Housing and mental health during outbreak of COVID-19

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ABSTRACT

With global health concerns of a novel coronavirus (COVID-19), house quarantine was considered to prevent the outbreak of the disease and to ensure physical health. However, it may cause serious mental health problems. The present study aimed to evaluate housing preferences, housing satisfaction, and mental health of residents during house quarantine of COVID-19 considering housing type, spaces, environmental factors, and function and activities. In this regard, quantitative data were gathered through administering online questionnaires. In April 2020, responses were collected from 421 residents who lived in Tehran, then the collected data were analyzed using the SPSS software. According to the results, environmental factors had a higher mean than spaces and functions and activities throughout housing preferences, and the best mental health was related to the very high satisfaction level of the roof, green space, and exercising outdoor indicators. Findings of housing type revealed that people who lived in private houses had better mental health than residents of low-rise or high-rise housing.

1. Introduction

In the last two decades, the world has experienced three coronaviruses that have caused global health concerns. The outbreak of SARS-CoV in Guangdong, China, began in 2002 and the last case occurred in September 2003. Nine years later, a new coronavirus called MERS CoV appeared in the Middle East and caused respiratory illness [1], and in December 2019, Wuhan and other parts of China experienced an outbreak of a new coronavirus called COVID-19 (SARS-CoV-2) [2] with symptoms such as fever, cough, dyspnea, headaches, and sore throats. SARS-CoV-2 can be effectively transmitted to humans, based on the evidence that there is a high possibility of transmitting the virus through asymptomatic carriers, the World Health Organization (WHO) ranks COVID-19 as the sixth public health emergency, after H1N1 (2009), polio (2014), Ebola in West Africa (2014), Zika (2016) and Ebola in the Democratic Republic of the Congo (2019). In this situation, general health measures are necessary to restrict the global spread of the virus and control its damages [3]. The first measure is quarantine and travel bans that have never been done or known before. In the US, thousands of people were subjected to legal quarantine or self-quarantine, Italy has imposed extreme severe restrictions across the country, and China has besieged entire towns [4]. WHO has also identified six pieces of advice to protect people against COVID-19, all of which begin with an emphasis on "**stay home**":

- **Stay home,** clean your home regularly, particularly frequently touched surfaces.
- **Stay home,** stay safe. Stay physically fit. Exercise regularly. Eat a nutritious diet. Don't smoke.
- **Stay home,** stay safe. Follow the Golden Rule. Wash your hands frequently with soap and water or use alcohol-based hand-rub.
- **Stay home**, stay safe. If you show symptoms of COVID-19, self-isolate yourself, wear a mask around others, and seek medical advice.
- **Stay home,** stay positive. Avoid alarmist news. Be connected to friends and family. Have a hobby.
- **Stay home,** if any member of the household shows symptoms of Covid-19, seek medical advice, and follow your local health authority's guidance [5].

Following the above recommendations, many governments have considered quarantine as a solution to the outbreak of COVID-19. Although this decision can be a preventative measure, studies have shown that it will cause negative psychological effects such as boredom, hopelessness, isolation and unhappiness [6]. Inadequate housing and residential environments can also lead to poor mental health [7]. According to the relationship between housing and human health, improving the housing environment and reducing psychological stress are two of the WHO principles [8], which can help residents a lot during the recent quarantine period.

Health professionals have established health protocols to preserve physical health. On the other hand, it seems that little attention has been paid to mental health in house quarantine at this time. Since there were fewer studies in the field of mental health during this period, the purpose of the present study is to investigate the indicators of housing and mental health during the quarantine imposed by the outbreak of COVID-19, which is a significant subject for architects and housing planners in relation to epidemic diseases. The present study was conducted in Tehran. It is a city where experts predict would need more quarantine to prevent the spread of the virus and control the disease due to the larger population. The findings of the study can be used to demonstrate the impact of housing design on residents' mental health during the quarantine as well as improving the quality of the house as a place to stay during such a crisis.

1.1. House quarantine

Quarantine means restricting a person who is exposed to a contagious disease to prevent the spread of transmission. It is different from isolating a person who has the disease. However, sometimes these terms are used interchangeably. In the case of new infectious diseases, many people can be quarantined, especially in the early stages. It was done in a previous similar situation. For example, during the outbreak of Acute Respiratory Syndrome (SARS) in 2003, 100 people were quarantined for each case of the disease in Toronto [9].

The rapid spread of Coronavirus since December 2019 has caused fear and anxiety among people, especially the elderly, care providers, and people with special health problems. With the new measures, especially quarantine and its effects on routine activities and livelihoods, the rate of loneliness, depression, alcohol and drug use, self-harm, and suicide has also increased. But in terms of mental health, the main psychological impact is stress or anxiety [10,11]. Studies on general psychiatric symptoms also reported emotional distress, depression, post-traumatic stress symptoms, emotional exhaustion, insomnia, anger, and irritability during quarantine [6]. In this period of time, social isolation also causes mental health problems in people who have previously had positive mental health, despite the psychological damage of all human beings in this situation, the elderly, children and adolescents, minority groups, lower socioeconomic groups, and women. In addition, people who have already been affected by mental health problems are more vulnerable [12]. Furthermore, the duration of quarantine will affect post-traumatic stress symptoms and anger. Hawryluck et al. [13] mentioned that individuals who have been in quarantine for more than 10 days have reported higher signs of post-traumatic stress. Due to the outbreak of COVID-19, universities, schools, libraries, restaurants, bars, music theaters, indoor sports centers and museums are closed in many countries. School classes for students are held only remotely, and people work remotely in the house [14,15], this collective quarantine caused significant anxiety [16], and decreased social interactions leading to boredom and feeling of isolation that are distressing to people. Duan and Zhu [17] reported psychological problems such as anxiety, depression, and stress during this situation. In the days of quarantine, WHO has recommended simple daily physical exercises to prevent boredom and hold mobility [18]. Cultivation and maintenance of plants are also of fundamental importance for body and mind activity [14].

1.2. Housing and mental health

According to the WHO definition, "health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" [19]. The definition refers to well-being which has been described as "… human beings' state of comfort, health and happiness, referring to human beings' environments, bodies, minds, and all other situations being in the most harmonious and satisfactory state" in Oxford Dictionary [20]. Hasselaar [21] also categorized health determinants into three general fields: individual, social, and physical.

In the past, psychologists paid more attention to illness than health and happiness [22]. In contrast, today it is more important to pay attention to improving positive emotions such as calmness, sympathy, attachment, and love in people [23]. For example, McAndrew [24] found that people express more affection to each other when they are in more attractive spaces. Fich et al. [25] revealed that mental health and human stress in space can be affected by the architectural features. Consequently, architects must pay more attention to the physical environment's impacts on the individual's body and mind health [26]. While the physical structure of the house provides shelter, housing is more than a shelter, providing comfort, privacy and security, and affecting health at all levels of structure, psychology and community [27]. In general, housing relationship with health is examined in two ways. One of them is the risk of healthy people becoming ill in the house environment, and the other one is when housing needs are not met and functional disability or stress are caused [21]. WHO has defined six general principles for the relationship between housing and human health needs. Those general principles are protection against infectious diseases, protection against injuries, poisoning and chronic diseases, reduction of psychological and social stress, improvement of housing environment, informing housing use, and protecting the population at risk [8].

An increasing body of literature review about indoor spaces on users' wellbeing [28] has shed light on the impact of view [20,29,30], daylight [20,28,29,31], noise [20,31–34], air quality [35], and green space around the residential environment [31,34,36–38] on mental health. Daylight, fresh air, view, access to the garden or balcony and also visual and sensory communication with the outdoors are considered as indicators that improve the quality of housing. The possibility to open windows or balcony doors to allow in fresh air, odors, and outside sounds as positive factor of residents' well-being should be considered when constructing energy-efficient housing. Energy-efficient housing must fulfill people's sensory demands in relation to nature and outdoor environment as well as satisfying a broad variety of economic and practical needs [39,40]. Environmental stressors such as poor air quality, insufficient lighting, and noise cause negative stress and annoyance that can lead to short-term and long-term health problems, both physically and mentally [28,33]. As the number of people living in urban areas are increasing in the future, more residents will be exposed to high levels of road noise, air pollution, and less greenery [34,41].

In addition to environmental factors, the type of housing [31,32,37,42,43] and the floor level [32] have been of great importance according to mental health. Many studies have been conducted on the impact of high-rise housing on the psychological, morphological, and physiological characteristics of residents. Kim and Ha [43] stated that the feeling of detachment from the ground level in super tall residential buildings has a negative physiological and psychological impact on people. It also has negative consequences for children, reducing their socialization and independence skills. In this regard, five-story or less housing was designated ideal from this perspective [20]. A considerable point in many high-rise housing studies is that some residents of this housing type live on the lower floors, so it can reduce the building height impact [32]. Today, with increasing urbanization, balconies in multi-family buildings are becoming a private outdoor space, which has various meanings depending on different cultures. These spaces play a significant role in terms of social interaction as semi-open spaces between the street and house, the interior space, and interface between private and public zones [44]. Terrace as a private outdoor area can be used as a living room and residents would be delighted to look at the outdoors from the terrace [39]. The relationship between the presence of a terrace with the parameters of house orientation, view, height, natural ventilation, dimensions of space, noise and people's preferences for a healthy house has been investigated following the outbreak of the

SARS virus in Hong Kong [45]. In addition to the terrace as a semi-open for people living in apartments, green roofs provide a place for activities such as exercise and relaxing opportunities [46]. Williams et al. [47] explored the characteristics of the physical environment, social climate, and activities such as exercise, social interaction, and relaxing on a green roof. Reducing negative mood and stress, improving the control of attention, and feeling alive as psychological benefits have been highlighted in studies on green roofs. Ghosh et al. [48] also stated that green roof gardening is an opportunity to improve social communication, provide food and enjoy aesthetics.

Following the frequent recommendations for compulsory or self-quarantine during the outbreak of COVID-19, housing indicators that affect people's mental health resulting from the literature review and WHO advices categorized into four main categories of housing type, spaces, environmental factors and function and activities can help investigate the effective indicators on residents' mental health during house quarantine. The current study aimed to investigate the four main categories, including 18 indicators (Fig. 1), related to residents' mental health and housing during quarantine in the crisis of the COVID-19.

2. Methodology

According to the research framework, the present study intends to study the housing preferences, housing satisfaction level, and residents' mental health in the recent quarantine period. Considering health perception as one of the most comprehensive health assessments, perception of health risks affects people's actual harm [21]. In the field of buildings, the WHO described common symptoms of sick building syndrome (SBS) in the early 1980s, claiming that the diagnosis of SBS correlates with increased complaints and its evaluation in different studies depends on self-administered questionnaires [49]. In this regard, due to the capability of the questionnaire as an objective tool to produce generalizable results using large sample size and collecting quantitative data with standard methods and also due to the Covid-19 crisis and the impossibility of having interviews, an online questionnaire was used to collect self-report data. The survey was anonymous and ensured that the information was confidential. It was found to be in accordance to the ethical principles and national norms and standards for conducting research in IRAN (Approval ID: IR.SBU.REC.1399.063).

The experimental questionnaire consisted of 71 items in 5 sections including demographic data (9 items), residential house characteristics related to the research topic (14 items), housing satisfaction (18 items), housing preference (18 items), and General Health Questionnaire (GHQ) with 12 items, that took about 10 min to complete. Housing satisfaction level and housing preferences for each of the indicators were asked based on the 4-point Likert scale ranging from 1 to 4 (4 = very high, 3 = high, 2 = low, and 1 = very low), and GHQ as a self-assessment screening questionnaire was used to identify residents'

mental health situation [50]. The original version had 60 items (GHQ-60), which was reduced to 30 (GHQ-30), 28 (GHQ-28) and 12 (GHQ-12) items [51]. The GHQ-12 version was used in this research, which is a valid measurement of common mental disorders like anxiety and depression and can measure general mental health during the "past few weeks". In GHQ-12 test, items such as "much sleep over worry", "feeling unhappy and depressed", "losing confidence", and so forth are questioned. Each item is given a score from" 0 "to" 3 "(0 = Not at all, 1 = No more than usual, 2 = Rather more than usual, and 3 = much more than usual). Total score of each respondent will be between 0 and 36, and the higher score indicates lower mental health [52].

The data were collected over a period of 2 weeks in April 2020, using emails and social media (e.g. WhatsApp, Telegram, and Instagram). Recipients were asked to resend the link to their contacts and social networks. According to the Cochran's formula and using a simple random sampling method, a minimum sample of 385 was sufficient for this research, and in the period of 2 weeks, 421 valid responses were received. The collected data was analyzed using Statistical Package for Social Sciences (SPSS) version 26 for Windows. Paired (sample *t*-test), ANOVA test, and Spearman correlation coefficient were used to compare the significant differences between housing satisfaction and preferences, significant differences between groups, and the relationship between the satisfaction level of each indicator and the GHQ-Score.

3. Result

3.1. Sample characteristics

The mean and standard deviation of respondents' age was 32.73 ± 9.01. Table 1 shows the demographic data of the sample. 70.3% (N = 296) of the participants were women, indicating the importance of the issue of house quality for women and their sense of belonging to the house. From an economic point of view, about 50% of respondents belong to the middle class of society (deciles 4–7) with 20–50 million Rials monthly income, and approximately 77% of respondents were homeowners. Ownership and optimal economic situation of the majority of participants reduce these dimensions of concern and anxiety in the present study. In terms of education, 31.6% (N = 133) and 54.6% (N = 230) of the respondents had bachelor's, master's and Ph.D. degree, and in general, most of the respondents (86%) had a university degree. The lowest illiteracy rate of Tehran province in the country, the method of collection questionnaires via email and social media, and greater access of educated groups to social media can be the reasons for the result. Data showed that 6.8% of respondents or individuals in their family had COVID-19, so it is expected that the results of the research in the field of residents' mental health would not be disturbed highly in this regard.

Housing and mental health during quarantine in outbreak of COVID-19			
Housig Type	**Space**	**Environmental Factors**	**Functions and Activities**
Private House	Kitchen	View Quality	Exercise (indoor)
Low-rise Housing	Bedroom	Daylight Quality	Exercise (outdoor)
High-rise Housing	Livingrom	Air Quality	Working/Online class
	Terrace	Acoustic Quality	Cultivation and maintenance of plants
	Roof	Green Space	Social interaction

Fig. 1. Housing and mental health indicators.

Table 1
Demographic data of respondents.

		Frequency	Percent
Gender	Female	296	70.3
	Male	125	29.7
Education	Lower than diploma degree	9	2.1
	Diploma	49	11.6
	Bachelor degree	133	31.6
	Master's degree and Ph.D.	230	54.6
Marital status	Married	187	44.4
	Single	234	55.6
Ownership	Owner	327	77.7
	Tenant	94	22.3
Employment	Employed	240	57
	Unemployed	41	9.7
	Retired	12	2.9
	Housewife	47	11.2
	Student	5	1.2
	University student	76	18.1
Monthly income **(in Iranian Rial)**	<20,000,000	29	6.9
	20,000,000–35,000,000	91	21.6
	35,000,001–50,000,000	111	26.4
	50,000,001–100,000,000	124	29.5
	>100,000,000	66	15.7
COVID-19	Yes	28	6.7
	No	393	93.3

3.2. Housing satisfaction and housing preferences

As it was mentioned, the research aimed to compare significant differences between housing satisfaction and housing preferences, according to the indicators of the research framework. Table 2 shows the mean of housing preferences and satisfaction level for indicators of three categories that are spaces, environmental factors, and activity and functions. The results showed that environmental factors had a higher overall mean value (3,37) than spaces (2.98) and functions and activities (2.96) according to housing preferences, and kitchen (3.23), air quality (3.54), and cultivation and maintenance of plants (3.19) had a higher priority among the indicators of spaces, environmental factors, activities and functions.

Findings revealed that in all indicators of main categories, except the bedroom, the sig. value was less than 0.05, which indicates a significant difference between the residents' housing satisfaction and preferences (Table 3). It can be said that among interior spaces, there is an agreement on the bedroom between the assessment of housing satisfac-

tion and preferences. However, there is no consensus on the living room and kitchen. There is also no agreement on open and semi-open spaces, terraces and roof gardens. While the mean satisfaction of the terrace (mean value = 2.05) was lower than the mean, but in terms of preference, the terrace is of great importance (mean value = 3.01). Moreover, the mean preference for roofs was higher than the satisfaction level with the current situation. 54.6% of respondents rated their terrace size as small or very small, and 16.6% of houses did have no terrace. 86% of residents who considered the satisfaction of terrace in low or very low level, evaluated it as very small or small, it indicates that there is a direct relationship between residents' satisfaction with the terrace and its size.

The higher difference between the mean value of housing satisfaction and preferences was revealed in the indicators of "green space" and "outdoor exercise" among environmental factors, activities and functions. Considering the impact of gender on housing preferences, the data analysis of ANOVA test indicated that respondents' housing preferences of men and women in indicators of "view quality", daylight quality", "acoustic quality", "air quality", and "exercising (both inside and outside)" were significantly different at the $p < 0.05$ level, and in other indicators there was no significant difference between the two groups of men and women ($p > 0.05$). All of the above indicators were more important for women than men in terms of priority. According to telecommuting and virtual education and work during quarantine, different employment status and the importance of suitable space for working and online classes for each group were also examined using ANOVA test, but there was no difference between employment status and this indicator ($p > 0.05$).

3.3. Housing satisfaction level and mental health

The relationship between GHQ-12 score and the level of satisfaction for the indicators of spaces, environmental factors and activities and functions, as well as the relationship between house type and GHQ-score were elaborated in this section. Table 4 shows the mean GHQ-12 scores for people living in private, low-rise and high-rise houses. The lowest mean of GHQ-12 score for residents of private houses indicated that they had better mental health than those living in low-rise and high-rise houses, and among the residents of low-rise and high-rise houses, the residents of high-rise housing were in a better mental health situation. The reason for the results of low-rise and high-rise houses could be due to the ownership and income status of respondents. Among participants of this study, about 25.4% of low-rise residents were tenants, while 100% of high-rise residents owned their houses.

Table 2
Mean value of housing satisfaction and housing preferences.

		N	Mean value of housing satisfaction		Std. Deviation	Mean value of housing preferences		Std. Deviation
Space	Kitchen	421	3.01	2.54	0.69	**3.23**	2.98	0.75
	Bedroom	421	2.90		0.73	2.99		0.81
	Living room	421	3.08		0.61	3.18		0.74
	Terrace	421	2.05		1.26	3.01		1.09
	Roof	421	1.68		0.82	2.49		1.07
Environmental Factors	View quality	421	2.71	2.80	0.95	3.39	3.37	0.86
	Daylight quality	421	3.19		0.81	3.49		0.70
	Air quality	421	3.19		0.74	**3.54**		0.66
	Acoustic quality	421	2.56		0.90	3.19		0.87
	Green space	421	2.34		1.01	3.26		0.91
Functions and Activities	Exercise (indoor)	421	2.59	2.49	0.79	3.02	2.96	0.86
	Exercise (outdoor)	421	1.96		0.89	2.91		1.04
	Working/Online class	421	2.94		0.69	3.18		0.70
	Cultivation and maintenance of plants	421	2.66		0.92	**3.19**		0.85
	Social interaction	421	2.31		0.99	2.51		0.90

Table 3
Paired (sample *t*-test) of housing satisfaction and housing preferences.

		Paired Differences					t	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference			
					Lower	Upper		
Space	Kitchen	-.21853	.92053	.04486	-.30671	-.13034	−4.871	**.000**
	Bedroom	-.08551	1.01527	.04948	-.18277	.01175	−1.728	.085
	Living room	-.10451	0.83581	.04073	-.18458	-.02444	−2.566	**.011**
	Terrace	-.95962	1.54482	.07529	−1.10761	-.81163	−12.746	**.000**
	Roof	-.81710	1.19813	.05839	-.93188	-.70232	−13.993	**.000**
Environmental factors	View quality	-.67221	1.12838	.05499	-.78031	-.56411	−12.223	**.000**
	Daylight quality	-.67221	1.12838	.05499	-.78031	-.56411	−12.223	**.000**
	Air quality	-.34679	.84144	.04101	-.42740	-.26618	−8.456	**.000**
	Acoustic quality	-.62945	1.21909	.05941	-.74624	-.51267	−10.594	**.000**
	Green space	-.91924	1.22984	.05994	−1.03706	-.80142	−15.336	**.000**
Functions and activities	Exercise (indoor)	-.43468	.97767	.04765	-.52834	-.34102	−9.123	**.000**
	Exercise (outdoor)	-.95012	1.33091	.06486	−1.07762	-.82262	−14.648	**.000**
	Working/Online class	-.24228	.83849	.04087	-.32261	-.16195	−5.929	**.000**
	Cultivation and maintenance of plants	-.52257	1.14750	.05593	-.63249	-.41264	−9.344	**.000**
	Social interaction	-.19952	1.15598	.05634	-.31027	-.08878	−3.542	**.000**

Table 4
Mean GHQ-12 scores for housing types.

Housing types	GHQ - Score					
	N	%	Minimum	Maximum	Mean	Std. Deviation
Private	68	16.15%	.00	29.00	**10.36**	7.65
Low-rise	339	80.52%	1.00	36.00	13.58	6.74
High-rise	14	3.32%	3.00	29.00	12.28	8.82

Furthermore, 64.3% of the residents of high-rise houses had more than 50 million Rials as salary, while this ratio for low-rise residents was 45.4%. The collected data also showed that 7.1% of high-rise houses did not have a terrace, while this amount was 16.5% for low-rise housing, and 1.6% of low-rise housing was good/very good in terms of roof design, while this percentage was 4.21% for residents of high-rise housing. Recent factors could be influential in the mental health of residents of high-rise housing relative to residents of low-rise housing in this study.

Spearman correlation coefficient between indicators and GHQ-score was calculated to identify their impact on residents' mental health during the house quarantine. The spearman correlation coefficient between the satisfaction level of each indicator and the GHQ-Score is shown in Fig. 2. Negative values of the Spearman correlation coefficient showed that the better level of satisfaction, the lower GHQ-score, and a lower score means better mental health in the individual. According to Fig. 2, among the house spaces, the correlation between GHQ-score and

kitchen, living room and terrace satisfaction level was higher (−0.24, −0.23, and −0.22) respectively, and the lowest effect was related to the roof spaces (−0.17). Among environmental factors and activities and functions, satisfaction with green space (−0.23), view quality (−0.21), exercise in indoor spaces (−0.30), and cultivation and maintenance of plants (−0.29) had the greatest effect on residents' mental health.

Given the importance of cultivation and maintenance of plants and residents' mental health during quarantine, the area of the terrace, its relationship to the satisfaction level of the terrace and maintaining plants, and GHQ-scores in low-rise and high-rise houses are shown in Table 5. The results showed that 92.3% of people evaluated terraces of less than 2 m² to be small or very small, and the mean satisfaction level and the possibility of cultivation and maintenance of plants in theses terrace were 1.8 and 2.1, respectively. Houses with 2–3 m² terraces were higher in terms of satisfaction and the possibility of maintaining plants, but still 85.7% of people evaluated their terrace small or very small. In the 3–5 m² terraces, in addition to increasing the level of satisfaction and the possibility of cultivation and maintenance of plants, about 30% of residents evaluated the terrace as large or sufficient. However, a significant change in the percentage of residents who evaluated their terrace as sufficient or large was achieved in the area above 5 m² (52.4%). According to Fig. 3, the terraces with 5 m² and more have a significant effect on reducing the GHQ-score and improving mental health, and the highest mean GHQ-score, which indicated that lower mental health belonged to residents of houses without terrace.

Table 6 shows the mean GHQ-scores for satisfaction levels of space, environmental factors, and activity and functions indicators. The low-
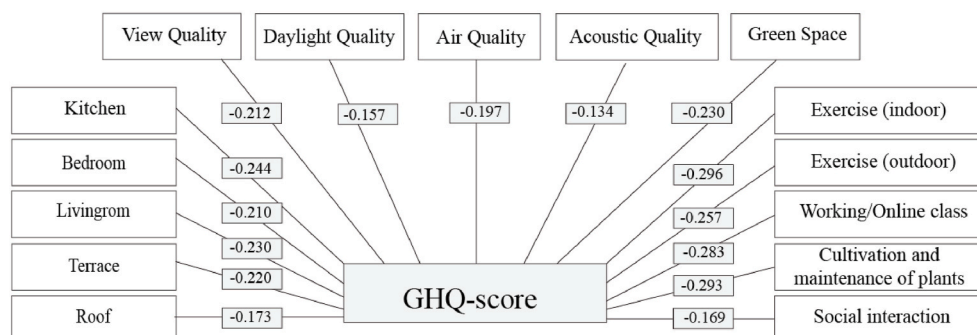

Fig. 2. Spearman correlation coefficient between satisfaction level of indicator and GHQ-Score.

Table 5

Terrace area, satisfaction level, cultivation of plants and GHQ-score.

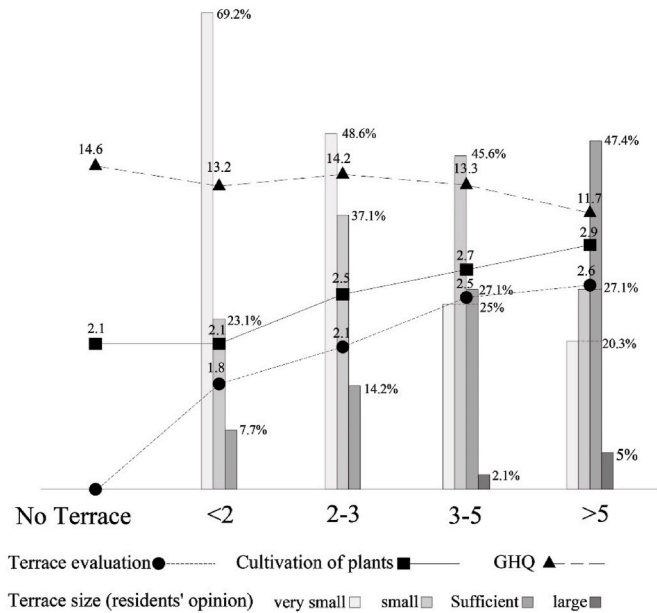| Terrace area (m²)	N	Terrace satisfaction level (mean)	Cultivation of plants (mean)	GHQ-score (mean)	Terrace size (residents' opinion)				
					Very small	Small	Sufficient	Large	**Very large**
no terrace	57	–	2.1	14.6	–	–	–	–	–
<2	40	1.8	2.1	13.2	27(69.2%)	9(23.1%)	3(7.7%)	–	–
2–3	105	2.1	2.5	14.1	51(48.6%)	39(37.1%)	15(14.2%)	–	–
3–5	92	2.5	2.7	13.3	23(25%)	42(45.6%)	25(27.1%)	2(2.1%)	–
>5	59	2.6	2.9	11.7	12(20.3%)	16(27.1%)	28(47.4%)	3(5%)	–

Fig. 3. Terrace size, satisfaction level, cultivation of plants, and GHQ-score.

Table 6

Mean GHQ-scores for satisfaction levels.

		Mean GHQ-scores for satisfaction levels			
		Very low	**Low**	**High**	**Very high**
Spaces	Kitchen	13.75	16.18	13.23	10.17
	Bedroom	12.85	16.57	12.61	10.99
	Living room	12.33	15.72	13.60	9.89
	Terrace	15.20 *No terrace = 13.82	14.78	11.43	9.55
	Roof	14.16	11.92	12.11	8.25
Environmental factors	View quality	15.93	13.69	12.91	10.71
	Daylight quality	15.78	14.54	13.61	11.60
	Air quality	17.00	14.72	13.74	11.19
	Acoustic quality	14.02	13.72	12.97	10.73
	Green space	14.85	13.91	12.07	9.98
Functions and activities	Exercise (indoor)	17.34	14.38	12.15	8.88
	Exercise (outdoor)	15.08	12.65	11.61	8.18
	Working/Online class	17.59	15.44	13.15	9.29
	Cultivation and maintenance of plants	16.66	14.66	12.43	9.47
	Social interaction	14.26	13.82	12.19	10.72

est mean of GHQ-score was related to very high satisfaction level of roof, green space, exercising outdoor, and the highest score was related to low/very low satisfaction level of terrace, air quality, and working/online class. Prioritizing more effective indicators in the design process can improve the quality of housing, mitigate mental health problems, and make it easier for residents to cope with serious and traumatic emergencies like infectious disease outbreaks.

The data analysis of ANOVA test in Table 7, indicated that respondents' mean GHQ-score of different categories of "monthly income", "employment", and "Covid-19" were significantly different at the $p < 0.05$ level, and for "gender", "education", "marital status", and "ownership", there was no significant difference between the categories ($p > 0.05$). The highest mean GHQ-score, which means poor mental health, in terms of income, employment status and Covid-19 belonged to the lowest income group (16.17), students (17.40) and a positive covid-19 respondent or the individual from family members (16.03).

4. Discussion

Residential preferences refer to a wide range of inclinations and desires of human beings. It represents the mental and ideal image of the individual and also expresses what can actually happen in reality [53]. The results of this study about residents' preferences support the findings of previous studies about the importance of air quality as the most significant priority [31,54] and natural light [55,56] as a preferred criterion among healthy house factors. Since airflow in the house during the Covid-19 epidemic helps to ventilate the air and prevent the disease from spreading at home, air quality seems to be the priority for residents in this period. Considering that differences between satisfaction and preferences can lead to displeasure and complain, the lowest satisfaction level of "activities and functions" indicators and the highest dif-

Table 7

One-way analysis of variance (ANOVA), comparing GHQ-score between groups of demographic characteristics.

		Sum of Squares	df	Mean Square	F	Sig.
Gender	Between Groups	39.169	1	39.169	.786	.376
	Within Groups	20873.638	419	49.818		
	Total	20912.808	420			
Education	Between Groups	299.005	3	99.668	2.016	.111
	Within Groups	20613.802	417	49.434		
	Total	20912.808	420			
Marital status	Between Groups	188.422	3	62.807	1.264	.286
	Within Groups	20724.386	417	49.699		
	Total	20912.808	420			
Ownership	Between Groups	63.314	1	63.314	1.272	.260
	Within Groups	20849.493	419	49.760		
	Total	20912.808	420			
Employment	Between Groups	577.646	5	115.529	2.358	**.040**
	Within Groups	20335.162	415	49.000		
	Total	20912.808	420			
Monthly income	Between Groups	567.798	4	141.950	2.902	**.022**
	Within Groups	20345.009	416	48.906		
	Total	20912.808	420			
Covid-19	Between Groups	272.541	1	272.541	5.533	**.019**
	Within Groups	20640.267	419	49.261		
	Total	20912.808	420			

ference of satisfaction and preferences level of "terrace", "green space", and "outdoor exercising" indicate that the house spaces, especially semi-open spaces, did not have the possibility to adapt new activities such as working in the house, attending online classes, daily exercises and maintenance of plants. Recognizing housing preferences can lead to the housing design that provides an appropriate space to stay in conditions such as house quarantine caused by the spread of infectious diseases or other similar conditions.

Since previous studies considered the connection with nature and working with plants as a restorative and relaxing quality [57,58] that reduce anxiety and improve satisfaction and quality of life [59], growing plants indoors and outdoors, including in balconies, as a form of gardening, can be suggested as a solution to alleviate poor mental health of low-rise and high-rise housing. In this regard, special attention was paid to the semi-open spaces of the balconies and their impact on mental health and well-being during COVID-19 crisis. According to the study conducted by Amerio et al. [60], in a large survey in Milan, the symptoms of moderate to severe depression were significantly higher in people living in apartments less than 60 m² with unusable balconies. But the area of open and semi-open spaces in residential buildings have decreased due to the greater economic value of closed spaces. The hierarchy of closed, semi-open, and open spaces would help to improve the quality of housing, mental health of residents and their satisfaction level, especially in crises when people are forced to stay in houses, like the recent health crisis caused by the outbreak of COVID-19 pandemic or other situations that may occur during a person's life, such as illness or the need for more rest during an old age.

Considering housing type, multi-dwelling units (low-rise and high-rise housing) associated with poor mental health in this study as well as in previous studies [42]. But better mental health for high-rise housing than low-rise was not in consistency with the past findings [20]. Studies [42,61] showed that tenants and people with lower income have poor mental health than people with better economic situation. The economic downturn during Corona crisis, ownership and economic status of the people living in these types of housing may have impacted on the result of this study. The causes of the difference between residents' mental health in low-rise and high-rise housing during quarantine period can be studied in more depth and completeness in future research.

5. Conclusion

Housing is inextricably linked to human health and poor living conditions can lead to poor mental health. Forgetting the house as a space to stay can lead to decrease the quality of housing, residents' satisfaction level and threat their mental health. Recently, due to the outbreak of COVID-19, house quarantine has been considered as the first solution to maintain the physical health. However, this measure will threaten the mental health of people and cause problems such as boredom, stress and a sense of loneliness.

The present study aimed to evaluate housing preferences as well as housing satisfaction with the current state of housing and their impact on residents' mental health during the COVID-19 crisis among those residing in Tehran. Housing indicators related to mental health according to the purpose of the study are classified into four main categories: housing type, spaces, environmental factors, and functions and activities.

Findings showed that in terms of housing preferences for residents in this period, environmental factors are the first priority compared to spaces and activities, and the most important priorities are air quality, daylight quality and view quality, respectively. In addition, among the indicators of space, and function and activities, kitchen and cultivation and maintenance of plants are more preferred. The difference between residents' preferences and satisfaction level with the current state of the house makes the house quarantine more difficult for residents. The results of this study revealed that among the residents of Tehran, the

highest difference between preference and satisfaction was in the indicators of terrace, green space and outdoor exercising. It indicates that the design of the semi-open space like the terraces can be considered by housing designers to have a significant impact on residents' satisfaction according to enjoying the fresh air, exercising, cultivation and maintenance of plants.

The results in the field of housing and residents' mental health showed that people who lived in private houses had better mental health, and the highest correlations were found between GHQ-score and satisfaction with the kitchen, green space, exercising (indoor). Housing designers can integrate the research findings with design solutions to enhance people's mental health during crises like house quarantine considering these criteria in housing design. To sum up, the design implications resulted from the data analysis act as a step toward an evidence-based design approach.

Since the present study only evaluated the indicators related to housing and mental health, it is recommended that other areas of healthy housing and housing layouts be explored in the future. According to some demographic characteristics of the respondents, such as the participation of the majority of women and people with university degrees, as well as conducting the study in Tehran, it is recommended to consider culturally diverse individuals, replicate research in different cities and represent the opinions in future research to provide a more definitive finding.

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CRediT authorship contribution statement

Paria Akbari: Conceptualization, Methodology, Software, Data curation, Investigation, Validation, Writing – original draft. **Seyed-Abbas Yazdanfar:** Conceptualization, Methodology, Supervision, Validation, Writing – review & editing. **Seyed-Bagher Hosseini:** Data curation, Validation, Writing – original draft. **Saeid Norouzian-Maleki:** Conceptualization, Methodology, Software, Investigation, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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