Impact of isolating COVID-19 patients in a supervised community facility on transmission reduction among household members

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ABSTRACT

Background Isolation of COVID-19 patients has been universally implemented to control transmission of the outbreak. Hotels and other facilities have been adapted to help appropriate isolation be achieved. Our study tested the efficacy of isolating patients in a reconditioned hotel versus isolation in their domiciles to reduce infection transmission.

Methods Observational cohort study based on a survey to COVID-19 patients between April and June 2020. One cohort had been isolated in a hotel and the other in their domiciles. Multivariate regression models analyzed the factors related to the occurrence of COVID-19 infection among the household members.

Results A total of 229 household members of COVID-19 patients were analyzed, 139 of them belonging to the group of hotel-isolated patients and 90 in the group of domicile-isolated ones. More than half of the household members became infected (53.7%). Higher risk of infection was found in the household members of domicile-isolated patients isolated and in those reporting overcrowding at home, (odds ratio [OR] 1.67, 95% confidence interval [CI] 0.89–3.12) and (OR 1.44, 95% CI 0.81; 2.56), respectively.

Conclusions The isolation of COVID-19 patients in community-supervised facilities may protect their household members from transmission of the disease. Overcrowded homes may contribute to the transmission of the infection.

Keywords housing, infectious disease, primary care

Introduction

Eleven months after the first patient was identified in Wuhan, China, confirmed cases of infection by SARS 2-Cov 2 have risen to 51 547 733, including 1 275 979 deaths.[1] And >188 countries have needed to implement control measures to mitigate its effect.

From the beginning, public health efforts have been focused on the investigation of new cases and contacts, as well as isolation measures, social distancing and the prohibition of meetings and limitation of social events.[3] The combination of these measures has been reported as being able to reduce the number of infections.[2]

Isolation, not only of confirmed, but also of suspected cases, is crucial, nevertheless, its role in achieving control of COVID-19 transmission is as yet unclear.[4]

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The probability of an infection occurring among susceptible individuals following contact with an infectious subject is variable. It is, however, greater among close household members, participants at crowded social events and nursing home inmates. In the case of household contacts, the rate has been described as up to 30%,[5] and 64% of the clusters have been found within these settings.[6] It is thought that currently households are one of the major sources of transmission.

Evidence regarding the optimum way to approach the outbreak has evolved from identification of the first cases in the early pandemic to mathematic models developed to predict the disease epidemiology. Nevertheless, their efficacy must be demonstrated in real life.[7,8]

Findings concerning the effect of the public health measures implemented during the first stage of the pandemic may help to prevent dramatic increases in morbidity and mortality in its successive waves. The aim of this article is to determine the impact of isolating confirmed COVID-19 patients in a community-supervised facility (reconditioned hotel) versus home isolation, in order to prevent disease transmission among their household members.

Methods

A dynamic cohort study in which patients confirmed as having COVID-19, through polymerase chain reaction (PCR) testing, were interviewed to collect information about themselves and their household members. These patients will be denominated 'index patients' for the purpose of this article.

From April to June 2020 two different cohorts of index patients were interviewed, one of them consisting of COVID-19 subjects isolated in a community-supervised facility (reconditioned hotel), and other one isolated at their domiciles. In both groups, isolation lasted until 14 days after the onset of the symptoms provided the patient was free from clinical manifestations.

Index patients were identified from the hotel admission lists and primary care electronic medical records. The participant sample was selected consecutively from these lists. Patients were contacted by telephone and informed consent was obtained. A survey asking them for data concerning themselves and their household was administered. For the purpose of the study we considered as household members those individuals living with the index patients in the same home for at least 2 weeks prior to their confirmed COVID-19 diagnosis.

Inclusion criteria for index patients were to be aged $\geq$ 18 years, and to have reported sharing a home with any household member for at least 2 weeks prior to their confirmed PCR diagnosis.

The index patients had been either referred from hospital discharge or directly from primary care, through the social services. Index patients were admitted to a hotel when they were unable to accomplish correct home isolation for a number of reasons. These included carrying out the role of caregiver to an individual needing to be shielded, being homeless or a tourist in transit, living in overcrowded or unhealthy housing, and other situations of social vulnerability assessed by a health social worker.

Whilst isolated in the hotel the index patients had no contact with the members of their households.

Nurses and healthcare auxiliary professionals specifically provided face-to-face care to the hotel-isolated patients. Nevertheless, these establishments were not set up as field hospitals habilitated to attend critical patients; their aim was solely to guarantee the patients' appropriate isolation.

All included index patients were contacted by phone every 24–48 h depending on their clinical status, and, if needed, family physicians and nurses came from the primary healthcare center (PHC) to attend them. The same primary healthcare team assisted both hotel and domicile-isolated patients.

The main outcome variable was the occurrence of COVID-19 infection in any of the household members of the index patients during a period ranging from 2 weeks prior to diagnosis to 4 weeks after termination of isolation.

Household members were considered infected when they presented symptoms compatible with COVID-19 or had a PCR confirming Sars-Cov 2 infection.

Information about household members comprised sociodemographic variables (age, sex and housing conditions including overcrowding index), comorbidities and hospitalization.

Overcrowding index was calculated as the number of persons living in the same house divided by the number of bedrooms. Variables to determine compliance with the recommended public health measures among home-isolated patients were also collected.

Statistical analysis

Descriptive statistics were employed to summarize the general data. The continuous variables are shown expressed by mean and standard deviation (SD) or medians and interquartile range, and the categorical variables are expressed by frequencies and percentages.

To evaluate differences between the characteristics (variables) according to the location of isolation the chi-square test was used and, when necessary, Fisher's test. When analyzing continuous variables, we employed the T-Student's test or Analysis of Variance (ANOVA).

Multivariate logistic regression was performed to adjust for potential confounding factors. Variables statistically significant with a P value < 0.10 in the univariate analysis, or those considered clinically relevant, were included in the multivariate model. Stepwise procedure was selected to obtain the final model, which included: household member's sex and age, place of isolation of index patient and overcrowding index. Statistical analysis was conducted using R Software for Windows version 3.6.1, Vienna, Austria.

Results

Index patients

A total of 89 index patients were interviewed. They provided information about 229 household members who had been living with them in the previous 2 weeks. Regarding isolation location, 45 (50.6%) were in their domiciles and 44 (49.4%) in the reconditioned hotel. Mean age of index patients was 53.6 (SD 16.9) years and 57 (64%) were women. A total of 77 patients had been hospitalized as a consequence of COVID-19. Out of these, 34 (81.0%) had been hospitalized prior to being referred home, and 43 (97.7%) before being accommodated in a hotel.

In our sample, the two motives identified for hotel-isolation were: sharing a home with vulnerable patients ($N = 22$) and living in multi-shared ones ($N = 22$).

Regarding compliance of the recommended public health measures among the home-isolated patients, 95% had an individual bedroom available which was ventilated at least 10 min/day in 97.7% of cases. In addition, 86.7% of the index patients used their own towels, and 80% reported that household members washed their hands after touching them. When approaching the index patients, 48.9% of the household members used gloves and 60% masks.

No differences in either sociodemographic variables or previous comorbidity according to isolation location of the index patients were found. The home overcrowding index was, however, among those isolated in the medicalized hotel (Table 1).

Household members of index patients

Information regarding household members was obtained from 90 home-isolated index patients and 139 hotel-isolated ones, respectively. We found a statistically significant relationship between being household member of an index patient referred to a hotel and a higher overcrowding index.

The household members of the home-isolated cohort were not only older (average 42.2 years [SD 22.5] versus 31.4 [SD 20.9] [$P < 0.001$]) but there was a 5-fold greater percentage aged $>$ 65 years (Table 2).

Although the number of household members of home-isolated patients with some comorbidity was greater with respect to those of the hotel-isolated cohort, no differences regarding cardiovascular comorbidity were found.

Out of all the index patients, COVID-19 infection was identified in 123 (53.7%) household members. Of these 17 were hospitalized (16 presented pneumonia, and 4 needed to be admitted to Intensive Care). Two household members of home-isolated patients died due to COVID-19. The infection percentage of those residing with home-isolated index patients was 52% higher than that of hotel-isolated ones, and their risk of being hospitalized due to pneumonia was 3-fold greater (Table 3).

Among the infected household members, 37.4% presented symptoms before the patient was aware of being ill. The percentage of infections after the end of the scheduled isolation was ~60% higher among household members of home-isolated patients.

Figure 1 shows the multivariate analysis adjusted by potential confounding factors. It identifies the isolation location of the index patient and the number of household members as potential independent variables related with the risk of being infected by Sars_Cov_2. Despite not being statistically significant, the household members of home-isolated patients had a 66% greater probability of being infected, with the older individuals at greater risk.

Discussion

In our study we observed that the isolation of COVID-19 patients in community-supervised facilities, such as a hotel, may protect household members from disease transmission. In general, older household members were found to be more susceptible to infection, and a greater presence of symptoms was reported after the scheduled isolation period among household members of the home-isolated index patients.

The current COVID-19 pandemic has tested the capacity of primary care to quickly adapt to new challenges.[9] Since the first stages of the infection, family physicians and nurses have been extremely active stressing the importance of promoting physical distancing and isolation measures for patients either infected or possibly exposed to the virus.[10] Moreover, these professionals have been forced to redesign their work to face the emerging health problem without neglecting the care of patients with other health issues, particularly chronic ones. The utilization of complementary facilities such as reconditioned hotels (to ensure proper isolation and adequate patient

Table 1 Characteristics of index patients infected with COVID-19 according to where they were isolated (supervised hotel) or domicile

	Total patients N = 89	*Patients isolated in the supervised hotel N = 44*	*Patients isolated in domicile N = 45*	*P-value*
Women	57 (64.0%)	26 (59.1%)	31 (68.9%)	0.458
Age (mean, SD)	53.6 (16.9)	53.0 (17.0)	54.2 (16.9)	0.735
Categorized age				0.493
[18–45] Years	25 (28.1%)	14 (31.8%)	11 (24.4%)	
[45–65] Years	40 (44.9%)	17 (38.7%)	23 (51.2%)	
>65 Years	24 (27.0%)	13 (29.5%)	11 (24.4%)	
Comorbidity				
Any comorbidity	40 (44.9%)	14 (31.8%)	26 (57.8%)	0.025
Cardiovascular comorbidity				
Coronary heart disease	4 (4.4%)	0 (0.0%)	4 (4.8%)	0.117
Stroke	1 (1.1%)	0 (0.0%)	1 (2.2%)	1.000
Peripheral arteriopathy	2 (2.2%)	0 (0.0%)	2 (4.4%)	0.494
Heart failure	3 (3.3%)	0 (0.0%)	3 (6.6%)	0.242
Atrial fibrillation	2 (2.2%)	0 (0.0%)	2 (4.4%)	0.494
Any cardiovascular comorbidity	8 (8.9%)	8 (17.8%)	0 (0.0%)	—
Other risk factors or comorbidities				
Hypertension	25 (8.1%)	13 (29.5%)	12 (26.7%)	0.947
Diabetes	6 (6.7%)	5 (11.4%)	1 (2.2%)	0.110
Cancer	5 (5.6%)	1 (2.2%)	4 (8.8%)	0.361
Chronic obstructive pulmonary disease	12 (13.5%)	3 (6.8%)	9 (20.0%)	0.131
Housing conditions				
Number of bedrooms (mean, SD)	3.0 (1.0)	3.0 (1.0)	3.1 (1.0)	0.767
Number of cohabitants in the same house (mean, SD)	3.5 (1.6)	4.1 (1.9)	2.9 (1.0)	0.001
Overcrowding index	1.2 (0.5)	1.4 (0.5)	1.0 (0.3)	0.001
Hospitalization before isolation	77(89.5%)	43 (97.7%)	34 (81.0%)	
Length of hospitalization (days) [mean (SD)]	5.90 (6.03)	5.13 (7.54)	6.68 (3.89)	0.234

care) and community premises (to perform tests and attend respiratory patients) may alleviate the backlog of PHC tasks.

Experiences describing implementation of medicalized hotels for the isolation of patients with Covid 19 have been published but they were coordinated by tertiary hospitals and the efficacy on the infection transmission was not analyzed.[11] With respect to our study, since it was community-based, most subjects were aged 45–65 years in contrast to hospital-based reports where patients were older.[12] Such a finding, and the higher percentage of women, concurs with the epidemiological data from the first COVID-19 wave in Spain.[13]

The high percentage of reported compliance regarding the recommended health measures for the home-isolated index patients and their household members is noteworthy. Nevertheless, only half the household members regularly used facial masks. We should point out, however, that at this crucial stage of the disease (March–May 2020) there was a dramatic shortage of masks available even for healthcare professionals. The public was unaware of the relevance of wearing them and, moreover, public health recommendations were changing constantly. Indeed, there was a problematic variability among the different national administrations which persists to the present, for instance, in the United Kingdom where different rules operate simultaneously.[14]

The high prevalence of comorbidity presented by our index patients was greater than that reported among Chinese patients in the same period.[15] It was, however, lower than the one described in a study from Chicago, where almost all the patients had at least one.[16] With respect to

Table 2 Characteristics of household members of patients according to patient isolation (reconditioned hotel or domiciliary isolation)

	Household of patients All [N = 229]	*Household of patients isolated in the hotel [N = 139]*	*Household of patients isolated in their domicile [N = 90]*	*OR [95% CI]*	*P-value*
Gender					0.809
Man	107 (47.3%)	63 (46.3%)	44 (48.9%)	Ref. [a]	
Women	119 (52.7%)	73 (53.7%)	46 (51.1%)	0.90 [0.53–1.54]	
Age (mean, SD)	35.7 (22.1)	31.4 (20.9)	42.2 (22.5)	1.02 [1.01–1.04]	<0.001
Categorized age					<0.001
<15 Years	46 (20.4%)	36 (26.7%)	10 (11.1%)	Ref.	
[15–45] Years	103 (45.8%)	69 (51.1%)	34 (37.8%)	1.75 [0.79–4.14]	
[45–65] Years	49 (21.8%)	19 (14.1%)	30 (33.3%)	5.53 [2.28–14.3]	
>65 Years	27 (12.0%)	11 (8.1%)	16 (17.8%)	5.06 [1.82–15.1]	
Any comorbidity	37 (16.2%)	16 (11.5%)	21 (23.3%)	2.33 [1.14–4.84]	0.028
Cardiovascular comorbidity [b]	12 (5.2%)	9 (6.4%)	3 (3.3%)	0.52 [0.11–1.82]	0.374
Other risk factor or comorbidities					
Hypertension	20 (8.7%)	8 (5.7%)	12 (13.3%)	2.49 [0.98–6.71]	0.081
Diabetes	11 (4.8%)	5 (3.6%)	6 (6.7%)	1.90 [0.54–6.99]	0.349
Cancer	5 (2.2%)	1 (0.7%)	4 (4.4%)	5.79 [0.79–160]	0.079
Chronic obstructive pulmonary disease	9 (3.9%)	2 (1.4%)	7 (7.8%)	5.45 [1.24–41.1]	0.030
Infected by COVID19					0.162
Not infected	106 (46.3%)	70 (50.4%)	36 (40.0%)	Ref.[a]	
Infected	123 (53.7%)	69 (49.6%)	54 (60.0%)	1.52 [0.89–2.61]	
Household hospitalization for COVID19	17 (7.4%)	7 (5.4%)	10 (11.1%)	2.33 [0.85–6.77]	0.146
Pneumonia	16 (6.9%)	5 (3.6%)	11 (12.2%)	3.65 [1.26–12.2]	0.025
Intensive care unit	4 (1.7%)	1 (0.7%)	3 (3.3%)	4.35 [0.50–12.6]	0.303
Death	2 (0.8%)	0 (0.0%)	2 (2.2%)	-	0.153
Housing conditions					
Number of bedrooms (mean, SD)	3.3 (1.0)	3.3 (1.1)	3.3 (0.9)	0.96 [0.75–1.23]	0.726
Household in the same house (mean, SD)	4.5 (1.9)	5.1 (2.0)	3.4 (1.1)	0.52 [0.41–0.65]	<0.001
Overcrowding index[c]	1.4 (0.5)	1.6 (0.5)	1.1 (0.3)	0.09 [0.04–0.19]	<0.001

[a]Reference cohort: isolation in the hotel.

[b]Coronary heart disease, stroke, peripheral arteriopathy, heart failure and atrial fibrillation.

[c]Number of individuals sharing home/Number of rooms in the house.

comorbidity we included cardiovascular diseases, hypertension, diabetes, chronic obstructive pulmonary disease and cancer, all of which have been the most commonly studied regarding COVID-19 epidemiology.

The elevated percentage of infected household members of index patients (>50%) concurs with a previous study by Wang *et al.*[5], from China. After analyzing 155 close contacts of COVID-19 patients they found that household transmission represented 30–50% and signified the major form of transmission.

Almost one in five household members of our index patients was hospitalized as a consequence of COVID-19. To

Table 3 Differences in the characteristics of household members of patients with COVID-19 who became infected, according to where the index patients were isolated (supervised hotel or domicile)

	All household members infected by COVID N = 123	*Infected household members of patients isolated in the hotel N = 69*	*Infected household members of patients isolated in their domiciles N = 54*	*P-value*
Women	70 (56.9%)	42 (60.9%)	28 (51.9%)	
Age (mean, SD)	38.1 (22.3)	32.7 (21.6)	44.6 (21.5)	0.003
Categorized age				0.002
<15 Years	17 (14.3%)	14 (21.5%)	3 (5.5%)	
[15–44] Years	58 (48.7%)	36 (55.4%)	22 (40.7%)	
[45–65] Years	26 (21.8%)	7 (10.8%)	19 (35.2%)	
>65 Years	18 (15.1%)	8 (12.3%)	10 (18.5%)	
Any comorbidity	20 (16.3%)	8 (11.6%)	12 (22.2%)	0.181
Cardiovascular comorbidity [a]	5 (4.0%)	4 (5.8%)	1 (1.8%)	0.384
Other risk factors or comorbidities				
Hypertension	10 (8.1%)	3 (4.3%)	7 (13.0%)	0.103
Diabetes	7 (5.6%)	1 (1.4%)	6 (11.1%)	0.043
Cancer	2 (1.6%)	0 (0.0%)	2 (3.7%)	0.191
Chronic obstructive pulmonary disease	6 (4.8%)	2 (2.9%)	4 (7.4%)	0.403
Hospital data				
Hospitalization	17 (13.8%)	7 (10.1%)	10 (18.5%)	0.284
Pneumonia	16 (13.0%)	5 (7.2%)	11 (20.4%)	0.060
Intensive care unit	4 (3.2%)	1 (1.4%)	3 (5.5%)	0.319
Death	2 (1.6%)	0 (0.0%)	2 (3.7%)	0.191
Housing conditions				
Individuals sharing home (mean, SD)	4.6 (2.1)	5.5 (2.2)	3.3 (1.2)	<0.001
Number of bedrooms (mean, SD)	3.3 (1.1)	3.5 (1.2)	3.2 (1.0)	0.159
Overcrowding index[b]	1.4 (0.5)	1.6 (0.5)	1.1 (0.3)	<0.001
Symptoms onset				0.169
No symptoms	9 (7.3%)	6 (8.7%)	3 (5.5%)	
Symptoms before the onset disease in case index	46 (37.4%)	23 (33.3%)	23 (42.6%)	
Symptoms during the disease/isolation case index	56 (45.5%)	36 (52.2%)	20 (37.0%)	
Symptoms after isolation case index	12 (9.7%)	4 (5.8%)	8 (14.8%)	

[a]Coronary heart disease, stroke, peripheral arteriopathy, heart failure and atrial fibrillation.
[b]Number of individuals sharing home/Number of rooms in the house.

the best of our knowledge, this study is the first to describe such a figure as we have not found any other publications referring to hospitalization rates among household members of COVID-19 patients.

The increased risk of presenting pneumonia for household members of home-isolated patients could be due to their higher average age and comorbidity, irrespective of the isolation location of the index patient. This concurs with Imam *et al.*[17] who showed that in a large outpatient cohort of COVID-19 patients older age, medical comorbidities, obesity, and male sex were independently related to the probability of needing to be attended in an emergency room. Indeed, after analyzing differences between infected household members according to the place of isolation of their index patients, only

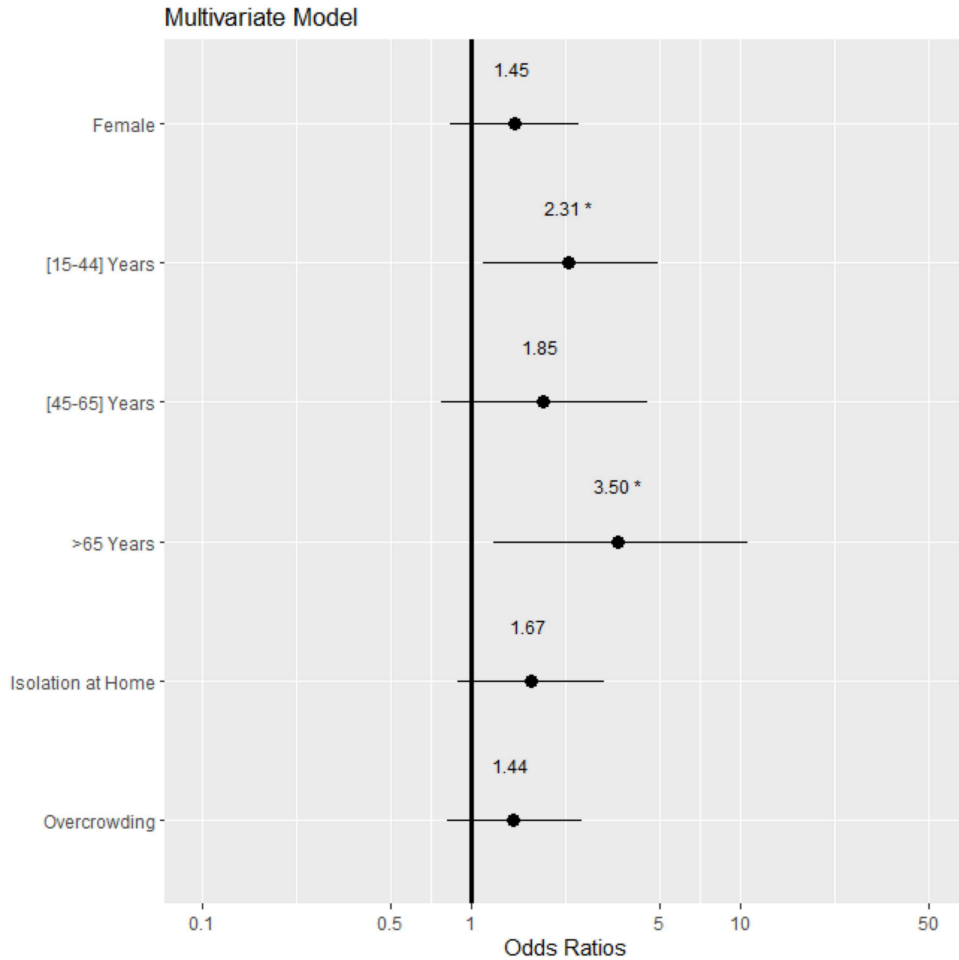

Fig. 1 Multivariate analysis of factors related with being infected by COVID-19 among household members of patients with confirmed diagnosis.

older age among those belonging to the domicile group was found to be statistically different. Previous comorbidity was not a factor determining differences in being infected.

Among the household members of hotel-isolated patients the overcrowding index was higher. Whilst this could be partially attributable to the criteria used to refer COVID-19 patients to supervised community facilities, it also shows a clear relationship between the probability of being infected and social vulnerability. As has been stated by the World Health Organization Housing and Health Guidelines, '… Household crowding is a condition where the number of occupants exceeds the capacity of the dwelling space available, whether measured as rooms, bedrooms or floor area, resulting in adverse physical and mental health outcome …'.[18]

It is well known that smaller homes, and those with multiple occupation, are associated with higher transmission of infectious disease, particularly respiratory infections.[19–21] As a consequence, primary care professionals need to be able to detect health inequalities associated with poverty and housing conditions in order to preventing health risks, such as the higher rate of COVID-19 transmission. Easy accessibility to primary health care permits the promotion of health-care counseling. Family physicians and nurses can contact social services to facilitate the isolation of infected patients in specific facilities and provide orientation about community services. Addressing social needs improves both the attention received by the vulnerable population and primary care professional satisfaction.[22]

The high percentage of household members presenting symptoms before onset of infection in the index patients is noteworthy. Early detection is crucial in preventing transmission to relatives and close contacts, and is one of the strategies to deal with the pandemic.[23]

The percentage of infections that occurred after the end of the index patients' isolation was elevated, and markedly higher among household members of home-isolated subjects. This could be due to the logistic, structural and emotional difficulties of carrying out an appropriate care and isolation of index patients at home. In addition, it has been described that the virus may stay on surfaces and in the air for up to 5 days, particularly in the bathroom and bedroom.[24]

The multivariate adjusted analysis confirmed a trend in the independent effect of isolating index patients in a supervised hotel to reduce COVID-19 transmission among household members. Although it did not reach statistical significance, this finding agrees with results from the biggest meta-analysis to date regarding secondary attack rate. The authors encouraged isolation away from the household for COVID-19 patients.[25]

Strengths and limitations

To the best of our knowledge, this is the first study analyzing the effect of a community-supervised isolation facility (reconditioned hotel) on COVID-19 transmissibility.

Information about the households was self-reported, and in some cases might not have been precise enough. Nevertheless, for the purpose of our study the main variables were the occurrence of infection and the overcrowding index which were not affected by inaccurate data.

Regarding infection diagnosis in the household members, in many cases we lacked a confirmatory PCR and it had to be based on the presence of symptoms compatible with COVID-19. It should be noted that in March 2020, PCR testing was only performed in patients admitted to hospital with symptoms and was not routinely indicated. Indeed, very often patients with scarce to mild symptoms were managed at home. As a consequence, it was epidemiologically accepted that those who had been in close contact with confirmed patients, and presented compatible symptoms, were potentially infected.

Since our findings did not reach statically significant differences, a larger sample size would be necessary to reinforce our conclusions. Nevertheless, our results concur with the evidence available and the number of participants was similar to the main studies analyzing household transmission in the United States[26,27] and China.[28]

Conclusions

Community-supervised facilities, such reconditioned hotels, which guarantee the appropriate isolation of COVID-19 patients, may be useful to protect household members from disease transmission. Overcrowded homes imply a higher risk of transmission of the infection among household members.

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