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Rethinking urban density, vitality and healthy environment in the post-pandemic city: The case of Istanbul

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ABSTRACT
The present study aims to examine the relationship between urban vitality, healthy environment and density through the city of Istanbul, which is going through the Covid-19 outbreak. In this context, an online survey was conducted to measure the assessments of the residents living in districts with different density categories regarding the neighborhoods and the city they live in. The evaluations made by the citizens in the dimensions of vitality, mobility, safety, healthiness, cleanliness, orderliness were reduced to two main factors as “urban vitality” and “healthy environment” using Principal Components Analysis. Then, the evaluations regarding these six variables and two factors were subjected to cross-inquiries with the personal, residential and district characteristics. Urban residents were also asked to evaluate the city life before and after the Covid-19 outbreak. The main findings of the study reveal that there is a statistically significant difference between the density levels of the districts in terms of the perception of urban vitality and some sub-variables of healthy environment. Also, there is an observed change in the thoughts about urban life in Istanbul due to the outbreak.

1. Introduction

The content and dimensions of the concept of urban vitality have been one of the important and controversial issues of urban planning discipline since the day modern urbanism was born. Jane Jacobs, one of the names in the focus of this discussion, emphasizes the importance of density (human and building density), diversity (a mix of old and new buildings, mixed-use), interaction, and permeability while listing the characteristics of a well-functioning and vibrant city. According to Jacobs (1961), urban vitality is essential for a healthy urban environment, and safety can only be ensured through vibrant urban streets.

Jacobs encouraged dense neighborhoods for metropolitan cities that suffered from poor health conditions during her lifetime. On the other hand, according to Lewis Mumford, what Jacobs describes as ‘urban vitality’ is a negative form of life. Mumford (1962, 1970) calls life in metropolitan cities ‘vicarious vitality’. According to him, the vitality of the metropolitan city is fake; and it does not offer real socialization opportunities to people. Also, the increasing density in metropolitan cities turns into a pathological disease after reaching the ‘climax stage’. Based on this, Mumford argues that an overcrowded urban setting creates stress conditions.

Many theoretical and experimental studies have been carried out in favor of and against both perspectives. While the most important thing that both approaches encourage is a healthy and vibrant urban environment, the first view argues that even in metropolitan cities and high densities, healthy urban environment and vitality can be ensured by certain principles, while the second view argues that these features disappear as the density and crowd increase. The Covid-19 outbreak, which has influenced the whole world since the beginning of 2020, has resulted in the questioning of both perspectives and discussions on how planning and design principles should be in post-pandemic cities: Will the metropolitan cities provide a healthy and vibrant urban environment for people in the post-pandemic process? Did the Covid-19 outbreak change people’s ideas about urban density and urban life in metropolitan cities? Is the pandemic process a flare of megalopolis’ transformation into necropolis?

The aim of the present study is to question the relationship between urban vitality, healthy environment and density through the Istanbul metropolitan city, which is going through the Covid-19 outbreak. The study makes a significant contribution to the current literature and discussions on ‘urban density’ and ‘urban vitality’ in megacities, pioneered by Jane Jacobs and Lewis Mumford, from three aspects. Firstly, although there are several papers related to urban density and vitality, studies that evaluate or measure urban vitality based on citizen’s

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perceptions (Mouratidis & Poortinga, 2020; Zarin et al., 2015) are quite a few. Since the perceptions are directly related to how citizens experience urban space, an evaluation based on individual perceptions about urban vitality is expected to deepen density and vitality discussions in the post-pandemic era. Moreover, both Jane Jacobs and Lewis Mumford based their discussions of vitality on their own experiences in New York City. Measuring perceptions in different contexts and periods will also contribute to the Jacobs-Mumford debate in a similar axis. Secondly, studies relating urban density to the Covid-19 outbreak mostly focus on Covid-19 infection and mortality rates or vulnerability of cities rather than citizen’s perceptions on living in post-pandemic megacities. The present study is also original in terms of evaluating city life over the impact of the first phase of the Covid-19 outbreak on the perception of urban residents living in districts with different densities. Thirdly, Istanbul, which is a megacity with a population of more than 15 million, is one of the leading cities in the focus of planning discussions in the pandemic process, just as before the pandemic with its high population density, inadequate infrastructure, and poor fiscal autonomy and flexibility (Clark & Moonen, 2015; Paköz, 2020). In the research carried out by Clark and Moonen (2015) to measure whether the density of megacities is sustainable, the city of Istanbul, which is a generally congested, poorly planned, and rapidly growing city, was evaluated in the bad higher-density category typologically. Especially the Covid-19 pandemic caused to question of the structure and human density of the cities, and in this process, discussions on how to manage the urban population density for the city of Istanbul and other megacities have started (Paköz, 2020). The spread rate of the Covid-19 in the city, which is the epicenter of the outbreak in Turkey according to the Ministry of Health, is much higher than in other cities and rural settlements. Besides, the fact that Istanbul has not been studied before in terms of density and vitality relationship makes the present study valuable.

The first section following the introduction provides a conceptual framework about urban density and vitality issues, and touches upon current discussions related to density, vitality, healthy environment and the Covid-19 outbreak. The second section explains the methodology of the study by introducing the research design, outlining the statistical analysis, giving information about the study area and the survey respondents. The third section gives the main findings of the study with brief explanations. The last section discusses the findings by adding concluding remarks and recommendations for policymakers.

### 1.1. Urban vitality and density: theoretical background and literature review

Since we designed this research by focusing on the concepts of ‘urban vitality’, ‘density’ and ‘healthy environment’, we first briefly explain how these concepts are defined and evaluated in the literature. Vitality is simply a term that shows a system is alive. Since it is closely related to movement, it can be defined as “the amount of activity in the city” (Montgomery, 1998; Zarin et al., 2015). Lynch mentioned five criteria as vitality, sense, fit, access, and control, and two metacriteria to measure them as efficiency and justice while defining the good city form (Banan & Rapino, 2009). According to Maas (1984), as the city is a multi-dimensional and complicated system, urban vitality is also a complex and enigmatic phenomenon. Vitality is associated with the different dimensions of the city, with both physical and social aspects, and is seen as an important indicator of their success in urban public spaces, especially on the streets (Jalaladdini & Oktay, 2012). Urban vitality is made of various integrations and relationships between complicated elements in the city and its growth depends on how healthy these interactions are. For this reason, urban vitality criteria were developed as an assessment for the quality of urban life. These criteria encompass economic, cultural, social, physical, and every other characteristic of the city (Selezneva, 2011). Urban vitality criteria indicate that the city is “alive” and there’s a healthy interplay between various elements of the city. In order to realize vitality, there’s a need for spatially applicable parameters and stimulators.

Density can be defined as “the amount of quantity per unit area” in urban studies, borrowing from physics. The numerator (unit area) in this definition can be people, buildings, dwellings, activities, and the denominator (quantity) can be different units of land measurement such as acre, hectare, square mile, and square kilometer. As seen, density does not have a single and precise definition and measurement accepted (Chuchman, 1999; Dovey & Pafolk, 2014). Different assumptions in density measurements also make it impossible to draw a clear outline of what the boundaries of high and low density are. Therefore, the density levels considered to be ‘high’ differ for each case.

In density measurements, net and gross density can be used according to the boundaries, scope and scale of the study area. While net density, which includes only residential areas/private lands, is used as a control tool in planning, the experience of urban space is mostly associated with gross density including public spaces (Pafolk, 2020). On the other hand, using the ‘average density’ value in density measurements may lead to ignoring the variations within the area (Chuchman, 1999). The “measured density” using certain quantities may differ from the “perceived density” that results from experiencing urban space. The perception of crowd and congestion as a result of personal experience and evaluations makes it possible to talk about “bad and good densities” (Clark & Moonen, 2015; Dovey & Pafolk, 2014; McFarlane, 2016).

Similar to density, ‘healthy urban environment’ is also an ambiguous term with broad meanings. Public health and related issues have been at the center of the urban planning agenda from first the industrial revolution up to date. Especially in the last three decades, WHO (World Health Organization) has pioneered the promotion of ‘healthy cities’. According to WHO (2021), one of the main aims of healthy cities is “to create a health-supportive environment”. A healthy urban environment can be achieved not only with health-related issues, but also through safety, interaction, accessibility and mobility (Sarkar et al., 2014).

Weston and Bullier (2013) extended the definition of ‘clean and healthy environment’ with the terms of “adequate, decent, balanced, biodiverse, resilient, safe, sustainable, and viable”. As can be shown, there is no solid and certain definition for ‘healthy urban environment’.

### 1.2. Jane Jacobs’ approach to urban density and urban vitality

Jane Jacobs who is a prominent figure in the urban vitality discussions puts forward density, diversity, interaction and permeability as features of a functional and vital city. According to Jacobs urban vitality has a critical importance for a healthy environment and security can only be achieved through the vitality of the streets (Jacobs, 1961). To ensure urban vitality, the physical environment should be sensitive to human scale and the social environment should be free from fear and danger (Maas, 1984). According to Jacobs, we must place “eyes on the street” in large numbers around the clock so that people feel secure enough. (Gordon & Ikeda, 2011).

Ellerman (2005) asserts that “one of the overarching themes in Jane Jacobs’ thought is the importance of diversification.” Under the diversification concepts, she encourages a functionally, physically and socially diverse structure. The first condition for diversity is a mixed-use of the land. She suggests diversity between old and new buildings as well as mixed functions. In addition, diversity in time periods and purposes should be aimed. Thus, the city will attract different people and it will be vital every hour of the day. “On successful city streets, people must appear at different times. This is time considered on a small scale, at different times throughout the day” (Jacobs, 1961). Diversity made of the presence of many people is seen as a key to a successful city (Montgomery, 1995).

Another vital criterion for Jacobs is density. The most important reason for this is that vital and diverse urban life is only possible with a dense population. “People then attract more people and this tends to create more economic opportunities, which in turn increases density” (Gordon & Ikeda, 2011). Thus density is related to not only people who
live there, but also people who come from other parts of the city. Diversity in function, building and resident density is needed for this. Jacobs tended to consider high density positively, and she evaluated a high-density neighborhood as a secure and vital one (Mellon, 2009). On the other hand, her and her followers' opposition towards low density is more about lack of complexity instead of density (Porqueddu, 2015). According to Glaser (2016), the fact that crime rates increase in parallel with the size of the city rather than the urban density supports Jacobs's claim that density has a positive effect on the reduction of crime cases.

Jacobs believes that big cities have a great ability to understand what is necessary to deal with hardship, to communicate, to participate and to invent (Jacobs, 1961). The foundations of vitality in the city, which she sees as a living organism, are natural order and originality and planners are mostly missing it (Tavolari, 2019). Jacobs' writings and her remarkable contribution to urban vitality and density have influenced a number of studies that came after her (Montgomery, 1995; Montgomery, 1996; Gehl, 1971; Gehl, 2010; Chion, 2009, Delclos-Alli et al., 2019, Laurence, 2006, Lunecke & Mora, 2018, Hirn & Zahm, 2012, Schepers, 2008, Wendt, 2009; Sung & Lee, 2015; Lan et al., 2020; Ye et al., 2018). Jacobs' views remain fresh and valid in the urban planning agenda.

Beyond the vitality factors that Jacobs listed in her book, current studies extended the 'vitality' approach by adding a variety of factors and components to examine 'urban vitality' in different contexts such as intersection/road junction density (Long & Huang, 2017; Yue et al., 2019; Yang et al., 2021; Scanepanico et al., 2021; Yue et al., 2021), human/walking activity (Jin et al., 2017; Sung et al., 2013), POI's (Chen et al., 2019; Yang et al., 2021; Yue et al., 2019; Yue et al., 2021), pedestrian flows (Awwaaw, 2017; Jalaladdini & Oktay, 2012; Lunecke & Mora, 2018; Mohamadi, 2019; Ravenscroft, 2000), social interaction/cohesion/networks (Akkar, 2015; Chion, 2009; Mouratidis & Poortinga, 2020; Zarin et al., 2015), public transport (Long & Huang, 2017; Lan et al., 2020; Mouratidis & Poortinga, 2020, Yang et al., 2021), amenities (Long & Huang, 2017; Mouratidis & Poortinga, 2020, Yue et al., 2021), urban form/morphology (Awwaaw, 2017; Kim, 2020), welfare, hostel activity, aesthetics, hygiene, readability (Zarin et al., 2015), green space (Lan et al., 2020; Mouratidis & Poortinga, 2020; Yang et al., 2021), street centrality/network, location advantage, (Yue & Zhu, 2019), intercirculation systems, external traffic system (Wu et al., 2018), building typology (Ye et al., 2018), small catering businesses (Xia et al., 2020; Ye et al., 2018), commercial yield and rent, occupancy rates, environmental quality, incidence of crime (Ravenscroft, 2000), dwelling density, (Oruc & Giritlioglu, 2008; Yue et al., 2021), business areas, the m² unit prices of the land (Oruc & Giritlioglu, 2008), authentcity, tolerance (Lopes & Camanho, 2013), heterogeneity and behavior of the society, level of occupancy in the public realm, time of happening, place characteristics (Awwaaw, 2017), better developed urban functions (Jin et al., 2017), design, city level control variables (Long & Huang, 2017), housing prices, population change (He et al., 2018), transversability, compactness, walkability (Lunecke & Mora, 2018), intercirculation systems, external traffic system (Wu et al., 2018), livability (Zeng et al., 2018), role of walkways (Mohamadi, 2019), balanced use, labor force, residential area ratio, subway station, bus stop, viaduct segregation, river vacuum (Yue et al., 2019), geographical boundary for walkers (Kim, 2020), economic efficiency, urban consumption, open interconnection, market freedom, employment, the number of college students/library collections/employees engaged, air quality, the waste utilisation rate, pollutant treatment (Lan et al., 2020), built environment, distance to city center, liveliness (Mouratidis & Poortinga, 2020), night-time light (Xia et al., 2020), floor area, share of commercial area/office area/residential area, bus density, distance to the closest subway station, distance to district center (Yang et al., 2021), human distribution (Chen et al., 2019), physical segregation to urban barriers (Yue et al., 2021), small parks, anisotropcity (Scanepanico et al., 2021). As seen, this long list includes the factors related to both density (building, population and activity density) and healthy urban environment that are associated with vitality of cities in the studies following Jacobs' work.

1.3. The other side of the coin: Lewis Mumford’s criticism on ‘Great Cities’

Talen classifies American planning tradition into four categories: Incrementalism, urban plan-making, planned communities and regionalism. She sees Jacobs as an incrementalist alongside William Whyte and Christopher Alexander because their approaches value high-density, mixed-use, diversity and conservation. On the other hand, she appraises Mumford as a regionalist alongside Henry Wright, Ian McHarg, Clarence Stein, Benton Mackaye and Catherine Bauer. Regionalism simply was focused on using resources efficiently and fairly. This term is not only about scale but is about social and economical composition (Talen, 2005). Mumford’s ideas on urban politics were influenced by the Garden City movement which is related to Ebenezer Howard, Patrick Geddes and Raymond Unwin. Howard was one of the first to realize centralization and aggregation in the metropolitan cities were unnecessary. He suggested the distribution of the population to rural areas in 1898 (Fishman, 1998).

According to Mumford (1925) “regional planning asks not how wide an area can be brought under the aegis of the metropolis, but how the population and civic facilities can be distributed so as to promote and stimulate a vivid, creative life throughout a whole region, a region being any geographic area that possesses a certain unity of climate, soil, vegetation, industry and culture”. This requires radical thinking but as Mumford stated, there was no point to build a life in the crowded metropolitan city which is “little more tolerable” (Mellon, 2009).

While Jacobs focused on the neighborhood and promotes high density, low-rise, mixed-use, Mumford focused on the entire city or metropolitan area. There was no ideal density for Mumford because he wanted decentralization. From his point of view, there could have been successful neighborhoods in distributed cities of various densities. (Mellon, 2009) “Mumford compared the energy of her beloved street diversity with the vitality of cancer” (Hill, 1985) and concluded that Jacobs’ views are not signs of treatment, but symptoms of a high-density city’s disease. According to Saunders (2012), if Howard, Wright, Corbusier or Mumford had experienced a contemporary city or region, they would use the term urban cancer for those cities as well and would say that the disease is still incurable.

Mumford’s criticism of great, dense, overcrowded metropolitan cities has been also influenced lots of scholars and practitioners. For them, urban density was to nurture the outstanding consumption habits of the elite (Ellerman, 2005); and the great American city, with its impersonal crowds and ever-changing social structure, left the individual without the support of the regional community “necessary for emotional health and democratic political participation” (Hill, 1988).

1.4. Rethinking urban vitality and density in the post-pandemic city

Both of the approaches, briefly summarized above, have made important contributions to the literature in the context of a city’s goal of being healthy and livable. The Covid-19 outbreak, which has influenced the whole world since the beginning of 2020, has led to the re-questioning of both perspectives and to discuss the views on what should be the principles of planning and design in post-pandemic cities. These different perspectives have also been a guide for our study on urban vitality and density in the post-pandemic city of Istanbul.

Urban density appears as an important indicator of how cities govern the course of urban change. Although the urban theorists and practitioners propose a variety of urban density targets to achieve urban vitality, sustainability, public health or accessibility (Banai, 2013; Paža, 2020) in cities and regions, there is no exact solution to the optimum city density problem. The criteria to define optimal urban density also may be changed according to targets to be achieved. This target may be defined as to produce “urbanity” (Montgomery, 1998), to create a lively
city (Gehl, 2010), to contribute to urban diversity and vitality (Jacobs, 1961; Moroni, 2016), or to provide effective public transit (Banai, 2020) and public infrastructure (Turok & McGranahan, 2013).

In the era of modern urbanism, different levels of urban densities have been related to urban, environmental and economic issues including vitality, health, safety, creativity and sustainability (Dovey & PaIka, 2014; Turok & McGranahan, 2013). Stating the context-dependent feature of density, Churchman (1999) explained the potential advantages and disadvantages of high densities in terms of transportation system, physical infrastructure and urban form, environmental, economic, personal, physiological and social aspects. The role of density to create a healthy environment is ambiguous. Webster (2021) claims that several studies suggest the positive role of higher densities for urban living in multiple aspects. While Sarkar et al. (2017) found a negative relationship between higher densities and the possibility of suffering from a chronic disease in the UK, Mouratidis (2018 & 2019) revealed the positive effects of high-density urban form on neighborhood satisfaction, subjective well-being, physical health and social relations in Oslo metropolitan area. On the other hand, Mitrany (2005) reviewed the studies that investigate the relationship between density and social pathology, psychological stress, health and social relations by pointing out complicated results in terms of negative and positive effects of high density. So, as Moroni (2016) states, “density is neither per se negative nor per se positive.”

In the literature, the relationship between urban vitality and density has been discussed from two aspects. Some studies employed density as a prerequisite for urban vitality (see Delclois-Alio et al., 2019; Jin et al., 2017; Zeng et al., 2018; Fuentes et al., 2020; Paköz et al., 2022) as Jacobs did, while some studies investigated the level of relationship between urban density and vitality in different contexts (Sung et al., 2013; Sung & Lee, 2015; Wu et al., 2018; Meng & Xing, 2019; Mitrany, 2005; Ye et al., 2018; Mouratidis & Poortinga, 2020). Building/dwelling density (Meng & Xing, 2019; Sung et al., 2015; Sung & Lee, 2015; Wu et al., 2018; Meng & Xing, 2019; Mitrany, 2005; Ye et al., 2018; Mouratidis & Poortinga, 2020), human activity density (Jin et al., 2017) or two and three of them with together (Delclois-Alio et al., 2019; Fuentes et al., 2020; Zeng et al., 2018) are used in vitality studies.

Meng and Xing (2019) conducted a regression analysis to examine

| Research problem | Authors | Case/scale | Time interval | Study methods | Density definitions | Main findings related to urban density |
|------------------|---------|------------|---------------|---------------|---------------------|----------------------------------------|
| The impacts of density on the COVID-19 infection and mortality rates | Hamidi et al. (2020) | 913 U.S. metropolitan counties | Jan 22, 2020–May 25, 2020 | Structural equation modeling (SEM) | Activity density (population + employment per square mile) | Density- infection rate: not significant |
| | Kadi and Khelfaoui (2020) | Algerian cities | March 02, 2020–June 10, 2020 | Cluster analysis | Population density (inhabitants/km²) | Density-infection rate: strong positive correlation |
| | Caruzeit et al. (2020) | The US county level (1197 counties) | Jan 22, 2020–July 1, 2020 | Cross-sectional correlations | Gross population density (total county pop/total county area) | Density-mortality rate: not significant |
| | Bhadra et al. (2020) | 600 districts of India | Till 10th September 2020. | Correlation and regression analysis | Population density | Density- mortality rate: positive correlation |
| | Boterman (2020) | Municipal level in the Netherlands | 16 April 2020 and 29 April 2020 | Poisson regressions | Population density (people/km²) | Density-infection/hospitalization/mortality rate: Not significant |
| Social, economic, and/or environmental factors affecting the COVID-19 infection and mortality rates | Jamshidi et al. (2020) | Global level | 1 January to 15 August 2020 | Multiple regression analysis | Urban density (Population of the urban area/Urban area (km²)) | Density- infection rate: contributing factor |
| | Wheaton and Thompson (2020) | The US: counties and metropolitan areas | Jan 22, 2020–March, 31, 2020 | Regressions | Overall residential density (population/mile²) | Density- infection rate: partial effect |
| | Hamidi and Hamidi (2021) | New York City, U.S.A. | From March 2, 2020 through April 1 and May 25, 2020. | Spatial lag models | Population density (Total population/land area (sq miles)) | Crowding (and not density) was linked to the higher infection rate. |
| | Coskun et al. (2021) | 31 provinces in Turkey | March 2020 | Regression analysis | Population density of the provinces | Density-infection rate: major and mediator factor |
| | Urban and Nakada (2020) | Sao Paulo, Brazil | From 8 March to 18 June 2020. | Geographically weighted regression model | Population density (people per square kilometer) | Density-infection rate: a determining factor in informal settlements. |
| | Carenti et al. (2020) | 20 Italian NUTS regions | From February 21 to May 5, 2020 | Multiple linear regression model | Population density (inhabitants/km² in the provincial capital of the region) | Density-infection rate: a direct relationship |
| | Qiu et al. (2020) | 304 prefecture-level cities in China | January 19 and February 29, 2020 | Regressions | Population density | Density-infection rate: significant for the second stage (negative correlation) |
| | Liu (2020) | 305 Chinese cities | Jan, 31; Feb, 5; March 2, 2020 | Simple log linear regression model | Population density (Person/km²) | Density-infection rate: significant for the early stage (negative correlation) |
| | Li et al. (2021) | Huangzhou district, China | No information | GIS, DBSCAN, SEM | Building density | Density-Covid-19 cluster size: indirect effect |
the relationship of landscape characteristics with urban vitality in the Futian district, Shenzhen. Their analysis revealed a significant impact of the density of urban facilities and buildings on improving urban vitality. Ye et al. (2018) found in their research in Shenzhen that building typology appears to play a more critical role in fostering urban vitality than building density. Wu et al. (2018) found a strong and positive correlation of high density and mixed land use with neighborhood vibrancy in their study based on a GIS-based activity survey in suburban Beijing. Sung et al. (2013) analyzed the walking activity data in the great Seoul city using a multiple linear regression model and found the association of the total net density of buildings with pedestrian activity on streets. Sung and Lee (2015) also found similar results about the relationship between density and walking activity in Seoul. Mouratidis and Poortinga (2020) tested the relationship between urban vitality and built environment characteristics and neighborhood social cohesion using survey and geospatial data from the Oslo metropolitan area. The results revealed a linkage of high density and local amenities with high urban vitality and low social cohesion. Mitran (2005) found in his study in two high-density neighborhoods in the city of Haifa that high density is evaluated as negative in residential areas while it is seen as positive in public spaces since it adds a “sense of vitality” to the neighborhood.

With many opportunities offered by megacities, the concentration of people in cities is the most important threat to the cities during the Covid-19 outbreak. The Covid-19 pandemic has been considered the most serious public health threat since the influenza pandemic in 1918, and the effects of density on the Covid-19 pandemic are at the center of public and planning discussions. (Hamidi et al., 2020; Sharifi & Khavarian-Garmsir, 2020; Wheaton & Thompson, 2020). Studies relating urban density to the Covid-19 outbreak have intensified in two main topics: The relationship between urban density (and other socioeconomic variables in some cases) and Covid-19 infection/mortality rates; the vulnerability of cities during the outbreak. While the studies in the first group investigate whether urban density significantly affects the

| Density level | Average density (people per km²) | Distribution of respondents | Type of residence of respondents (%) |
|---------------|----------------------------------|-----------------------------|------------------------------------|
| Low density   | 2346                             | 106 31.7%                   | 25.0% 59.6% 15.4%                  |
| Medium density| 11,416                           | 121 36.1%                   | 16.7% 76.7% 6.7%                   |
| High density  | 28,164                           | 108 32.2%                   | 10.2% 89.8% 0.0%                   |
| Total         | 335                              | 100.00%                     | 17.2% 75.6% 7.2%                   |

**Table 2** Distribution of respondents by district characteristics.

![Density levels of districts and distribution of survey samples.](image)
Covid-19 spread rates/death incidences or not (Hamidi et al., 2020; Jamshidi et al., 2020; Kadi & Khelfaoui, 2020; Carozzi et al., 2020; Wheaton & Thompson, 2020; Bhadra et al., 2020; Urban & Nakada, 2020; Boterman, 2020; Carteni et al., 2020; Qiu et al., 2020; Liu, 2020; Hamidi & Hamidi, 2021; Coskun et al., 2021; Li et al., 2021) the studies in the second group employ ‘high urban density’ as one of the factors increasing vulnerability of cities during the outbreak (Choerunnisa et al., 2020; Mishra et al., 2020; Prieto et al., 2020; Rahman et al., 2020). As seen in Table 1, which summarizes the cases, methods and findings of the studies in the first group, the level of impact of density on the Covid-19 infection and mortality rates differs according to cases, scales, and time interval. While the impact of density on infection and mortality rates was found insignificant in some studies (Carozzi et al., 2020; Boterman, 2020), some studies found positive (Bhadra et al., 2020; Carteni et al., 2020; Coskun et al., 2021; Kadi & Khelfaoui, 2020) or negative (Liu, 2020; Qiu et al., 2020) correlation. There are also studies that determined the partial or indirect effect of density (Hamidi et al., 2020; Jamshidi et al., 2020; Wheaton & Thompson, 2020; Hamidi & Hamidi, 2021; Urban & Nakada, 2020; Li et al., 2021) on the Covid-19 infection/mortality rates.

Hamidi et al. (2020) have studied the metropolitan area population, socio-economic and health infrastructure in the US, and concluded that the density is not directly related to Covid-19 infection rates. However, it is stated that the metropolitan population has the third most important relationship with Covid-19 mortality rates. The findings also reveal that the connection between the districts is more important than the density of the district for the pandemic spread and mortality. Similarly, Angel et al. stated that the density would not just explain the spread of Covid-19. In the United States, there are significant differences in mortality between rich and poor areas in similar densities (Angel et al., 2020). Carozzi et al. (2020) categorized the spread of the Covid-19 as ‘early arrival’ and ‘subsequent spread’; and asserted that while ‘urban cores and superstar cities’ are more influenced in the ‘early arrival’ stage, the spread rate in the second stage was not significantly different between dense cities and sparsely populated areas. On the other hand, Urban and...
Nakada (2020) found a significant correlation between Covid-19 death incidence and population density in their study conducted in São Paulo, Brazil. The spread rate of Covid-19 is influenced by the high-population density especially in informal settlements since people living in these settlements are likely not able to comply with social distancing measures (Urban & Nakada, 2020).

To summarize, urban density has been related to both urban vitality and healthy environment issues in the literature. Just as urban theorists have arguments for or against high urban densities, experimental studies also reveal the positive and negative effects of high densities from a variety of aspects. The Covid-19 outbreak has rekindled the discussions related to urban density and has spawned new theoretical expansions and research problems.

2. Methodology

The aim of the present study is to examine the relationship between urban vitality & healthy environment and urban density through the Istanbul metropolitan city, which is going through the Covid-19 outbreak. Within the scope of the present study, firstly, 39 districts of Istanbul were divided into three categories as low-density, medium-density and high-density according to their population densities (See Table 2 & Fig. 1). We used the gross population density of districts including non-residential uses and undeveloped lands, excluding water surfaces such as dams within districts. We defined density levels based on the breakdowns in the variations, and validated them with randomly selected urban texture samples in Figs. 5, 6, 7. We also limited the scope of our study with urban districts, so did not survey rural districts such as Silivri, Ärmavutköy, Çatalca and Şile.

Secondly, how this actual situation reflects people’s perception of the city and the neighborhood are examined by an online survey, which was conducted with 337 participants living in Istanbul between 1 and 5 June 2020. The questionnaire firstly was applied to six experts including architects and city planners. According to their recommendation, the questionnaire was revised and applied to the respondents. We also paid attention to distribute samples in a balanced manner, representing the urban area of Istanbul. Personal characteristics of the survey respondents in terms of age, gender, education level, income level, marital status and working status are given in Fig. 2. Within this survey, we measured the assessments of the residents living in different districts of the city (low-density, medium-density and high-density) regarding the city and the neighborhood they live in. We used both primary and secondary datasets to understand the changes in perceptions of the respondents according to the density level of districts (Table 3).
The questionnaire consists of six sections: 1. General questions revealing personal and residential characteristics of the respondents; 2. Perceptions and evaluations about the residence, neighborhoods and city life, 3. Neighborhood relations, 4. Working life, 5. Leisure activities, 6. Perceptions and usage of public spaces. Within the scope of this study, the first and second parts of the questionnaire were analyzed and cross-inquired. In the second part of the questionnaire following general questions, firstly the respondents were asked to evaluate the neighborhood they live in regarding six subtitles: vitality, mobility, safety, healthiness, cleanliness, orderliness. Secondly, they asked to evaluate city life before and after the outbreak with three questions (See Fig. 3 and Table 10). The evaluations made by the citizens in the dimensions of vitality, mobility, safety, healthiness, cleanliness, orderliness were reduced to two main factors as “urban vitality” and “healthy environment” using Principal Components Analysis. Then, the evaluations regarding these two factors were subjected to cross-inquiries with the personal characteristics of the respondents, the density level of the district they live in, and the characteristics of the house they reside in. Within the scope of the questionnaire, urban residents were also asked to evaluate the city life before and after the Covid19 outbreak, and the change in these responses was similarly cross-inquired with personal, residential and district characteristics (Fig. 3).

We defined “urban healthy environment” for this study as a roof-term for the variables of “clean, safe, healthy and orderly urban setting” since these variables are mostly associated with a healthy environment in the literature. We also used “urban vitality” and “vibrant urban environment” in the same meaning in our study that refers to the “activity and vibrancy of cities”.

We made two basic inquiries with the datasets aforementioned:

1. How does the perception about the neighborhood the respondents live in (regardless of the outbreak) and the perception about the city life in Istanbul before and after the Covid-19 outbreak change according to the personal characteristics of the respondents, the residential features, and the density of the districts?

2. How does the perception about the neighborhood the respondents reside in affect the perception about the city life in Istanbul before and after the Covid-19 outbreak?

In order to test whether there is a statistically significant relationship between test variables, four different tests are used. If all test variables are categorical, we used the Pearson’s Chi-squared test and Mantel-Haenszel test of trend (linear-by-linear association). Pearson’s Chi-Squared Test measures differences between observed and expected...
values, however, it doesn’t evaluate linear relationships between groups. Here the aim is to describe the structural relationships among the variables (Wrigley, 1985). Besides the Chi-squared test, to identify the linear relations between the groups, we used the Mantel-Haenszel test of trend. It is the way to determine correlations among the categorical variables (Kuritz et al., 1988). If one of the test variables is numeric, we used non-parametric tests of Kruskal Wallis and Mann-Whitney U since the data structure does not meet the assumptions of parametric tests. These non-parametric tests are used to examine whether two (Mann-Whitney U) or more (Kruskal Wallis) independent samples were selected from populations with the same distribution (Freund & Perles, 2004). We also employed Principal Components Analysis, which groups the variables that are correlated with each other into a single category (Hair et al., 1998), to produce new factors from the variable list, which includes the perceptions about the neighborhood the respondents live in.

The research has some limitations. Firstly, we used the average population densities of districts for the analysis. This is likely to ignore differentiations within districts in terms of density. Secondly, since the survey is conducted with a convenience sampling method, volunteer bias should be taken into account while interpreting the results.

2.1. Study area

The city of Istanbul, which has shown rapid urban growth from the 1950s to the present (Tekeli, 2010), is a permanent crossroads of vast and diverse mobilities when viewed from a distance (Sassen, 2009). Today, with its population of more than 15 million and its high density, it is one of the leading cities in the focus of planning discussions in the pandemic process, just as before the pandemic. Foreigners with a residence permit are also included in the official population of Istanbul which is 15,462,452 people by the end of 2020 (TURKSTAT, 2021). However, Syrians under temporary protection are not included in the official population. While the number of registered Syrians under temporary protection in Istanbul was 479,420 as of the end of 2019, this number has reached 518,519 people by the end of 2020, with an increase of approximately 40,000 (DGMM, 2021).

The spread rate of the pandemic in the city, which is the epicenter of the Covid-19 outbreak in Turkey according to Health Ministry data, is much higher compared to other cities and rural settlements. The first phase of the pandemic process, which started as of 10 March 2020 when the first case detected in Turkey was managed with strict restrictions on the use of public spaces and intra-urban and inter-urban mobility similar...
to many countries. Distance education, remote working and curfews followed the first restrictions. The curfew was first imposed for citizens over the age of 65, and then for young people under 20. Later, curfews on weekends and holidays were imposed for all citizens in metropolitan cities including Istanbul. (AHK Turkey, 2020). The first phase ended as of 1 June 2020 when some of the restrictions lifted. However, the restrictions were temporarily reinstated in some periods during the outbreak based on the increase in the number of active cases and deaths due to Covid-19.

We have used the term “post-pandemic city” to describe the emerging socio-spatial organization of cities that is associated with changes in urban life, working style, travel behaviors and perceptions of the city since the first Covid-19 case was detected (See also (Paköz et al., 2021)). In the pandemic process, Istanbul, Turkey’s most vibrant city, lost its daily rhythm. (Guerin, 2020) Restrictions on international mobility affected the city of Istanbul more than other cities in Turkey because of the geographic location and high global connectivity of Istanbul. Restrictions on inter-urban mobility has made life difficult for those who have to cross the border on their daily commute since the Istanbul city region covers the administrative borders of three different provinces. While white-collar workers were able to overcome this problem with remote working, blue-collar workers had to commute every day or leave work permanently. Restrictions on intra-urban mobility has led to decrease in the use of public transportation in the city. The total number of public transport passengers in Istanbul in 2020 decreased by 42% compared to 2019 (Doğan & Paköz, 2021). The high risk of contamination in public transportation has led some of the individuals who own vehicles to travel by private vehicle.

When the case distribution map (Fig. 4a,4b) showing the distribution of active Covid-19 cases in Istanbul province (as of 04.07.2020 and 06.10.2020) and the density map (Fig. 1) are evaluated together, it will be seen that the districts with the highest risks in terms of the number of active cases are those in the high-density category.

Figs. 5, 6 & 7 present randomly selected urban pattern examples, which represent the districts of low, medium and high densities both in the European and Anatolian side, derived from satellite images. These examples provide clues as to which density category corresponds to what type of urban pattern and their risk levels based on active Covid-19 cases.
3. Results

3.1. Changes in perceptions about the neighborhoods by personal, residential and district characteristics

Within the scope of the study, we questioned the perception of the survey respondents about the neighborhood they reside in regardless of the outbreak under six titles: vitality, safety, mobility, healthiness, cleanliness and orderliness. We categorized answers as −1 (negative perception), 0 (neutral), and 1 (positive perception). To evaluate the answers, we firstly cross-inquired the perceptions about neighborhoods (related to six variables) with the personal characteristics of the respondents (Table 4).

According to the results, while marital status, income level, and age are respectively the most effective factors that change perceptions of the respondents about the neighborhoods they reside in, education level does not affect perceptions significantly in terms of six variables. Since urban habits are subject to change by marital status and age, we can say

![Randomly selected urban pattern examples of high-density districts and their Covid-19 risk levels](Image)

Table 4
The change in perceptions about neighborhoods by personal characteristics: p values.

|                      | Vitality | Safety | Mobility | Healthiness | Cleanliness | Orderliness |
|----------------------|----------|--------|----------|-------------|-------------|-------------|
| Age                  | Pearson  | 0.009* | 0.022*   | 0.105       | 0.071       | 0.132       | 0.008*      |
|                      | LLA      | 0.250  | 0.006**  | 0.269       | 0.093       | 0.042**     | 0.003**     |
| Gender               | Pearson  | 0.062  | 0.070    | 0.026*      | 0.071       | 0.551       | 0.877       |
|                      | LLA      | 0.142  | 0.075    | 0.033**     | 0.142       | 0.296       | 0.615       |
| Education level      | Pearson  | 0.757  | 0.268    | 0.915       | 0.255       | 0.840       | 0.509       |
|                      | LLA      | 0.289  | 0.542    | 0.713       | 0.299       | 0.551       | 0.154       |
| Income level         | Pearson  | 0.010* | 0.078    | 0.421       | 0.000*      | 0.001*      | 0.006*      |
|                      | LLA      | 0.069  | 0.012**  | 0.355       | 0.060       | 0.001**     | 0.001**     |
| Marital status       | Pearson  | 0.028* | 0.004**  | 0.004       | 0.115       | 0.105       | 0.003*      |
|                      | LLA      | 0.154  | 0.017**  | 0.001**     | 0.039**     | 0.038**     | 0.003**     |
| Working status       | Pearson  | 0.400  | 0.101    | 0.340       | 0.114       | 0.489       | 0.592       |
|                      | LLA      | 0.715  | 0.132    | 0.421       | 0.044**     | 0.347       | 0.321       |

* Significant at 0.01/0.05 level (Pearson’s chi-squared).
** Significant at 0.01/0.05 level (Linear-by-linear association (LLA)).
that younger and single people seek a more vibrant and mobile environment contrary to married and older people who prefer a safe, calm, and healthy environment. On the other hand, since people with higher income mostly live in high-quality physical environments, their perceptions about five of six variables except mobility are more positive compared with other income groups.

We secondly cross-inquired the perceptions about neighborhoods with residential characteristics. According to the results, the perception of the respondents related to the six variables regarding the neighborhood they live in does not differ significantly according to the property status of the house (house owner/tenant) and type of the residence (apartment, gated community, single house). However, it appears that the respondents who live in Istanbul for less than 10 years are more sensitive to the 'safety' issues compared with those living in the city for more than 10 years.

The results reveal that the perception about the neighborhood significantly changes according to the reason to choose the district the respondents live in (Tables 5 & 6). As seen in Table 6, the residents whose first criterion while choosing the district to live in is having a quality social and physical environment have significantly the highest positive perceptions in terms of vitality, safety, healthiness, cleanliness, and orderliness compared with the other residents as expected. On the other hand, the residents who choose the district they live in because it is close to their children’s school have the highest negative perceptions in terms of vitality, safety, healthiness, and orderliness among the respondents. These differences in perceptions among the residents may be explained with priorities in district selection.

We thirdly questioned whether the population densities of districts affect the perceptions in terms of vitality, safety, mobility, healthiness, cleanliness, and orderliness. As shown in Table 7, perceptions related to five out of six factors significantly differ according to three density categories. As the density of the district increases, the positive perception in terms of vitality and mobility increases. On the other hand, it is seen that the highest ratio of positive perception regarding safety is measured in ‘medium density’ districts. As the density increases, it is seen that the positive perception in terms of safety decreases after a point. Interestingly, the residents living in low-density districts don’t have the highest positive perception in any of the six factors compared with medium and high densities.

In the second stage following the first cross-inquires, we reduced these six dimensions into two components using Principal Components Analysis. According to the results of Principal Components Analysis,

**Table 5**
The change in perceptions about neighborhoods by residential characteristics: p values.

| Property status of the house | Vitality (%) | Safety (%) | Mobility (%) | Healthiness (%) | Cleanliness (%) | Orderliness (%) |
|-----------------------------|-------------|------------|--------------|----------------|----------------|-----------------|
| Pearson                     | 0.050       | 0.496      | 0.069        | 0.168          | 0.349          | 0.747           |
| LLA                         | 0.362       | 0.821      | 0.631        | 0.300          | 0.184          | 0.525           |
| Type of the residence       |             |            |              |                |                |                 |
| Pearson                     | 0.581       | 0.250      | 0.559        | 0.255          | 0.339          | 0.117           |
| LLA                         | 0.845       | 0.147      | 0.197        | 0.074          | 0.206          | 0.055           |
| Duration of residence in Istanbul | 0.113   | 0.000*     | 0.359        | 0.302          | 0.458          | 0.750           |
| LLA                         | 0.444       | 0.993      | 0.053        | 0.150          | 0.782          | 0.355           |
| The reason to choose the district | 0.000*     | 0.000*     | 0.283        | 0.000*         | 0.000*         | 0.000*          |
| LLA                         | 0.001**     | 0.001**    | 0.782        | 0.000**        | 0.004**        | 0.004**         |

* Significant at 0.01/0.05 level (Pearson chi-square).
** Significant at 0.01/0.05 level (Linear-by-linear association (LLA)).

**Table 6**
The change in perceptions about neighborhoods by the reason to choose the district.

| Proximity to the workplace | Vitality (%) | Safety (%) | Mobility (%) | Healthiness (%) | Cleanliness (%) | Orderliness (%) |
|----------------------------|--------------|------------|--------------|----------------|----------------|-----------------|
|                           | –1 0 1       | –1 0 1     | –1 0 1       | –1 0 1         | –1 0 1         | –1 0 1          |
|                           | 5.3 82.9 11.8 | 6.6 51.3 42.1 | 50.0 31.6 18.4 | 6.6 78.9 14.5 | 9.2 65.8 25.0 | 15.8 60.5 23.7 |
|                           | 32.4 47.1 20.6 | 26.5 23.5 50.0 | 47.1 23.5 29.4 | 20.6 52.9 26.5 | 17.6 47.1 35.3 | 38.2 32.4 29.4 |
| Proximity to children’s school |           |            |              |                |                |                 |
|                           | 12.0 62.7 25.3 | 10.7 48.0 41.3 | 44.0 22.7 33.3 | 13.3 70.7 16.0 | 6.7 61.3 32.0 | 25.3 52.0 22.7 |
| Proximity to relatives | 22.2 60.0 17.8 | 11.1 48.9 40.0 | 44.4 33.3 22.2 | 13.3 73.3 13.3 | 17.8 57.8 24.4 | 35.6 44.4 20.0 |
| Housing (rent or sale) |                           |            |              |                |                |                 |
| Quality social and physical env. | 0.0 57.1 42.9 | 0.0 23.1 76.9 | 51.6 31.9 16.5 | 1.1 53.8 45.1 | 1.1 42.9 56.0 | 4.4 39.6 56.0 |
| Other | 18.8 56.3 25.0 | 25.0 25.0 50.0 | 25.0 37.5 35.7 | 6.3 68.8 25.0 | 12.5 68.8 18.8 | 37.5 37.5 25.0 |
| Total | 11.0 63.5 25.5 | 9.2 38.6 52.2 | 46.9 29.4 23.7 | 8.9 66.5 24.6 | 8.6 55.8 35.6 | 20.8 46.9 32.3 |

| –1: Negative perception; 0: Neutral; 1: Positive perception. |

**Table 7**
The change in perceptions about neighborhoods by the district density.

| Low density | Vitality (%) | Safety (%) | Mobility (%) | Healthiness (%) | Cleanliness (%) | Orderliness (%) |
|-------------|--------------|------------|--------------|----------------|----------------|-----------------|
| –1 0 1      | 13.2 76.4 10.4 | 4.7 51.9 43.4 | 65.1 29.2 5.7 | 2.8 74.5 22.6 | 2.8 66.0 31.1 | 14.2 53.8 32.1 |
| Medium density | 9.9 64.5 25.6 | 5.8 33.1 61.2 | 43.0 29.8 27.3 | 8.3 71.1 20.7 | 7.4 53.7 38.8 | 21.5 48.8 29.8 |
| High density | 10.2 49.1 40.7 | 17.6 31.5 50.9 | 33.3 28.7 38.0 | 15.7 52.8 31.5 | 15.7 47.2 37.0 | 25.9 38.9 35.2 |
| Total | 11.0 63.3 25.7 | 9.3 38.5 52.2 | 46.9 29.3 23.9 | 9.0 66.3 24.8 | 8.7 55.5 35.8 | 20.6 47.2 32.2 |
| Pearson Chi-Square | 0.000** | 0.000* | 0.000* | 0.002* | 0.004* | 0.146 |
| Linear-by-Linear Association | 0.000** | 0.542 | 0.000** | 0.598 | 0.398 | 0.380 |

* Significant at 0.01/0.05 level (Pearson chi-square).
** Significant at 0.01/0.05 level (Linear-by-linear association).
which are shared in Table 8, the variables of safety, healthiness, cleanliness, and orderliness are grouped in the first component which we named as 'healthy environment'; and the variables of vitality and mobility are grouped in the second component which we named as 'urban vitality'. The two components explain 66.5% of the total variance.

The formation of the two components also reveals the directions of the relationships between six variables. The factor scores of the two components (healthy environment and urban vitality) are calculated using regression method in SPSS to be able to test the differentiations by personal, residential, and district characteristics. While the perception of 'healthy environment' differs by age, income level, marital status and district choice, the perception of ‘urban vitality’ differs by gender significantly among personal and residential characteristics (Table 9). On the other hand, as the density of the district increases, the positive perception in terms of ‘urban vitality’ increases significantly. As seen in Fig. 8, the mean value of perceptions of ‘urban vitality’ in low-density districts is measured negative. The perception of ‘healthy environment’ does not differ significantly according to the population density of the districts. However, the mean values of perceptions of ‘healthy environment’ is positive in ‘low’ and ‘medium density’ districts, while it is negative in high-density districts (Fig. 8).

3.2. Changes in perceptions about the city life in Istanbul after the Covid-19 outbreak

In addition to the questions, which are cross-inquired above, we asked three questions to the respondents about the city life in Istanbul to trace the effects of the Covid-19 outbreak:

1. Compared to other cities in Turkey, do you think Istanbul is a suitable city for a family to live in? (regardless of the outbreak)
2. Did the Covid-19 outbreak change your thought about living in Istanbul?
3. Are you considering changing your home after the Covid-19 outbreak?

Fig. 9 displays descriptive statistics for these three questions in percentage. According to the results, while 67.3% of the respondents think that Istanbul is not a suitable city for family life compared to other cities in Turkey, the Covid-19 outbreak is expected to reinforce this perception because it has made living in Istanbul more difficult. Therefore, 16.5% percent of the respondents stated that they decided to leave the city after the outbreak, while 16.0% of the respondents are considering moving their home within the city.

We cross-inquired these three questions with personal, residential and district characteristics to test whether the answers differentiate by some of these characteristics. The main findings derived from Table 10 can be listed as follows:

- As the education level increases, both the negative perception about Istanbul in terms of family life and the decision rate to move within the city also increases significantly. It can be explained with that educated people have more expectations from city life.
- As the duration of residence in Istanbul increases, the positive perception about Istanbul in terms of family life increases

| Table 8 | The summary of Principal Component Analysis. |
|---------|---------------------------------------------|
| Rotated component matrix | Component weight | Total variance explained (Rotation sums of squared loadings) |
| | | Total % of Variance |
| Component 1: Healthy Environment | 2.799 | 46.655 | 46.655 |
| Vitality | 0.472 | | |
| Safety | 0.757 | | |
| Mobility | -0.385 | | |
| Healthiness | 0.762 | | |
| Cleanliness | 0.805 | | |
| Orderliness | 0.791 | | |
| Component 2: Urban Vitality | 1.192 | 19.866 | 66.522 |
| Vitality | 0.711 | | |
| Safety | 0.167 | | |
| Mobility | 0.799 | | |
| Healthiness | -0.024 | | |
| Cleanliness | -0.131 | | |
| Orderliness | -0.049 | | |
| Extraction method: Principal Component Analysis. |
| Rotation method: Varimax with Kaiser normalization. |
| Rotation converged in 3 iterations. |
| KMO and Bartlett’s Test |
| Kaiser-Meyer-Olkin measure of sampling adequacy | 0.792 |
| Bartlett’s test of sphericity | Approx. Chi-Square: 523.494 df: 15 Sig: 0.000 |

* Weights greater than 0.5 are highlighted in bold, others in italics.

| Table 9 | The change in perceptions of ‘healthy environment’ and ‘urban vitality’ by personal, residential and district characteristics: p values. |
|---------|--------------------------------------------------------------------------------------------------------------------------------|
| Personal characteristics | Healthy environment | Urban vitality |
| Age | 0.005* | 0.258 |
| Gender | 0.405 | 0.012* |
| Education level | 0.787 | 0.810 |
| Income level | 0.000* | 0.941 |
| Marital status | 0.001* | 0.228 |
| Working status | 0.220 | 0.830 |
| Residential characteristics | Property status of the house | Healthy environment | Urban vitality |
| Type of the residence | 0.094 | 0.295 |
| Duration of residence in Istanbul | 0.489 | 0.196 |
| The reason to choose the district | 0.000* | 0.095 |
| District Density of districts | 0.861 | 0.000* |

* Significant at 0.01/0.05 level (Kruskal Wallis/Mann-Whitney U).
significantly. It can be explained with that former residents of the city are more adapted to life in the megacity than newcomers.

- Married people compared with singles, tenants compared with house owners are more inclined to move their home within the city.
- Even though the negative externalities such as congestion, lack of facilities, spread rate of diseases caused by high population density complicated the city life, the perceptions of the respondents about city life before and after the outbreak do not differentiate by density categories significantly.

Secondly, we cross-inquired these three questions with six variables (vitality, safety, mobility, healthiness, cleanliness and orderliness). As

Table 10
The change in perception about the city life in Istanbul by personal, residential and district characteristics: p values.

|                          | Thought about the suitability of Istanbul for a family to live compared to other cities (regardless of the outbreak) | Decision to move within the city (after the outbreak) | Decision to leave the city (after the outbreak) |
|--------------------------|-----------------------------------------------------------------------------------------------------------------|------------------------------------------------------|-----------------------------------------------|
| **Personal characteristics** |                                                                                                                 |                                                      |                                               |
| Age                      | 0.184                                                              | 0.829                                                | 0.056                                          |
| Gender                   | 0.476                                                              | 0.362                                                | 0.086                                          |
| Education level          | 0.217                                                              | 0.115                                                | 0.302                                          |
| Income level             | 0.000*                                                             | 0.115                                                | 0.200                                          |
| Marital Status           | 0.001**                                                            | 0.010*                                               | 0.168                                          |
| Working status           | 0.972                                                              | 0.721                                                | 0.476                                          |
| **Residential characteristics** |                                                                                                                |                                                      |                                               |
| Property status of the house | 0.045*                                                            | 0.010*                                               | 0.224                                          |
| Type of the residence    | 0.471                                                              | 0.119                                                | 0.427                                          |
| Duration of residence in Istanbul | 0.000*                                                            | 0.012*                                               | 0.011*                                         |
| The reason to choose the district | 0.462                                                              | 0.432                                                | 0.619                                          |
| **District characteristics** |                                                                                                                |                                                      |                                               |
| Density of district resident | 0.488                                                              | 0.423                                                | 0.317                                          |

* Significant at 0.01/0.05 level (Pearson chi-square).
** Significant at 0.01/0.05 level (Linear-by-linear association).
thought about the suitability of Istanbul for a family to live compared to other cities (regardless of the outbreak) and the perceptions of ‘safety’ and ‘healthiness’. The respondents who think their neighborhood is safer and healthier has also more positive perception about the city for family life. On the other hand, the decision to move within the city or to leave the city after the outbreak does not differentiate significantly according to the six variables regarding the neighborhood perceptions.

Finally, we cross-inquired these three questions with the two factors obtained via Principal Component Analysis. According to the results, there is no significant relationship between the answers to the three questions and two factors (‘healthy environment’ and ‘urban vitality’) regarding the neighborhood perceptions (Table 12).

### 4. Discussion

The present study aims to investigate the relationship between urban vitality & healthy environment and urban density through the Istanbul metropolitan city with an online survey conducted at the end of the first phase of the outbreak. The main findings of the study can be evaluated under two titles: Rethinking ‘urban density’ and ‘urban vitality’ issues over Istanbul and other megacities; Evaluating the impact of the first phase of the Covid-19 outbreak on the perception of urban residents living in an over-crowded megacity.

Firstly, the survey results reveal the significant relationship between ‘urban population density’ and ‘urban vitality’. As the population density of the districts increases, the positive perception in terms of ‘urban vitality’ increases dramatically. In addition, the mean value of perceptions of ‘urban vitality’ is measured negative in high-density districts. Our study also found some negative externalities in terms of perceptions on safety, cleanliness and healthiness related to high density in the districts of Istanbul. Despite the fact that some studies pointed out the positive role of higher densities in creating a healthy environment (Sarkar et al., 2017; Webster, 2021) and increasing residential satisfaction (Mouratidis, 2018; Mouratidis, 2019), both the positive and negative effects of high density on the healthy urban environment are stressed in many studies (Churchman, 1999; Mitrany, 2005; Moroni, 2016) similar to the findings of our study. When we evaluate these results through the Jacobs-Mumford debate, we can say that the positive perceptual effect of high urban density on ‘urban vitality’ is stronger than its negative perceptual effect on ‘healthy environment’. However, as some scholars have stated, not only population density but also physical and social structure of neighborhoods have effects on the perception of ‘urban vitality’ and ‘healthy environment’. In addition, the fact that two-thirds of the participants thought as Istanbul was not a city suitable for family life compared to other cities indicates that the population size of the city has reached and passed the “climax stage” as expressed by Mumford. As Clark and Moonen (2015) stated, the city of Istanbul as a high-density urban setting is suffering from congestion, poor planning, rapid urban growth which may affect the negative perceptions on safety, cleanliness and healthiness. This is an expected result not only for Istanbul but also for other megacities considering that the inadequacies in social and technical infrastructure and higher costs of living in megacities make urban life difficult for families. The Covid-19 outbreak is also likely to foster negative perceptions of residents who reside in higher-density districts since there is a direct relationship between density levels and Covid-19 risk levels in Istanbul.

Secondly, the negative perception about the city in terms of family life is expected to be reinforced by the Covid-19 outbreak, which has complicated living in a megacity, which is suffering from the congestion in public transport, and lack of public facilities and open-green areas. The survey results reveal that the Covid-19 outbreak has changed the thoughts of approximately 40% of the respondents about living in Istanbul. This trend may lead to an acceleration of relocations within/outside the Istanbul metropolitan area or urban sprawl towards rural settlements or natural areas. The decline of Istanbul’s population for the first time in the last century (from 1923 to the present), according to the 2020 census (TURKSTAT, 2021), confirms this trend. However, despite the overall negative perception about high-density districts in terms of the spread rate of the Covid-19 pandemic, it appears that living a high-density district is not a determinant factor to influence the perceptions of the respondents about city life in Istanbul after the outbreak. As we stated in the literature review section, previous studies relating urban density to the Covid-19 outbreak mostly focus on Covid-19 infection and mortality rates or vulnerability of cities using Covid-19 cases/death incidences as dependent or independent variables. The present study opens a new window by adding the perception of urban residents to the density-Covid-19 discussions in the literature.

The present study both contributes to the discussions on ‘urban density’ and ‘urban vitality’ in megacities, and extends the framework by adding the impact of the first phase of the Covid-19 outbreak on the perception of urban residents. However, the research has some limitations as we used average population densities of districts for the analysis. This is likely to ignore differentiations within districts in terms of density. Further studies may be repeated in neighborhood scale, and may also add some other variables such as land use features, building typologies, block size, walkability or public transit availability to the analysis. In addition, not only population density but also density of buildings, dwellings, or activities may be included in further studies.

### Table 11

The change in perception about the city life in Istanbul by six variables: p values.

| Thought about the suitability of Istanbul for a family to live compared to other cities (regardless of the outbreak) | vitality | Safety | Mobility | Healthiness | Cleanliness | Orderliness |
|---|---|---|---|---|---|---|
| Decision to move within the city (after the outbreak) | 0.782 | 0.045 | 0.620 | 0.039 | 0.513 | 0.165 |
| Decision to leave the city (after the outbreak) | 0.951 | 0.029 | 0.482 | 0.025 | 0.289 | 0.120 |
| Decision to move within the city (after the outbreak) | 0.592 | 0.287 | 0.569 | 0.215 | 0.817 | 0.920 |
| Decision to leave the city (after the outbreak) | 0.640 | 0.464 | 0.927 | 0.507 | 0.729 | 0.959 |
| Decision to leave the city (after the outbreak) | 0.682 | 0.333 | 0.212 | 0.732 | 0.999 | 0.662 |
| Decision to leave the city (after the outbreak) | 0.812 | 0.669 | 0.591 | 0.646 | 0.976 | 0.747 |

* Significant at 0.01/0.05 level (Pearson chi-square).
** Significant at 0.01/0.05 level (Linear-by-linear association).

### Table 12

The change in perception about the city life in Istanbul by two factors: p values.

| Healthy environment | Urban vitality | Healthy environment | Urban vitality |
|---|---|---|---|
| Thought about the suitability of Istanbul for a family to live compared to other cities (regardless of the outbreak) | 0.155 | 0.941 |
| Decision to move within the city (after the outbreak) | 0.326 | 0.690 |
| Decision to leave the city (after the outbreak) | 0.773 | 0.383 |
New studies are also expected to deepen the inquiries on the post-pandemic city and discuss them in different cases and different phases of the outbreak.

4.1 Takeaway for practice

Urban density has been one of the most important issues in urban policy and planning agenda for more than 100 years. The Covid-19 outbreak has brought urban density discussions again to the forefront. The results of our study give some clues to the policymakers and practitioners to deal with density-related problems in post-pandemic megacities. Firstly, since urban density is still a very useful tool to provide urban vitality, policymakers should focus on well-managed density strategies that increase vitality and diversity without leading to socioeconomic problems. It should be taken into consideration that higher densities without inadequate public transit and public infrastructure may result in a drastic decrease in the quality of urban life. Secondly, the increase in negative perceptions on dense settlements and megacities may accelerate urban sprawl that is more harmful to the environment than the spread of the pandemic. To prevent urban sprawl, urban policymakers should work on improving the quality of physical space and providing amenities in neighborhoods that are emerging live/ work space for post-pandemic communities.

CRediT authorship contribution statement

Muhammed Ziya Pakoz: Conceptualization, Methodology, Resources, Formal analysis, Software, Writing – original draft, Writing – review & editing. Merve İsk: Resources, Writing – original draft, Visualization.

Declaration of competing interest

No conflict of interest was declared by the authors.

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