The availability of shading also appeared to attract sedentary activities. Children were frequently observed sitting, eating, playing on mobile phones, lying on the ground, or just standing in shaded places such as under large trees (see Fig. 5b).

As shown in Fig. 4, a higher incidence of vigorous activity for both girls and boys was observed in GA2 compared to GA1 and GA3. It could be suggested that this is related to the greater diversity in physical characteristics in GA2. Compared to the other two green area settings, GA2 is characterized by greater diversity in types of vegetation and a greater variety in topography. GA2 is also one of the two green areas that border the lake. GA2 also features more shaded areas. While it is true that shaded areas tend to attract sedentary activities, sedentary activities can be important resting time for children between episodes of vigorous activity.

Design features of playgrounds and children’s physical activity

For boys, the SOPARC observation data show that vigorous activity was the highest level of physical activity in the three playgrounds investigated (see Fig. 8). For girls, this was also the case in PG1 and PG3. In PG2, however, walking was the highest level of physical activity recorded for girls. The percentage of girls recorded as engaged in vigorous activities was very similar in PG1 and PG3 (53% and 57% respectively) and much lower in PG2 (31%). The percentage of boys engaged in vigorous activities was highest in PG1 (71%) and to some extent lower in PG2 and PG3 (54% and 55% respectively). Both PG1 and PG3 feature a similar mixture of traditional and contemporary play equipment.

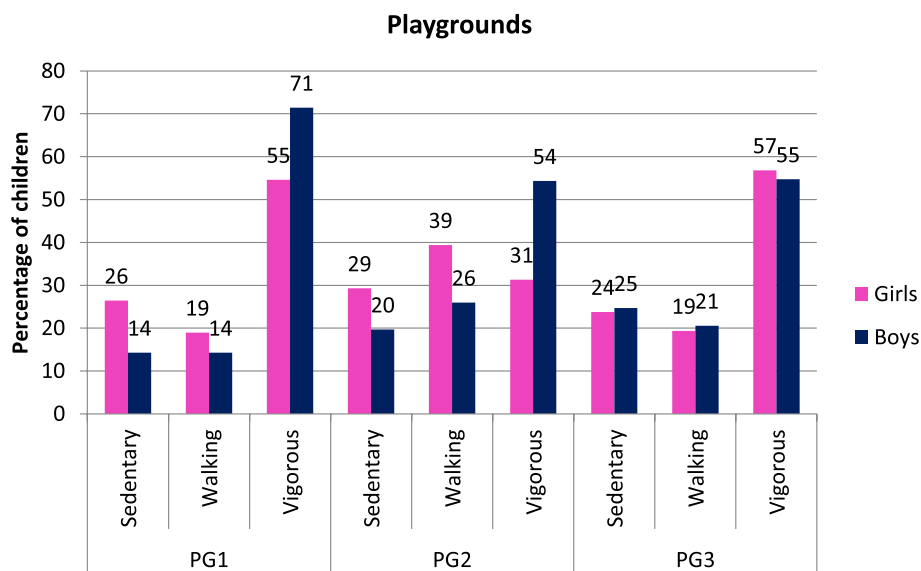


Fig. 8 Physical activity levels of children in playgrounds

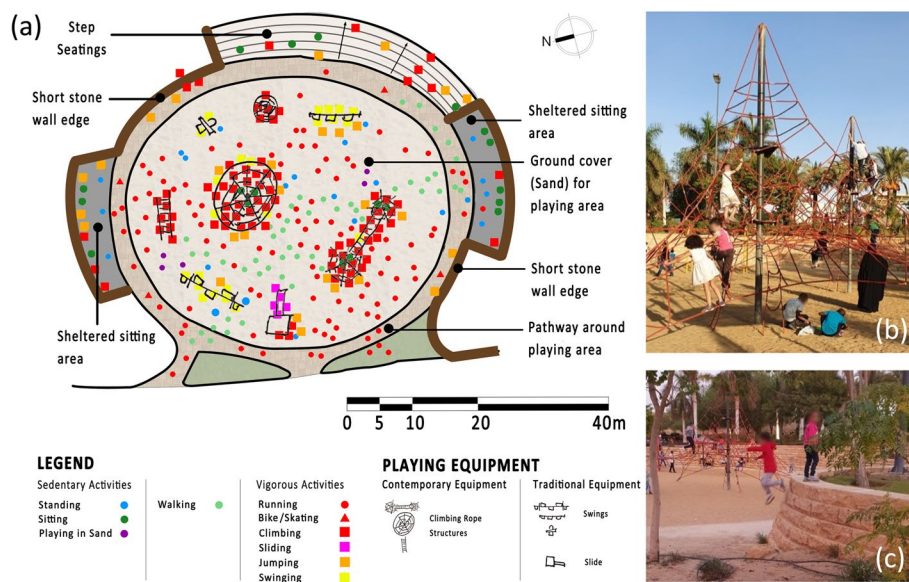


Fig. 9 PG1, combined behavior map and photographs

However, the lower incidence of vigorous activity recorded in PG3 compared to PG1 appears to be related to the fact that PG3 features more play equipment that requires children to wait for their turn. Accordingly, in PG3, a relatively large number of boys waiting for a turn to play on various play equipment was recorded as sedentary rather than engaged in vigorous activity. This was particularly the case for the zipline in PG3. The percentage of girls engaged in sedentary activities was about the same in all three playgrounds (26%, 29%, and 24%). On the other hand, the percentage of boys engaged in sedentary activities was higher in PG3 (25%) than in PG1 and PG2 (14% and 20% respectively). In the playgrounds, like for green areas, the specific types of activities that both girls and boys were observed to be engaged in were very similar.

Running was the most frequently observed type of vigorous activity in the playgrounds. Children were mainly observed running from the main pathway to the playgrounds or running between the different pieces of play equipment. Other types of vigorous activity observed in the playgrounds were particularly related to the specific types of play equipment present (see Figs. 9, 10, and 11). For example, the tall slides, the climbing wall, and the rope structures in PG1 and PG3 encouraged climbing. These rope structures (Figs. 9 b and 11b) presented exciting challenges to children. One of the boys interviewed indicated: “I like that big rope structure in the playground. I can climb all the way to the top but my brother can only climb to here [pointing to a lower spot]” (Ch. 16). The rope structures also afforded other types of vigorous activity. Some children were observed jumping from the structures or swinging while dangling by their legs. It can be pointed out that sedentary behavior such as standing or sitting at the top of the rope structures was occasionally observed. The slides and swings in PG1 and PG3 encouraged sliding and swinging and, sometimes, even jumping from the swings as they are moving at high speeds. In PG3, the trampolines encouraged jumping up and down (Fig. 11c). The statues and military equipment in PG2 (see Fig. 10b) and the elevated

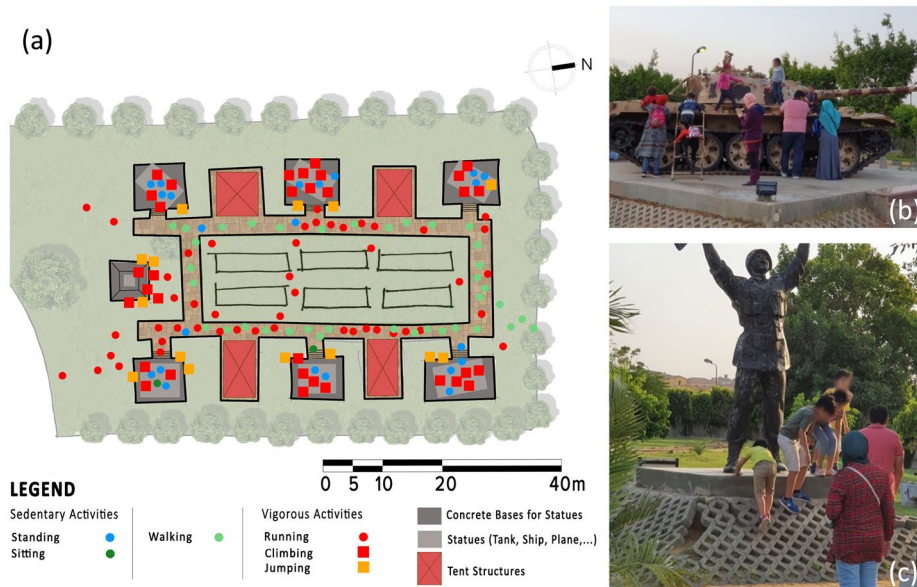


Fig. 10 PG2, combined behavior map and photographs

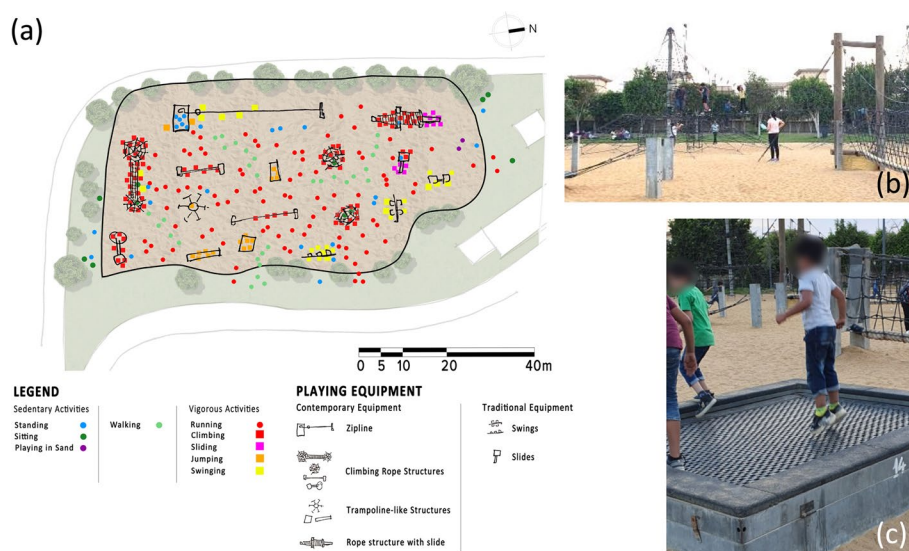


Fig. 11 PG3, combined behavior map and photographs

bases on which they are placed (Fig. 10c) also afforded climbing and jumping. Because not really a form of traditional play equipment, these pieces of climbable military equipment tended to attract children. Children were also observed standing or sitting on top of the statues and military equipment to take photographs. One of the girls interviewed indicated “We like to go to the place with the statues [PG2] because we like to climb up the statues and take pictures there” (Ch. 4). A boy also indicated: “I like the statues over there [PG2]. I like to climb on the tank. I would really like to drive a tank someday” (Ch. 15). As previously mentioned, the percentage of girls engaged in vigorous activity in PG2

(31%) was found to be much lower than in PG1 and PG3 (55% and 57% respectively). This was not found to be the case for boys (see Fig. 8). This could possibly be because the military equipment used as play equipment in PG2 is not as exciting or attractive for girls as it is for boys. Apart from the play equipment, other physical features of the playgrounds also afforded various types of vigorous activities. For example, the presence of pathways around the playgrounds afforded the use of wheeled toys such as scooters or skates. Also, the stepped seating in PG1 (Fig. 9a) and the low stone walls surrounding the playground (Fig. 9c) afforded climbing and jumping. Some of the physical features of the playgrounds were observed to be associated with sedentary behavior. The choice of sand as the ground surface material in PG1 and PG3, besides being a relatively safe choice to minimize risks of injury, afforded sedentary behavior such as playing in the sand. Also, the availability of shade under built shelters or below trees on the playgrounds' periphery afforded resting sedentary behavior such as sitting down or standing still.

Discussion

Results of the study suggest that, in urban parks, playgrounds are more attractive to both girls and boys than green areas. This does not seem to be specific to the Egyptian context as, in a study conducted in the USA, similar findings were reached [45]. This suggests that the area dedicated to playgrounds in urban parks and the amount of play equipment need to be carefully studied to avoid potential overcrowding and excessive wait for turns at various pieces of play equipment. Results also show that playgrounds tend to be associated with greater amounts of vigorous activity than green areas. However, to really promote children's vigorous activity, the study suggests that parks should include both types of settings as results indicate that playgrounds and green areas tend to promote different types of vigorous activity. The study also identifies design characteristics of green areas and playgrounds in urban parks that can affect children's physical activity levels and promote vigorous activity.

For green areas, the presence of wide open spaces was observed to afford a large range of vigorous activities such as running, playing with a ball, playing gymnastics, and playing various active group games (see also [23, 25]). The presence and variety of vegetation such as the presence of larger trees, smaller trees, and date palms was found to provide opportunities for different forms of vigorous activity. This supports the findings of previous studies which suggest that variety in types of trees and shrubs tends to promote a greater variety in children's play activities [26, 29]. The study also shows that a variation in topography, including both leveled and sloped areas, affords children to engage in different vigorous activities. According to the literature, the complexity and variety in topography does enable different forms of physical activity and plays an important role in predicting children's preferred play locations [23]. In this study, the presence of the lake by some of the green areas was found to attract children and promote both sedentary and vigorous behavior. Similarly, it was previously suggested in the literature that water features in parks serve as calming elements and attract children to explore the outdoors, and subsequently encourage them to be physically active [27].

The results of the study indicate that the presence of playgrounds featuring a variety of age-appropriate play equipment is also important for the physical activity of children as

it allows them to engage in a wide range of vigorous activities such as climbing, jumping, sliding, and swinging (see also [23]). Moreover, the study suggests that untraditional and challenging play equipment, such as the rope structures, the zip line, and the climbable military equipment, tend to be much more attractive to children. Such play equipment is viewed as more exciting and encourages children's risky play which is an important and integral subcategory of outdoor physical play [34, 35].

The study also identifies design characteristics that can be found in both green areas and playgrounds and that similarly impact children's physical activity levels. For example, the availability of pathways promotes particular types of vigorous activities as it affords the use of wheeled toys such as bikes, scooters, and skates (see also [25, 28]). In addition, the presence of sloped pathways was observed to create increased excitement in the use of wheeled toys. Shaded areas under shelters or large trees, whether in green areas or in playgrounds, were found to promote sedentary behavior. This appears to contradict previous findings from the literature which suggest that children, specifically girls, tend to engage in higher physical activity levels while playing in shaded areas [58]. In any case, sedentary activities can constitute important resting time for children between episodes of vigorous activity. It is clear that the use of soft ground materials around play equipment in playgrounds is important for safety purposes [25]. On the other hand, results of the study suggest that the variety of ground surface materials in both green areas and playgrounds, including for example grass, sand, and hard materials, tends to promote a greater variety in types of vigorous activities children engage in (see also [26]).

The results of the study also stress that, in designing urban parks to promote children's vigorous activity, design features should not be considered only in relation to their intended function and/or aesthetic qualities. They should also be looked at by designers in terms of affordances that children could perceive and use. For example, the stepped seating and low stone walls in playgrounds were observed to promote climbing and jumping. Similarly, some of the trees in the green areas were observed to promote climbing and swinging and to be used as football goalposts and as hiding spots during hide and seek play.

Conclusions

The aim of this study was to address the gap in research concerning how urban parks can be designed to provide increased physical activity opportunities for children. Study results show that the presence of both green areas and playgrounds is important in the design of parks. The study also identifies the design features needed to be considered in the design of parks to promote children's vigorous activity. These features are the presence of wide-open green spaces, the presence and variety of vegetation, the presence of water bodies, the presence of challenging age-appropriate play equipment in playgrounds, the availability of pathways, the availability of shading, the variety and appropriate use of ground surface materials, and the variety in topography.

The use of several methods of data collection including the SOPARC observation tool, behavioral mapping, and interviews is considered a strength of the study. However, the use of the SOPARC tool also constitutes one of the limitations of the study as it relies on a snapshot time sampling. Accordingly, the activity level of each child was assessed once at a very specific point in time and not over an extended period of time. In addition, the

SOPARC tool did not permit to differentiate between the vigorous activities recorded in terms of physical intensity. The particular period of data collection, in September and October, with its specific weather conditions, could constitute another limitation of the study. There is a need for research to further confirm the findings of this study. Such future research could particularly investigate parks in a variety of socio-economic contexts in Egypt. Future studies could also be designed to quantitatively measure the physical activity intensity of children in relation to the different areas of parks over an extended period of time.

Abbreviations

Ch Child

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Authors' contributions

All three authors collaborated in the conceptualization of the research idea and the discussion of the results. MA guided the selection of the study settings and assisted with the study design. YM supervised the entire project and reviewed and edited the first draft of the manuscript. SE conducted the data collection and data analysis, took part in the interpretation of the results, and produced the first draft of the manuscript. All authors have read and approved the manuscript.

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Availability of data and materials

The data that support the findings of the current study and analyzed during the study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

Participation of the children in the interviews conducted in this study was totally on a voluntary basis. Consent for their participation was obtained from their parents or legal guardians who were approached and explained the objective of the study prior to the conduct of interviews. The article does not identify participants in any way and does not contain any of their personal information.

Consent for publication

No informed consent for publication was required from the park users because only de-identified data was collected in this study. Also, any identifiable features of children were blurred in the photographs presented in this article to preserve their anonymity.

Competing interests

The authors declare that they have no competing interests.

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