

Exploring the Availability and Distribution of Public Green Spaces among Riyadh Residential Neighborhoods

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Abstract—Public green space promotes community health including daily activities, but these resources may not be available enough or may not equitably be distributed. This paper measures and compares the availability of public green spaces (PGS) among low, middle, and high-income neighborhoods in the Riyadh city. Additionally, it compares the total availability of PGS to WHO standard and Dubai availability of PGS per person. All PGS were mapped using geographical information systems, and total area availability of PGS compared to WHO and Dubai standards. To evaluate the significant differences in PGS availability across low, medium, and high-income Riyadh neighborhoods, we used a One-way ANOVA analysis of covariance to test the differences. As a result, by comparing PGS of Riyadh neighborhoods to WHO and Dubai-availability, it was found that Riyadh PGS were lower than the minimum standard of WHO and as well as Dubai. Riyadh has only 1.13 m² per capita of PGS. The second finding, the availability of PGS, was significantly different among Riyadh neighborhoods based on socioeconomic status. The future development of PGS should be focused on increasing PGS availability and should be given priority to those low-income and unhealthy communities.

Keywords—Spatial equity, green space, healthy city, quality of life, income, built environment.

I. INTRODUCTION

PGS have positive contribution to sustainable urban health; their availability and distribution equity is a matter [1]. PGS can offer opportunities for many physical activities including walking, running, and playing sports. Studies found that residents who live in residential areas that have availability of PGS are most likely to achieve the physical activity daily standard, comparing to those communities who have not had enough spaces [2]. World Health Organization (WHO) considered that PGS can positively or negatively impact community health based on their availability or deprivation [3].

In developing countries like Saudi Arabia, improving a quality of life became an essential aim, not only for achieving sustainability cities indexes but more importantly to overcome resident's health challenges for the community health of Saudi residents [4]. A recent national survey has found that almost 80% of the Saudi population were not physically active enough and Riyadh communities were ranked as the least physically active compared to other Saudi communities [5]. Moreover, the prevalence of obesity among the adult population in Saudi Arabia in 2016 reached up to 35% [6]. WHO annual report

showed 3.2% death annually for being physically inactive [1].

The health challenges that Saudi and specifically Riyadh communities are facing have given rise to attention not only to measure the availability of PGS but also to their distribution equity. This paper aims to explore the equity and availability of PGS among Riyadh neighborhoods in relation to socio-economic factor to understand how many spaces neighborhoods need and which residential area has top priority.

Defining and Measuring PGS

Global organizations such as WHO and United Nations (UN) defined open and green spaces in cities, due to the importance of these spaces to community health and the sustainability of cities. For example, WHO identified public open spaces as "all urban land covered by any natural greenery. It referred to the natural resources such as trees, water, and other sources. WHO referred to what called in the urban planning "a park" at all urban scales, city, direct, and neighborhood scale [7]. Furthermore, from a policy perspective, the UN has defined a public space as "all places that publicly owned, of public use, accessible and enjoyable by all for free and without profit motive. [8]" UN defends both indoor and outdoor spaces that owned and by public usage as open spaces such as streets, parks, and public buildings [9].

The availability standards of PGS provide consistency and certainty but it may not be enough. According to UN, "Public spaces in well planned and adequately functioning cities should make up 45 to 50 per cent of its land area with 30-35 per cent of the total allocated to streets and 15-20 per cent allocated to other public spaces" [10]. WHO has also determined the PGS minimum size per-capita to be 9 square meters, but it encourages decision-makers to raise it to 50 m² per person. In fact, the widely used formula of measuring the availability of PGS is the total of green specs with respect to the population total (m²/inhabitant) [11].

The comparative analysis approach can measure in-depth understanding [12]. Global standards are not explained enough. For example, Golf Cities have their own cultural, hot climate, and water resource difficulties that may need a local city with these challenges to measure the availability of PGS. Dubai city is one of the Middle East and gulf successful cities that can be used to compare to for some reasons. First, Riyadh and Dubai are both Middle East golf cities and both have almost the same climate and water resources condensations. According to the

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Quality-of-Life Index [13], Dubai city was ranked at 104 of 251 cities. Dubai facing some challenges that such as hot climate weather and low water resources that may also be compared to Riyadh city.

Local Definition

Riyadh Municipality has classified public outdoor spaces into five types at three scales [14]. On a neighborhood scale, *Hadeqah's* Arabic name referred to the neighborhood. It is the smallest size of PGS; most are located in neighborhood

centers. It contains a sidewalk (*Mammsha*), sports area (*Sahat*), and playground. This area is covered by greenery and some trees. At the district and the city, the scale is the (*Montzahat*) area. At these two scales, the only difference between neighborhood parks is the levels of availability and accessibility. The size of Montzahat is 3-10 acres or more. The final type of PGS at both a neighborhood and a city scale, Wahaat & Myadaan, is designed as street landscape and roadway greenery and beauty (Fig. 1 shows types of PGS).

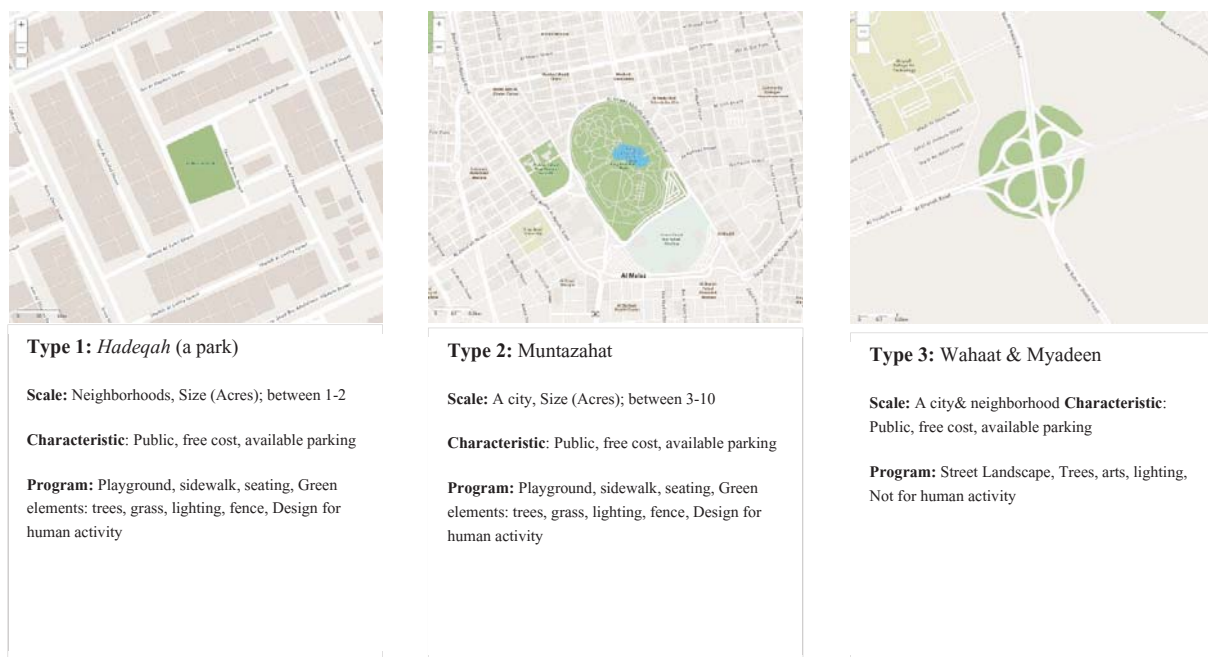


Fig. 1 Classification of PGS outdoor spaces for both usage and non-usage

Study Definition of PGS

We defined PGS as determinable public space, free, outdoor, and has been developed within the boundary of the selective neighborhood. PGS should be designed for human activity such as practicing physical activity or social gathering, not for roadway landscape. All spaces that fit this criterion will be identified as PGS for this study. Only the neighborhood parks, *Maumsha*, and *Sahat*, fall under our criteria. Many times, all three types have combined within a neighborhood park, for this reason, this study focused on only the neighborhood park (type 1), as the main PGS, see Fig. 1.

The study aims to measure and compare the availability and the distribution of PGS at a neighborhood scale, local comparison among Riyadh neighborhoods, regional comparison as compared to Dubai, and to WHO standard. Therefore, we developed a framework Fig. 2 for the following research questions:

1. Which neighborhoods have low and high coverage of PGS? (Quantity/Acreage)
2. Does socioeconomic status affect PGS distribution among Riyadh neighborhoods? (Quantity/Acreage)
3. Does the availability of PGS meet the minimum (WHO) standard per person? and (Dubai) city availability per

person?

II. MATERIALS AND METHODS

A. Study Area

The study was carried out in the city of Riyadh, the capital city of Saudi Arabia (Fig. 3). It located between longitudes 47320E and 37400E and latitudes 35150 N and 35350 N. Riyadh city is one of the largest cities in Saudi Arabia for both size and population. In the 2019 census by the Central Saudi General Authority for Statistics, Riyadh had a population of 6.500 million [15]. The city area size is 3115 km². Riyadh is subdivided into 18 municipalities and 208 neighborhoods. Each municipality includes several neighborhoods [14]. The neighborhoods range from traditional to modern design and from low, middle, to high income communities. Also, the neighborhoods have different size and population density.

B. Data and Methods

We used government authorities' websites to collect special and socioeconomic data. We first have depended on our early criteria for defining PGS ace. For this step, the Riyadh municipality website [16] and the Royal Commission for Riyadh City website [17] were used to help determine the

definition of “free cost, public spaces, private spaces, developed spaces.” These official websites show all types of PGS, size, name, location, and more information. Also, the website provides maps with data that helped us determine how to

categorize each green space. To conclude, we selected a neighborhood park to measure the availability level and then compare them among each other’s and to Dubai and WHO standards.

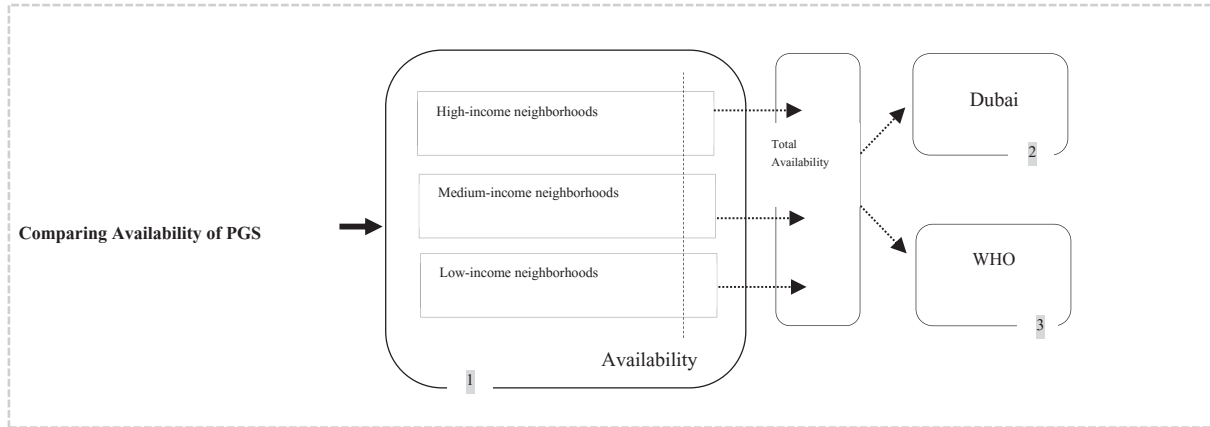


Fig. 2 Research framework

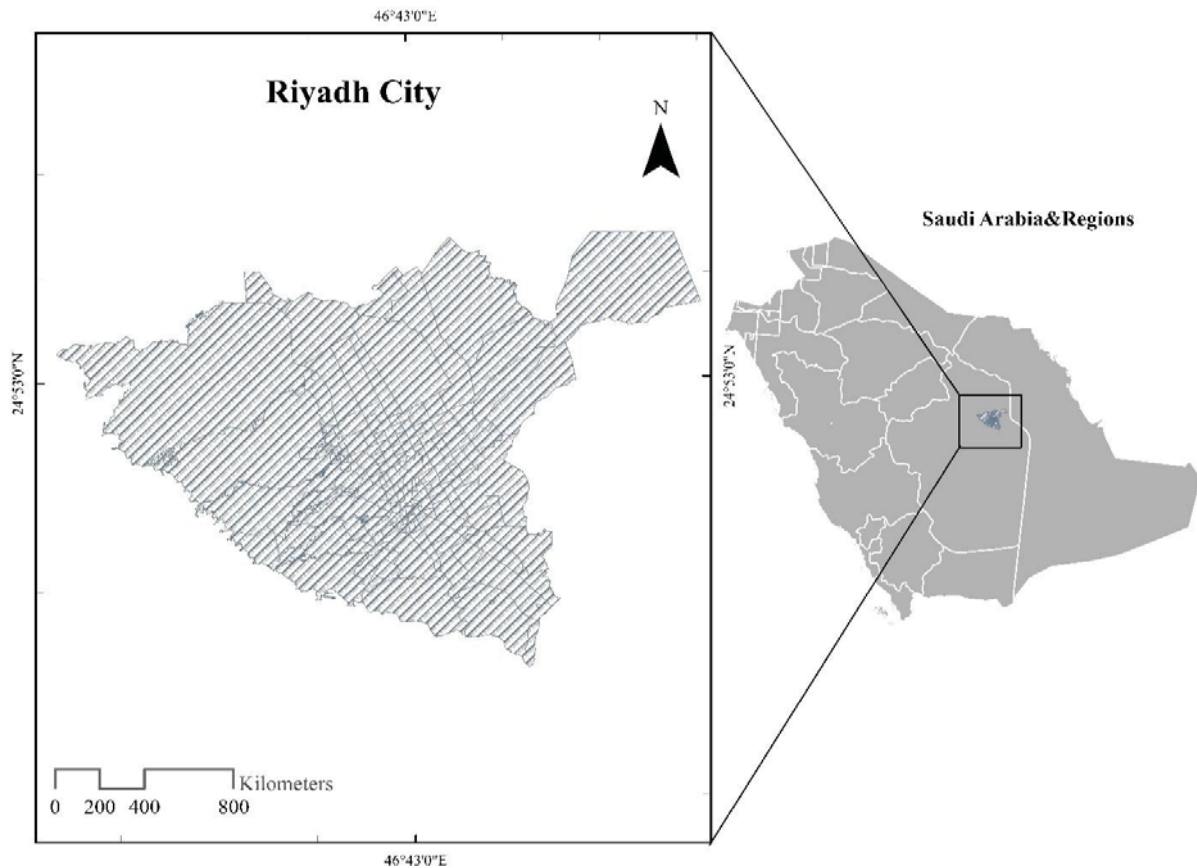


Fig. 3 Riyadh City

C. Neighborhoods Selection and Sampling

To the classified neighborhood groups, socioeconomic data are required. For this phase, *Zaad* helped us not only collect demographic data but also defined neighborhood boundaries. *Zadd* [18] is an official website under Human Resources Development Fund (Hadaf) that is designed to help users find

valid business and demographic data. Based on the median annual household income, Riyadh neighborhoods have been categorized into three neighborhood groups, (low-income neighborhoods, medium income neighborhoods, and high-income neighborhoods). Total neighborhoods for each group were 55 high income neighborhoods, 45 neighborhoods middle

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income, and 42 low-income. For this pilot study, 11 neighborhoods from each group were randomly selected. Total neighborhoods of all three groups were 33 neighborhoods as shown in Table I.

D. One-Way ANOVA Test and Post-Hoc Tukey HSD Test

The one-way ANOVA test is an interval level that applies to test for differences between categorical groups. To apply the

one-way ANOVA test, one independent variable is required (here: income status) with independent groups (high, middle, and low) and one dependent variable (here: Availability of PGS per Person_m²). The one-way ANOVA test can show if there a significant difference between the independent groups. We used one-way ANOVA to understand if there is a significant difference between Riyadh neighborhoods in relation to income level.



Fig. 4 Selective neighborhoods in Riyadh city based on socio-economic levels

TABLE I
 POPULATION AND SOCIOECONOMIC CHARACTERISTICS IN RIYADH

Socio-Economic Classes	Number of Neighborhoods	Average Annual Income (Riyal)	Area (m ²)	Population Average	Population density (average) (Persons/m ²)/11
High	11	123,927	50341.75	35,536.36	0.72
Median	11	98,400	57624.91	56,563.64	1.47
Low	11	47,564	28198.10	60,996.69	2

III. RESULTS AND DISCUSSION

This study's primary purpose was to measure PGS availability among Riyadh neighborhoods then compare the outcome results to WHO metrics and to a thriving local example of Dubai. Our analysis found that the availability of PGS among Riyadh neighborhoods is not distributed equally;

simultaneously, the total availability of PGS among all neighborhood classes did not meet the WHO standard, nor did it come close to the levels of PGS in Dubai.

A. Comparing to WHO and Dubai

Comparing our data to the WHO standard, we have found that the average total of all three type of selective neighborhoods (high, middle, low) are not meeting the WHO minimum standard of 9 m²PGS per person. Average availability of PGS Per Person was only 1.13 m² per person, which indicates that it is lower than the Dubai availability of 3.1 m² PGS per person and the WHO minimum.

B. Availability among Groups

The second purpose of the pilot study is to measure the spatial equity of the availability of PGS in relation to the

socioeconomic (income) status among Riyadh neighborhoods. It was found that the availability of PGS among Riyadh neighborhoods were not distributed equally. The Average Availability of PGS per-person among high income neighborhoods was 1.94 m² per person, while average availability of middle-income neighborhoods was 1.08 m² per person, and average availability of PGS among low-income neighborhoods was only 0.38 m² per person.

TABLE II
AVERAGE AVAILABILITY OF PGS PER PERSON OF RIYADH SELECTED NEIGHBORHOODS COMPARING TO WHO STANDARD AND DUBAI AVAILABILITY OF PGS

	Average Availability of PGS Per Person	WHO	Dubai
Riyadh (Low, Median, High) Neighborhoods Average availability of PGS per person	1.13 ²	9 m ²	3.1 m ²

TABLE III
THE AVAILABILITY OF THE PGS PER PERSON AMONG LOW, MIDDLE, AND HIGH NEIGHBORHOODS IN RIYADH

Neighborhoods class	PGS_ Per Person
Low-income Neighborhoods	0.38
Median income Neighborhoods	1.08
High income Neighborhoods	1.94

C. One-Way ANOVA Test and Post-Hoc Tukey HSD Test

After having determined the available levels of PGS among the three socioeconomic categories, we analyzed the data to answer the second question regarding the availability level of

PGS and if there is a significance difference of availability of PGS per person among Riyadh neighborhoods. It was found that there is a statistically significant difference between the three socioeconomic groups (low income, medium income, high income).

There was a significant between the three socioeconomic groups (high, middle, and low income) of the amount of availability of PGS per person among Riyadh neighborhoods at the $p < .05$ level for the three conditions [F (2, 12) = 4.03, $p = 0.028$]. Post hoc test comparisons using the Tukey HSD test indicated that the mean score for the high-income neighborhoods (M = 4.20, SD = 1.30) was significantly different than the low-income neighborhoods (M = .38, SD = .42), see Table IV. One-Way ANOVA test showed the significant difference of availability of PGS per person among Riyadh neighborhoods.

TABLE IV
RESULT OF ONE-WAY ANOVA TEST TO MEASURE THE SIGNIFICANT DIFFERENCE OF AVAILABILITY OF PGS PER PERSON AMONG RIYADH NEIGHBORHOODS

ANOVA					
Public_Green_Space_per_Person_m ²					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	13.531	2	6.765	4.032	.028
Within Groups	50.338	30	1.678		
Total	63.869	32			

TABLE V
POST-HOC TUKEY HSD TEST

Descriptive								
Public_Green_Space_per_Person_m ²								
	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
High income	11	1.9499	1.91906	.57862	.6607	3.2392	.30	6.35
Middle income	11	1.0815	1.08122	.32600	.3552	1.8079	.08	4.04
Low income	11	.3845	.42663	.12863	.0979	.6712	.00	1.20
Total	33	1.1387	1.41277	.24593	.6377	1.6396	.00	6.35

IV. CONCLUSIONS

This study fills part of the significant gap in the urban planning studies in Riyadh. The study quantifies and explores the availability of PGS at among Riyadh neighborhood scale. Furthermore, it compares the outcomes of the availability of PGS to different standards using public health standard recommended by the WHO and to one of the Middle East, Dubai to compare. The study measured the availability of PGS using socioeconomic factors to underscore to the importance of the environmental justice issue of equity of spaces that affect overall satisfaction and community health.

Although this study compared a small sample size of only 33 neighborhoods in Riyadh city, it can be helpful to increase the attention to policy and decision makers to distribute recreation spaces equally and be prepared to provide more or differently to those who with adverse conditions such as health issues in low-income communities.

We suggest some recommendations to conclude this study as follows. First, all Riyadh neighborhoods, regardless of class, need to increase the availability rate of PGS, and, more importantly, start improving PGS for those who need it first. Second, analyzing the level of availability of PGS without considering the level of accessibility cannot be successful. For example, walking distance is a critical element that needs to be considered as a marker of a successful recreation space. Kids and older people are the most important age groups needing access these spaces easily and safely, but the level of accessibility may be a barrier to these groups using PGS. Some studies suggested [1], [2] that the average walking distance is between 150-300 meters. Third, the park design quality can influence people to increase the frequency and duration of their visit; for this reason, it is essential to give enough attention to the design aspect.

Future studies can measure the accessibility factor in general

or select specific public spaces for a fine grain analysis. For example, Wadi Hanifah is a public green area under the construction phase; it may be interesting to measure the accessibility to this public area that will become the most attractive green area for Riyadh communities.

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