Housing and Mental Health during Outbreak of COVID-19

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Abstract

Background: Recently, a novel coronavirus (COVID-19) has caused global health concerns. Due to the outbreak of COVID-19, house quarantine was considered to prevent the outbreak of the disease and ensure physical health, but it may cause serious mental health problems. The present study aims to assess housing satisfaction, housing preference of residents, and their mental health in house quarantine of COVID-19 considering housing type, spaces, environmental factors, and function and activities.

Methods: Quantitative data were gathered through administering online questionnaires. In April 2020, 421 valid responses were gathered from people who were living in Tehran. Then the collected data were analyzed using SPSS.

Results: According to the result, environmental factors have a higher mean than spaces and functions and activities throughout housing preference. Satisfaction with all parameters affects improving mental health. The kitchen, view quality, exercise, and cultivation and maintenance of plants have the greatest impact on improving mental health among house spaces, environmental factors, activities, and functions, respectively. The mental health of people living in private houses is better than residents of low-rise and high-rise housing.

Conclusions: Residents' opinions about the houses showed that there are differences between the current situation of the house and the preferences of the people during the house quarantine period, which has been effective in the mental health of the residents in this period. Consideration of parameters in housing design by architects and home planners can improve people's mental health during special and critical situations such as house quarantine due to the spread of epidemics.

1. Background

In the last two decades, the world has experienced three coronaviruses that have caused disease and 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. To date, no conclusive treatment has been found for COVID-19. SARS-CoV-2 can be effectively transmitted to humans, based on evidence of the 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 in order to restrict the global spread of the virus and control its damages [3]. The first measure of new infectious diseases is quarantine and travel bans that never 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 identified six advices to protect people from COVID-19, all of which begin with an emphasis on "**stay home**":

1. **Stay home**, clean your home regularly, particularly frequently touched surfaces.
2. **Stay home**, stay safe. Stay physically fit. Exercise regularly. Eat a nutritious diet. Don't smoke.
3. **Stay home**, stay safe. Follow the Golden Rule. Wash your hands frequently with soap and water or use alcohol-based hand-rub.
4. **Stay home**, stay safe. If you show symptoms of COVID-19, self-isolate yourself, wear a mask around others, and seek medical advice.
5. **Stay home**, Stay positive. Avoid alarmist news. Be connected to friends and family. Have a hobby.
6. **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].

In the above recommendations, housing is a space to stay during the epidemic, the WHO and many governments have considered house quarantine as a solution to deal with the outbreak of COVID-19. While quarantine can be a preventative measure against the outbreak of these diseases, studies show that it has negative psychological effects on people. Loss of routine and social interactions cause boredom, disappointment, sense of isolation that is distressing [6].

Inadequate housing conditions and residential environments can always lead to poor mental health in individuals [7]. Reducing psychological and social stress and improving the housing environment has been cited as items of the WHO's principles according to the relationship between housing and human health [8], which can be very important during quarantine and help the residents a lot.

According to studies, in addition to threatening the physical health of people, the outbreak of COVID-19 also threatens their mental health due to staying in the house as a quarantine. In order to maintain physical health, health protocols have been developed by health professionals, but it seems that at this stage less attention has been paid to mental health in the period of house quarantine. Due to fewer studies in the field of mental health during this period, the present study aims to address the mental health of the individual during quarantine and the parameters of a healthy house in the field of mental health. Following the outbreak of COVID-19, the need to stay in house, quarantine, and the importance of housing and its role in the mental health of residents can be an important topic for architects and planners of housing in relation to epidemic diseases. The present research intends to study the effective parameters of housing and mental health during the quarantine caused by the outbreak of COVID-19. Research results can help improve the quality of the house as a place to stay in such crises.

1.1. House Quarantine

In the case of new infectious diseases, many people can be quarantined, especially in the early stages. In Toronto for example, during the outbreak of Acute Respiratory Syndrome (SARS) in 2003, 100 people were quarantined for each case of the disease. Quarantine means restricting a person who is exposed to a contagious disease to prevent the spread of it. It is different from isolating a person who has the disease; however sometimes these terms are used interchangeably [9]. The present study aims to focus on quarantine as a way to prevent the outbreak of COVID-19.

Coronavirus is spreading rapidly around the world, causing fear and anxiety among people, especially the elderly, care providers, and people with special health conditions. With the new measures, especially quarantine and its effects on routine activities and livelihoods, the rate of loneliness, depression, alcohol, and drug use, and self-harm or suicide behavior has also increased, but in terms of mental health, the main psychological impact is stress or anxiety [10–11]. Studies on general psychiatric symptoms in quarantine reported emotional distress, depression, post-traumatic stress symptoms, emotional exhaustion, insomnia, anger, and irritability [6].

Despite the psychological damage of all human beings in this situation, the elderly, children and adolescents, minority groups, lower socioeconomic groups, women and people who have already been affected by mental health problems are more vulnerable. Social isolation during quarantine can also cause mental health problems in people who have previously been in good mental health [12]. According to studies, the duration of quarantine will affect mental health, post-traumatic stress symptoms, and anger. Hawryluck, L., et al. [13] mentioned that individuals who have been in quarantine more than 10 days have reported higher signs of post-traumatic stress than those who were in quarantine less than 10 days. Collective quarantine causes significant anxiety which has health consequences [14]. Duan and Zhu [15] stated psychological problems, including anxiety, depression, and stress increase during the epidemic of COVID-19.

Due to the outbreak of COVID-19, universities, schools, libraries, restaurants, bars, music theaters, indoor sports and museums are closed in many countries. School classes for students are held only remotely, and people work remotely in the house [16–17], therefore, decreased social relationships with others lead to boredom and feelings isolation that are distressing to humans [6].

In these days, WHO has recommended simple daily physical exercises to prevent quarantine boredom and hold mobility [18]. The benefits of cultivation and maintenance of plants for the activity of the body and mind are also of fundamental importance [16].

1.2. Housing and Mental Health

In order to satisfy living needs, architects must pay attention to the physical environment’s impact on the individual’s body and mind health [19], Hasselaar, E. [20] also noticed health determinants in three general fields: individual, social, and physical. In 1946, the WHO defined health: " Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" [21]. The WHO's definition of health refers to well-being. Well-being in Oxford Dictionary 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.” [22]

In the past, psychologists paid more attention to illness than health, emphasizing less help to people to be happier, more optimistic and hopeful [23], but today, in psychology, it is more important to pay attention to improve positive emotions such as calmness, sympathy, attachment, and love in people [24], for example, research done by McAndrew [25] in the *Environmental Psychology book* found that people express more affection for each other when they are in more attractive spaces.

Mental health and level of human stress in space can be affected by the architectural features [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’s relationship to health is examined in two ways: 1- The risk of healthy people becoming ill in the house environment, and 2- when housing needs are not met and functional disability or stress are caused [20]. WHO has defined six general principles for the relationship between house and human health needs: protection against infectious diseases, protection against injuries, poisoning and chronic diseases, reduction of psychological and social stress, improvement of housing environment, informing housing use, protecting the population at risk [8].

Studies have shown that workplaces and living spaces, as well as indoor spaces, have a major impact on users' wellbeing [28]. In researches in the field of mental health and housing, view [22–29–30], daylight [22–28–29–31], noise [22–31–32–33–34], air quality [35] and green space around the residential environment [31–34–36–37–38] have been studied as mental health parameters of the houses.

How a house is perceived is affected by indoor environments such as daylight, view, and contact with the outside of the house, such as open windows [39]. Daylight, fresh air from a window, views, access to the garden or balcony, as well as visual and sensory communication with the outdoors considered by architects and residents as parameters that improve the quality of housing. Possibility of opening windows or balcony doors to expose the air, odors and outside sounds are important for the well-being of the residents and are therefore important factors that must be taken into account when designing energy-efficient housing. In addition to addressing a range of economic and functional needs, energy-efficient housing often needs to satisfy people 's sensory demands and needs in relation to nature and its environment [39–40–41]. Environmental stressors like poor air quality and insufficient lighting cause negative stress, which can lead to short-term and long-term health problems, both physically and mentally [28].

Balconies and terraces have 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 and can be directly connected to the street as the interior of the building and interface between private and public [42]. A study found that the terrace as a private outdoor area can be used as a living room and residents were delighted to be able to see 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 preference for a healthy house and spending money on it has been investigated following the outbreak of the SARS virus in Hong Kong [43]. In addition to the terrace as a semi-open space, the roofs of houses are also effective in improving the quality of life and relaxing of apartment dwellers. For people living in small apartments, green roofs provide a place for activities such as exercise and relaxing opportunities [44]. Williams, K et al. [45] studied the characteristics of the physical environment, social climate, activities such as exercise, social interaction, and relaxing of green roofs. Reducing negative mood and stress, improving control of attention, and feeling alive as psychological benefits have been highlighted in studies on green roofs. Ghosh et al. [46] also noted that green roof gardening is an opportunity to improve social communication, provide food and enjoy aesthetics.

Green space in a residential environment can improve the mental health of residents. Many people consider mental fatigue can be decreased with connecting to nature [36], even observing nature through the window can create "micro-restorative" opportunities and lead to stress resistance [30].

Exposure to noise as a stressor may have negative impacts on the health of individuals. Annoyance is the most common reaction to noise and can cause physiological stress and physical and mental symptoms [33]. Noise and air pollution can lead to chronic physical illnesses and mental disorders, as the number of people living in urban areas will increase in future more residents will be exposed to high levels of road noise and air pollution, and less greenery [34–47]. In research on mental health in housing, the type of housing [31–32–37–48–49], and the floor level [32] have been of great importance. Individuals in multi-apartment units are associated with poorer mental health, compared to private houses. Additionally, house ownership conditions affect people's mental health. People who own a house (private or apartment) have better mental health than people living in rented houses [48]. In addition, many studies have been conducted on the impact of high-rise housing on the psychological, morphological, and physiological characteristics of residents. Kim, N. G., & Ha, J. M. [49] stated that the feeling of detachment from the ground level in super tall residential buildings has a negative physiological and psychological impact on people. As the floor height increases, so does the person's stress level. It has negative consequences for children, the level of socialization of children is reduced, thus negatively affecting their independence. In this regard, five-story or less than five-story housing was designated ideal from this perspective [22]. A considerable point in many high-rise housing studies is that some residents of this type of housing live on the lower floors, so it can reduce the building height impact. This was investigated in researches comparing residents at different levels [32]. On the other hand, variables such as age, gender, level of education, married, income and ownership status have been considered in many studies related to mental health and housing [22–33–37–48].

Following the frequent recommendation to stay in house during the outbreak of COVID-19 and compulsory quarantine or self- quarantine, in the present study, housing parameters that affecting people's mental health resulting from the literature review and WHO advises categorized into four main categories of housing type, spaces, environmental factors and function and activities to investigate the effective parameters on the mental health of house residents during house quarantine.

According to the literature review, the type of housing has been studied in three types of private houses, low-rise and high-rise housing.
In the field of spaces, the interior of the house: kitchen, bedroom and living room will be of great importance, on the other hand, due to the significant disconnection or reduction of people's connection with the outside world, terrace, and roofs, as open and semi-open spaces can help calm residents. So, these 5 spaces are selected to study.

Environmental factors affecting a person's mental health at the house have also been investigated in five areas: view, daylight, acoustic and air quality, and green space. Due to the impossibility of communication and use of public green spaces in the neighborhood, this parameter is examined regarding the green space on the terrace, roof garden, or courtyard.

About the functions in this period, providing adequate space for working and having online classes as essential functions will help reduce stress and help continue a normal life. On the other hand, as mentioned,

exercising and cultivation and maintenance of plants can help reduce mental stress and increase for the activity of the body and mind. In the case of exercise, the possibility of exercising indoors and in open and semi-open spaces such as roofs, terraces are important. Communicating with neighbors while keeping social distance during this time can improve mental health due to reducing the impact of a sense of isolation.

Figure 1 shows the four main categories and its parameters related to a person's mental health and house during quarantine in the crisis of the COVID-19, which are investigated in this study.

2. Research Methodology

Health perception is one of the most comprehensive health assessments. When a person feels healthy, he or she is physically healthy. Perception of health risks even increases a person's actual harm [20]. 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 does not established a standardized diagnostic procedure for SBS. Evaluation of SBS symptoms in different studies depends on self-administered questionnaires with different definitions [50].

In addition to identifying the effects of house parameters on mental health, the present study intends to study the housing preference and housing satisfaction of residents in the quarantine and their mental health situation in the recent period.

General Health Questionnaire (GHQ) as a self-assessment screening questionnaire used to identify people with a mental disorder [51]. The original version had 60 items (GHQ-60), which reduced to 30 (GHQ-30), 28 (GHQ-28) and 12(GHQ-12) items [52]. General mental health can measure with the GHQ during the "past few weeks". It is a valid measurement of common mental disorders like anxiety and depression [53].

2.1. Participants

To collect data, we used an online questionnaire that took about 10 minutes to answer. Residents of Tehran have been selected for this study, over a period of 2 weeks in April 2020, 421 valid responses were received.

The average age of the participants in this study was 33 years.
Table 1 shows the demographic data of the sample.

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
Married	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
Income	< 2m	29	6.9
	2–3/5m	91	21.6
	3.5-5m	111	26.4
	5-10m	124	29.5
	> 10m	66	15.7
COVID-19	Yes	28	6.7
	No	393	93.3

296(70.3%) of the participants were women, which could indicate the importance of the issue for women and their sense of belonging to the house and the importance of the quality of the house for them.
From an economic point of view, 45% of respondents belong to the 8–10 income decile and 26% belong to the 5 to 7 deciles (average deciles). However, 71% of respondents belong to the middle and upper economic groups. Considering that about 52% of Tehran's population belongs to the upper deciles, economic research can be generalized in Tehran.

In terms of education, 86% of the participants had bachelor's, master's and Ph.D., and in general, most of the respondents were educated.
About 77% of respondents have been homeowners.

Ownership of the majority of participants reduces this dimension of concern and anxiety in the present study.
The last question of demographic items asked people to report if they or someone in their house has been diagnosed with COVID-19. According to the results, 6.8% of participants or individuals in their family had COVID-19, so it is expected that the results of the research in the field of mental health assessment of the individual and its relationship with the house during quarantine would not be disturbed highly in this regard.

2.2. Measures

According to the research framework, the main goal of the study is to assess housing satisfaction level with the current status, housing preferences for residents during the house quarantine and residents' mental health situation during the "past few weeks" using GHQ-12.
For theses purpose, a questionnaire containing 71 questions in 4 main categories: demographic data, housing satisfaction, housing preference, and GHQ-12 test was used.

Housing satisfaction level and housing preferences for each of the parameters were asked separately based on the 4-point Likert scale ranging from 1 to 4 (4 = very high, 3 = high, 2 = low, and 1 = very low).

In GHQ-12 test, items such as "Losing a lot of sleep due to anxiety, feelings of satisfaction and happiness, self-confidence and etc. are questioned. Each item is given a score from" 0 "to" 3 "(for example: "0 = Not at all ", "1 = No more than usual ", "2 = Rather more than usual ", "3 = much more than usual"). The higher

score indicates lower mental health and the total score of each person will be between 0 and 36 [53].

The collected data was analyzed using SPSS software. Paired (sample t-test) has been used to compare the presence or absence of significant differences between housing satisfaction and housing preferences.

Spearman correlation coefficient used to assess the relationship between the satisfaction level of each parameter and the GHQ-Score.

3. Findings And Discussion

3.1. Housing Satisfaction and Housing Preference

Table 2 shows the average mean of each parameters according to housing preference and satisfaction level in three categories: spaces, environmental factors, and activity and functions.

Environmental factors have a higher overall mean value (3,37) than spaces (2.98) and functions and activities (2.96) according to housing preference.
The results show that kitchen (3.2304), air quality (3.5416), and cultivation and maintenance of plants (3.1876) have been a higher priority among the spaces, environmental factors, activities and functions.

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	3.0119	2.54	0.68824	**3.2304**	2.98	0.74746
	Bedroom	421	2.9026		0.73194	2.9881		0.80614
	Living room	421	3.0760		0.61250	3.1805		0.74367
	Terrace	421	2.0523		1.26006	3.0119		1.09647
	Roof	421	1.6770		0.82529	2.4941		1.07264
Environmental Factors	View Quality	421	2.7150	2.80	0.95093	3.3872	3.37	0.86174
	Light Quality	421	3.1876		0.81090	3.4964		0.70583
	Air Quality	421	3.1948		0.74006	**3.5416**		0.65922
	Acoustic Quality	421	2.5653		0.90166	3.1948		0.86744
	Green Space	421	2.3420		1.01271	3.2613		0.90929
Functions and Activities	Exercise (indoor)	421	2.5938	2.49	0.78913	3.0285	2.96	0.86693
	Exercise (outdoor)	421	1.9667		0.89381	2.9169		1.04436
	Working/Online class	421	2.9382		0.69075	3.1805		0.70758
	Cultivation and Maintenance of Plants	421	2.6651		0.91778	**3.1876**		0.85659
	Social Interaction	421	2.3159		0.99401	2.5154		0.89861

Differences between satisfaction and preferences in individuals can lead to dissatisfaction. Preferences point to a wide range of inclinations to meet the basic needs of human beings, residential preferences reflect the mental and ideal image of the individual, and also express what can actually happen [54].

The results in Table 3 show that in all parameters 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. The Sig value in the bedroom is 0.085, which indicates the agreement between the assessment of the current situation and the ideal situation.

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**
	Light 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**

Assessing the current situation shows that bedrooms are at a lower level of satisfaction (mean value = 2.9026) than the kitchen and living room (mean value = 3.0119 and 3.0760). The assessment is consistent with the average scores related to preferences of space.

It can be said that there is an agreement about the bedroom, between the assessment of housing satisfaction and preference, but there is no consensus on the living room and kitchen.
The average use of these three spaces in the survey showed that during the house quarantine, the use of the kitchen, living room and bedroom had the highest increase respectively.

There is also no agreement on open and semi-open spaces, terraces and roof gardens.
While the average satisfaction of the terrace (mean value = 2.0523) was lower than the average, but in terms of preference, the terrace is of great importance (mean value = 3.0119). 54.6% of users rated their terrace size as small or very small, and 16.6% of houses didn't have a terrace.

According to the results, there is a direct relationship between people's satisfaction with the terrace and their opinion about the terrace size.
86% of residents who consider the satisfaction of terrace in low or very low level, have evaluated it as very small or small.

In the case of roofs, the average preference has been higher than the satisfaction with the current situation and only 7.1% of the houses designed space like a canopy, living space, or greenery on the roofs.

Parameters of Environmental factors are of great importance to participants, but there is a higher difference between housing preferences and satisfaction with the current state of housing in three factors: view quality, acoustic quality, as well as green space.
satisfaction with the current situation in the field of activities and functions showed that the spaces of the house did not have the possibility to adapt by changing activities such as working in the house or attending online classes and making the possibility for relaxing activities like simple daily exercises and maintenance of plants. The biggest difference between the mean value of satisfaction and preference of the parameters is related to outdoor exercising, which is also confirmed by the dissatisfaction with the terrace and roof space. Recognizing housing preferences can lead to the design of houses that provide an appropriate space to stay in conditions such as house quarantine caused by the spread of infectious diseases or other similar conditions.

3.2. Housing Satisfaction level and Mental Health

The questions in the last part of the questionnaire were related to the standard General Health Questionnaire (GHQ-12). In this section, we study the relationship between scores of GHQ-12 and level of satisfaction for the parameters of spaces, environmental factors and activities and functions, as well as the relationship between house type and GHQ-score. The maximum of total scores of 12 questions will be 36 in the worst case of mental health and 0 in the best case. Table 4 shows the average of GHQ-12 scores for people living in private, low-rise and high-rise houses separately.

Table 4
Average of GHQ-12 scores for housing types

Type of house	GHQ - Score					
	N	%	Minimum	Maximum	Mean	Std. Deviation
Private	68	16.15%	.00	29.00	**10.3676**	7.65663
Low-rise	339	80.52%	1.00	36.00	13.5841	6.74523
High-rise	14	3.32%	3.00	29.00	12.2857	8.82678

The average score for residents of private houses is the lowest, indicating that they have 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 are 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 the people living in these two types of housing. About 25.4% of low-rise residents were tenants in the survey, while 100% of high-rise residents owned their houses. On the other hand, 64.3% of the residents of high-rises belong to high economic deciles (8–10 income decile), While this ratio for low-rise residents was 45.4%. In addition to the economic dimension, the results show 7.1% of high-rise houses do not have a terrace, while this amount was 16.5% for low-rise housing. Also, 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. The results revealed the factors influencing the mental health of individuals in high-rise housing compared to low-rise housing.

Spearman correlation coefficient between parameters and GHQ-score has been calculated to identify the effect of them on improving the mental health of the residents during the house quarantine. Figure 2 shows the Spearman correlation coefficient between the satisfaction level of each parameter and the GHQ-Score. Negative values of the Spearman correlation coefficient show that the better the level of satisfaction, the lower the GHQ-score, and this decrease 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 (-0.0244, -0.210, and – 0.220 respectively), and the lowest effect was related to roof space (-0.173). Among environmental factors, satisfaction with view quality (-0.212) and green space (-0.230) had the significant impact on reducing GHQ-scores and improving mental health. In the field of activities and functions, exercise in indoor spaces (-0.296) and cultivation and maintenance of plants (-0.293) had the greatest correlation and effect on improving mental health.

Given the importance of cultivation and maintenance of plants in a person's mental health during quarantine, the area of the terrace and its relationship to the satisfaction level of the terrace, maintaining plants and GHQ-scores in low-rise and high-rise houses are shown in Table 5.

Table 5
Terrace: 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	large Very
no terrace(57)	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%)	-

The results showed that 92.3% of people consider terraces of less than 2 square meters to be small or very small, and the average satisfaction level and the possibility of cultivation and maintenance of plants in theses terrace during this period was 1.8 and 2.1, respectively.

Houses with 2–3 square meters' terraces are higher in terms of satisfaction and the possibility of maintaining plants, but still 85.8% of people consider their terrace small or very small.

In the 3–5 square meter terraces, in addition to increasing the level of satisfaction with the terrace and the possibility of cultivation and maintenance of plants, about 30% of the people have evaluated the terrace as large or sufficient. However, a significant change in the percentage of people who have evaluated their terrace as sufficient or large has been achieved in the area of the terrace above 5 meters (53.4%).

The possibility of cultivation and maintenance of plants is the same in houses with terraces smaller than 2 square meters and houses without terrace, and in fact, such terraces did not allow this activity.

According to Fig. 3, the terraces with 5 and more than 5 square meters have a significant effect on reducing the GHQ-score and improving mental health, and the highest average GHQ-score, which indicates lower mental health belonged to residents of houses without terraces.

Tables 6, 7, and 8 show the average GHQ-scores for each level of satisfaction (very low, low, high, very high) for space, environmental factors, and activity and functions separately.

Table 6
GHQ-scores and satisfaction levels of spaces

	Kitchen				Bedroom				Living room				Terrace
	very low	low	high	very high	very low	low	high	very high	very low	low	high	very high	No Terrace
Mean GHQ-Score	13.7500	16.1803	13.2326	10.1778	12.8571	16.5694	12.6157	10.9863	12.3333	15.7174	13.6022	9.8889	13.8194

Table 7
GHQ-scores and satisfaction levels of environmental factors

	View Quality				Daylight Quality				Air Quality				Acousti
	very low	low	high	very high	very low	low	high	very high	very low	low	high	very high	very lov
Mean GHQ-Score	15.9286	13.6970	12.9086	10.7143	15.7778	14.5385	13.6087	11.6048	17.0000	14.7174	13.7393	11.1974	14.016

Table 8
GHQ-scores and satisfaction levels of functions and activities

	Exercise (indoor)				Exercise (outdoor)				Working/Online class				Cultivation
	very low	low	high	very high	very low	low	high	very high	very low	low	high	very high	very low
Mean GHQ-Score	17.3421	14.3796	12.1569	8.8810	15.0811	12.6506	11.6125	8.1852	17.5882	15.4444	13.1481	9.2958	16.6607

Table 6 shows, according to the effect of space satisfaction on mental health, the average score of GHQ-12 was much lower for very high levels of satisfaction. In the terrace space, people who didn't have a terrace in their house had better mental health than people who have evaluated terrace satisfaction at very low or low levels. Due to the role of the terrace on the cultivation and maintenance of plants and their effect on improving mental health (Fig. 3), it can be said that the existence of inappropriate terraces will have a more negative impact than its absence due to people's interest in growing and maintaining plants during Quarantine (Table 2).

Table 7 shows the relationship between the satisfaction level of environmental factors in the current state of houses and the average GHQ-score. According to the results, with the increase in users' satisfaction with environmental factors, their mental health has improved. The highest decrease in the average GHQ-score was related to the better air and view quality, and the lowest effect was considered in acoustic quality.

Table 8 shows that among the activities and functions, the possibility of exercising and social interactions had the greatest and the least impact on improving mental health respectively.

4. Conclusion

Forgetting the house as a space to stay over time can lead to decrease the quality of the house, residents' satisfaction level and threat their mental health. Indeed, housing is inextricably linked to human health and poor living conditions can lead to poor mental health. Recently, due to the outbreak of COVID-19, house quarantine and staying in the house were considered as the first solution to maintain the physical health of people, but in addition to physical health, mental health is also important in quarantine. Given increased presence of people in the house, they will be more anxious and stressful. The present study evaluates housing satisfaction with the current state of housing, its impact on the mental health of residents and housing preferences during this period. The housing parameters affecting people's mental health have been categorized into four main categories: type of house, spaces, environmental factors, and the functions and activities.

According to housing preference, the results showed that environmental factors are generally more important than spaces and activities.

Kitchen, air quality and cultivation and maintenance of plants have been of higher priority and importance for the residents among spaces, environmental factors and activities. Respondents' idea revealed, in the spaces of house, the most disagreement between preference and satisfaction level was seen in terrace. It indicates that the design of the semi-open space like the terraces needs to be considered by the designers.
Today, the level of open and semi-open spaces in residential buildings have decreased due to the greater economic value of closed spaces, but the presence of semi-open spaces such as terraces can have a significant impact on a residents' mental health according to enjoy the fresh air, cultivation and maintenance of plants, exercising.
It will be more important in crises that people are forced to stay in houses, like the recent crisis caused by the outbreak of COVID-19 or other situation that may occur during a person's life, such as illness or the need for more rest during old age. Considering the hierarchy of closed, semi-open, open space and using this type of space in housing will help to improve the quality of housing, mental health of residents and their satisfaction.

According to the results, the mental health of people living in private houses is better than residents of low-rise and high-rise housing, and residents of high-rise houses had better mental health than residents of low-rise houses.
Multi-dwelling units (low-rise and high-rise houses) associated with poor health in this study as well as in previous studies [48], but better mental health for high-rise houses than low-rise houses were not in line with the results of past research [22]. Ownership and economic status of the people living in these two types of housing may impact on this result. Studies [48–55] showed that tenants and people with lower income have poor mental health than people with better economic situation.

Not living in a private house is associated with poor mental health, which will harmful to society and public health. Consequently, providing small but qualitative and highly useful green areas in apartments and high rises, assured that people have access to health-promoting green environments, can be consider as a solution to this problem. Past studies considered that humans perceive natural environment as healthy and possessing restorative qualities [56–57], Biophilia theory explain connection with nature as the innate human need [58].

In the field of housing and mental health of residents, the findings revealed that the correlation between GHQ-score and satisfaction with kitchen, view quality and green space, exercise and cultivation and maintenance of plants were higher among the parameters of spaces, environmental factors, activities and functions. Considering these parameters in housing design by architects and house planners can improve people's mental health during house quarantine.

For future studies, the reasons for the difference between people's mental health in low-rise and high-rise housing during the quarantine period and the quality and features of semi-open spaces like terrace can be study more deeply and completely.

Abbreviations

WHO: World Health Organization; GHQ: General Health Questionnaire, SBS: Sick Building Syndrome; SARS: Acute Respiratory Syndrome

Declarations

Ethics approval and consent to participate

The study (approval ID: IR.SBU.REC.1399.063) was approved by the Ethics Committee of the Shahid Beheshti University on January 9, 2021. Written informed consent to participate was obtained from all study participants. Participation in this survey was online and completely based on the desire for full participation. The information of all participants was processed anonymously and no information was recorded in their name. All authors confirmed that all methods were carried out in accordance with relevant guidelines and regulations.

Consent for publication

Not applicable.

Availability of data and materials

Studies reviewed in the current study have been published and are widely available. Data supporting the conclusions are included in the article.

Competing interests

The authors declare that they have no competing interests.

Funding

None.

Authors' contributions

SAY and PA developed the ideas for this research. PA and SNM drafted the initial report. PA and SNM analyzed the data and wrote the final version of the report. SAY and SBH interpreted the data. All authors reviewed and approved the final version.

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Figures

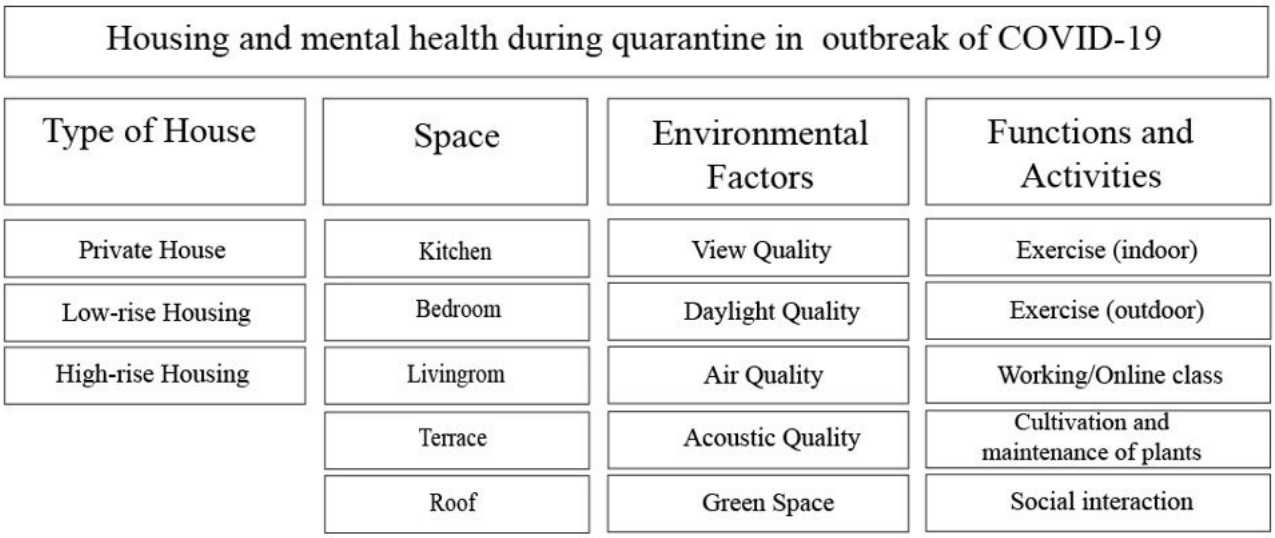

Figure 1

Housing and mental health parameters

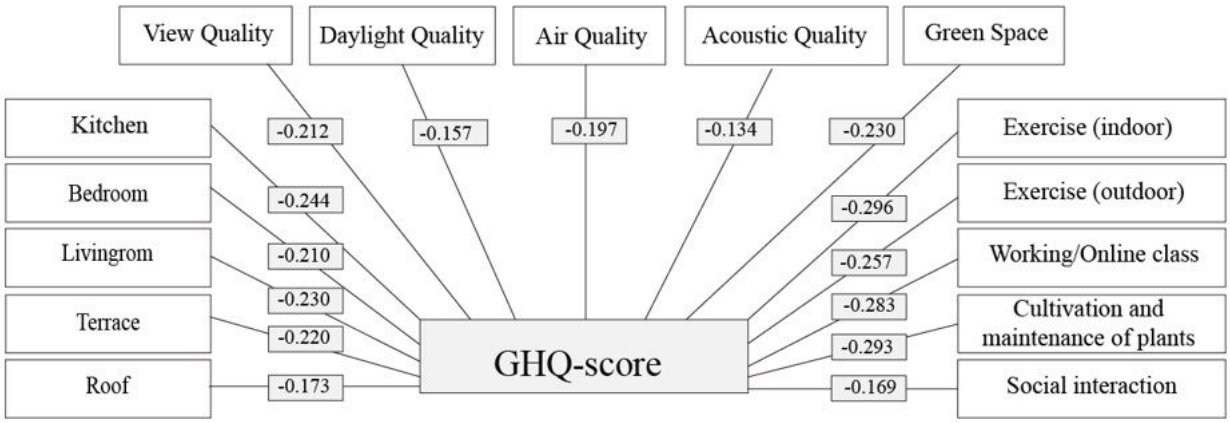

Figure 2

Spearman correlation coefficient between satisfaction level of parameter and GHQ-Score

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- Questionnaire.docx