Time-Dependent Moderating Effect of Exposure to Nature on Relations between Perceived Interior Crowding, Social Isolation, and Psychological Distress of Residents during Pandemic of COVID-19

Seyyedeh Fatemeh Mousavinia (s_f_mousavinia@yahoo.com)
Ferdowsi University of Mashhad

Research Article

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Abstract

Due to the results of the COVID-19 epidemic on mental health, some studies have highlighted the positive effects of nature exposure. Nevertheless, this beneficial role has not yet been explored over time of the pandemic. In mid-rise housing, in addition to the small home size, most people do not have access to private outdoor spaces and they use shared open and green areas. It is necessary to understand how household density and nature exposure affect people's mental health in this housing type. The current study examines the longitudinal changes in (a) social isolation, (b) psychological distress, (c) intensity of the effect of social isolation on psychological distress, and (d) moderating effect of nature exposure on the relation between perceived interior crowding, social isolation, and psychological distress. Focusing on six mid-rise housing developments in Mashhad, longitudinal data were collected from 718 middle-aged women (Mage = 49.63, SD = 12.39) in two waves during the Iranian national lockdowns (wave1 in May 2019 and wave2 in April 2020, before nationwide vaccination). A paired-sample t-test showed increased social isolation and psychological distress after one year of the pandemic. Also, using structural equation modeling and multi-group analysis (wave 1 vs. wave 2) revealed that social isolation has an increasing influence on psychological distress over time. Exposure to nature moderates the effect of perceived interior crowding on psychological distress. However, this moderating role is time-dependent and nature exposure during the time did not necessarily assist in reducing the negative impact of perceived interior crowding. Finally, at any given time, nature exposure mitigated the effect of social isolation on psychological distress.

1. Introduction

The global outbreak of coronavirus disease, which began in 2019, has had a tremendous impact on people's health and quality of life (Díaz de León-Martínez et al., 2020). It has changed recent sustainability notions and emphasized the resilience of systems to recover from disruptions (Tahvonen & Airaksinen, 2018) and promote citizens' well-being (Hakovirta & Denuwara, 2020; Megahed & Ghoneim, 2020).

Well-being is linked not just to the environment through the dangers of pollution exposure, but also to mental health (Díaz de León-Martínez et al., 2020, p. 3). COVID-19 became a global pandemic and caused a variety of precautionary measures, including national quarantines and stay-at-home orders (Olszewska-Guizzo et al., 2021). Social isolation and loneliness have been linked to poor mental health outcomes such as cognitive decline, anxiety, depression, and psychological distress (Gorenko et al., 2021; Pakenham et al., 2020; Brooks et al., 2020). The effects of socioeconomic, physical, and environmental factors on people's health have been extensively researched and documented. Their relationship in the context of the COVID-19 pandemic, on the other hand, is still a work in progress (Viezzer & Biondi, 2021). We must find ways to mitigate the adverse effects of pandemic and its resulting lockdowns on mental health in residential environments (Allam & Jones, 2020).

While lockdown restrictions compelled people to stay home with their families or cohabitants, there will be a substantial amount of perceived interior crowding. Chronic crowding in a high interior density residence is a substantial cause of stress and harms psychological health (Evans, 1979; Rollings & Evans, 2019, p. 592). At the same time, the built environment has a direct impact on human health, whether inside the structures in which we live or in the open spaces that connect buildings (Jens & Gregg, 2021). An increasing amount of

data supports the importance of nature exposure and access to green spaces in promoting urban sustainability and improving human health (Ahmadpoor & Shahab, 2020; Gascon et al., 2015; Olszewska-Guizzo et al., 2020; Kim & Miller, 2019; Jiang et al., 2021). Several studies have identified links between exposure to nature and reduced risk of mental health problems, reduced stress, improved mood, and mental stimulation (Cohen-Cline et al., 2015; Houlden et al., 2018; Pope et al., 2018; Twohig-Bennett & Jones, 2018).

During the COVID-19 pandemic, some cross-sectional studies suggest that domestic gardens and private green spaces could be a potential health resource (e.g., Corley et al., 2021). In residential environments consisting of apartments with shared open spaces, few longitudinal investigations compare the psychological effects of the COVID-19 epidemic over time, focusing on the beneficial role of exposure to nature. In addition, there is no study exploring the potential role of nature exposure in reducing perceived interior crowding-related psychological distress during the pandemic. By conducting empirical research in Mashhad, Iran, and studying the link between perceived interior crowding, social isolation, and psychological distress, this study intends to fill current gaps in the literature. The first goal of this research was to see if social isolation and psychological distress increased over time of the pandemic. Second, in addition to its direct impact on psychological distress, social isolation is thought to mediate the relationship between perceived interior crowding and psychological distress. Third, it is aimed to investigate if nature exposure can alleviate the influence of perceived interior crowding and social isolation on psychological distress. Finally, to understand the role of time, all hypotheses were tested utilizing two waves of data, Structural Equation Modeling (SEM), and Multi-Group Analysis (MGA).

2. Literature Review

2.1. Pandemic, social isolation, and mental health

COVID-19 home confinement is frequently considered social isolation and a lack of social ties (Pasion et al., 2020). Because humans are social beings that rely on secure social ties, being socially isolated has been related to poor mental health (Taylor et al., 2016; Cacioppo & Hawkley, 2003; Olszewska-Guizzo et al., 2021; Hyun-Soo & Jung, 2021). According to a traditional Durkheimian approach, individual pathology is conditioned by social dynamics and large-scale social crises may harm individual health and well-being by reducing social integration (Durkheim, [1897] 1951, cited by Berkman et al., 2000).

2.2. Perceived interior crowding and mental health

Stokols (1972) has distinguished the psychological state of feeling crowded from the physical state of high spatial or social density (cited by Vine, 1981). The density of interior spaces is referred to as crowding (Forsyth et al., 2007). Rather than square footage per person, the number of occupants per room is a measure of density more strongly linked to behavioral outcomes (Evans, 2006). Chronic crowding is a major source of stress via the subjective inability to cope with the high-density situation (Vine, 1981) and has a negative impact on mental health. Reduced feelings of control, particularly over desired social interaction (Altman, 1975); overstimulation (Evans, 1979); interference with socially supportive relationships among home residents leading to social withdrawal (Rollings & Evans, 2019); and adverse health outcomes such as

psychological distress (Evans et al., 2002; Chan et al., 2020) and anxiety (Evans, 2003; Cavazza et al., 2021) are among the psychosocial processes that result from perceived crowding.

Evans and Lepore (1993) proposed three mechanisms through which the negative effects of perceived crowding could lead to adverse consequences: (1) reduced access to valuable resources, increased social competition, and interfering with goal attainment; (2) lack of perceived control over and predictability of, the environment; and (3) enforcing excessive stimulation causing overload and unpleasant over-arousal. Furthermore, high social density is linked to a drop in perceived social support (Cavazza et al., 2021), while a lack of social support is linked to higher levels of depressed symptoms (especially for women) (Mair et al., 2010). Based on the above brief review, it is hypothesized that perceived interior crowding not only has the potential to affect psychological distress but it also has the potential to be a perceptual factor linked to social withdrawal and social isolation, having an indirect impact on psychological distress.

2.3. The beneficial role of exposure to nature

Exposure to nature has been linked to lower mental ill-health indicators such as cognitive decline (Astell-Burt & Feng, 2020) and psychological distress (Sturm & Cohen, 2014). Access to green spaces has also been linked to indicators of positive mental health, including the restoration of depleted attention capacity and cognitive processes (Kaplan & Rogers, 2003), reduced risk of anxiety mood disorder treatment and the rate of antidepressant prescriptions (Nutsford et al., 2013; Kim & Miller, 2019), a greater sense of mental well-being and place-making (Hadavi, 2017; Hernandez et al., 2018), and subjective well-being (Mavoa et al., 2019; Olszewska-Guizzo et al., 2021).

The Attention Restoration Theory (ART), which claims that exposure to nature can restore depleted attention capacity (Kaplan, 2001), is one of the most well-known hypotheses explaining the salutogenic potential of natural environments. This theory contends that spending time in nature, even in urban open spaces with vegetation, replenishes weary attention, allowing individuals to function more effectively than when they are mentally exhausted (Kim & Miller, 2019). The restorative effect of green space helps develop prosocial tendencies through increasing positive emotionality and attention recovery (Ohly et al., 2016). Nearby green spaces might facilitate social interactions and foster their prosocial behavior by encouraging residents to be physically active (Di Bartolomeo & Papa, 2019; Putra et al., 2021). Thus, exposure to nature is expected to moderate the association between social isolation and psychological distress.

In addition, previous studies have suggested that exposure to nature and neighborhood green spaces can help to 'buffer' the physiological and psychological effects of stressful life events (Marselle et al., 2019; Corley et al., 2021; Ulrich, 1983; Putra et al., 2021). Stress Reduction Theory (SRT) (Ulrich et al., 1991) has suggested that exposure to nature can facilitate restoration from mental fatigue, stress, and negative moods. According to Ulrich (1991), following a stressful experience, exposure to an unthreatening natural setting has a calming effect. This emotional response is immediate, unconscious, and spontaneous accompanied by increased positive feelings and reduced arousal levels (Jiang et al., 2021). Considering perceived interior crowding as a source of stressful life (Vine, 1981), exposure to nature is expected to moderate the association between perceived interior crowding and psychological distress.

2.4. Study design

During the COVID-19 epidemic, few longitudinal studies have focused on the impacts of exposure to nature on people's mental health. Over time, social isolation and psychological distress are expected to rise (H1). According to the presented conceptual model (Fig.1), perceived interior crowding not only has a direct positive impact on psychological distress (H2) but also serves as a potential perceptual factor associated with social isolation (H3). The effect of perceived interior crowding on psychological distress is mediated through social isolation (H4). During the pandemic, the intensity of the link between social isolation and psychological distress changes (H5).

Another goal of this research was to see if nature exposure could help to mitigate the adverse effects of perceived interior crowding and social isolation on psychological distress, thereby acting as a buffer against potential environmental stressors (H6 & H7). To investigate the effect of time on the connections between variables, hypotheses are examined using two waves of data at different time intervals at the start of the lockdown and one year later.

3. Method

3.1. Study area and time

After China, Iran became the second focal location for spreading COVID-19 worldwide in mid-February 2020. The head of the Ministry of Health and Medical Education's Public Relations and Information Center declared on April 23, 2020, that the third level of COVID-19 quarantine had begun. The first order for a stay-at-home lasted 42 days (from 29 February until 10 April). Iran has had five peaks of the Coronavirus pandemic and its associated quarantine. Due to the significant spread of the Delta version of COVID-19, a severe lockdown lasted over 10 days, from August 12 to August 21, 2021. People were forced to spend the entire day and night indoors with their family or cohabitants, leaving only for fundamental reasons.

According to Hu et al. (2021), housing quality and living conditions were substantial predictors of the ward level COVID-19 mortality count. The study focused on six mid-rise and dense gated communities with comparable housing quality in Mashhad, Iran's second-largest city. The case studies were chosen based on middle-income status, housing rate, comparable residential density, the amount of green space in the community areas, and various housing layouts.

3.2. Participants and data collection

Participants were solicited via telegram groups to which inhabitants of the gated residential neighborhoods were members about two months after COVID-19's first lockdown began in May 2020. Respondents received a message with the survey URL and an explanation that participation in the survey was voluntary to complete an online survey questionnaire. They were demanded to take a 20-minute online survey about mental health outcomes and perceptual characteristics. To assure data quality, human verification and attention checks were used.

In previous research, demographic data on gender, age, education, household income, and employment status have been considered as potential intervening variables in relationship between perceptions and psychological well-being (Cleary et al., 2019). A Participant Information Sheet, including information on gender, education background, number of children, known mortality cases in neighbors, colleagues, or family members involved, and pre-lockdown emotional-mental health was placed at the start of the questionnaire. The latter was assessed with a single item: "In general, my emotional and mental health was... before the COVID-19 pandemic". The responses were graded on a three-point scale (good, fair, and poor).

Given the cultural context and the role of women in maintaining family order during the epidemic, data were collected from women. The first sample for the online survey consisted of 1284 women who lived in six gated communities using the cluster sampling method. Participants who indicated the number of deaths on the Participant Information Sheet were eliminated from the sample due to known death cases, which may have influenced psychological distress. Participants were selected based on their claimed pre-pandemic emotional-mental health (good or fair), not living alone, and having at least one child.

A total of 947 respondents from the first wave accepted to participate in the second phase. Data were taken in April 2021, around one year after the declared state of emergency of COVID-19 and during the lockdown. Due to a lack of accountability or missing data, 229 participants were eliminated from the analyses. Finally, valid responses were found on all of the variables in a sample of 718 women (Mage = 49.63, SD = 12.39). Table 1 shows the demographic characteristics of the sample.

3.3. Measurement of variables

Perceived interior crowding: Participants rated their level of agreement with five statements on a 5-point Likert-type scale (1=strongly disagree, 5=strongly agree) to express their opinions of the adequacy of home space and perceived interior crowding: “Despite the mandatory stay-at-home order, the size of my home is insufficient to ensure my personal space”; "I have a space at home where I can be alone away from others” (inverse-scored); “Verbal and, or physical violent behaviors have increased at home during the current mandatory lockdown” (Pakenham et al., 2020); “I feel squished or cramped at home” (Rollings & Evans, 2019).

Exposure to nature: The health advantages can only be obtained if residents have reasonable access to open and green places (Wang et al., 2015, p. 85). In this study, the term “nature exposure” refers to accessible shared open and public areas with natural vegetation that can include any amenities that enhance its quality and utilization. Participants were asked three questions about their perceptions of the presence of nature in their neighborhood. “There is much greenery in public open spaces”; “I have physical activity in green spaces”; and “I miss seeing/talking to people in green spaces.” were all assessed on a 5-point scale (1=strongly disagree, 5=strongly agree).

Psychological Distress: The Kessler Psychological Distress Scale (K6) was employed in this study as a mental health screening tool. The K6's six items use a 5-point scale (ranging from 0 = never to 4 = always) to assess how often the respondent felt (a) nervous (e.g., “How often have you felt nervous? ”), (b) hopeless, (c)

restless or fidgety, (d) so depressed that nothing could cheer you up, (e) that everything was an effort, and (f) worthless over the previous two weeks (Kessler et al., 2002; Taylor et al., 2016).

Social isolation: Five previously approved questions were used to assess subjective social isolation: (a) subjective closeness between family members, (d) subjective closeness between friends, (c) a lack of companionship, (d) feeling left out, and (e) feeling alienated from others (Taylor et al., 2016).

3.4. Statistical analyses

The mean differences of social isolation and psychological distress between two waves were analyzed using paired-samples t-tests. Structural equation modeling (SEM) was used to investigate the relationship between variables to answer other research issues. To assess the research model, this study used the partial least square (PLS) technique and Smart-PLS 3.0 software. A variance-based SEM can estimate complex cause-effect models using latent variables. The essential advantage of adopting the PLS approach is that it allows latent components to be modeled as reflective or formative constructs and has fewer sample size restrictions (Chin, 1998). The researchers often use a two-stage method including a measurement and a structural model.

4. Results

Table 1 shows that the age range of 35–44 years was the most common (67.27%), followed by 45–54 years (32.73%). The majority of respondents (60.58%) held a university degree, followed by those with professional education (22.15%) and those who had just completed high school (13.09%).

Table 1: Survey respondents demographic characteristics (N = 718).

Measure	Item	N	(%)
Age	35–44 years old	483	67.27%
	45–54 years old	293	32.73%
Education	Lower than high school	30	4.18%
	High school only	94	13.09%
	Professional education	159	22.15%
	Undergraduate degree	423	58.91%
	Postgraduate degree	12	1.67%
Employment status	Public sector	167	23.26%
	Private sector	191	26.60%
	Self employed	71	9.89%
	housekeeper	289	40.25%
Marital status	Married/Living with a partner	631	87.88%
	Widowed/Divorce/Separated	87	12.12%
Household size	2	52	7.25%
	3	393	54.73%
	5	236	32.87%
	More than 5	37	5.15%

4.1. Descriptive statistics

A paired-samples t-test was conducted to compare social isolation and psychological distress over time. Participants in wave 2 reported higher levels of psychological distress (M = 2.925, SD = 0.591) than those in wave 1(M=2.683, SD=0.583), t (1434) = 7.830, p<0.000. Wave 2 had a higher level of social isolation (M = 3.007, SD = 0.546) and there was a significant difference between the two waves (wave 1 (M=2.713, SD=0.647), t (1434) = 9.293, p<0.000), supporting H1.

4.2. Assessment of measurement model

The conceptual model and causal linkages were evaluated using PLS-SEM. In the first stage, the indicator reliability, construct reliability, convergent validity, and assessment of the measurement models were investigated, while the second stage established testing the proposed structural linkages in the conceptual model.

Cronbach's alpha and composite reliability (CR) were more than 0.70 (Table 2), indicating strong internal consistency and reliability (Henseler et al., 2009). The model's capacity to explain the variance of the indicator is known as convergent validity. A criterion of 0.5 for average variance extracted (AVE) is suggested for providing convergent validity. The AVE for two waves in this investigation varied from 0.501 to 0.554, significantly over the needed minimum, showing an acceptable level of convergent validity. Each set of predictors was checked for probable collinearity. If the variance inflation factor (VIF) is 5 or higher, it suggests collinearity (Hair et al., 2017). As a result, there was no problem with collinearity in our investigation.

Table 2: Descriptive statistics, Cronbach's alpha, composite reliability, and discriminant validity of constructs.

	Wave1					Wave2				
	M	SD	Alpha	CR	AVE	M	SD	Alpha	CR	AVE
PD	2.683	0.583	0.801	0.856	0.501	2.925	0.591	0.838	0.881	0.554
PIC	2.610	0.612	0.784	0.848	0.529	2.809	0.551	0.787	0.854	0.541
SI	2.713	0.647	0.786	0.856	0.550	3.007	0.546	0.789	0.856	0.549

Notes: M = mean; SD = standard deviation; Alpha = Cronbach's alpha; CR = composite reliability; AVE = average variance extracted; PIC = perceived interior crowding; PD = psychological distress; SI = social isolation; EtN = exposure to nature.

4.3. Assessment of structural models in two waves

The conceptual model was calculated separately for the two waves to ensure significance of structural pathways. The Multi-Group Analysis (MGA) technique, which examines the differences between the path coefficients among two groups (Henseler et al., 2015; Hair et al., 2017), was used to evaluate wave differences in PLS-SEM. To determine the model's t-values, 5000 bootstrapping samples were utilized, each with the same amount of observations as the original sample (Hair et al., 2011). With a P-value of less than 0.1, values of t equal to or greater than 1.96 suggest a significant level of the proposed link (Hair et al., 2017;

Chin, 1998). The significance and magnitude of the path coefficients were used to estimate path links between the latent variables in the model. Table 3 demonstrates associations among constructs without the moderation effects of nature exposure.

Table 3: Base model- without moderation effects of nature exposure

	Wave1					Wave2					PLS-MGA	
	Path c	Mean (M)	SD	T-Value	p-Value	Path c	Mean (M)	SD	T Value	p-Value	Path Coefficients-diff	p-Value
PIC -> PD	0.552	0.552	0.033	16.756	0.000	0.367	0.367	0.031	11.766	0.000	0.185	**0.000**
PIC -> SI	0.706	0.707	0.020	34.807	0.000	0.593	0.595	0.030	20.110	0.000	0.113	**0.001**
SI -> PD	0.323	0.324	0.035	9.163	0.000	0.551	0.551	0.029	19.176	0.000	0.228	**0.000**

Hair et al. (2017) suggested that the structural model could be evaluated using the coefficient of determination (R-square) and predictive relevance (Q-square). R^2 values of 0.67, 0.33, and 0.19, according to Chin (1998), must be considered for substantial, moderate, and weak estimations, respectively. The R^2 values in this study were above the acceptable level, with an acceptable (0.659) value for wave 1 and (0.678) value for wave 2, indicating that the corresponding construct has a good predictive potential. All of the path coefficients are also significant. The Q^2 calculation yielded 0.31(wave1) and 0.35(wave2) for psychological distress in the current investigation, showing that they are sufficiently predictive.

Perceived interior crowding had a significant impact on psychological distress (ß = 0.55; $p < 0.001$ at wave 1 and ß = 0.36; $p < 0.001$ at wave 2), as demonstrated in Table 3, confirming H2. This is in line with the belief that people with higher level of perceived interior crowding are more likely to express psychological distress. Regarding the direct impacts of perceived interior crowding on social isolation (ß = 0.70; $p < 0.001$ at wave 1 and ß = 0.59; $p < 0.001$ at wave 2), H3 was supported. According to these positive coefficients, individuals who perceive more interior crowding are more likely to feel social isolation. This finding is consistent with previous studies (e.g., Evans, 2003; Rollings & Evans, 2019).

The effects of social isolation on psychological distress were both positive and significant (ß = 0.32; $p < 0.001$ at wave 1 and ß = 0.55; $p < 0.001$ at wave 2). This implies that people who experience a higher level of social isolation express more psychological distress (Hyun-Soo & Jung, 2021; Taylor et al., 2016). As shown in Table 3, social isolation has an increasing influence on psychological distress over time and the p-value of the difference in path coefficients between Wave 1 and Wave 2 for the structural link hypothesized in H5 is significant.

Both direct and indirect effects were examined to test H4, which predicts that social isolation will mediate the relationship between perceived interior crowding and psychological distress. There was a significant indirect effect of perceived interior crowding on psychological distress ($\beta = 0.228$, $p < 0.000$ at wave 1 and $\beta = 0.327$, $p < 0.000$ at wave 2).

4.4. Moderating effect of nature exposure

First, the moderation role of nature exposure on the relation between perceived interior crowding and psychological distress (H6) has been separately examined for each wave (Fig. 2). Nature exposure moderated this relation only in wave1 (Table 4), supporting the change in the moderation role of exposure to nature during the epidemic. In Wave 1, participants with more nature exposure in their areas were less likely to experience psychological distress. Second, the moderation role of nature exposure on the relationship between social isolation and psychological distress (H7) has been tested (Fig. 3). Hypothesis 7 was significant in two waves.

Table 4: Moderating effect of exposure to nature on the relation between PIC and PD (H6)- Hypotheses test by Groups: Wave1 Versus Wave2 (MGA).

	Wave1					Wave2					PLS-MGA	
	Path c	Mean	SD	T-Value	p-Value	Path c	Mean	SD	T Value	p-Value	Path Coefficients-diff	p-Value
Moderating Effect 1 -> PD	0.067	0.065	0.024	2.737	**0.006**	0.013	0.010	0.023	0.561	**0.575**	0.054	**0.049**
PIC -> PD	0.568	0.568	0.033	17.347	**0.000**	0.367	0.366	0.031	11.914	**0.000**	0.201	**0.000**
PIC -> SI	0.706	0.707	0.020	35.669	**0.000**	0.593	0.593	0.030	20.087	**0.000**	0.113	**0.001**
SI -> PD	0.309	0.309	0.036	8.620	**0.000**	0.550	0.550	0.029	18.702	**0.000**	0.241	**0.000**
EtN -> PD	0.057	0.059	0.024	2.354	**0.019**	0.015	0.018	0.024	0.630	**0.529**	0.042	**0.106**

Notes: The multi-group comparison is based on a non-parametric approach (MGA); *, **, *** indicate significance at the 5%, 1% and 0.1% levels.
PIC = perceived interior crowding; PD = psychological distress; SI = social isolation; EtN = exposure to nature.

Table 4: Moderating effect of exposure to nature on the relation between SI and PD (H7)- Hypotheses test by Groups: Wave1 Versus Wave2 (MGA).

	Wave1					Wave2					PLS-MGA	
	Path c	Mean	SD	T-Value	p-Value	Path c	Mean	SD	T Value	p-Value	Path Coefficients-diff	p-Value
Moderating Effect 2 -> PD	0.069	0.067	0.024	2.913	**0.004**	0.061	0.059	0.018	3.452	**0.001**	0.008	**0.389**
PIC -> PD	0.558	0.559	0.034	16.456	**0.000**	0.364	0.363	0.031	11.935	**0.000**	0.193	**0.000**
PIC -> SI	0.706	0.707	0.020	35.075	**0.000**	0.593	0.594	0.030	20.046	**0.000**	0.113	**0.001**
SI -> PD	0.317	0.317	0.036	8.821	**0.000**	0.559	0.559	0.031	18.306	**0.000**	0.242	**0.000**
EtN -> PD	0.054	0.056	0.024	2.284	**0.022**	0.012	0.015	0.023	0.512	**0.609**	0.042	**0.104**

Notes: The multi-group comparison is based on a non-parametric approach (MGA); *, **, *** indicate significance at the 5%, 1% and 0.1% levels.

PIC = perceived interior crowding; PD = psychological distress; SI = social isolation; EtN = exposure to nature

5. Discussion

Subjective well-being has been proved to be an independent predictor of health (Corley et al., 2021). In addition to its terrible physical implications, the COVID-19 pandemic has posed mental health issues. The prevention of disease spread prompted governments worldwide to impose lockdowns. When people's access to work, education, and public spaces is limited, their homes must play a special role in their daily lives and mental health (Meagher & Cheadle, 2020). Like many other developing countries, Iran has witnessed rapid development in residential environments during the last 20 years. In this context, with a relatively large household, perceived interior crowding relating to home size is likely to be more critical than in other contexts with large lots and small households.

There is a well-established link between perceived interior crowding, social isolation, and poor mental health. The great majority of studies have reported a positive relationship between overcrowding and psychological distress (Evans et al., 2002; Chan et al., 2020). It is widely acknowledged that exposure to nature has a positive impact on mental health. Nonetheless, in the contemporary setting of COVID-19, little is known about the critical role of time in correlations between perceptual characteristics and the repercussions of social isolation (Melo & Soares, 2020). Our goal was to shed more light on this topic by examining changes in psychological distress in a cohort of women during the pandemic, using two waves of data. The current study adds to the body of knowledge by addressing the following issues: During a pandemic and its related lockdowns, did social isolation and psychological distress increase? Is there a link between nature exposure and psychological distress caused by perceived interior crowding? Does nature exposure moderate the relationship between social isolation and psychological distress? Is this moderating role time-dependent?

5.1. Perceived interior crowding, social isolation, and psychological distress

The most important predictor variable in the model was perceived interior crowding, which had both direct and indirect effects on psychological distress. Perceived interior crowding was associated with social isolation and psychological distress in both waves indicating that people's impressions of their homes can contribute to poor mental health outcomes. Household crowding effects even prevail over community density in that an optimal household density counteracts the deleterious impact of community density in terms of psychological distress and residential satisfaction (Gomez-Jacinto & Hombrados-Mendieta, 2002).

The model revealed that social isolation was the second predictor of psychological distress, confirming Durkheim's theory that lack of social integration has negative mental health repercussions (Berkman et al., 2000). Also, social isolation was a significant mediator variable in relation between perceived interior crowding and psychological distress, confirming prior findings (e.g., Wells & Harris, 2007). In the context of coronavirus pandemic, many areas of people's lives, including levels of physical activity, psychological and physical wellbeing, have been negatively impacted by crucial policies such as social distancing and self-isolation (Cellini et al., 2020; Corley et al., 2021). Self-reported social isolation and psychological distress were considerably higher in wave 2 than in wave 1. This finding demonstrated that, while social distancing techniques may assist in safeguarding public health, they may have unanticipated negative repercussions for mental health, consistent with evidence identifying loneliness as a risk factor for mental health (e.g., Liu et al., 2020).

Cutting off from social networks can make people feel vulnerable and pessimistic about their situation, resulting in negative mood states during a pandemic. Because residents are likely to have already experienced a loss of interpersonal bonds due to the epidemic, the additional social isolation from mandatory physical separation can exacerbate the psychological toll (Hyun-soo & Jung, 2021). The pandemic is a global stressor with no predictable endpoint, and its effects cannot be controlled by a single individual factor; additionally, psychological distress can arise not only from isolation and loneliness but also from increased worry (Gorenko et al., 2020) and the pandemic's simultaneous impacts on various domains (e.g., financial and physical health) (Liu et al., 2020).

5.2. Time-dependent effect of nature exposure

Exposure to nature has been linked to various health advantages based on classic early studies, such as attention restoration theory (Kaplan, 2001) and stress reduction theory (Brooks et al., 2020). However, some studies have discovered significant positive correlations between perceptions of urban green space quantity and mental health outcomes (Sugiyama et al., 2008; Cleary et al., 2019); recent urban studies have found that psychological well-being has a significant relationship with perceptions of green space, which may differ from objective measures. Considering the quantity and objectively quantifying green space without taking into account how people perceive the space may not provide the full picture of a situation (Hyun-soo & Jung, 2021). As a result, we have concentrated on how people feel about being in nature rather than quantitative measurements.

Access to nature has been rapidly acknowledged as playing a buffer against the psychological consequences of the COVID-19 epidemic (Ahmadpoor & Shahab, 2020; Ferrini & Gori, 2021). Exposure to nature during the stay-at-home order was also thought to mitigate the negative impacts of perceived interior crowding on mental health outcomes. Our findings imply that exposure to nature may aid in maintaining people's health during a pandemic, but this effect is time-dependent. It is worth noting that exposure to nature predicted a short-term effect in reducing the unfavorable outcomes of perceived interior crowding. At any stage throughout the pandemic, individuals' reported exposure to nature did not help to mitigate the detrimental effect of perceived interior crowding on psychological distress. During the earliest stages of the national response to the outbreak, one's link to nature was vital. As a result, the mental health benefit of exposure to nature may not be sufficient to safeguard against psychological distress over the long-term widespread pandemic. This problem, however, can be linked to the quality of green space emphasizing the need to provide high-quality natural environments in cities as well as a variety of visual exposures (Olszewska-Guizzo et al., 2021).

As a moderator variable in both waves, exposure to nature mitigated the negative impacts of social isolation on psychological distress. Spending time in public open areas may encourage people to interact with their neighbors, fostering a sense of community and social relationships. Increased social cohesion has been identified as a fundamental factor of psychological wellbeing and an underlying mechanism in the link between green space and health (De Vries et al., 2013; Corley et al., 2021). Furthermore, neighborhood identification is an essential driver of responses to the local and has environment a direct impact on mental health (Fong et al., 2019). The advantages of having an optimistic attitude in life are amplified by community

togetherness. This conclusion emphasizes that a home's appraisal will vary depending on the amount to which particular sorts of psychological needs are addressed or not. Individuals' ability to organize their home environment allowing desirable behaviors can be a vital aspect of maintaining mental health (Meagher et al., 2020).

Limitations and future studies

To promote mental health through the built environment, residential spaces should be planned and managed to accommodate different preferences and perceptions, particularly among people from various socioeconomic backgrounds. Only individuals with a particular degree of technical skill and internet connection were eligible to participate; the study sample may be biased toward people from higher socioeconomic backgrounds. Because the relationship between perceived interior congestion and adverse outcomes varies by gender (Rollings & Evans, 2019), generalizing the findings should be done with caution.

Given that this case study was limited to a small number of socio-demographic and health-related characteristics, as well as mid-rise housing in a specific context, future research could investigate the outcomes in other cities and socio-cultural settings. It seems logical that the physical, social, and cultural contexts can foster or restrain social distancing; consequently, future research should compare the influence of open space arrangements and home layouts. Our longitudinal data support the core assumption that the effects of built environment features linked to mental health outcomes change with time. Future longitudinal studies could concentrate on different waves of data collection in order to better address the issue of temporal ordering of the structural relationships. Finally, future research should confirm the findings of this study using a larger, more representative sample in various settings and demographics.

Declarations

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Competing interests

The authors have no relevant financial or non-financial interests to disclose.

Ethics approval

This research is not based on laboratory data and the satisfaction of all participants has been obtained.

Data availability

The datasets generated during the current study are available from the corresponding author on reasonable request.

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Figures

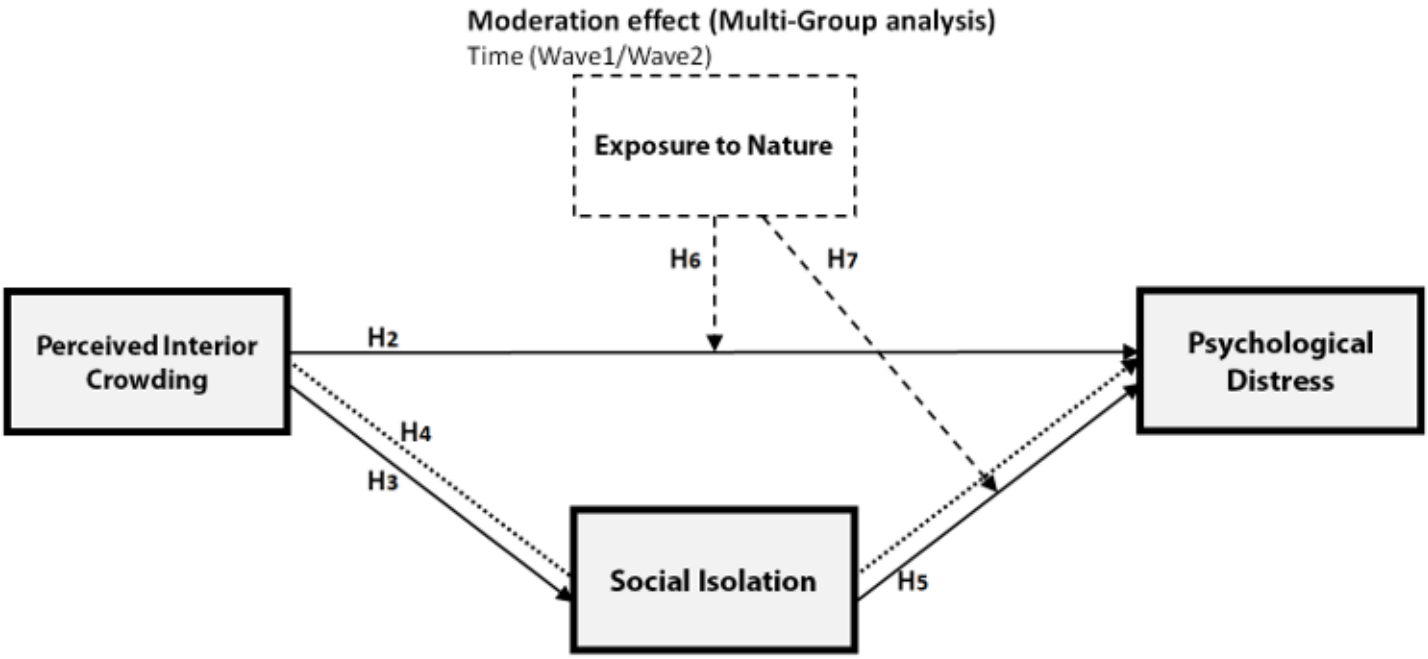

Figure 1

Conceptual model.

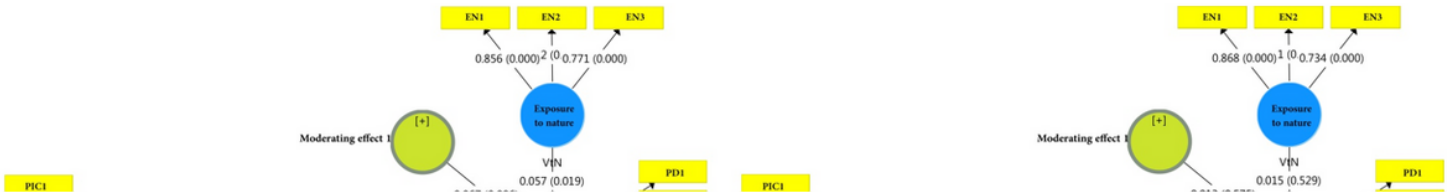

Figure 2

Structural equation modeling- moderating effect of exposure to nature on the relation between PIC and PD

Figure 3

Structural equation modeling- moderating effect of exposure to nature on the relation between SI and PD