Green spaces in residential communities: the potential for ecological and health

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Abstract. Urban green spaces, involve gardens, vegetation cover and trees, contribute to ecosystem services. Green spaces enhance residents’ public health through promoting physical activities and psychological well-being particularly contributing in protecting people’s health from the negative effects caused by the coronavirus disease 2019 (COVID-19). The aim of the research is to examine the relationship between perceived green space and health with interaction of green space correlation and its socio-economic features. This paper investigates how the provision of green spaces and correlated features are associated with the improved residents’ health in residential areas. However, this association varies according to urban design quality. The analysis and its interpretation that include environmental and socio-economic variables suggest that green spaces play a vital role in benefiting residents’ health and providing more greening communities. Ecological factors include quality and access to green spaces that affect its uses for physical activities. Walking for recreational could explain the association between green space and general health. Urban designers and ecologists thus need to pay attention to greenery that can promote environmental sustainability.

Keywords: Green spaces, health, physical activity, housing, environmental sustainability.

1. Introduction

This paper investigates the association between urban green spaces in residential areas and the improved residents’ health. Urban green spaces create ecological cities where the built and the natural environment can be linked. Though, creating green spaces particularly in developing countries are ignored because of the pressure for spaces, resources and development. Green spaces contribute to a wide range of ecosystem services that improve urban space and enhance city inhabitants’ life, particularly their health and wellbeing. Such greenspaces are varied in size, plants cover, species richness, ecological quality, access to public transport, amenities, and services (1, 2). Public green spaces such as parks, river banks, plazas and greenways, community gardens, street trees, botanic gardens and natural areas, beside less conventional spaces such as green walls and green alleys. Added to the list are the private green spaces for example backyards and communal gardens of apartment housing (2, 3).

Ecosystem services offered by greenery can protect the public health of residents as well as support the environmental integrity of urban areas such as housing communities. Urban green spaces can be beneficial for the residents via [1] improving physical health; social and psychological well-being; and enhancing satisfaction with local environment, which hence develop quality of life for people [1]. [2] Exposure to green spaces might have an impact on urban socio-economic health inequalities, since it was found that inner city and poor populations tend to participate less in outdoor recreations activities [4]. For example, research in (2008) found that low-income households in less accessible neighbourhoods were less likely to take part in physical activity and less assisted by affordable services compared to wealthy residents that on the other hand are more likely to live in well accessible and proximity to facilities [5]. This indicates that green spaces are not equitably distributed because access to these spaces is often highly stratified in terms of income, age, gender and disability which is identified as an environmental injustice. In other words, unequal distribution of green spaces leads to cross-cultural
and socio-economic differences in their use [1][4]. [3] Ecological benefits provide conservation of nature and biodiversity where protect reproduction centre for species and preserve the plants; cool temperatures; reduce pollution by filtering air [6] and decrease noise depending on its design [7] that can protect from the risk of high blood pressure and heart diseases [8]. For example, greenery improves air circulation and provides shades. This in turn affects the cooling and assists in moderating air temperature [9]. However, such places cannot be of great contribution unless they meet the residents’ needs and preferences.

Thus, this research addresses the question of how the provision of green spaces and correlated features associate with improved residents’ health in urban area? This research question is in line with the argument that green spaces are beneficial for ecological sustainability (1).

2. Green space features and public health

Recent studies in (2011, 2014) have found evidence of the importance of green space for health and wellbeing with special emphasis on the relationship between access to urban parks and class and ethno-racial dimensions. However, the relationship between design features and public health benefits have been neglected [1][6]. Yet, research on urban green spaces and health has investigated provision of parks, green cover and lack of park access and have been linked to health protection [10][11] via affecting physical activity [12][13]. Furthermore, green spaces also provide opportunities for inhabitants to use the outdoors and connect with natural environment and others. For example, according to the review of Jennings et al (2016, 2019), the relationship between nature and health suggests that social connection is positively affected by the existence and quality of urban green spaces and thus this association identifies as a key for natural environment that contribute to health promotion [14][15]. Additionally, a number of studies examine connections between urban park proximity and physical activity [16-19]. the presence of greenery and social bonds in urban areas in turn meaningfully contributes to perceived safety of residents but most of the literature on the psychological effects of green spaces have tended to be qualitative and often considered socioeconomic variables [4]. Thus, there is a lack of robust investigation for the importance of health and green space as a physical character of built environment. This might be due to the inherent difficulties in undertaking quantitative measures of green space impacts.

In addition, physical activity in green spaces is found to have significant role in psychological health. For example, a multi-study analyses conducted in UK and the Netherlands (2010, 2009) showed there is an important impact of green space on several measures of psychological health. Accordingly, meta-analysis suggested that the development of the use of green exercise as a therapeutic measure should be given more attention and architects of urban designer and planners should develop access to green spaces [20][21].

Moreover, it has been suggested that residents with more green space within their housing area were less influenced by life stress as compared to residents in a low green space access [22]. Therefore, ecosystem services provision via urban nature are a significant aspect of a high-quality living environment [23]. This suggests in turn physical features correlated to green spaces including: (1) adequate recreation areas; (2) good accessibility; (3) environmental diversity; (4) services; (5) quality and attractiveness ; (6) availability of space; and (7) connectivity and walkability [1][4][24-29]. Safety is also identified as a vital character of green space (30). Surveys stated a strong connection between perception of safety and physical activity levels. For example, safety is found as concern for children, young people and women, which particularly linked to levels of walking [25][26]. Hence, a well accessible recreational services and quality recreational environment are important for public health since people can be more attractive, mainly for disabled and elderly [24]. Figure 1 shows the relationship between green space and health.
2.1. Data collection
Quantitative methodology is used to collect data and analysis in 2019-2020. First, residents were invited to fill the online survey instrument residents’ experiences in relation to the use of open green spaces in their neighbourhoods. The online form was posted via social media such as (Facebook and Twitter) and invitation was sent to participants. Second, face-to-face survey was conducted parallel used the same instrument, with residents recruited from the open green spaces in various neighbourhoods. Those who met the eligibility criteria in terms of age between 20 and 69 years, and able for walking without assistance. Participants were answered survey involving questions related to health status, their perception of greenery and factors associated with health and green space including: walking for recreation and transport, access to green space, frequency of visit, safety and sociodemographic features: gender; length of residence; age; employment; education; and income. Thus, 237 completed questionnaires were received from Karkh and Rusafa districts in Baghdad; 53.8 % of responses were from Rusafa and 46.2 % from Karkh. The overall gender distribution was discrepancy with 47.7% men, 52.3% women. The respondents ages were varied, with 86% of residents in the age range of 21–55, and 14% in age range of 56–65.

2.2. Measures and instruments
The result of this study were contributors’ ratings of their perceived health and perception of green spaces and correlated factors.

Health status measure is frequently used consisting of a single item enquiring participant to rate their general health as ‘excellent; very good; good; fair; and poor [31]. On the other hand, physical health measured according to how much of the time that physical activity interfered with the social activities such as visiting of friends. So, the participants rate their physical health as ‘all of time; most of the time; some of the time; a little of time; none of the time [32]. The average scores for the 2 measures are separately considered in the analyses the relationship between the variables.

To identify the perceived green spaces of a neighbourhood, ten questions from the established scale comprising physical features items. Positive items refer to usability and availability of city green areas for recreation, social contacts and child playgrounds, for example (there are enough green areas; and there are green areas for relaxing, green areas are in good condition, and the green areas are well-equipped). Negative items related to the lack of neighbourhood’s green areas such as (there is no park where children can play freely; and going to a park means travelling to other parts of the city, and Many green areas are disappearing) [33]. So, the participants were asked to respond to the ten questions on a five-point scale ranging from ‘strongly agree (score 1) to ‘strongly disagree’ (score 5). Safety is also ranked using Likert scale five -point scale.

To assess outdoor physical activity, the amount of walking for recreation and for transport were measured adopting the related items from the form of international physical activity questionnaire [34].
Respondents were asked to record the frequency by minutes of both types of walking. The average daily time (minutes/day) of each category of walking was calculated and analysed related to socio-economic features and green spaces data. Access to green spaces is measured via walking distance with above and below (10-15) minutes of travelling time. Frequency of visit is also measured via number of recreation spaces visit [25]. Table 1 presents the indicators of the urban green spaces and correlated features affecting health.

**Table 1.** The indicators of the urban green spaces and correlated features affecting health

| Variables               | Independent variables | Indicators                                      |
|-------------------------|-----------------------|-------------------------------------------------|
| Socio-economic variables| Gender                | Length of residence                              |
|                         | Age                   | Income                                           |
|                         | Level of education    | Employment                                       |
| Green space             | Usability and availability | Quality (Vegetation, greenness and Aesthetic) |
|                         | Size                  | Condition (maintenance)                          |
|                         | Facilities            | Safety                                          |
| Correlated features     | Walking for recreation | Walking for transport                           |
|                         | Access to green space | Frequency of visit                               |

3. **Data analyses and results**

This study hypothesised that green spaces affect health in urban areas associate with socio-economic variables, this relationship is analyzed for the urban area. Table 2 shows the descriptive data of socio-economic features.

The results are described in two sections: correlation with social-economic and health items, and hierarchical regression analysis.

3.1. **Correlations of health, green spaces and socio-economic variables**

Correlation analyses were used to examine how participants’ socio-economic variables and green spaces relate to health. The results showed that three socio-economic variables: age ($r = 0.12$, $p < 0.01$), income ($r = 0.15$, $p < 0.01$) employment; ($r = 0.1$, $p < 0.01$) have positive significant correlation with health, while safety and education; have negative significant correlation with health ($r = -0.27$, $p < 0.000$) and ($r = -0.17$, $p < 0.001$) respectively.

On the other hand, health has a number of positive correlations with the green space ($r = 0.23$, $p < 0.000$), walking to recreation ($r = 0.2$, $p < 0.000$) and walking for transport ($r = 0.3$, $p < 0.000$), frequency of visit ($r = 0.3$, $p < 0.000$), and access to green space ($r = 0.2$, $p < 0.001$). Other variables: gender; length of residence have no significant correlation with health. Only variables significant in correlation analyses at the ($p$-value $< 0.01$) level were considered for inclusion in the hierarchical regression analyses. Results also confirmed the association between green space and (walking to recreation and walking for transport, frequency of visit and access to green space) with $p$-value $< 0.000$. 


3.2. Regression model for predicting general health from green space and related factors

Hierarchical multiple regression was conducted to analyse the influence on health of green space and related factors. Table 3 illustrates the linear regression analyses predicting the chances of having a high level of health. In the first model which is unadjusted, included perceived green space as a single predictor. This model contributed significantly to the regression $F = 22.1$, $p < 0.000$ and accounted for 8.6% of the variance in perceived health. The second step, socio-economic controlled variables (age, income, employment and education level) were entered and the level of association did not change significantly after controlling socio-economic variables in perceived health. In the final step, green space features and correlated health factors were added (safety, walking for recreation and for transport, access to green space and frequency of visit), to investigate whether they mediate the effect of green spaces on health. The total variance increasing explanation of the whole sample at 18.5%. The five adjusted measures explained an additional 10.6% of the variance in health. After further adjusting (model 3), the association between green space and health was remained statistically significant recording $F = 14.1$, $p < .000$. In this model also, walking for recreation; access to green space; frequency of visit and safety were significant predictors but walking for transport was not associated with health. Only education from the socio-economic variables was predictor of the total sample, whereas age and employment were not significant predictors.

Table 2: The socio-economic features of respondents in two districts

| Socio-economic feature                  | Karkh            | Rusafa           |
|----------------------------------------|------------------|------------------|
| Percent                                | Mean (std. deviation) | Mean (std. deviation) |
| Male                                   | 47.7%            | 16.23 (2.12)     | 23.43 (2.13)     |
| Female                                 | 52.3%            | 15.45 (2.32)     | 24.17 (2.61)     |
| Age group                              |                  |                  |
| 20-30                                  | 43 (18.1%)       |                  |
| 31-40                                  | 71 (30 %)        |                  |
| 41-50                                  | 79 (33.3%)       |                  |
| 51-60                                  | 29 (12.2%)       |                  |
| 61-69                                  | 15 (6.3%)        |                  |
| Length of residence                    |                  |                  |
| ≤5 years                               | 2.43 (1.01)      | 2.33 (1.03)      |
| 5–10 years                             | (21.5%)          |                  |
| 11–20 years                            | (31.6%)          |                  |
| over 20 years                           | (29.1%)          |                  |
| Income                                 | 4.85 (1.8)       | 4.45 (1.76)      |
| Level of education                     |                  |                  |
| Less Secondary school                  | 2.9 (0.9)        | 2.58 (1.04)      |
| Secondary school                       | (3.4%)           |                  |
| College graduate                       | (30.4%)          |                  |
| University graduate or professional degree | (29.5%)     |                  |
| Employment                             | 1.42 (.49)       | 1.67 (7.8)       |
| employment                             | (67.8%)          |                  |
| unemployment                           | (32.2%)          |                  |
Table 3. Results of the hierarchical regression analyses; unstandardized coefficients (t-values in brackets), dependent variable: health status level

| Independent variables | Model 1 (unadjusted) | Model 2 (adjusted) | Model 3 (adjusted) |
|-----------------------|----------------------|--------------------|--------------------|
| Green space           | 0.363^ (6.714)       | .375^ (6.376)      | .358^ (6.287)      |
| Age                   | n.s.                 | n.s.               | n.s.               |
| Income                | n.s.                 | n.s.               | n.s.               |
| Employment            | n.s.                 | n.s.               | n.s.               |
| Education level       | - .298^ (-3.234)     | - .264^ (-2.647)   |                    |
| Safety                | .242^ (2.133)        |                    |                    |
| Walking for recreation| .322^ (4.234)        |                    |                    |
| Walking for transport | n.s.                 |                    |                    |
| Access to green space | -.496^ (-2.044)      |                    |                    |
| Frequency of visit    | -.799^ (3.268)       |                    |                    |

n.s. = not significant.
^p<.000,  ^p<.00.
(Adjusted for age, income, employment, education level).
(Adjusted for age, income, employment, education level, walking for recreation and transport, safety, access to green space and frequency of visit)

3.3. Regression model for predicting physical health from green space and related factors
Hierarchical multiple regression was conducted to analyse the influence on physical health of green space and related factors. Table 4 shows the linear regression analyses predicting the odds of physical health level. In the unadjusted first model, perceived green space included as a single predictor and contributed significantly to the regression F = 21.5, p < 0.000 and accounted for 7.7 % of the variance in perceived physical health. Socio-economic controlled variables (age, income, employment and education level) were entered in the second model and the level of association did not change significantly after controlling socio-economic variables. In the final model, the features linked to green space and physical health were included (safety, walking for recreation and for transport, access to green space and frequency of visit), to investigate whether they mediate the effect of green spaces on physical health. The total variance increasing explanation of the whole sample at 15.5%. The five adjusted measures explained an additional 9.8 % of the variance in physical health. The association between green space and physical health was continued statistically significant with F = 12.3, p < .000. In the final model, walking for recreation; access to green space; frequency of visit and safety were significantly impacted health but walking for transport was not associated with physical health. The socio-economic variables were not predictor of the total sample.

Table 4. Results of the hierarchical regression analyses; unstandardized coefficients (t-values in brackets), dependent variable: physical health level

| Independent variables | Model 1 (unadjusted) | Model 2 (adjusted) | Model 3 (adjusted) |
|-----------------------|----------------------|--------------------|--------------------|
| Green space           | 0.373^ (6.321)       | .375^ (6.376)      | .358^ (6.287)      |
| Age                   | n.s.                 | n.s.               | n.s.               |
| Income                | n.s.                 | n.s.               | n.s.               |
| Employment            | n.s.                 | n.s.               | n.s.               |
| Education level       | -.254^ (-2.879)      | -.248^ (-2.378)    |                    |
| Safety                | .234^ (2.674)        |                    |                    |
| Walking for recreation| .384^ (4.464)        |                    |                    |
| Walking for transport | n.s.                 |                    |                    |
| Access to green space | -.386^ (-2.230)      |                    |                    |
| Frequency of visit    | .489^ (3.328)        |                    |                    |

n.s. = not significant.
^p<.000,  ^p<.00.
(Adjusted for age, income, employment, education level).
(Adjusted for age, income, employment, education level, walking for recreation and transport, safety, access to green space and frequency of visit)
4. Discussion
The aim of this research was to examine the relationship between perceived green space and its health benefits and the interaction of green space with and socio-economic features. The study found that health is influenced by the perception of the green space in terms of quality, availability and usability. Significant positive correlations were found between green spaces quality and provision and residents health. Green space and correlated factors: safety, walking for recreation and for transport, access to green space and frequency of visit were also found as significant predictors. Such findings are congruent with ‘Sugiyama, 2008’ who suggesting that greenery improves health, which is frequently connected with safe, pedestrian friendly and walkable neighbourhood [29]. The study supports the findings of Sugiyama, 2008’ and ‘Lee 2011’, who suggested that green spaces are linked with people’ perceptions of health. However, socio-economic variables showed less significant in relation to health [4][29].

The Association between green space and health was investigated using a linear regression model. The study explored the interaction between green space after adjusting for the socio-economic variables and green space features. The strength of the relationship of the green space and health was continued and remained highly significant even with adjusted features. On the other hand, the results indicated that the association between green areas and health was not facilitated by walking for transport. The findings stated that safety was an important factor for improving health since safe place encourages more people to use the green space and hence improves physical activity and general health, which is in contrast with recent research by (Wang, 2019) representing that there was no significant association between safety and the physical activity [35].

While previous research examined the link between green space and health [13][21], this study precisely focused on green spaces qualities, provision and correlated features that associated with health. The study also suggests that perception of the green space environment found to be positive predictor of general health. This is consistent with research showed that people who live in green environments have better health and well-being [13][29].

The results suggest that green spaces with good access are important determinants of physical health. Indeed, the regression models showed that residents live in greener area within walking distance are likely to use spaces for physical activity. This finding is in line with research presenting that easily accessible and adjacent green areas contribute to outdoor recreation and conducive to improved public health [22][24]. Green neighbourhoods also can be a powerful instrument to promote physical health of people for example, walking in green areas encourage physical activities [1][12][35].

The relationship between green environments in neighbourhoods and walking was previously investigated but this present study provides evidence that perceived green space contributed to perceived general health in housing communities. Recreational walking, safety, access to greenery and frequency of visit appeared to clarify the association between green space and health, whereas the connection between green space and health was not impacted by walking to transport. However, the impacts of green environments might be involved in the residual relationship of the later connection. Accordingly, the findings suggest that residents living in walking environments associated with green spaces are significantly seemed to be more physically active than people living within beyond walking distance.

This study suggests that an importance of the sustainable environment in urban area is reinforced by the significant association between provision and quality of greener and health. This a relationship reflects the deficiency of green space in the residential communities of this study, where greenery is frequently neglected on the list of the priorities of urban designers and developers. Accordingly, considering ecological strategies not only contribute to health but if urban densification can be addressed, this could create vital sustainable communities.

There are limitations to this study. Most noteworthy are the influences on health not measured due to the empirical limits of the study, for example, environmental justice, traffic density, income deprivation and crime rate (1, 13, 36) other psycho-social factors, mainly social coherence and interaction [29] that would also be worth examining how these factors influence psychological and physical health. Although the study adopted established scale with valid and reliable measures, another limitation of the study is the dependence of self-report measures for green spaces and correlated features.
Thus, future research may add objective scale of green space via remote sensing data. However, recent studies have stated that perceptions of the green environments were strongly associated with physical health than objective measure, reporting that the significance of people perception of their green spaces should therefore be considered [13][22][29].

5. Conclusion
This research sought to determine how provision of green space and correlated features associate with better residents’ health. Although previous research has mostly been investigated the connection between green space and health in developed countries, their findings cannot merely be adopted to the eastern developing contexts, where urban green space and health level are comparatively different. This research has mainly focused on investigating the relationship between green space and public health and found that green space quality and associated factors are strongly impacted health.

The study provides clear evidence that controlling of socioeconomic factors, cannot reduce the impact of availability of greenery areas that were the most robust predictor of general and physical health.

Also, recreational walking, easy access, frequency of visit and safety strongly contributed to health. This supports the case for the significant of these features linked to availability of green space and health. The findings indicate that accessible and attractive green space encourage physical activity and reduce stress life, which are vigorous to better health and suggest that urban areas need to ensure satisfactory and healthy environments for residents to live in. Moreover, green space quality and physical features increase visiting rates, and then contribute to enhancing general health level. However, urban environments have recently experienced a decline in the quality and quantity of the green space and poor accessible. Due to the growth of urban densification, more residents may be faced to live in housing environments with lack of green resources. Thus, urban designers and ecologists need to consider that provision of green space and qualities should be prioritised in the urban green space policy to ensure guidance for design procedures of green spaces.

Although this research may offer some insights into the issue, yet further study needs to consider urban blue spaces to examine the interchanges between greenness and blue spaces and greenery correlated variables focusing on green space preferences for health improved. In addition, the type of activities in green spaces can be included in investigating the connection with public health.

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