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This is the final peer-reviewed author's accepted manuscript (postprint) of the following publication:

*Published Version:*

Fornara F., Mosca O., Bosco A., Caffo A.O., Lopez A., Iachini T., et al. (2022). Space at home and psychological distress during the Covid-19 lockdown in Italy. JOURNAL OF ENVIRONMENTAL PSYCHOLOGY, 79, 1-10 [10.1016/j.jenvp.2021.101747].

*Availability:*

This version is available at: <https://hdl.handle.net/11585/849850> since: 2024-05-23

*Published:*

DOI: <http://doi.org/10.1016/j.jenvp.2021.101747>

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(Article begins on next page)

## **Space at home and psychological distress during the Covid-19 lockdown in Italy**

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# Space at home and psychological distress during the COVID-19 lockdown in Italy

## Abstract

Prolonged periods of restrictions on people's freedom of movement during the first massive wave of the COVID-19 pandemic meant that most people engaged in all their daily activities at home. This suggested the need for the spatial features of the home and its occupants' perception of them to be investigated in terms of people's wellbeing.

The present study was conducted on a large sample ( $N = 1354$ ) drawn from different Italian regions. It examined the relationship between the "objective" and "subjective" dimensions of the home, measured in terms of objective home crowding and satisfaction with the space at home, in relation to perceived stress and the perceived risk of COVID-19 infection during the lockdown. The results showed that perceived stress is influenced by objective home crowding through the mediation of satisfaction with the space at home. These associations were more pronounced in younger generations. The negative association between satisfaction with the space at home and perceived stress was higher, the lower the perceived COVID-19 risk.

## Keywords

perceived stress; COVID-19; restricted movement; satisfaction with the space at home; crowding; perceived risk of COVID-19 infection

## Highlights

- Data were collected during the first national lockdown in Italy (2020).
- The greater the objective crowding, the lower the satisfaction with the space at home.
- The lower the satisfaction with the space at home, the higher the perceived stress.
- This latter association was stronger when the perceived COVID-19 risk was lower.
- All these associations were stronger in younger generations than in older people.

## 27    **1. Introduction**

28    During a national lockdown imposed by the Italian government from March to May 2020 to combat  
29    the first wave of the COVID-19 pandemic, people were obliged to stay at home all day (09.03.2020,  
30    DPCM #iorestoacasa – I stay at home). They were only allowed to go out for necessities, such as to  
31    purchase food or medicines, or to work if smart working was impossible. The COVID-19 outbreak  
32    changed people's habits, routines and lifestyles, affecting human relationships and work productivity  
33    all over the country. Streets remained deserted and the fear of infection a constant companion. The  
34    experience of life at home was strongly affected too, especially during periods of enforced quarantine  
35    (Rogers & Power, 2020). Home became the place where most of the population conducted most or  
36    all of their daily activities. Its occupants worked, studied, socialized, and engaged in physical exercise  
37    routines, sharing the available space throughout the day, sometimes not without family conflicts and  
38    tensions (Prime, Wade, & Browne, 2020). The arrival of the COVID-19 pandemic led to a 69%  
39    increase in the number of people in Italy working remotely (Savic, 2020). Numerous narratives have  
40    emerged regarding the meaning of 'home' in these pandemic times (Devine-Wright et al., 2020),  
41    some positive (home as a safe and healthy place, peaceful and restful, with more time to spend with  
42    the family), some negative (home as a place of isolation, loneliness, threat, oppression and  
43    imprisonment).

44    The central role of the home was dramatically emphasized during the COVID-19 lockdown,  
45    suggesting the need to see it as more than just a physical living space. It is important to its occupants'  
46    social and psychological wellbeing (Daniela et al., 2020). This has shifted the focus to the spatial  
47    adequacy of people's homes as a factor to consider in efforts to reduce the psychological distress  
48    caused by lockdowns.

49    The present study focused on the relationship between the space at home, residential satisfaction, and  
50    perceived stress during the first nationwide lockdown in Italy, between March and May 2020. These  
51    issues, and the specificity of any age-related differences, are addressed in the following sections.

52

53 ***1.1. Residential satisfaction***

54 The literature describing research on individuals in relation to their residential environments has  
55 addressed various spatial levels applicable to the term “residential” (Marans, 2003), from the micro  
56 to the macro level (see also Lewicka, 2010; Bonaiuto & Alves, 2012), from the single dwelling (e.g.,  
57 Gómez-Jacinto & Hombrados-Mendieta, 2002; Pasca, Aragones, & Poggio, 2016; Anton &  
58 Lawrence, 2014) to the residential complex or facility (e.g., Cerina, Fornara, & Manca, 2017), the  
59 neighborhood (e.g., Hernandez, Hidalgo, Salazar-Laplace, & Hess, 2007; Fleury-Bahi et al., 2008;  
60 Bonaiuto et al., 2015; Fornara, Lai, Bonaiuto, & Pazzaglia, 2019), and the broader urban context (e.g.,  
61 Brown & Kyttä, 2014; Casakin, Hernandez, & Ruiz, 2015).

62 Housing satisfaction has been examined as one of the facets of residential satisfaction (Francescato,  
63 2002; Lu, 1999; Weidemann & Anderson, 1985), which contributes greatly to overall life satisfaction  
64 and happiness (Peck & Kay 1985; Hu 2013; Kahlmeier, Schindler, Grize, & Braun- Fahrländer,  
65 2001). On the other hand, the spatial features of the home have rarely been the focus of research in  
66 the recent literature (Campagna, 2016; Aragones, Amerigo, & Perez Lopez, 2017).

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68 ***1.2. The spatial dimension of the home***

69 There is empirical evidence of housing quality and the spatial adequacy of housing both affecting  
70 housing satisfaction (Lu 1999; Levy-Leboyer1993; Elsinga & Hoekstra, 2005; Vera-Toscano &  
71 Ateca-Amestoy, 2008). On the role of a home’s size in predicting residential satisfaction (e.g., Ibem  
72 & Aduwo, 2013; Zhang et al., 2018 and the review on this topic by Aigbavboa & Thwala, 2016), a  
73 positive correlation has been reported between the number of bedrooms in a home and its occupants’  
74 general satisfaction (Cheshmehzangi, 2020). Crucially, in a study conducted on students during the  
75 lockdown in Lombardy (one of Italy’s geographical regions most affected by the pandemic), living  
76 in small homes (less than 60 square meters in size) was associated with a higher likelihood of  
77 depressive symptoms (Amerio et al., 2020).

78 Besides the size of a home, another important issue concerns its spatial configuration (Campagna,  
79 2016). Partitions convey separation and depth, protecting against unwanted stimuli and intrusions  
80 (Evans, Lepore, & Schroeder, 1996). This relates to social spacing aspects, such as crowding and  
81 privacy, which are closely related (Bell et al. 2001) because they both concern the interface between  
82 spatial layouts and people. As Gatersleben and Griffin (2017) reported, crowding and (lack of)  
83 privacy have been among the most often studied social-environmental stressors.

84 The stressful impact of crowded conditions has been demonstrated in various settings, such as offices  
85 (Veitch, 2012), correctional facilities (Wener, 2012), and students' dormitories (Baum et al., 1981).  
86 In a sample of US college students, Evans, Lepore and Schroeder (1996) found smaller spaces at  
87 home associated with higher levels of psychological distress. This effect seems to emerge not only in  
88 noncontact cultures (as in Northern European and North American societies), but also in contact  
89 cultures (in Latin America, for instance), as shown by Evans, Lepore, and Allen (2000). The stressful  
90 influence of chronic residential crowding has been judged to be "moderately strong" (Evans &  
91 Stecker, 2004), though the evidence mainly concerned dormitories or laboratory studies. To be more  
92 specific, research has demonstrated that the degree of psychological distress increases with the  
93 number of people per room (Evans, 2003), which has also shown to influence the support to anti-  
94 democratic political systems in Italy during the COVID-19 lockdown (Cavazza, Russo, Colloca, &  
95 Roccato, 2021).

96 Amongst the indicators of crowding, Torshizian and Grimes (2020) mention the floor area per person  
97 used by the United Nations and World Health Organization as a quality of life indicator in judging  
98 sustainable human settlements. The people-per-room index, also known as the American Crowding  
99 Index (ACI), is another commonly used measure<sup>1</sup>. In their literature review on the relationship  
100 between crowding in homes and infectious diseases, Baker et al. (2013) found that the people-per-

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<sup>1</sup> These crowding indicators refer to what Veitch (2012) - for office environments - called "spatial density" (the area available to each office occupant) or "social density" (the number of occupants per office). For a given space, the two indexes are two sides of the same coin, of course: if one increases, the other decreases.

101 room index was the most often used measure of crowding, followed by people-per-house and people-  
102 per-bedroom indexes. Studies that considered stress as the outcome variable also considered people  
103 per room as a measure of crowding (e.g., Evans et al., 1996; Gomez-Jacinto & Hombrados-Mendieta,  
104 2002; Campagna, 2016). For instance, Gomez-Jacinto and Hombrados-Mendieta (2002) reported a  
105 multiplicative effect of crowding at home and in the community in influencing both psychological  
106 distress and residential satisfaction.

107 Crowding at home might be addressed as both an “objective” and a “subjective” condition, as  
108 suggested by Bonnes et al. (1991). Thornock et al. (Thornock , Nelson, Porter, & Evans-Stout, 2019)  
109 made the point that, despite growing evidence of the prominence of perceived space over actual  
110 (objective) space, there have been few studies on the subjective aspect, or perceived crowding, which  
111 has to do with “feeling too close to others” and “how distant one feels from others in his or her space”  
112 (Thornock et al., 2019, p. 40). For instance, Rodgers (1982) found that the relationship between  
113 satisfaction with a community, neighborhood and dwelling related more to perceived crowding than  
114 to objective crowding. Torshizian and Grimes (2020) reported instead that perceived crowding and  
115 various objective crowding measures carried much the same weight in terms of people’s residential  
116 satisfaction. The dichotomy between objective and subjective crowding recalls the broader distinction  
117 between objective and subjective assessment of environmental quality of places, e.g. concerning the  
118 urban contexts (Gifford, 2002; Bonaiuto & Alves, 2012) and the healthcare settings (Fornara &  
119 Andrade, 2012). In this regard, some studies (Andrade e al., 2013; Fornara, 2005) found that users’  
120 perceived quality of hospital environmental features (i.e., a kind of subjective assessment) mediate  
121 the relationship between expert ratings of the hospital design (i.e., a kind of objective assessment)  
1221 and a global response of users’ satisfaction towards their experience.

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**124    1.3. Age-related differences in home satisfaction**

125    Age needs to be borne in mind when addressing the influence of the spatial dimensions of homes.

126    Zhang et al. (Zhang et al., 2018) found that several features of a home - such as ownership, type, size,



127 number of bedrooms, and the presence of living rooms or bathrooms - predicted older adults' level  
128 of satisfaction with their homes, whereas only the size of the home and the number of bedrooms were  
129 significant predictors for younger people.

130 The Tiny House Community Survey conducted by Boeckerman and colleagues (Boeckerman,  
131 Kaczynski, & King, 2019) identified age as a significant sociodemographic predictor of respondents'  
132 satisfaction with their tiny homes: people from 40 to 66 years old were more satisfied than younger  
133 residents (from 19 to 39 years old). Other studies found that residential satisfaction tends to increase  
134 with age (Lu, 1999; Mridha, 2020). The home probably tends to have a more central role in the lives  
135 of older adults, who are more likely to organize their daily activities around their place of residence  
136 than younger adults (Bonaiuto, Bonnes, & Continisio, 2004; Fornara & Manca, 2017; Fornara, Lai,  
137 Bonaiuto, & Pazzaglia, 2019). The spatial adequacy of a home is therefore more crucial to the  
138 satisfaction of older people's personal needs (Mridha, 2020). The home may also be more important  
139 to older people because it gives them a sense of continuity with the past (Korpela, 2012), helps them  
140 retain a positive self-image (Rubinstein & Parmelee, 1992), and sustains their sense of identity,  
141 independence and wellbeing (Eyles & Williams, 2008).

142 Both the above-mentioned research findings and the lifestyle changes prompted by the pandemic  
143 suggest that age could play a significant part in both residential satisfaction (in relation to the actual  
144 space available) and stress responses (in relation to satisfaction with the space at home). This is  
145 because during lockdown the home would presumably be the place where older people already  
146 conducted most of their activities, whereas younger people would have generally been obliged to  
1471 change their habits and rearrange their daily routines.

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## 149 2. Study objectives and hypotheses

150 The present study aimed to explore the relationship between home crowding, residential satisfaction,  
151 and perceived stress during a period of lockdown, when people were obliged to stay at home and  
152 environmental variables were likely to be more influential than usual. A first aim was to assess the

153 impact of home crowding on perceived stress because very few studies have analyzed this specific  
154 issue (Evans et al., 1996, 2000). Our study drew theoretical and applicative support from the strong  
155 interest in the psychology of home environments (e.g., Graham, Gosling, & Travis, 2015) prompted  
156 by the COVID-19 emergency and the associated restrictions on people's movements (e.g.,  
157 <https://www.covidfamilystudy.org/>). A second aim was to examine the link between home crowding  
158 and residential satisfaction. Various studies (e.g., Ibem & Aduwo, 2013; Zhang et al., 2018) found an  
159 influence of a home's size and level of crowding on the prediction of residential satisfaction. The  
160 novelty of our work lies in that it analyzed the three variables - home crowding, perceived stress, and  
161 residential satisfaction, and the associations between them - in the same study. We focused on the  
162 spatial dimension of residential satisfaction, since it represents the "subjective" side of home  
163 crowding. In particular, we tested the hypothesis that the relationship between crowding and  
164 perceived stress could be mediated by satisfaction with the space at home. We also considered the  
165 moderating role of the perceived risk of COVID-19 and age, based on the relationships between  
166 perception of safety, age, and satisfaction with the space at home (Ahn & Hedge, 2011). To achieve  
167 our aims, we estimated a moderated mediation model (see Figure 1) where perceived stress during  
168 lockdown was expected to be influenced by objective home crowding (an "objective" measure of the  
169 actual space available), both directly and also indirectly through the mediation of satisfaction with  
170 the space at home (i.e., a "subjective" measure of environmental satisfaction, including aspects related  
171 to perceived crowding, privacy, lighting conditions, and more generally of satisfaction with one's  
172 home). We also considered the role of perceived risk of COVID-19 and age as moderators in the  
173 model.

174 We tested the following hypotheses.

175 H1: The lesser the degree of Objective home crowding, the greater the Satisfaction with the space at  
176 home.

177 H2: The greater the degree of Objective home crowding, the higher the Perceived stress.

178 H3: The greater the Satisfaction with the space at home, the lower the Perceived stress.

179 H4: The relationship between Objective home crowding and Perceived stress is indirect, mediated by  
 180 Satisfaction with the space at home.  
 181 H5: The relationship between Satisfaction with the space at home and Perceived stress is moderated  
 182 by Perceived COVID-19 risk. In particular, we expected the influence of any dissatisfaction with the  
 183 space at home on perceived stress to be weaker in cases of a high perceived COVID-19 risk.  
 184 H6: The relationship between Objective home crowding and Satisfaction with the space at home is  
 185 moderated by Age. To be more specific, we expected a weaker influence of objective home crowding  
 186 on any dissatisfaction with the space at home in older adults.  
 187 H7: Age has a moderating role in the relationship between Satisfaction with the space at home and  
 188 Perceived stress. In particular, we expected the influence of any dissatisfaction with the space at home  
 189 on perceived stress to be weaker for older adults.  
 190 We also considered the possibility of gender-related differences in people's satisfaction with the space  
 191 at home and psychological distress under lockdown, as a few studies found females more satisfied  
 192 with their homes than males (Hu, 2013; Huang et al. 2015; Mridha, 2020; Vera-Toscano & Ateca-  
 193 Amestoy, 2008). Recognizing the extent to which disease outbreaks affect women and men  
 194 differently is a fundamental step towards understanding the primary and secondary effects of a health  
 195 emergency on different individuals and communities, and devising effective, equitable policies and  
 196 interventions (Wenham, Smith, & Morgan, 2020). Wang et al. (2020) found that gender influenced  
 197 symptoms of stress, anxiety and depression in a Chinese sample during the initial stage of the COVID-  
 198 19 outbreak, though only a minority of the participants reported having been obliged to stay at home.  
 199 In another study on Italian healthcare workers during the COVID-19 outbreak, women expressed  
 200 higher levels of anxiety (but not of stress) than men (Mazza et al., 2021). Gender was consequently

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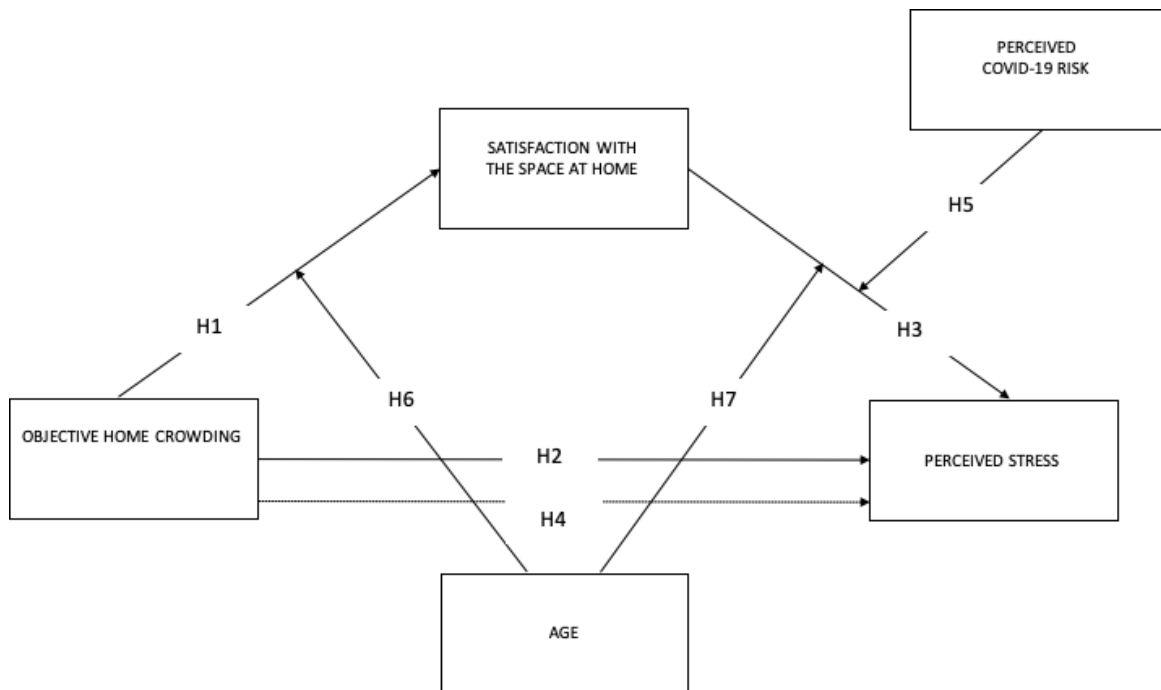


Figure 1. Conceptual model.

### 3. Method

#### 3.1. Participants and procedure

Data were collected between April 23<sup>rd</sup> and May 2<sup>nd</sup> 2020, during “Phase 1” of the Italian lockdown to mitigate the spread of COVID-19. The sample size required was estimated with G\*Power 3.1 (Faul, Erdfelder, Buchner, & Lang, 2009). The  $\alpha$  was set to .05 and the power to 0.95. Analysis indicated that a total of 1145 participants was needed to detect a small effect size (.02), 160 for a medium effect size (.15), and 74 for a large effect size (.35). A convenience sample of 1354 participants ( $F = 896$ ,  $M = 458$ ) aged 18 to 82 years ( $M = 35.44$ ,  $SD = 15.95$ ) took part in the study. Informed consent was obtained from all participants. Recruitment and testing were done in accordance with the ethical standards of the Institutional Review Board at the Department of Psychology (University of

217 Campania L. Vanvitelli, Caserta, Italy; N. 8 prot. #16.20) and with the Declaration of Helsinki.  
218 Participants answered an online questionnaire using the PsyToolkit, a free online platform for  
219 demonstrating, programming and performing psycho-cognitive experiments and investigations. A

link to the electronic survey was distributed worldwide by consortium colleagues (i.e., the Universities of Bologna, Bari, Cagliari, Campania, Milano-Bicocca, and Padova) using various methods: e-mail invitations, the official pages of the consortium's faculties, and other social media platforms such as Facebook™, WhatsApp™, and Twitter™. Participants were also involved in the plans to disseminate the research through the promotion of the survey in their networks. The questionnaire included an introductory page containing the background and aims of the survey. All participants completed the questionnaire, answering all the items, after reading the instructions and digitally signing the informed consent form.

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### 229 3.2. Measures

The study tools inserted in the online questionnaire included the following measures, among others<sup>2</sup>. *Perceived stress* - assessed with the Italian version of the Perceived Stress Scale (PSS: Cohen, Kamarck, & Mermelstein, 1983), the most widely-used psychological tool for measuring the degree to which situations in one's life are perceived as stressful. Psychological stress can be defined as the extent to which people perceive that demands placed on them exceed their ability to cope. The PSS consists of 10 items (e.g. "In the last month, how often have you been upset because of something that happened unexpectedly?", "In the last month, how often have you found that you could not cope with all the things that you had to do?") rated on a 5-point Likert scale, ranging from 0 = "never" to 4 = "very frequently". These items relate to feelings and thoughts during the previous month (i.e. during lockdown in our case), and participants indicated how often they had felt or thought a certain way ( $\alpha = .87$ ).

*Satisfaction with the space at home* - four questions investigated respondents' satisfaction regarding the spatial aspects of their homes: 1) "How satisfied are you generally with your home?", 2) "How



243 satisfied are you with the space, or square footage, of your home?"; 3) "How satisfied are you with

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<sup>2</sup> This study was part of a wider research project, and the questionnaire included a set of other measures that are not the focus of the present report. See XXX (2021), blinded for review.

244 your privacy at home?"; and 4) "How satisfied are you with the natural light in your home?". These  
245 items were rated on a Likert scale ranging from 1 = not at all satisfied to 5= completely satisfied ( $\alpha$   
246 = .78).

247 *Objective home crowding* - this was operationalized in terms of the number of occupants divided by  
248 the number of rooms in the home, i.e., the people-per-room ratio most often used in the literature  
249 (e.g., Evans et al., 1996; Gomez-Jacinto & Hombrados-Mendieta, 2002; Campagna, 2016; Baker et  
250 al., 2013). Two questions were asked: 1) "How many people live in your home, including you?"; and  
251 2) "How many rooms are there in your home (excluding the kitchen, bathrooms, toilets, and utility  
252 rooms)?".

253 *Perceived COVID-19 risk* - four questions investigated how dangerous people felt the COVID-19  
254 virus could be in the present and in the future, and in general and in their local area, i.e.: "How  
255 dangerous do you consider the coronavirus in general in the present/future?"; and "How dangerous  
256 do you consider the coronavirus in the area where you live in the present/future?" Participants had to  
257 indicate the degree of perceived risk by moving a slider. Scores could vary from 0 (no risk) to 100  
258 (maximum risk) ( $\alpha = .84$ ).

259 Sociodemographic information was also collected, including age, gender, education level, marital  
2602 status, having children or not, and place of residence (see Table 1).

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262 *Table 1. Sociodemographic data*

<b>Variables</b>	<b>N</b>	<b>Frequency (%)</b>
<b>1. Sex</b>		
Males	458	33.8
Females	896	66.2
Total	1.354	100.0
<b>2. Education level</b>		
Primary school	9	0.7
Middle school	64	4.7
High school	603	44.5
Bachelor's degree	252	18.6
Master's degree	338	25.0
PhD/Specializations	88	6.5
Total	1.354	100.0
<b>3. Marital status</b>		
Single/Unmarried	812	60.0
In a relationship/Living together	121	8.9
Married	357	26.4
Divorced/Separated	46	3.4
Widowed	18	1.3
Total	1.354	100.0
<b>4. Region of residence</b>		
Lombardy	218	16.1
Emilia-Romagna	212	15.7
Veneto	184	13.6
Campania	315	23.3
Apulia	210	15.5
Sardinia	156	11.5
Other regions	59	4.4
Total	1.354	100.0
<b>5. Having children</b>		
Yes	960	70.9
No	394	29.1
Total	1.354	100.0

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265    3.3. Statistical analysis

266    Data analyses were performed with SPSS version 25, including the PROCESS model macro (Hayes,  
267    2013). PROCESS is a modelling tool that calculates the direct and indirect effects of mediation  
268    models, as well as the interactions and conditional indirect effects in moderation and moderated  
269    mediation models (see <http://www.processmacro.org/index.html> for more details). It generates not  
270    only an ordinary least squares regression-based path analysis similar to structural equation modeling  
271    (SEM), but also additional useful statistics and safeguards against irregular sampling distributions  
272    (Hayes et al., 2017). Continuous measures involved in the interaction term (Age, Satisfaction with  
273    the space at home, Objective home crowding, and Perceived COVID-19 risk) were mean-centered  
274    prior to the analysis (Aiken & West, 1991). We calculated descriptive statistics and zero-order  
275    correlations, which are given in Table 1. Then, we conducted dual moderated mediation regression  
276    analyses (Hayes, 2017, Model 64), assuming that the indirect effects of the independent variable  
277    (Objective home crowding) on the dependent variable (Perceived stress during lockdown), through  
278    the mediator (Satisfaction with the space at home) depends on two moderators, namely Age and  
279    Perceived COVID-19 risk. As reported in the Hypotheses section, we assumed that age would have  
280    an effect at both the first- and the second-stage mediation, and that Perceived COVID-19 risk would  
281    have an effect only in the second stage of the dual moderated mediation analysis. Gender was input  
2822    as a covariate in the model.

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284    3.3.1. Test of mediation

285    Recent methodological approaches suggest that mediation analysis should be conducted on a formal  
286    significance test of the indirect effect “ab”, obtained from the product of the regression coefficients  
287    between the predictor and mediator variables (“a”) and the mediator and outcome variables (“b”).

288 Bootstrap confidence intervals afford a superior test of the significance of indirect effects in mediation  
289 models, however (Hayes, 2013; MacKinnon et al., 2002). We thus tested our mediation hypothesis  
290 using the PROCESS program made available by Hayes (Hayes, 2013). Table 2 shows the regression

coefficients for the model with Objective home crowding (Y), Satisfaction with the space at home (M) and Perceived stress during lockdown (Y), controlling for Gender, based on the PROCESS output reported in the Appendix.

3.3.2. *Test of moderated mediation*

Assuming that the mediation hypothesis is supported by the data (i.e., that the relationship between Objective home crowding and Perceived stress is indirectly mediated by Satisfaction with the space at home), the strength of the indirect effect (mediation) may be influenced by the value of the moderators, Age and Perceived COVID-19 risk. This is termed a conditional indirect effect, or moderated mediation (Hayes, 2013; Preacher, Rucker, & Hayes, 2007). As recommended by Preacher et al. (2007), we estimated the conditional indirect effects using ordinary least squares regression, and tested these effects with bootstrap confidence intervals, assessing whether the indirect effects differ from zero for various values of the moderator. We used 5000 bootstrap estimates to generate 95% bias-corrected confidence intervals for the conditional indirect effects observed. The conditional indirect effects of Objective home crowding on Perceived stress were assessed for three different levels of Age (16<sup>th</sup>, 50<sup>th</sup> and 86<sup>th</sup> percentiles<sup>3</sup>) and Perceived COVID-19 risk (16<sup>th</sup>, 50<sup>th</sup> and 86<sup>th</sup> percentiles).

**4. Results**

Table 2 shows the descriptive statistics concerning the model measures and zero-order correlations between variables, and Table 3 shows the results of the moderated mediation analysis.

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<sup>3</sup> The 16<sup>th</sup>, 50<sup>th</sup> and 84<sup>th</sup> percentiles of Age correspond to 22, 28 and 56 years, respectively.

Table 2. Means  $\pm$  standard deviations, skewness, kurtosis, and zero-order correlations (Pearson's  $r$ ) for variables included in the model.

	Mean (SD)	Skewness	Kurtosis	1	2	3	4	5
Objective home crowding (1)	0.72 $\pm$ 0.33	0.85	1.08	1				
Perceived stress (2)	1.91 $\pm$ 0.74	0.03	-0.38	.14***	1			
Satisfaction with the space at home (3)	3.67 $\pm$ 0.86	-0.54	.10	-.30***	-.25***	1		
Perceived COVID-19 risk (4)	64.02 $\pm$ 21.16	-0.49	-0.19	.06*	.12***	-.01	1	
Age (5)	35.44 $\pm$ 15.95	.89	-0.53	-.22***	-.38***	-.25***	.017	1

Notes. \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

Perceived stress is negatively associated with Satisfaction with the space at home ( $r = -.25, p < .001$ ) and Age ( $r = -.38, p < .001$ ), and positively associated with Objective home crowding ( $r = .14, p < .001$ ) and Perceived COVID-19 risk ( $r = .12, p < .001$ ).

Central to the mediation hypothesis, the effect of Objective home crowding on Satisfaction with the space at home (H1) is significant ( $B = -.7405, t = -10.5570, p < .001$ ), as is the effect of Satisfaction with the space at home on Perceived stress (H3) ( $B = -.1917, t = -8.5399, p < .001$ ). On the other hand, there is no significant direct effect of Objective home crowding on Perceived stress (H2) ( $B = -0.0570, t = -0.9546, p = .339$ ). These results confirm H4, showing an indirect effect of Objective home crowding on Perceived stress through the mediation of Satisfaction with the space at home.



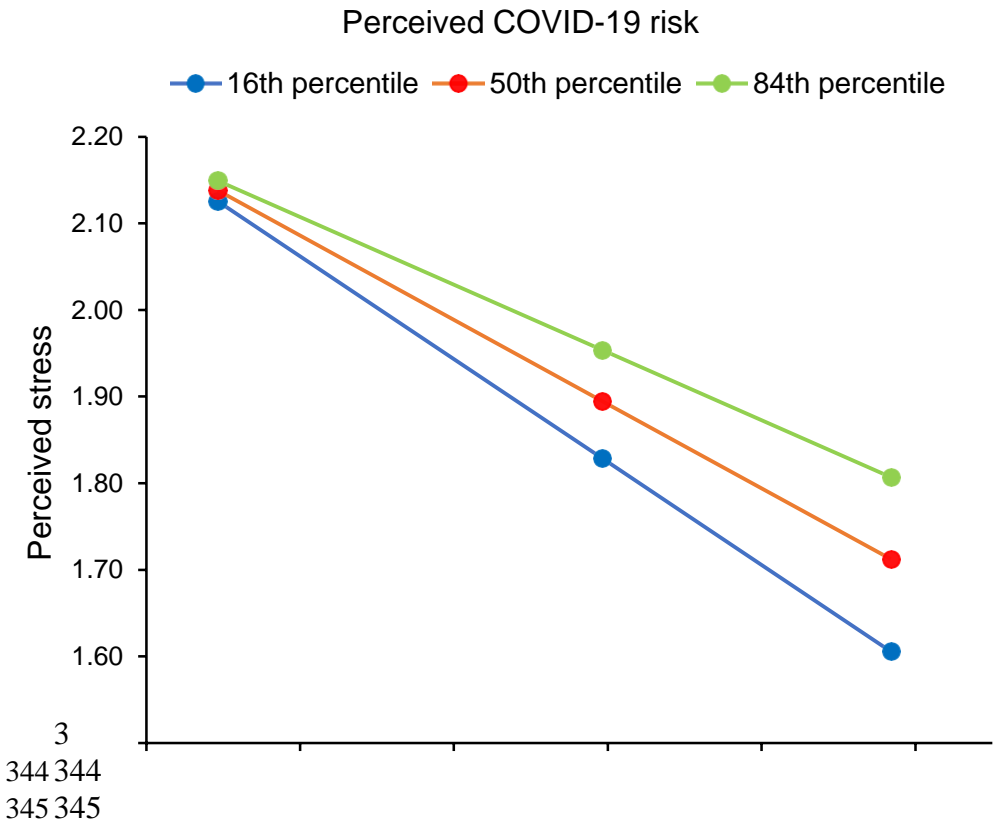
328 Table 3. Moderated mediation analysis. Estimated coefficients, *t*-values and 95% confidence  
 329 intervals (CI) for each effect, *R*<sup>2</sup> and  $\Delta R^2$  for mediator and dependent variable.

Mediator variable model			
	Satisfaction with the space at home		
	<i>B</i>	<i>t</i>	<i>CI</i>
Objective home crowding	- 0.7405	-10.5570***	[-.8781, -.6029]
Age	0.011	8.1500***	[.0084, -.0138]
Objective home crowding*Age	0.0157	3.7202***	[.0074, .0239]
<i>R</i> <sup>2</sup>		0.1441	
$\Delta R^2$		.0081	
	[ΔF (1, 1349) = 13.5704, <i>p</i> < 0.001]		
Dependent variable model			
	Perceived stress		
	<i>B</i>	<i>t</i>	<i>CI</i>
Objective home crowding	-0.0570	-0.9546	[-.1742, .0602]
Age	-0.0142	-11.9520***	[-.0165, -.0119]
Perceived COVID-19 risk	0.0033	3.8681 ***	[.0016, .0049]
Satisfaction with the space at home	-0.1917	-8.5399***	[-.2358, -.1477]
Satisfaction with the space at home*Perceived COVID-19 risk	0.0020	2.2379*	[.0002, .0037]
Satisfaction with the space at home*Age	0.0032	2.2936*	[.0005, .0059]
<i>R</i> <sup>2</sup>		.2560	
$\Delta R^2_1$		.0027	
	Satisfaction with the space at home*Age [ΔF (1, 1346) = 5.2604, <i>p</i> < .05]		
$\Delta R^2_2$		.0025	
	Satisfaction with the space at home*Perceived Covid-19 risk [ΔF (1, 1346) = 5.0083, <i>p</i> < .05]		

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332 Regarding the moderator Perceived COVID-19 risk, the effect of Satisfaction with the space at home  
333 on Perceived stress is significant for both high and low levels of Perceived COVID-19 risk. As  
334 concerns the direction of this moderating effect, the ‘Satisfaction with the space at home x Perceived  
335 COVID-19 risk’ interaction reveals a significant effect in the expected direction (H5) on Perceived  
336 stress ( $B = 0.020$ ,  $t = 2.24$ ,  $p < .001$ ), since the moderated relationship is stronger the lower the  
337 Perceived COVID-19 risk (see Figure 2).



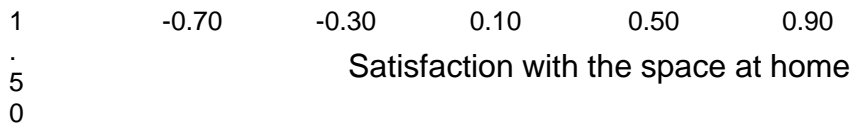
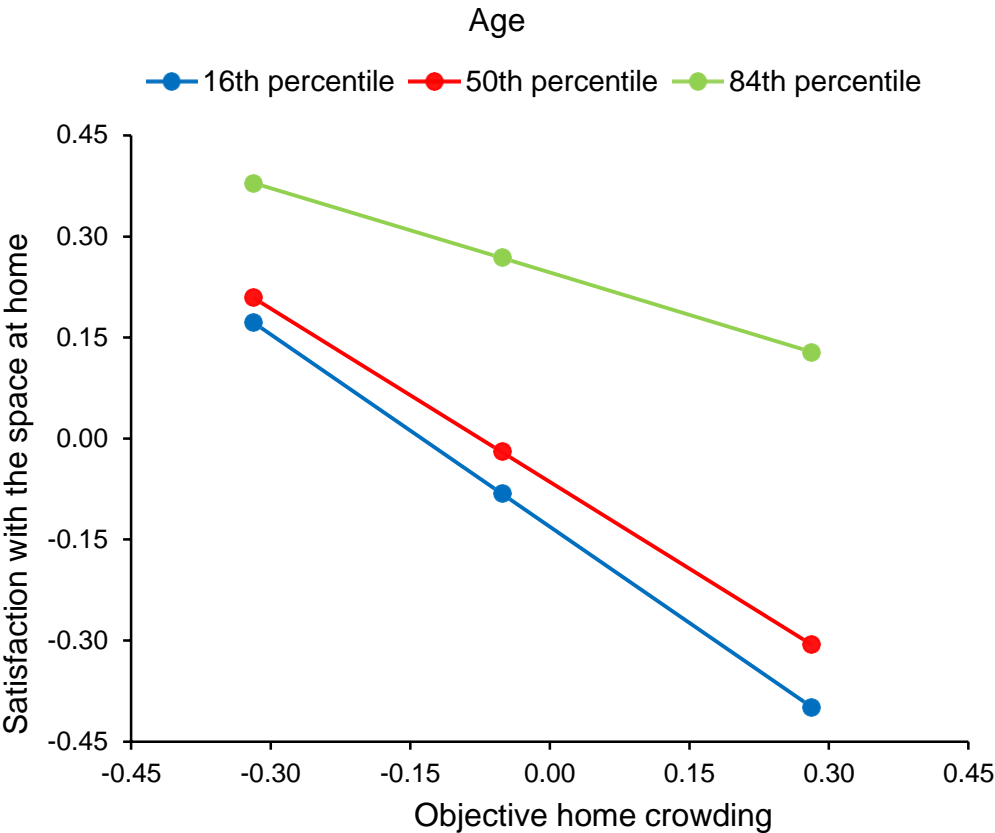


Figure 2. Conditional indirect effect of Satisfaction with the space at home on Perceived stress through the mediation of the Perceived COVID-19 risk estimates (16<sup>th</sup>, 50<sup>th</sup> and 84<sup>th</sup> percentiles). Ninety-five percent bootstrap confidence intervals for indirect effects involving those in the 16<sup>th</sup>, 50<sup>th</sup> and 84<sup>th</sup> percentiles of Perceived COVID-19 risk did not include 0, indicating meaningful indirect effects.

346 As concerns Age, the conditional effect of this moderator is verified in both stages of the model. In  
 347 the first stage, the effect of Objective home crowding on Satisfaction with the space at home is  
 348 significant for both younger and older respondents. Regarding the direction of this moderating effect,  
 349 the ‘Objective home crowding  $\times$  Age’ interaction has a significant effect in the expected direction

350 (H6) on Satisfaction with the space at home ( $B = .0157, t = 3.72, p < .001$ ), as the moderated  
 351 relationship is weaker for older respondents (see Figure 3).



3523  
 5 *Figure 3. Conditional indirect effect of Objective home crowding on Satisfaction with the space at*  
 2 *home through the mediation of the Age estimates (16<sup>th</sup>, 50<sup>th</sup>, and 84<sup>th</sup> percentiles). Ninety-five percent*  
 3533 *bootstrap confidence intervals for indirect effects involving those in the 16<sup>th</sup>, 50<sup>th</sup> and 84<sup>th</sup> percentiles*  
 5 *of Age did not include 0, indicating meaningful indirect effects.*  
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358 In the second stage of the model, the effect of Satisfaction with the space at home on Perceived stress  
 359 is significant for both younger and older respondents. As for the direction of this moderating effect,  
 360 the ‘Satisfaction with the space at home × Age’ interaction has a significant effect (H7) on Perceived

361 stress ( $B = 0.0032$ ,  $t = 2.29$ ,  $p < .01$ ), and the moderated relationship is stronger for younger  
3623 respondents (see Figure 4).  
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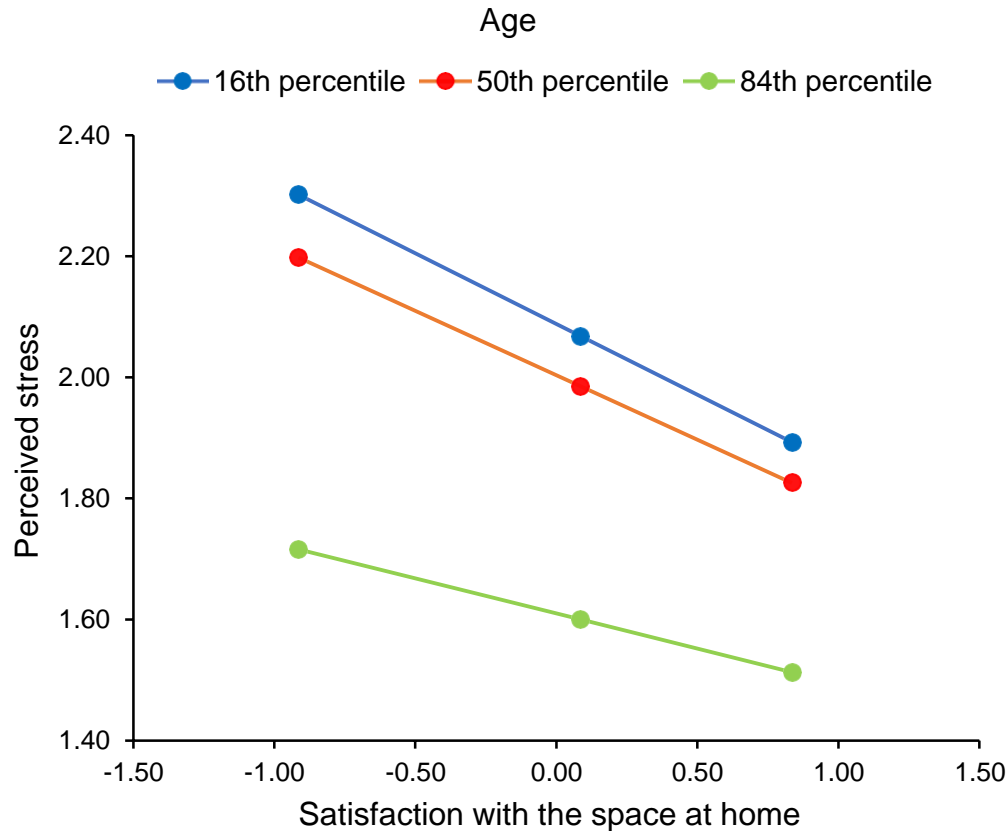


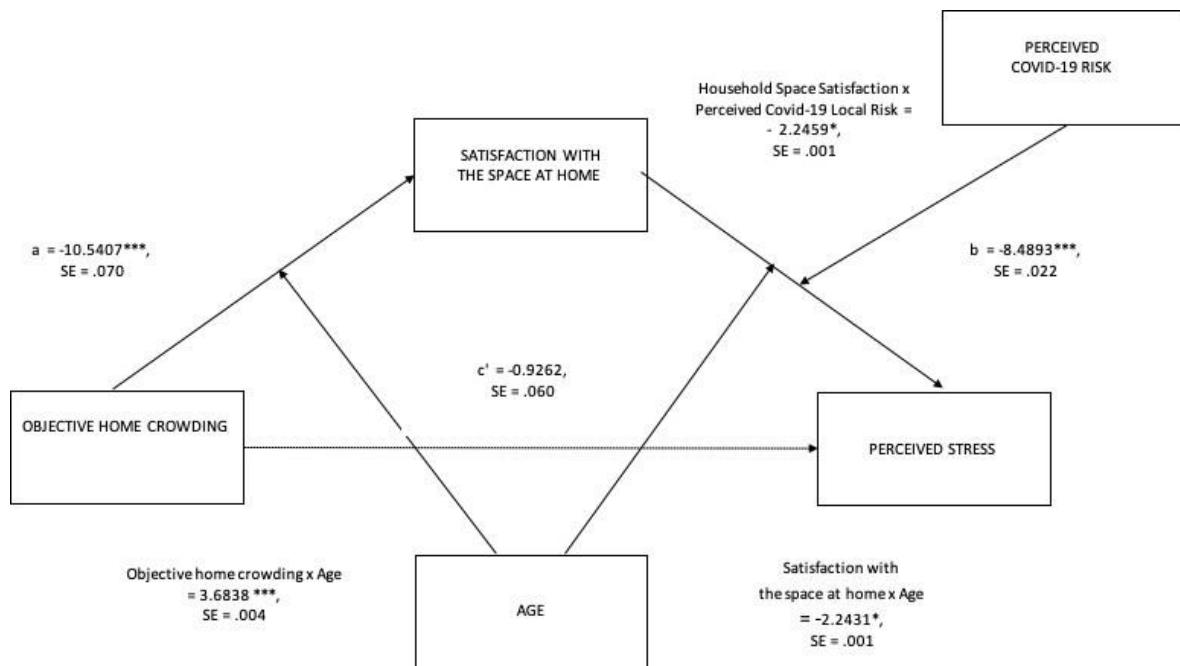
Figure 4. Conditional indirect effect of Satisfaction with the space at home on Perceived stress through the mediation of the Age estimates (16<sup>th</sup>, 50<sup>th</sup> and 84<sup>th</sup> percentiles). Ninety-five percent bootstrap confidence intervals for indirect effects involving those in the 16<sup>th</sup>, 50<sup>th</sup> and 84<sup>th</sup> percentiles of Age did not include 0, indicating meaningful indirect effects.

The conditional effects postulated (moderated mediation) were significant for both Perceived COVID-19 risk ( $B = -0.002$ ,  $CI = -0.0037, -0.006$ ) and Age ( $B = -0.002$ ,  $CI = -0.0055, -0.006$ ). Finally, when the covariate Gender was inserted in the model, there was no significant effect on the relationship between Objective home crowding and Satisfaction with the space at home ( $B = .0311$ ,  $t = .6733$ ,  $p = .500$ ), whereas its effect on Perceived stress was significant ( $B = .339$ ,  $t = 8.97$ ,  $p <$

3753 .001), with women feeling more stressed under lockdown than men.  
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Notes. \*\*\*  $p < 0.001$ , \*  $p < 0.05$ ; SE = standard error

Figure 5. Path model with parameter estimates for all variables.

## 5. Discussion

Our findings provide some first evidence of Satisfaction with the space at home mediating the relationship between Objective home crowding and Perceived stress in a sample of respondents largely obliged to stay at home to comply with governmental measures to contain the COVID-19 pandemic. The mediating role of Satisfaction with the space at home was significant for different levels of both Age and Perceived COVID-19 risk, but its effect was stronger for younger people, and for those who perceived a higher risk of catching the infection.

389 As concerns H1, we confirmed that Satisfaction with the space at home increases when Objective  
390 home crowding decreases, consistently with previous findings on the influence of “objective” home  
391 crowding on the perception of living in crowded conditions (Evans et al., 2000) and on residential  
392 satisfaction (Gomez-Jacinto & Hombrados-Mendieta, 2002). On the other hand, our model revealed

393 no direct influence of Objective home crowding on Perceived stress<sup>4</sup> (H2), in contrast with much of  
394 the literature on the relationship between crowding and stress (e.g., Baum et al., 1981; Evans &  
395 Stecker, 2004; Veitch, 2012; Wener, 2012), in the home environment too (Evans et al., 1996, 2000).  
396 Instead, a significant indirect link emerged between Objective home crowding and Perceived stress  
397 through the mediation of Satisfaction with the space at home (H4). The more residents were satisfied  
398 with the spatial dimensions of their home, the lower the levels of psychological distress they  
399 experienced (H3). This would confirm reports on the effect of residential satisfaction on positive  
400 global human psychological responses, such as overall life satisfaction and happiness (Peck & Kay  
401 1985; Hu 2013; Kahlmeier, Schindler, Grize, & Braun-Fahrlander, 2001). Both the direct stress-  
402 reducing effect of satisfaction with the space at home and its pivotal role in mediating between  
403 crowding and stress take on a special meaning in a situation where people are obliged to stay at home.  
404 People who feel that their living space suffices, and meets their need for privacy, are less likely to  
405 experience a sense of helplessness, which is often closely related to psychological distress and a  
406 perceived lack of control over the situation (Evans & Stecker, 2004; Gatersleben & Griffin, 2017).  
407 As concerns the perceived COVID-19 risk, alongside its predictable significant association with the  
408 level of stress (i.e., the higher the perceived risk, the greater the stress), this variable also emerged as  
409 a moderator between Satisfaction with the space at home and Perceived stress. As expected (H5), the  
410 strength of the association between these two variables is greater the lower the Perceived COVID-19  
411 risk. In other words, appreciating the space available at home is much more important in containing  
412 stress levels for people who are less concerned about the COVID-19 risk than for those more worried  
413 about the pandemic.  
414 As well as confirming that residential satisfaction increases with aging (Campbell, Converse, &  
415 Rodgers, 1976; Lu, 1999; Mridha, 2020; Zhang et al. 2018), older people also seem to be less affected  
416 by home crowding than younger people, as hypothesized in (H6). This is consistent with previous

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<sup>4</sup> It is worth mentioning that the zero-order bivariate correlation between Objective home crowding and Perceived stress is .14, so - although it is significant ( $p < .01$ ) - it seems quite low because of the large sample size.

417 reports of older adults being more satisfied with their tiny homes than younger generations  
418 (Boeckerman et al., 2019). In our study, older people also felt less stressed than younger people,  
419 although it has been amply acknowledged that the harm caused by COVID-19 disease increases with  
420 age (Calderón-Larrañaga, Dekhtyar, Vetrano, Bellander, & Fratiglioni, 2020). On the other hand, the  
421 restrictions imposed to combat the pandemic are likely to have affected the younger generations more.  
422 While older people already tended to organize their daily activities in and around their home  
423 (Bonaiuto, Bonnes, & Continisio, 2004; Fornara & Manca, 2017), lockdown brought far more  
424 dramatic changes for younger adults and children. This situation is also confirmed by the fact that  
425 satisfaction with the space at home has a less important role in containing psychological distress for  
426 the elderly than for the younger generations (H7).

427 Finally, regarding gender-related differences, our results show that women perceived more stress than  
428 men under lockdown, in line with previous findings (for a review, see Ahuja et al., 2020). In fact,  
429 even if men and women tended to cope differently with stress, women seemed to be more severely  
430 stressed by lockdown and COVID-related restrictive measures than men (e.g., Song et al., 2020; Qiu  
431 et al., 2020, Mazza et al., 2020). This may be because of women's front-line role in caring for the  
432 family in Italian society as a whole, and thus they might have reached the peak of psychological  
433 distress during the first period lockdown (Salfi et al., 2020).

434 Our findings support an indirect link between objective conditions of crowding at home and  
435 psychological distress, mediated by (dis)satisfaction with the spatial dimensions of the home, but the  
436 correlational and cross-sectional nature of our study prevents us from inferring any causal chain  
437 connecting the variables considered. Future, preferably longitudinal studies should address this  
438 limitation, to lend further strength to these findings. A further dimension that could be considered in  
439 future research on this topic is the resident's Socio-Economic Status (SES), since it is supposed to  
440 impact on objective home crowding, assuming that high SES people have averagely more home space  
441 than low SES people, at least in urban contexts. Given that SES is a highly sensitive and confidential  
442 piece of data (e.g., see Schwartz & Paulin, 2000; Andreenkova & Javeline, 2019), we decided to not

443 include this measure in our survey, also because we did not have a clear hypothesis on how SES  
444 would have influenced our model's paths. In other words, we did not find grounds in literature about  
445 variations of the association between objective and subjective crowding at home - or between the  
4464 latter and stress - at different SES levels.  
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448 **6. Conclusion**

449 The present study, based on a large sample recruited in different Italian regions, sheds some light on  
450 the sense of wellbeing associated with the objective and subjective characteristics of our homes. The  
451 data examined were collected about six weeks after the start of a national lockdown imposed by the  
452 central government in Italy, as in many other European countries, at the start of the COVID-19  
453 pandemic.

454 The study outcomes point to the crucial importance of carefully assessing the influence of satisfaction  
455 with the space at home on the association between objective home crowding and perceived stress.  
456 Age reveals an important role in these relationships, with younger people's satisfaction with the space  
457 at home being more affected by objective home crowding, and their consequent perceived stress is  
458 more severe than in older people. The mitigating effect of satisfaction with the space at home on  
459 perceived stress was also found weaker when the perceived COVID-19 risk was greater.

460 Overall, a coherent picture emerges from our results: home means a safe haven, especially for the  
461 elderly, but for the younger generations its objective and subjectively-perceived spatial features have  
462 a key role in mitigating the stressful effects of having to stay at home under lockdown. Taken together,  
463 these findings show that issues relating to the space available at home - in terms of residential  
464 satisfaction and crowding - are fundamental to people's wellbeing and perceived stress in response  
465 to the restrictions imposed by the COVID-19 emergency. It is therefore important to consider these

466 aspects with a view to designing adequate, flexible living spaces in the homes of today and tomorrow.  
467 In conclusion, it is to mention that the same notion of pandemic has been questioned, and a syndemic  
468 approach was recently proposed (Horton, 2020), in order to demonstrate how an integrated

469 perspective to understanding and coping with diseases can be far more successful than simply  
470 controlling epidemics or treating individual patients. Such an approach advocates the inclusion of the  
471 economic, social, and environmental factors that could amplify (or buffer) the effect of diseases  
472 (Singer, Bulled, Ostrach, & Mendenhall, 2017), as in the case of the COVID-19 pandemic. Given  
473 that poor-quality housing is associated with various negative health outcomes, including chronic  
474 diseases (Hu, Roberts, Azevedo, & Milner, 2021), it is essential that policy makers and other public  
475 health stakeholders take into account the pivotal role of house conditions for individual's wellbeing,  
476 considering that, even when hopefully the pandemic will be over, many people will continue to work  
4774 from home, either entirely or partially (Guyot & Sawhill, 2020).

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**480   Declarations of interest**

4814   None.  
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**483   Data availability**

4844   The data examined in this study will be made available upon reasonable request.  
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**486    Acknowledgements**

487    We thank Frances Coburn for her valuable work of language revision.



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**Supplementary Material**

Appendix\_PROCESS output of the Moderated Mediation  
Analysis.docx

