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EDITED AND REVIEWED BY
Victor L. Barradas,
National Autonomous University of
Mexico, Mexico

*CORRESPONDENCE
Ayman Mohamed Mostafa
✉ amyossef@uqu.edu.sa

RECEIVED 09 December 2024

ACCEPTED 21 March 2025

PUBLISHED 03 April 2025

CITATION

Mostafa AM and Alshahrani A (2025)
Corrigendum: Humanizing sustainable
development through green spaces: a case
study of Saudi cities.
Front. Sustain. Cities 7:1542464.
doi: 10.3389/frsc.2025.1542464

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Corrigendum: Humanizing sustainable development through green spaces: a case study of Saudi cities

Ayman Mohamed Mostafa^{1*} and Adnan Alshahrani²

¹Two Holy Mosques Institute for Hajj and Umrah Research, Umm Al-Qura University, Makkah, Saudi Arabia, ²College of Engineering and Architecture, Umm Al-Qura University, Makkah, Saudi Arabia

KEYWORDS

humanization of urban spaces, sustainable development, Saudi cities, urban green infrastructure, environmental quality, quality of life

A Corrigendum on

Humanizing sustainable development through green spaces: a case study of Saudi cities

by Mostafa, A. M., and Alshahrani, A. (2024). *Front. Sustain. Cities* 6:1416983.
doi: 10.3389/frsc.2024.1416983

In the published article, there were several errors. All references to the World Health Organization's (WHO) minimum standard indicator of 9 m² green space per person have been removed due to the absence of an official publication, despite its academic recognition.

A correction has been made to the **Abstract**. This previously stated:

"This research investigates the role of urban green spaces in raising the quality of life and achieving sustainable development in Saudi cities, particularly under desert conditions. A quantitative approach was adopted, and data were collected from municipal records and demographic statistics with an emphasis on public green areas such as parks and gardens. The analysis was based on widely cited international standards for green space availability and the City Prosperity Index to evaluate the role of green spaces in improving quality of life and achieving sustainable development. The results showed a disparity in the per capita share of green spaces across Saudi cities, with the Northern Borders region having 21.08 m² per capita, while Jeddah recorded only 3.21 m² per capita. These results underline the critical role of green spaces in safeguarding public health, fostering social cohesion, and building climate resilience. It places a focus on programs like the Saudi Green Initiative and the Humanization of Neighborhoods in their ability to meet challenges by, for example, using plant species that are drought resistant and enhancing urban greening methodologies. The paper closes with recommendations to increase the intensity of green spaces, ensure equitable distribution, and raise public awareness of the ecological and social benefits of green infrastructure."

The corrected sentence appears below:

"This research examines the significance of green areas in urban communities in contributing to quality of life and fostering sustainable development for Saudi cities, specifically desert cities. The quantitative method was adopted relying on municipal records and population data, specifically for public green areas such as parks and gardens.

The analysis was conducted with reference to the City Prosperity Index (CPI) to ascertain the role of green spaces in urban livability and sustainability. The results revealed enormous disparities in per capita green space provision across Saudi cities. While the Northern Borders region contributed 21.08 m² per capita, Jeddah contributed only 3.21 m² per capita. This observation stresses the immediate necessity to maximize urban greenery to augment quality of life and urban resilience. The results stress the vital importance of green spaces in advancing public health, supporting social cohesion, and promoting climate resilience. Moreover, the research highlights the importance of governmental programs, including the Saudi Green Initiative and the Humanization of Neighborhoods Initiative, that tend to solve these issues by promoting the use of drought tolerant plants and enhancing urban greening. The report ultimately presents key suggestions, including optimizing green space density, encouraging fair distribution, and raising people's appreciation of the environmental and social values of green infrastructure. These actions must be taken to foster sustainable urban development and enhance the overall well-being of urban residents."

A correction has been made to the **Introduction**, paragraph 4. This paragraph previously stated:

"A study reveals that Saudi Arabia, particularly in cities like Riyadh, Jeddah, and Tabuk, is undergoing rapid urbanization, which has led to significant gaps in green space provision compared to international standards such as those set by the World Health Organization (WHO). Most Saudi cities fall below the WHO's minimum standard of 9 m² per person, emphasizing the urgent need for increased green spaces to enhance quality of life and boost urban resilience (Addas, 2022; Metwally and Ibrahim, 2022)."

The corrected paragraph appears below:

"A study reveals that Saudi Arabia, particularly in cities like Riyadh, Jeddah, and Tabuk, is undergoing rapid urbanization, which has led to significant challenges in the availability of green spaces. Research indicates that many cities across the country have lower per capita green space compared to global trends, emphasizing the urgent need to expand urban greenery to improve quality of life and enhance resilience against environmental changes (Addas, 2022; Metwally and Ibrahim, 2022)."

A correction has been made to the **Materials and methods**, paragraph 2. This paragraph previously stated:

"After getting the total area of green space, it was divided by the population in order to determine how much green space each municipality has *per capita*. Such a calculation method is aligned with the advice of Metwally and Ibrahim (2022), who, similarly, underscored that comparing *per capita* green space to international benchmarks —9 m²/person as recommended by the World Health Organization (WHO), and 15 m²/person as required in the City Prosperity Index (CPI). This facilitates benchmarking Saudi municipalities' performance against not only international but also national benchmarks. The products showed that there were 301 municipalities with green space deficits and 93 ones with surpluses. The results of this analysis are in line with the Alajlan and Alreshaidi (2022) study that suggested a complex relationship exists between economic growth, urbanization, and environmental degradation, which makes it essential to consider sustainable urban planning and expansion of green space."

The paragraph has been split into two. The corrected paragraphs appear below:

"The total area of green spaces in each municipality was divided by the *respective population* to calculate *per capita green space availability*. To evaluate the adequacy of green space distribution, the study references the *City Prosperity Index (CPI)*, developed by *UN-Habitat*, which recommends a minimum of 15 m² per person as a benchmark for sustainable urban environments and improved quality of life (UN Habitat, 2016). This benchmark serves as a comparative reference for assessing how Saudi municipalities align with internationally recognized urban sustainability targets.

The collected data were analyzed to identify *patterns in green space distribution* and examine variations across municipalities. The study aims to provide *insights into disparities in green space allocation*, supporting a deeper understanding of the relationship between urban planning strategies and green infrastructure development."

The subsection *The World Health Organization*, appearing under the section **Materials and methods**, has been deleted. This section previously stated:

"The World Health Organization

The World Health Organization (WHO) has acknowledged the significance of green spaces in urban planning for fostering health and well-being at various life stages. The WHO has established a minimum requirement of 9 m² of urban green space (UGS) per person, which is not fulfilled in certain cities. This suggests a need for greater investment in urban greening initiatives (Prospects et al., 2012; Russo and Cirella, 2018)."

As a result, the following entries have been deleted from the Reference list:

"Prospects, W. U., Nations, U., Nations, U., and Settlements, H. (2012). Health indicators of sustainable cities in the context of the Rio + 20 UN conference on sustainable development key messages: May 17–18."

"Russo, A., and Cirella, G. T. (2018). Modern compact cities: how much greenery do we need? *Int. J. Environ. Res. Public Health* 15. doi: 10.3390/ijerph15102180"

A correction has been made to the **Results and discussion**, paragraphs 6–8. These paragraphs have been deleted. They previously stated:

"Najran Municipality barely satisfies the WHO standard but falls short of the CPI benchmark, implying a moderate impact on urban prosperity stemming from its abundant green spaces.

Most municipalities in Saudi Arabia meet the minimum standard for green space per capita set by the World Health Organization (WHO). However, some municipalities fall below this standard of 9 m² per person. The graph illustrates the current average per capita standard. The *x*-axis represents the different municipalities, while the *y*-axis indicates the amount of green area per person. Jizan Municipality has the highest average, with 7.2 m² of green space *per capita*. Conversely, Hail Municipality has the lowest average, with only 0.4 m² of green space per person.

In sum, this graph shows large differences in green *per capita* among municipalities in Saudi Arabia. From the data itself, it shows that Jizan Municipality has the highest average green space *per capita* at 17.61/cap while Riyadh and Tabuk municipalities are tied at 0.18/cap. These results are consistent with a study conducted by

Addas (2022), indicating the scarcity in green spaces in large cities like Jeddah, and another by Metwally and Ibrahim (2022), listing similar obstacles for Riyadh. Nearly all Saudi municipalities are below the World Health Organization (WHO) minimum standard of 9 m² per person, highlighting the urgent need to increase green space provision to meet these benchmarks and exceed basic standards that can enhance quality of life.”

A correction has been made to the **Conclusion**, subsection *Assessment of green spaces in Saudi Arabia*. This paragraph previously stated:

“Comparing the provision of green spaces in Saudi Arabian municipalities with international standards highlights the need for significant improvements. Meeting the minimum requirement established by the World Health Organization (WHO) is crucial, but striving for higher standards is even more important. By enhancing the quality and distribution of green spaces, Saudi cities can improve their urban environments and boost the well-being and prosperity of their residents.”

The corrected paragraph appears below:

“Comparing the provision of green spaces in Saudi Arabian municipalities with international benchmarks underscores the need for substantial improvements. While aligning with globally recognized sustainability targets is essential, striving for even higher standards remains a priority. By enhancing the quality

and equitable distribution of green spaces, Saudi cities can foster healthier urban environments, elevate overall well-being, and contribute to long-term urban prosperity.”

Figure 4 has been removed from the published article as it provided a comparison with the WHO indicator. The subsequent Figure 5 has been renumbered as Figure 4. The original Figure 4 and its caption appear below.

In the published article, there was an error in Table 1 as published, which again referenced the WHO indicator. The corrected Table 1 and its caption appear below.

The authors apologize for these errors and state that they do not change the scientific conclusions of the article in any way. The original article has been updated.

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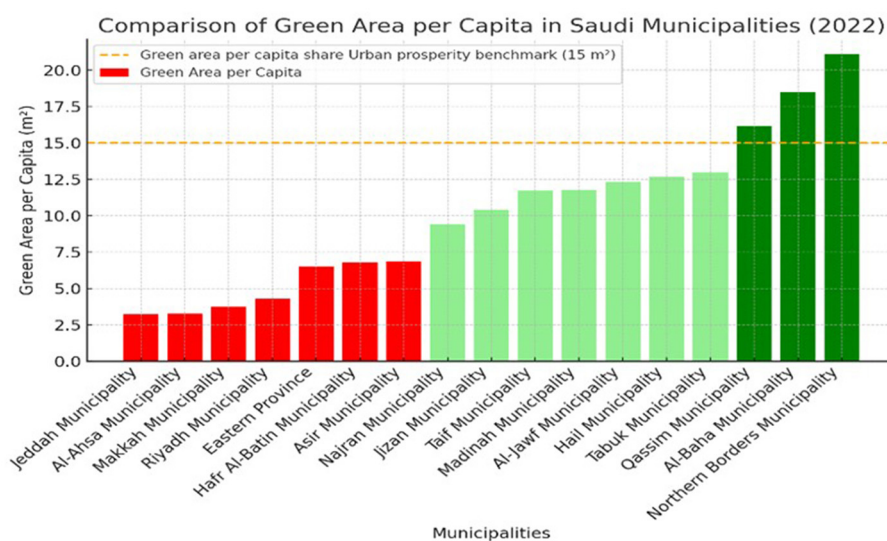


FIGURE 4

Comparison of the current average *per capita* share of green areas in the municipalities of Saudi Arabia in 2022 with the standard of the urban prosperity index.

TABLE 1 Assessment of green area distribution in Saudi Arabian municipalities 2022.

Municipality	Green area	The need for the CPI benchmark (15m ²)	CPI benchmark 15 m ²	Green area per capita	Population	Scale of urban prosperity	
Jeddah Municipality	12,058,198	−11.7859	15	3.214062	3,751,700	21.43%	Under moderate
Al-Ahsa Municipality	3,627,305	−11.7152	15	3.284808	1,104,267	21.90%	
Makkah Municipality	10,716,711	−11.2476	15	3.752415	2,855,950	25.02%	
Riyadh Municipality	37,041,229	−10.6887	15	4.311256	8,591,748	28.74%	
Eastern Province Municipality	23,220,719	−8.46628	15	6.533722	3,553,980	43.56%	
Al-Hafar Batin Municipality	3,161,402	−8.2305	15	6.769496	467,007	45.13%	
Asir Municipality	13,851,366	−8.1574	15	6.842597	2,024,285	45.62%	
Najran Municipality	5,557,909	−5.6164	15	9.383605	592,300	62.56%	Moderate
Jizan Municipality	14,619,155	−4.59489	15	10.40511	1,404,997	69.37%	Strong factors
Taif Municipality	16,552,071	−3.2926	15	11.7074	1,413,813	78.05%	
Madinah Municipality	25,204,428	−3.21112	15	11.78888	2,137,983	78.59%	Very strong factors
Al-Jawf Municipality	7,322,529	−2.71021	15	12.28979	595,822	81.93%	
Hail Municipality	9,482,310	−2.29604	15	12.70396	746,406	84.69%	
Tabuk Municipality	11,497,247	−2.02395	15	12.97605	886,036	86.51%	
Qassim Municipality	21,616,943	1.178179	15	16.17818	1,336,179	107.85%	
Al-Baha Municipality	6,271,534	3.49061	15	18.49061	339,174	123.27%	
Northern Borders Municipality	7,877,825	6.087554	15	21.08755	373,577	140.58%	

Source: Cols. 1, 2 from the Ministry of Municipal and Rural Affairs. Cols. 3, 5, 7 from the authors. Col. 4 from CPI. Col. 6 from the General Authority for Statistics.