International Journal of Human Capital in Urban Management
(IJHCUM)

Homepage: http://www.ijhcum.net/

Investigation of the relationship between urban stress and urban resilience

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ARTICLE INFO

ABSTRACT

BACKGROUND AND OBJECTIVES: Making society resilient is considered a critical and challenging issue in mental health planning or stress-relieving urban planning. However; although in recent years, many studies have separately addressed stress and urban resilience, no study has explained the relationship between the two. Therefore, the present study aims to explain the relationship between urban stress and urban resilience in the Region 8 of the District 1 of Tehran Municipality.

METHODS: This study is applied descriptive-analytical research. The required data are collected using both quantitative and qualitative methods and analyzed by regression analysis. First, using the library method, the indicators of urban stress and urban resilience were identified, then the study sample was selected using these indicators and the Delphi method. After; that, the information related to the indicators was collected using questionnaire and library methods, and finally, the relationship between urban stress and urban resilience was investigated through multivariate regression.

FINDINGS: The research findings indicate a high correlation between the two abovementioned concepts (correlation coefficient= 0.925). Moreover; the adjusted R^2 shows that resilience indicators explain 83% of the total variations in urban stress. Also; the most critical indicators affecting the citizens' stress include the status of open space, gender structure of the population, permeability, average building density, education level, resident participation, spatial diversity, citizen's sense of belonging, social diversity, violence, crime, the safeness of the environment, social capital, social solidarity, the strength of buildings, vulnerability to natural hazards, income status, employment status, environmental pollution, access to services, the age structure of the population, and safety, respectively.

CONCLUSION: it is possible to significantly reduce urban stress by enhancing urban resilience and paying attention to its effective indicators.

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
85	2	6

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INTRODUCTION

Cities are expanding rapidly (Evans *et al.,* 2020). In; 2007, the global urban population exceeded 50% for the first time (Chinomnso, 2014). Also; by 2025, about 70% of the global population is expected to reside in cities (Adli and Schondorf, 2020), and about 90% of this growth will happen in Africa and Asia (Kirkbride *et al.,* 2018). Urban areas, where half of the global population lives, experience many problems and issues due to their advantages (Mahmodzadeh and Herischian, 2018). For example, urban life affects mental health (Kyriakou and Resch, 2019), and urban stress and its adverse effects are the most important factors in increasing mental disorders in cities (Streit *et al.,* 2014). The stress of city life can be a basis for developing psychosis and mental disorders (Kennedy and Adolphs, 2011), (Wandersman and Nation, 1998). Urban stress is one of the important factors for physical and mental diseases, moral anomalies, reduced security of citizens, and waste of human capital in cities. For this reason, urban planners and designers must pay attention to this issue especially. The environment, especially the built environment of the city, greatly influences humans (Rishi and Khuntia, 2012; Neisiani *et al.,* 2020). Urban stress is one of the mental health challenges faced by urban communities (Pykett *et al.,* 2020). Despite the frequent use of this term in scientific articles and the media, its exact nature remains poorly defined. This concept is neither clearly defined nor well studied, and a better understanding of its nature seems to be a critical element for progress in this research area (Abrahamyan Empson *et al.,* 2019). For this reason, according to the definitions provided by (Rishi and Khuntia, 2012; Mehdipour *et al.,* 2017; Kyriakou and Resch, 2019; Elsamahy and Abd EL-Fattah, 2018; Miller and Phillips, 2005; Ventriglio, 2020; Abrahamyan Empson *et al.,* 2019; Kumar *et al.,* 2020), urban stress seems to be cumulative stress induced by the experience of living in the urban environment with undesirable conditions. It is a general term referring to the relationship between urban context and its impact on citizens' psychological state and a response to some perceived threats induced by adverse urban events such as pollution, high population, extreme temperature, crowding, noise, destroyed landscape, excessive accumulation of solid waste, waste of time during commuting, etc. It is created when the mentioned undesirable conditions

are beyond the tolerance of the city dweller. Also; nowadays, the global perspective has changed from reducing damage to increasing resistance to risks, so it is essential to consider the issue of resilience in urban decisions (Mahmodzadeh and Herischian, 2018). Enhancing urban resilience will result in minimized damage caused by hazards. This issue is so important that it is considered a new model for urban development by some researchers (Rezaie et al., 2021). The term resilience stems from the Latin Resilio, meaning to rebound (Rezaie *et al.*, 2021), and it refers to the extent to which a system is capable of absorbing risks and reorganizing itself (Alberti *et al.,* 2003). Although many definitions have been presented for this concept, all these definitions are in the same direction. Enhancing resilience in cities is an important issue, and cities must react more quickly and more effectively to minimize risks. Urban resilience refers to the ability of a city to absorb disturbances while maintaining its functions and structures (Mahmodzadeh and herischian, 2018). Urban resilience refers to the ability of a city or an urban system to withstand stress and shocks (Karimi Razkani *et al.,* 2019), and it aims to reduce the vulnerability of cities and strengthen the abilities of citizens to deal with risks (Mohammadi Kazemabadi *et al.*, 2020). The research background includes two parts: urban stress and urban resilience. The study of urban stress began with Simmel's thesis in 1903 (Simmel, 1903). Next; in the 1950s and 1960s, Prindle (Prindle, 1968), and Milgram (Milgram, 1970) addressed this issue.)Table 1(presents the background of urban stress.

Reviewing previous studies on urban stress identifies 12 approaches: Studies on the relationship between urbanization and stress, Studies on the difference between urban and rural environments in stress, Studies on urban stress, Studies on urban stressors, Studies on only a stressful factor or stress induced by a part of the city, Studies on the relationship between stress and mental health or diseases such as asthma, Studies on stressful places, Studies on the effects of urban stress on specific groups, Studies on effective solutions or approaches to urban stress, Studies on the ranking of cities in the stress rate, Studies on the design of non-stressed spaces, and Studies on new urban stress assessment techniques. The study of resilience was started in 1973 by Holling. And his opinion resilience is defined as a "measure

Table 1: Background investigation of urban stress

Authors	Year	Research title	Results
Simmel	1903	The Metropolis and Mental Life	Proof of the relationship between urbanization and stress.
Proshansky	1972	Urban Stress	Stress factors such as noise have many effects.
Christmas	1973	Psychological stresses of urban living: a new direction for mental health services in the inner city	Emphasizing the necessity of developing health services against urban stress.
Lazarus and Cohen	1977	Environmental Stress	Wust examine urban stress continuously and in the natural environment.
Baum *et al.*	1981	Stress and the Environment	Stress affects the relationship between people and their surroundings.
Cohen *et al.*	1986	Environmental stress and cognitive performance	Stress affects human behavior and health.
Burton	1990	Factors in urban stress	Introduction of urban stressors.
Haines *et al.*	2001	Chronic aircraft noise exposure, stress responses, mental health and cognitive performance in school children	Airport noise causes stress.
Jaffee *et al.*	2005	Race, urban community stressors, and behavioral and emotional problems of children with special health care needs	Urban stress assessment is the most crucial way to identify urban stressors.
Quinn *et al.*	2010	Stress and the city: housing stressors are associated with respiratory health among low socioeconomic status Chicago children	Urban stress as a social pollutant has a significant effect on the exacerbation of asthma symptoms.
Lederbogen *et al.*	2011	City living and urban upbringing affect neural social stress processing in humans	Cities negatively affect mental health and mood, and anxiety disorders are more common in cities.
Adli	2011	Urban stress and mental health	Urban stress should be investigated thoroughly interdisciplinary manner.
Seth *et al.*	2012	The Concrete Jungle: City Stress and Substance Abuse among Young Adult African American Men	Public health interventions to control drug use should address psychological factors such as stress and neighborhood violence.
Rishi and Khuntia	2012	Urban Environmental Stress and Behavioural Adaptation in Bhopal City of India	Provide guidelines for other cities to develop environmental competence and raise awareness about urban stress.
Lederbogen *et al.*	2013	Urban social stress Risk factor for mental disorders	To understand urban stress, factors such as social conditions, environmental pollutants, infrastructure, and economic issues should be considered.
Steinheuser *et al.*	2014	Stress and the City	Urban upbringing is associated with increased cortisol response to acute stress.
Freeman *et al.*	2015	The Stress of the Street for Patients with Persecutory Delusions: A Test of the Symptomatic and Psychological Effects of Going Outside into a Busy Urban Area	Compared to staying at home, street exposure resulted in significant increases in paranoia, voices, anxiety, negative beliefs about self, and negative beliefs about others.
Willie *et al.*	2016	Stress in the City: Influence of Urban Social Stress and Violence on Pregnancy and Postpartum Quality of Life among Adolescent and Young Mothers	A stress reduction program is needed to help young mothers in urban areas.
Adli *et al.*	2016	Neurourbanistik-ein methodischer Schulterschluss zwischen Stadtplanung und Neurowissenschaften	Introducing an interdisciplinary approach between architecture, urban planning, neuroscience, and medicine, for which the term neuro-urbanism is proposed.
Söderström *et al.*	2017	Unpacking 'the city: An experience-based approach to the role of urban living in psychosis	Identifying stress coping tactics through systematic analysis of interviews and observations.
Mubi Brighenti and Pavoni	2017	City of unpleasant feelings	Adaptation strategies to stressful environments are not only personal or individual but also group and social.
Knöll *et al.*	2017	A tool to predict perceived urban stress in open public spaces	Types of public open space, street network characteristics, and building density are, the most important predictors of perceived urban stress.
Maureen	2017	Revealed: The world's least stressful cities	According to the findings of the Zipjet Institute, the least stressful cities in the world are including Stuttgart, Luxembourg, Hanover, Bern, Munich, Bordeaux, Edinburgh, Sydney, (Kravat) Graz, and Hamburg. Moreover; the tensest cities in the world are Baghdad, Kabul, Lagos, Dakar, Cairo, Tehran, Dhaka, Karachi, New Delhi, and Manila. According to these results, Tehran is the sixth most stressful city in the world.
Li and Liu	2018	Housing stress and mental health of migrant populations in urban China	Poor housing conditions are significantly associated with perceived stress.

Table 1: Background investigation of urban stress

Authors	Year	Research title	Results
Chrisinger and King	2018	Stress Experiences in Neighborhood and Social Environments (SENSE): a pilot study to integrate the quantified self with citizen science to improve the built environment and health	The results of this research are identifying several stress factors through biosensing.
Elsamahy and Abd EL-Fattah	2018	Designing non-stressed psychological public spaces	Development of a methodology for designing stress-free public spaces.
Fett *et al.*	2019	Psychosis and urbanicity	Library research in the field of mental health and urban stress and identification of challenges.
Meloni *et al.*	2019	Predicting pro-environmental behaviors in the urban context: The direct or moderated effect of urban stress, city identity, and worldviews	City identity moderates the relationship between urban stress and willingness to pay for green energy and non-waste generation, respectively.
Baumann *et al.*	2020	Urban remediation: a new recovery-oriented strategy to manage urban stress after first-episode psychosis	Examining possible strategies to help promote mental health and reduce urban stress.
Evans *et al.*	2020	Urbanicity, biological stress system functioning and mental health in adolescents	The findings of this research provide evidence of the relationship between urbanization, stress, and mental health problems.
Pykett *et al.*	2020	From Urban Stress to Neurourbanism: How Should We Research City Well-Being?	Citizen-centered approaches can create more effective ways to address urban stress and promote wellness in urban communities.
Shannon *et al.*	2020	Neighborhood Violent Crime and Perceived Stress in Pregnancy	Regardless of race, violent neighborhood crimes are associated with high levels of perceived stress in an urban cohort and pregnant women.
Hernandez *et al.*	2020	Urban Stress Indirectly Influences Psychological Symptoms through Its Association with Distress Tolerance and Perceived Social Support among Adults Experiencing Homelessness	Increasing social support reduces urban stress.
Adli and Schondorf	2020	Macht uns die Stadt krank. Wirkung von Stadtstress auf Emotionen, Verhalten und psychische Gesundheit; Does the city make us ill? The effect of urban stress on emotions, behavior, and mental health	The final finding of this research is to introduce a method to study stress in cities.
Vargas *et al.*	2020	Chronic stress, structural exposures, and neurobiological mechanisms: A stimulation, discrepancy and deprivation model of psychosis	Determining the cause of stress at the systems level is a necessary step in reducing barriers to effective interventions and health policy.
Dykas *et al.*	2021	Early Adolescents' Risk-Taking Propensity, Urban Stress, and Affiliation with Risky Peers	Dependence on risky peers is in high levels of urban stress.
Buttazzoni *et al.*	2021	How Do Urban Environments Affect Young People's Mental Health? A Novel Conceptual Framework to Bridge Public Health, Planning, and Neurourbanism	Proposing two new conceptual frameworks (research-oriented and practice-oriented), which focus on the relationship between urban environments and the mental health of young people. And can help guide practice and future research in this field.
Moghani Rahimi *et al.*	2022	Investigating the Factors Affecting Urban Stress in World Literature	Urban stress is mostly due to social stressors such as population density, social isolation, social deprivation, and poor social interactions, as well as environmental stressors such as noise pollution and air pollution.
Moghani Rahimi *et al.*	2023a	Explaining the Relationship between City and Mental Health Using Content Analysis Technique and Maxqda Software	urban stress and physical health can mediate the effects of urbanization on mental health and the effects of mental health on the city. A better understanding of this relationship and the effect of mediators and trying to reduce the negative effects of cities on mental health will help a lot to develop coping strategies, better planning of future cities and maximum exploitation of the benefits of urban life.

of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations or state variables" (Holling, 1973). In recent years, the study of this concept has attracted particular attention. Studies such as Dadashpoor and Adeli (2015), Mohammadi Kazemabadi *et al.* (2018), Mahmodzadeh and Herischian (2018), Dawley (2010), and Kimhi and Joshua (2016) have measured resilience in a specific city or Region. Also; studies such as Zhang *et al.* (2013), and Foster (2007), have discussed strategies to promote resilience, and Meerow and Joshua (2016), have reviewed the theoretical literature on this issue. However; there are a few studies on the relationship between resilience and another issue. Zhang and Li (2018), investigated the relationship between resilience and urban sustainability, Leitner *et al.* (2018), examined the relationship between resilience and globalization; and Jones *et al.* (2011), studied the relationship between resilience and tourist attraction. As mentioned; many studies have separately addressed urban stress and resilience using different approaches. However; no study has explained the relationship between these two topics

Table 2: Indicators and metrics of the concept of urban resilience

Expert	Year	Social diversity	Crime	Violence	Security	The age structure of the population	The gender structure of the population	Education level	Resident participation	citizens' sense of belonging	Population density	Social solidarity	Social capital	Employment status	Income status	Spatial diversity	Strength of buildings	Permeability	Status of urban open space	Access to services	Average building density	Safety	Environmental pollution	Vulnerability to natural hazards
														Economic Resilience			Spatial Resilience						Environmental Resilience	
Rezaie *et al.*	2021										*			*			*	*	*	*				*
Maleki *et al.*	2020										*						*	*		*	*			
Mohammadi Kazemabadi *et al.*	2020								*		*			*	*					*			*	*
Mahmodzadeh and herischian	2018							*	*	*				*	*	*	*		*	*	*		*	*
Gharai *et al.*	2017	*	*	*	*										*	*	*	*	*	*		*	*	*
Dadashpoor and Adeli	2015					*	*	*			*			*	*	*				*	*			
Ribeiro and Gonçalves	2019						*	*			*			*	*		*			*				

| The gauges | | People's opinion about the amount of social diversity of the residents from economic and social points of view | The level of exposure of the residents to the occurrence of crime in the urban context | The level of exposure of residents to the occurrence of violence in the urban context | Residents' sense of security in the context | Percentage of the population under 6 years old and over 65 years old | Percentage of female population | Literacy rate | The level of participation in local decisions and programs | The extent of residents' sense of belonging to the place of residence | - | The degree of feeling of social solidarity by residents | The extent to which residents' interactions, participation, and relationships are perceived as capital for them | Employment rate | Income rate | Variety of houses, façades, and land uses | Percentage of resistant buildings | Percentage of passages with a width of less than 6 m | Access to open space, percentage of open space Being located within walking distance from open space | Being located within the access radius of green spaces, and sports, religious, educational, cultural, and healthcare uses | Being located within the performance radius of the fire department, being far from dangerous land uses, pedestrian-vehicle separation, the status of pavements | - | Air, sound, light, visual, and water pollution, and waste accumulation | Vulnerability to floods, and earthquakes, |

| Data collection methods and data resources | | Questionnaire | Questionnaire | Questionnaire | Questionnaire | The authors' calculations according to the 2015 census data received from the Statistics Organization | The authors' calculations according to the 2015 census data received from the Statistics Organization | The authors' calculations according to the 2015 census data received from the Statistics Organization | Questionnaire | Questionnaire | The author's calculations according to the 2015 census data received from the Statistics Organization | Questionnaire | Questionnaire | The author's calculations according to the 2015 census data received from the Statistics Organization | The author's calculations according to the 2015 census data received from the Statistics Organization | The author's calculations according to the 2015 census data received from the Statistics Organization | The author's calculations according to the 2015 census data received from the Statistics Organization | Author's calculations according to the 2015 census data received from the Statistics Organization | Authors' calculations and municipal information Spatial analyses | Spatial analyses and municipal information | Authors' calculations and municipal information | Spatial analysis using municipal information received from the municipality in 2020, and a field survey | Spatial analyses (Taking into account the functional radius in the software GIS was buffered and finally the buffers coincided) Zoning of air pollution presented in (Bahari *et al.*, 2016), field sampling using a sound level meter, light pollution from the map presented in (Serat news, 2020), exposure to polluted water and waste in tissue through field sampling | Documentary study (Summarizing the degree of vulnerability of the studied area against earthquakes (Hashemi *et al.*, 2014) and the degree of vulnerability of the studied area against floods (Shahroudi Tail & Derafshi, 2015)) |

so far, although identifying this relationship can be very effective in stress-relieving urban design and urban planning. The degree of correlation between these two issues is not known. Also, it is not clear what effect each of the indicators or dimensions of urban resilience has on urban stress. Making society resilient, or enhancing the ability of a society to resist past and future difficulties and promoting belief in this ability, is a critical and challenging issue in mental health planning or stress-relieving urban planning (Lloyd *et al.*, 2005). Therefore; the present study aimed to explain the relationship between urban stress and urban resilience in the Region 8 of the District 1 of Tehran Municipality, which is identified as the most stressful Region in the district according to the expert's opiniun. The current study was carried out in Tehran, in 2022.

MATERIALS AND METHODS
Survey design and data collection

The present study is applied descriptive-analytical research. The required data were collected using quantitative and qualitative methods such as the questionnaire, interview, observation, and library studies and then, analyzed using regression analysis. In the present study, 23 resilience indicators (Table 2) were examined, and the data on seven indicators were collected using a questionnaire and the rest through quantitative methods such as spatial analysis, field sampling, etc. To assess urban stress, 34 indicators (Table 3) were examined, and the data on 15 indicators were collected using a questionnaire and the rest through quantitative methods. According to the residents of the case study in 2020 (59429 people), and Cochran's formula, with a confidence level of 95%, an error of 0.05%, and a normal variable rate of 1.96, the minimum number of questionnaires was 381 people. Considering that proportional stratified sampling was used in this research and the number of questionnaires related to each block is proportional to its population. However, since the population percentage of some blocks is less than the others and the number of questionnaires related to them is less than 0.5, one questionnaire was distributed in that block, and finally, 413 people in the case study were selected as samples using the simple random sampling technique, and the questionnaires were distributed among them. The data on objective indicators were also collected using

field surveys, library studies, and spatial analyses. The reliability of the questionnaire was examined with Cronbach's alpha coefficient, which was calculated as 0.73. Finally, the correlation between mixed-use and urban stress reported by citizens was evaluated with regression analysis. It should be noted that the Likert scale was used to measure qualitative indicators. Also, how to collect information related to indicators and metrics related to them is described in the tables.

Introduction of case study

The Delphi technique was used to identify the case study considering that the relative certainty of the stressfulness of the studied area was critical. For this purpose; in several steps, using the Delphi technique, first, a region of Tehran city and then a district of that region have been selected. In the first step, the indicators presented in (Table 3) were checked by 15 experts familiar with the city of Tehran in 22 districts of this city. In fact, at this stage, the experts were given a table with the indicators in the rows and the regions in the columns, and they were asked to rate each region from 1 to 5 based on their knowledge. Then the scores were analyzed and District 1 of Tehran city was selected. This area is one of the upper-class districts of Tehran city, which has experienced high-rise building construction and a sharp increase in population and building densities in recent years. Moreover; Municipal Districts 1 and 2 in Tehran are known as the districts where one can see the neighborhood of upper and lower-class residents (Young Journalists Club, 2018). In addition, this district is one of the hazard-prone areas of Tehran, which is in poor conditions in terms of safety and vulnerability to natural hazards (Hashemi et al., 2014). In the next step, it was attempted to identify the experts in the field of urban planning who were familiar with the Municipal District 1 of Tehran and the issues of mental health and urban stress. To this end, Authors who had a history of research in this area and those urban planning experts who have a history of non-research activity in this area (municipal employees or consulting companies) were identified. Next, using a semi-structured questionnaire, the individual characteristics of 21 experts and their interest in participating in the next stage were measured. Then, a structured questionnaire was developed, and 15 experts interested in participating in the next step were asked to rank the regions in this district in urban

Table 3: Indicators and metrics of the concept of urban stress

Expert	Year	Social										Economic		Environmental			Cultural	Land-use and activity		Transport					Individual characteristics				Physical form					Housing	
		Exposure to crime	Social support	Social interactions	Justice in the city	Immigration	Security in the environment	Population density	Sense of belonging	Drug exposure and use	Participation rate	Employment and income	Economic deprivation	Environmental pollution	Safety	Temperature	Cultural and psychological deprivation	Mixed land-use	Access to services	Traffic	Quality of roads	Walking facilities	Public transportation	Urban texture permeability	Unhealthy lifestyle	Knowledge of coping skills	Self-confidence	Communication with nature	Average building density	The beauty of the environment	Stressfulness of the urban environment	State of urban furniture	Quality of disabled facilities	Quality of the residential unit	Rent and price of land and housing
Knox Mental Health Action Plan 2021– 2025	2021	*	*	*	*	*	*			*		*					*		*								*	*							
Litman	2021	*	*	*	*	*						*	*	*				*	*	*	*						*							*	
Ventriglio	2020	*	*	*	*	*	*	*				*	*	*				*				*	*				*							*	
Adli and schondorf	2020					*						*		*			*		*																*
Vargas *et al.*	2020	*			*			*	*								*		*																
Baumann *et al.*	2020		*	*		*						*	*					*											*						
Abrahamyan Empson *et al.*	2019		*	*		*							*																						
Interdisciplinary Forum Neurourbanism	2019			*			*			*						*					*						*								
Vojnovic *et al.*	2019				*	*		*			*				*		*		*	*	*						*	*							
Knöll *et al.*	2017				*								*		*			*	*	*	*						*								
The gauges		The level of exposure of residents to the occurrence of crime in the urban context	The amount of support residents has for each other	The amount of social communication between residents	The degree of feeling of fairness in the distribution of resources by the people, the degree of feeling of provision of facilities for all by the people, the degree of feeling of providing adequate access to services by the people, the degree of feeling of fair provision of employment and housing	The percentage of immigrants in the texture	Residents' sense of security in context		The extent of residents' sense of belonging to the place of residence	The amount of exposure to drug use or buying and selling in context and the amount of drug use	Rate of participation in local decisions	The employment percentage, percentage of lower-income residents	Unemployment rate, percentage of lower-income residents	Air, sound, light, visual, and water pollution, and waste accumulation	Being located within the performance radius of the fire department, being far from dangerous land uses, pedestrian-vehicle separation, the status of pavements		Being located within walking distance from cultural institutions and places, the use of cultural institutions and places, the feeling of shame in using mental health services	Being located within the access radius of green spaces, sport, religion, educational, cultural and healthcare uses, and mental health services	Being located within walking distance from bus and metro stations, number of stations, waiting time for public vehicles	The amount of the appearance quality of the roads, the average width of the roads	The existence of separate sidewalks, the quality of the path, and suitable furniture on the sidewalks	Percentage of passages with a width of less than 6 m		The amount of use of healthy food, the amount of exercise		The level of self-confidence of residents	The number of monthly visits to nature		How beautiful the environment is according to the residents	Residents' opinion about the stress caused by the city to residents			Percentage of resistant buildings, percentage of non-apartment residential units, average area	The authors' calculations according to the 2015 census data received from the Statistics Organization
Data collection methods and data resources		Questionnaire	Questionnaire	Questionnaire	Questionnaire	The authors' calculations according to the 2015 census data received from the Statistics Organization	Questionnaire	Questionnaire	Questionnaire	Questionnaire	The authors' calculations according to the 2015 census data received from the Statistics Organization	The authors' calculations according to the 2015 census data received from the Statistics Organization	Zoning of air pollution presented in (Bahari *et al.,* 2016), field sampling using a sound level meter, light pollution from the map presented in (Saraei News Club, 2020), exposure to polluted water and waste in tissue through field sampling	Spatial analysis using municipal information received from the municipality in 2015, and a field survey		Spatial analysis and municipal information	Documentary study (Temperature zoning of Tehran city based on the annual average of 2017 prepared by the National Drought and Crisis Management Organization (National Drought and Crisis Management Organization, 2017))	In order to measure the level of traffic congestion, the amount of traffic has been checked by using the map finder and route finder application on three days of the week, the functional radius in the software GIS was buffered and finally the buffers coincided. Calculation of entropy rate	Spatial analyses (Taking into account the functional radius in the software GIS was buffered and finally the buffers coincided.) Calculation of the percentage according to the information specification table (GIS) of the municipality received from the municipality in 2020	Field surveys, Calculation of the percentage according to the information specification table (GIS) of the municipality received from the municipality in 2020	Field surveys	Spatial analysis, field survey, and documentary study	Authors' calculations and municipal information	Questionnaire	Questionnaire	Questionnaire	Questionnaire	the information specification table (GIS) of the municipality received from the municipality in 2020	Questionnaire	Questionnaire	Field surveys	Field surveys	The authors' calculations according to the 2015 census data received from the Statistics Organization	Interview with local real estate consultants

stress (Based on the indicators presented in Table 3). The reliability of the questionnaire was examined with Cronbach's alpha coefficient, which was calculated as 0.79. The validity of the questionnaire was also evaluated by experts. Experts, experts were asked to give each of the 9 areas a score from 1 to 5. f the experts, 53.33% were female, and 46.66% were male. Also; four experts had a doctoral degree, 6 had a master's degree, and 5 had a bachelor's degree. It should be noted that before this step, objective indicators such as temperature, environmental pollution, building density, *etc.*, were examined in region 1, and related information was provided to the experts along with a questionnaire. This action was very useful in ranking objective indicators by experts. Finally; the total score of each Region was analyzed,

and the Region 8 of the District 1 was selected as the case study (More information on how to choose a case study is mentioned in this reference (Moghani Rahimi *et al.*, 2023b). As shown in Fig. 1, this region, with an area of 3.13 km², is located in the northern part of Tehran and has two neighborhoods, Hekmat and Chizar.

RESULTS AND DISCUSSION

In this section, according to the purpose of the research and the reviewed literature, urban resilience, which was evaluated with 23 indicators presented in Table 2, was considered an independent variable, and urban stress of citizens was considered a dependent variable. The relationship between them was investigated through a multivariate regression model. To measure the urban stress in the blocks, several experts familiar with the study area were asked to make a pairwise comparison between the 34 indicators presented in Table 3. Then, using Expert Choice software and AHP method, the importance coefficient of each index was determined. Finally, considering the importance coefficient of each index and the direction of its impact on urban stress, and using the weighted average, The stress value of each block is calculated and considered as a dependent variable. This model examines the correlation coefficient between independent and dependent variables, the amount of explanation of changes in the dependent variable by the independent variable, and the regression coefficient of each of the independent variables (Saidi *et al.*, 2021; Jehan *et al.,* 2020). In fact; at this stage, the data on each urban stress indicator were collected and analyzed, and the stressfulness of each block was calculated. Then; the final data on this question were analyzed as the dependent variable and the data on resilience indicators as the independent variable in SPSS software. Table 4 shows the summary of this model. The correlation coefficient between the variables was estimated as 0.925, indicating a very high correlation between the identified indicators of resilience and urban stress. Moreover; the adjusted R^2 shows that 23 resilience indicators explain 83% of the total variations in the stressfulness of the living environment. In other words, the identified factors predict 83% of the variance of the dependent variable. This result shows that urban resilience has a great impact on urban stress. In fact, by making the urban environment resilient, urban stress can be greatly reduced and the
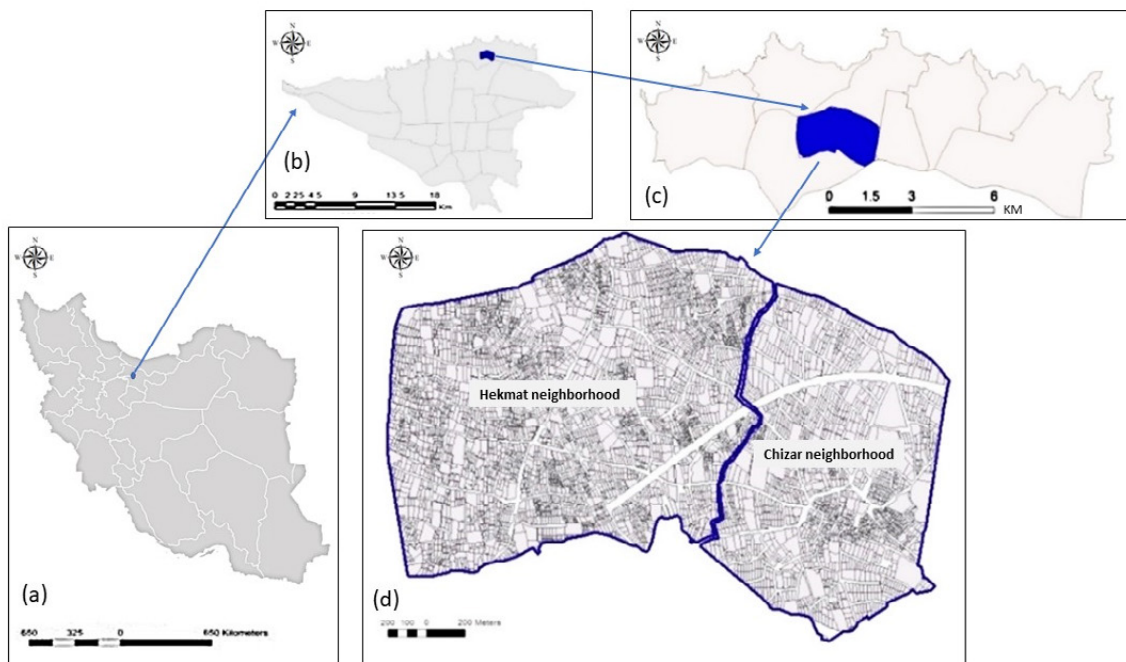

Fig 1: Geographic location of the study area; (a) Iran, (b)Tehran, (c) District 1 of Tehran, (d) Region 8 of the District 1 of Tehran Municipality

Table 4: Summary of the regression model

Correlation coefficient	R^2	Adjusted R^2	Std. Err
0.925	0.855	0.834	0.7698

Table 5: F test of the regression model

Model	The sum of squares of dispersion	df.	The mean of squares (MS)	F-statistic	Sig.
Variations in or dispersion of the contribution of the model	5.536	23	0.241	40.417	0.000
Variations according to residuals	0.936	158	0.006		
Total variation of dispersion	6.472	181			

mental health of citizens can be improved. Of course, this result was somewhat predictable. But the most important measure to make the urban environment resilient to reduce stress is to identify the importance of urban resilience indicators.

(Table 5) shows the second significant output of regression analysis and answers whether the independent variables can explain the variations in the dependent variable. According to; this table, the Sig. of the F-value is explained at the error level < 0.05. According to; this table and the Sig. of the F-test (< 0.05), it can be said that the set of identified factors can predict variations in citizens' stress.

The third significant output of the regression analysis includes the coefficients of the independent variables, as shown in (Table 6). Since independent variables, i.e., resilience indicators, differently influence citizens' stress, beta coefficients can be used in regression analysis to determine the relative significance of each independent variable (Tabaeian *et al.*, 2021).

In this section, beta coefficients have been used to measure the impact of each urban resilience index (independent variable) on urban stress (dependent variable). The values of these coefficients show the sensitivity of the dependent variable to each of the indicators of the independent variable. According to (Table 6) and the beta coefficients presented in it, the most critical indicators affecting citizens' stress include the status of open space (-0.345), the gender structure of the population (0.285), permeability (0.28), the average building density (0.264), the education level (0.24), the resident participation (-0.191), spatial diversity (-0.174), citizens' sense

of belonging (-0.171), social diversity (-0.163), violence (0.154), crime (0.136), safeness of the environment (-0.135), social capital (-0.132), social solidarity (-0.129), the strength of buildings (-0.126), vulnerability to natural hazards (0.115), income status (-0.113), employment status (-0.112), environmental pollution (0.097), access to services (-0.077), the age structure of the population (0.077), safety (-0.069), and population density (0.058), respectively. At the 95% confidence level, one can say that the population density indicator has no significant effect on the citizens' stress. This indicator does not affect the dependent variable because its error value or Sig. is more significant than 0.05. This conclusion is quite logical considering that different individuals may have different perceptions of population density because they have various preferences regarding the crowd around them. Some people experience more stress in solitude, while others experience urban stress when they are in a crowd. Low population density and high population density are both considered stressful. Also; the indicators of crime, violence, the age structure of the population, the gender structure of the population, education level, permeability, average building density, and environmental pollution directly influence urban stress. In other words; urban stress will also increase as these indicators are enhanced. The higher the amount of crime and violence, the percentage of the population under 6 years old and over 65 years old, the percentage of the female population, the literacy rate, the percentage of passages with a width of less than 6 m, the building density, and environmental pollution in the city, the more urban stress citizens

Table 6: Coefficients of factors identified in the model

	Independent variable		Non-normalized coefficient		Normalized coefficient	T	Sig.
			B	Std. Err	Beta		
			3.947	0.112		35.289	0.000
1		Social diversity	-0.032	0.007	-0.163	-4.761	0.000
2		Crime	0.032	0.009	0.136	3.521	0.001
3		Violence	0.034	0.008	0.154	4.065	0.000
4		Safeness of environment	-0.025	0.007	-0.135	-3.644	0.000
5		The age structure of the population	0.025	0.011	0.077	2.259	0.025
6	Social	The gender structure of the population	0.051	0.007	0.285	7.476	0.000
7		Education level	0.053	0.007	0.24	7.178	0.000
8		Resident participation	-0.047	0.008	-0.191	-5.558	0.000
9		Citizens' sense of belonging	-0.038	0.008	-0.171	-4.926	0.000
10		Population density	0.014	0.011	0.058	1.302	0.195
11		Social solidarity	-0.039	0.01	-0.129	-3.994	0.000
12		Social capital	-0.044	0.011	-0.132	-3.928	0.000
13	Economic	Employment status	-0.023	0.007	-0.112	-3.33	0.001
14		Income status	-0.045	0.017	-0.113	-2.614	0.010
15		Spatial diversity	-0.035	0.007	-0.174	-5.036	0.000
16		Strength of buildings	-0.049	0.013	-0.126	-3.698	0.000
17	Spatial	Permeability	0.043	0.005	0.28	8.528	0.000
18		Status of urban open space	-0.087	0.008	-0.345	-10.372	0.000
19		Access to services	-0.034	0.014	-0.077	-2.315	0.022
20		Average building density	0.066	0.012	0.264	5.629	0.000
21		Safety	-0.021	0.011	-0.069	-2.023	0.045
22	Environmental	Environmental population	0.03	0.012	0.097	2.547	0.012
23		Vulnerability to natural hazards	0.029	0.011	0.115	2.723	0.007

experience. However; since an individual's education level can lead to the knowledge of coping skills and, thereby, the perception of less urban stress, its positive effect on urban stress was observed in the present study. Also; the indicators of social diversity, safeness of the environment, resident participation, citizens' sense of belonging, social solidarity, social capital, employment status, income status, spatial diversity, the strength of buildings, the status of open space, access to services, and safety indirectly influence urban stress. In other words; increasing these indicators will result in reduced urban stress. As shown in Fig. 2, in the spatial dimension, the "status of open space" indicator is the main indicator affecting citizens' stress, followed by the gender structure of the population in the social dimension, the vulnerability to natural hazards in the environmental dimension, and the income status in the economic dimension. According to the research findings, "the status of open space" is known as the indicator with

the greatest impact on urban stress. In fact, the lack of open space and large constructions in the urban environment have the greatest impact on the stress of citizens. The more urban open space there is in the city, the less urban stress a person experiences. According to)Table 6(, social resilience has the greatest impact on urban stress. After this dimension, spatial resilience, environmental resilience, and economic resilience are important, respectively.

urban stress by Knöll *et al.* (2017) was measured using indicators such as Population density, Environmental pollution, Temperature, Quality of roads, Urban texture, and Average building density. Then, Vojnovic *et al.* (2019) introduced indicators such as Security in the environment, Population density, Employment and income, Safety, Mixed land use, Traffic, Quality of roads, walking facilities, Average building density, and Urban furniture as the most critical indicators affecting urban stress. Then, the Interdisciplinary Forum Neurourbanism
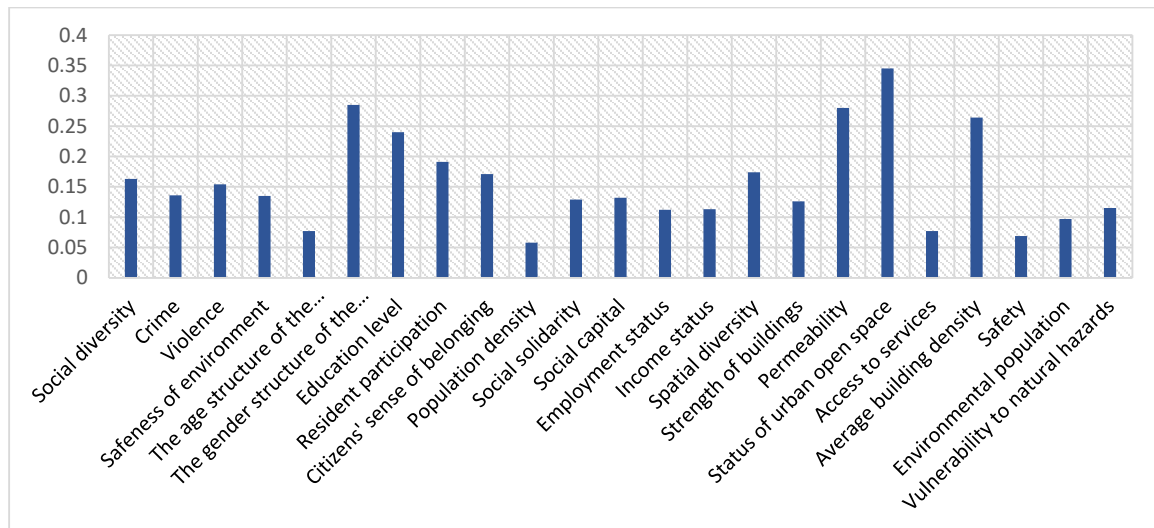
Fig 2: Investigating the influence of resilience indicators on urban stress

(2019), introduced proposed indicators such as social interactions, population density, participation rate, cultural and psychological deprivation, public transportation, and the beauty of the environment The current study also identified urban resilience as a critical factor in reducing citizens' stress and indicators such as the status of open space, the gender structure of the population, permeability, the average building density, the education level, resident participation, spatial diversity, citizens' sense of belonging, social diversity, violence, crime, the safety of the environment, social capital, social solidarity, the strength of buildings, vulnerability to natural hazards, income status, employment status, environmental pollution, access to services, the age structure of the population, safety, and population density, as the most critical effective indicators. This research develops the results of previous studies and promotes urban resilience as an effective solution to reduce urban stress.

CONCLUSION

Urban stress is a critical cause of physical and mental disorders in cities. Also, enhancing urban resilience results in minimized damages caused by hazards. Making the community resilient is a critical and challenging issue in mental health planning or stress-relieving urban planning. However, although many studies have separately addressed urban stress

and resilience in recent years, no study has explained the relationship between the two. Therefore; the present study aimed to explain the relationship between urban stress and urban resilience in the Region 8 of the District 1 of Tehran Municipality, which was selected based on the status quo of Tehran and District 1 of this city. The research findings indicated that the correlation coefficient between the variables was estimated as 0.925, indicating a very high correlation between the identified resilience indicators and urban stress. Moreover; the adjusted R^2 shows that 23 resilience indicators explain 83% of the total variations in the stressfulness of the living environment. In other words; the identified factors predict 83% of the variance of the dependent variable. Also; the most critical indicators affecting the citizens' stress include, respectively, the status of open space, gender structure of the population, permeability, average building density, education level, resident participation, spatial diversity, citizens' sense of belonging, social diversity, violence, crime, the safeness of the environment, social capital, social solidarity, the strength of buildings, vulnerability to natural hazards, income status, employment status, environmental pollution, access to services, the age structure of the population, and safety. Also; the indicators of crime, violence, the age structure of the population, the gender structure of the population, education level, permeability, average building density,

and environmental pollution directly influence urban stress. In other words, urban stress will also increase as these indicators are enhanced. The higher the amount of crime and violence, the percentage of the population under 6 years old and over 65 years old, the percentage of the female population, the literacy rate, the percentage of passages with a width of less than 6 m, the building density, and environmental pollution in the city, the more urban stress citizens experience. However; since an individual's education level can lead to the knowledge of coping skills and, thereby, the perception of less urban stress, its positive effect on urban stress was observed in the present study. Moreover; the indicators of social diversity, safeness of the environment, resident participation, citizens' sense of belonging, social solidarity, social capital, employment status, income status, spatial diversity, the strength of buildings, the status of open space, access to services, and safety indirectly influence urban stress. In other words, increasing these indicators will result in reduced urban stress. Also; at the 95% confidence level, one can say that the population density indicator has no significant effect on the citizens' stress. This indicator does not affect the dependent variable because its error value or Sig. is more significant than 0.05. This conclusion is logical, considering that different individuals may have different perceptions of population density. Because different individuals have various preferences regarding the crowd around them, some people experience more stress in solitude, while others experience urban stress when they are in a crowd. Low population density and high population density are both considered stressful. As a result; it is possible to significantly reduce urban stress in the studied Region and Tehran city by enhancing urban resilience and paying attention to its effective indicators.

AUTHOR CONTRIBUTIONS

Kh. Moghani Rahimi performed the literature review, experimental design, compiled the data, analyzed and interpreted the data, prepared the manuscript text, and manuscript edition. M. Behzadfar performed the literature review, compiled the data and manuscript preparation. S. Jalilisadrabad performed the literature review, compiled the data, analyzed and interpreted the data, and manuscript preparation.

CONFLICT OF INTEREST

The authors declare no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the authors.

PUBLISHER'S NOTE

Tehran Urban Planning and Research Center remains neutral with regard to jurisdictional claims in published maps and institutional afflictions.

ABBREVIATION

B	Uncorrected regression coefficient
Beta	Beta coefficient
df.	Degrees of Freedom
MS	The mean squares
R^2	R-squared correlation
Sig.	significance

Std. Err   standard error of the mean

T   T-test

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