

COVID-19 AND FUNCTIONAL DEPENDENCE: COHORT STUDY OF AN OUTBREAK IN A NURSING HOME FOR ELDERLY

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Authors declare that there is not conflict of interest.

ABSTRACT

Background: Older people have been severely affected by the COVID-19 pandemic. The aim of this study was to describe the main epidemiological findings of a COVID-19 outbreak occurred in March 2020 at a nursing home for elderly in Granada. Risk factors associated with the spread of the virus in the center were investigated.

Methods: A retrospective cohort study was conducted, collecting the most relevant clinical and epidemiological findings, occurred during the outbreak follow-up period (from 03/13/2020 to 06/20/2020). The association between the residents' health conditions (underlying diseases, level of physical dependence, level of cognitive impairment) and the risk of infection was estimated using multivariate Cox regression.

Results: 52 PCR-confirmed COVID-19 cases were identified among the residents and 50 cases among the employees of the nursing home. The epidemic curve was characteristic of a person to person transmission. Among residents with a higher level of physical dependence, according to the Barthel index score, a higher incidence of infection was detected, adjusting for age, sex and health conditions. After 55 days of exposure, moderately (RR 2.82), severely (RR 4.71) and completely (RR 3.49) dependent residents had between 2-4 times greater risk of infection than the minimally dependent residents ($p < 0.05$).

Conclusions: The epidemic curve supports the hypothesis of a cross-transmission of infections between residents and staff members of the nursing home. In the context of sustained transmission of the virus, physical dependence of the residents increases the risk of exposure to the virus, facilitating its spreading.

Key words: COVID-19, Aged, Skilled nursing facilities, Nursing homes, Disease outbreaks, Infections, Epidemiologic studies, Public health surveillance, Frail elderly, Barthel index.

RESUMEN

COVID-19 y dependencia funcional: análisis de un brote en un centro socio-sanitario de personas mayores

Fundamentos: Los mayores institucionalizados han sido el grupo más afectado por la pandemia de COVID-19. El objetivo del presente estudio fue describir las principales características epidemiológicas de un brote de COVID-19, detectado en marzo 2020 en una residencia para mayores de Granada, e identificar los factores de riesgo asociados a la propagación del virus en el centro.

Métodos: Estudio observacional de cohorte retrospectivo. Se describieron los principales aspectos clínicos y epidemiológicos registrados durante el periodo de seguimiento del brote (13/03/2020-20/06/2020). Mediante regresión de Cox multivariante se estimó la asociación entre las condiciones de salud de los residentes (enfermedades de base, nivel de dependencia física y deterioro cognitivo) y el riesgo de contraer la infección.

Resultados: Se encontraron 52 casos, confirmados mediante PCR, entre los residentes y 50 casos entre los trabajadores del centro. La curva epidémica fue compatible con un tipo de transmisión persona-persona. Se detectó una mayor incidencia de infección entre los residentes más dependientes, de acuerdo con la puntuación del Índice de Barthel, ajustando por edad, sexo y condiciones de salud. Los residentes con nivel de dependencia moderada (RR 2.82), grave (RR 4.71) y total (RR 3.49) tuvieron de 2 a 4 veces más riesgo de contraer la infección que aquellos con dependencia leve, a los 55 días de exposición ($p < 0,05$).

Conclusiones: La curva epidémica orienta hacia la hipótesis de un fenómeno de transmisión cruzada trabajadores-residentes al origen del brote. En un contexto de elevada circulación del virus, el nivel de dependencia funcional de las personas institucionalizadas multiplica el riesgo de exposición al virus, facilitando su transmisión.

Palabras clave: COVID-19, Ancianos, Residencias, Centros socio-sanitarios, Brotes, Infecciones, Estudios epidemiológicos, Salud Pública, Vigilancia epidemiológica, Ancianos dependientes, Índice de Barthel.

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Suggested citation: Causa R, Almagro Nievas D, Bermúdez Tamayo C. COVID-19 and functional dependence: cohort study of an outbreak in a nursing home for elderly. Rev Esp Salud Pública. 2021; 95: March 26th e202103045.

INTRODUCTION

Residential care facilities and nursing homes for the elderly are contexts especially vulnerable to the SARS-CoV-2 (COVID-19) infection. Due to the characteristics of the residents (age, comorbidities, specific care needs), which act as risk factors for infection, and due to the centers settings (closed environment, proximity between residents and staff) that may facilitate the spread of the virus^(1,2,3,4).

In Spain, the older population has been disproportionately affected by the COVID-19 sanitary crisis⁽⁵⁾. Official reports on the epidemiological situation about the COVID-19 cases notified before May 10 2020 reveal that, at the early stages of the pandemic, most of the COVID-19-related hospitalizations and deaths (48% and 86%, respectively) occurred among people over 70 years old. Moreover, approximately 70% of all these deaths occurred among the institutionalized elderly⁽⁶⁾. Indicators of severity among the cases reported after May 10, 2020, suggest that this trend persisted also during the following pandemic phases. As of November 12, 2020, the percentage of hospitalizations, Intensive Care Unit admissions and deaths continues to mostly affect the population over 70 years old, compared to the other age groups⁽⁷⁾.

International evidences show higher COVID-19 mortality rates among the residents of nursing homes^(8,9). Outbreaks described in residential facilities are associated with high attack rates, both among residents and staff^(10,11,12). Elderly, multi-pathological and frail residents are at increased risk for severe illness^(2,5). Furthermore, the physical dependence to perform the basic activities of daily life could contribute to a greater vulnerability to contract the infection^(3,4).

COVID-19 outbreaks in residential care facilities for the elderly needs to be urgently addressed by Public Health Services, with specific and context-adapted interventions to reduce the disease transmission^(1,13).

Between March 13 and June 20, 2020, an outbreak of COVID-19 occurred in an elderly nursing home in Granada (Spain) with 88 residents.

The aim of this study was to describe the main epidemiological findings of the outbreak and to investigate risk factors associated with the spread of the virus in the center.

SUBJECTS & METHODS

Study design. A retrospective cohort study was conducted. We analyzed the most relevant clinical and epidemiological outcomes, occurred during the outbreak follow-up period: from March 13, 2020 (symptom onset date of the first confirmed case) to June 20, 2020 (two incubation periods from the last positive microbiological result). The first case was notified to the Epidemiology Service of the Granada - Metropolitan Sanitary District on March 20, 2020. Since then, the epidemiological measures to control and investigate the outbreak were implemented.

All residents and employees who were present in the nursing home from the start of the follow-up period were included. According to the official protocol instructions, a SARS-CoV-2 confirmed case was defined as any person, with or without symptoms, with a positive molecular test (PCR of nasopharyngeal swab sample)⁽¹⁴⁾.

Study variables. The main variable was the SARS-CoV-2 infection. In addition to the

information about the molecular results, initial presentation and clinical evolution of the infection, sociodemographic characteristics (sex, age) and health conditions of the residents of the center were also included: presence of underlying diseases (cardiovascular, pulmonary, chronic kidney disease, type 2 Diabetes Mellitus, obesity), physical dependence level (measured through the Barthel Index) and cognitive impairment level (measured through the Pfeiffer Questionnaire).

The Barthel Index is a functional evaluation scale used to measure a person's ability to perform ten basic activities of daily life. A score of 100 classified a person as independent, while scores of 60-95 indicate minimal dependency, 40-55 indicate moderate dependency, 20-35 indicate severe dependency and 0-20 indicate complete dependency⁽¹⁵⁾.

Data source and epidemiological survey. The main epidemiological data were collected from the Andalusian Epidemiological Surveillance System (SVEA), with the information provided during the usual case-notification process. Clinical information of the residents was also collected through the “*Diraya*” digital health history (underlying health conditions, clinical evolution of hospitalized patients, results of microbiological tests) and through periodical update reports from the health-care professionals of the nursing home (clinical evolution of the not hospitalized cases).

Statistical analysis. Univariate and bivariate statistical analyses of all variables with the dependent variable (SARS-CoV-2 infection) were performed. Epidemic curve of cases was represented by date of symptoms onset (symptomatic cases) and by date of laboratory confirmation (symptomatic and asymptomatic cases).

Finally, a survival analysis using multivariate Cox regression was performed to estimate the association between the health conditions of the residents and the risk of infection during the follow-up period of the outbreak.

Time to event was considered as the period (days) from the onset of the outbreak to the case confirmation. The association was quantified in terms of adjusted relative risk RR (RR), with 95% confidence intervals (CI). The overall significance of the model was verified through a likelihood ratio test, while the individual significance was verified through a Wald test. A p value of <0.05 was considered as statistically significant. A graphical representation of the function $\text{Ln}(-\text{LnS}(t))$ was carried out to verify the hypothesis of proportionality of risks.

Data analyses were performed using the IBM SPSS® Statistics 26.0 package.

Ethics. The present study has been performed in the context of the epidemiological surveillance activities aimed to control the outbreak. The World Health Organization ethical guidelines in epidemiological surveillance and investigation of infectious epidemic outbreaks⁽¹⁶⁾ were followed during all the study phases. All data were completely anonymized before performing the analysis.

RESULTS

Descriptive temporal analysis. 92 outbreak-related cases were detected. 52 cases were identified among the residents and 50 cases among the employees. 52 cases among the 88 residents (Attack rate: 59%) and 50 cases among the 152 employees (Attack rate: 33%) of the nursing home. Among the 50 employees infected, 37 were health workers.

The first confirmed case was a health worker, with illness onset on March 13, 2020. His disease signs and symptoms were initially mild, and he first contacted with healthcare services on March 16, 2020. A nasopharyngeal swab sample for PCR was taken on March 20, 2020 and the case was notified as suspected of COVID-19 to the Epidemiology Service of the Granada - Metropolitan Sanitary District.

The case was then confirmed on March 23. Subsequently, another 49 cases were identified among the employees. 28 of them, asymptomatic, were diagnosed on March 30 during a massive screening with PCR of nasopharyngeal swab sample to all the staff of the center. Although 5 of the symptomatic cases required hospitalization, finally all of them had a good clinical progression (recovery).

Among residents, the first case was reported on March 23, 2020 and the last on May 7, 2020. Regarding the clinical presentation of the disease, 27 of the confirmed cases presented typical clinical manifestations of acute respiratory infection (dyspnea, cough, fever), 5 presented gastrointestinal symptoms (diarrhea, nausea, abdominal pain) and 12 presented non-specific or subclinical symptoms (low-grade fever, general discomfort, fatigue, asthenia, irritability). 8 cases were asymptomatic at the moment of diagnosis. 26 cases required hospitalization. The clinical course of the disease was critical (death) for 9 cases and favorable (recovery) for the other 43 cases.

On April 11 and 22, 2020, two rounds of SARS-CoV-2 rapid antibody tests were applied to the 68 residents by then at the nursing home. 22 positives results were detected, but 10 of them were positive at the first round and negative at the second. Although only the cases confirmed by PCR were included for this study,

at that time, following the official instructions then in force, all residents with a positive rapid antibody test were also considered as COVID-19 cases, declared to the SVEA and isolated in a specific area of the center.

The last positive (follow-up) PCR was detected on May 25, 2020. The outbreak was considered concluded on June 21, 2020, two incubation periods after this last positive test.

In figures 1 and 2, the epidemic curve of the outbreak is graphically represented.

Bivariate analysis. Table 1 summarizes the main clinical and sociodemographic characteristics of the residents, compared according to the infection status.

A significant association ($p=0.007$) was detected between the level of physical dependence (Barthel index) and the incidence of infection. The risk was higher among with a completely (RR 6.76, 95% CI 1.24-36.84), severely (RR 6.20, 95% CI 1.45-26.42) and moderately (RR 3.76, 95% CI 1.32-10.67) level of dependency, compared to those with a minimally level of dependency. A previous diagnosis of Type 2 Diabetes Mellitus was also significantly ($p=0.012$) associated with a higher risk: RR 3.87, 95% CI 1.29-11-61.

Multivariate analysis. Table 2 summarizes the results of the Cox regression model. After adjusting for the other potential prognostic factors of infection risk, the level of physical dependence was the only variable significantly related to an increased risk of infection ($p=0.008$). At 55 days of exposure, moderately, severely and completely dependent residents had between 2-4 times greater risk of infection than the minimally dependent residents (figures 3 and 4).

Figure 1
Epidemic curve by date of symptoms onset.

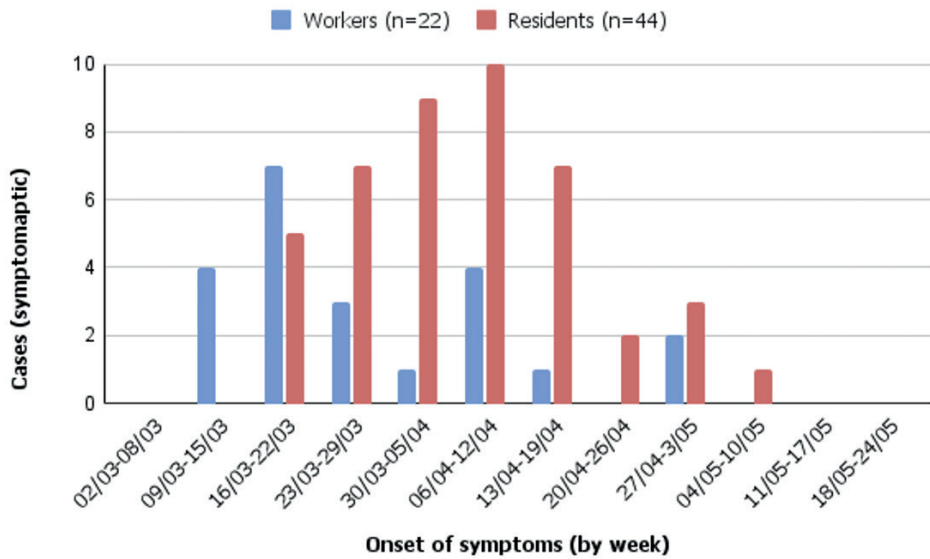


Figure 2
Epidemic curve by date of laboratory confirmation (PCR sample collection).

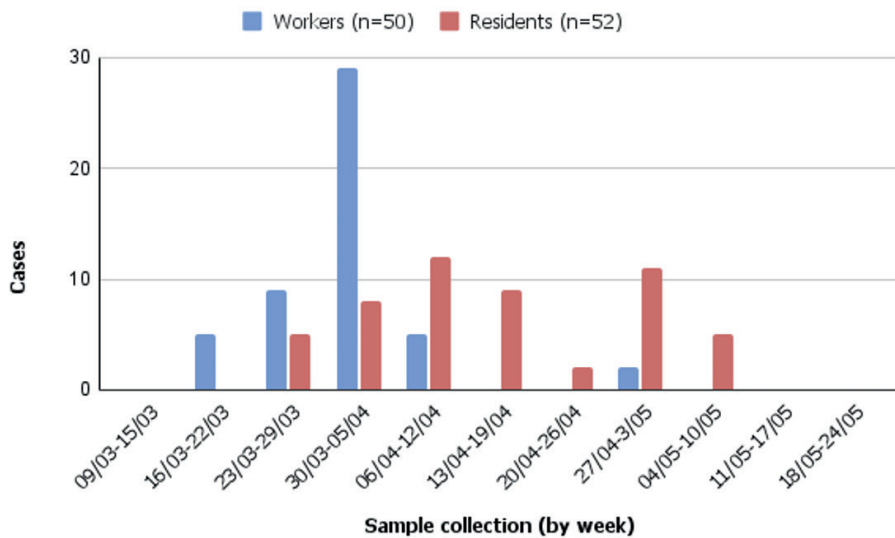


Table 1
Clinical and sociodemographic characteristics of the residents.

Variables		Residents (n=88)		COVID-19 cases (n=52)		RR	95% CI	P value
		n	%	n	%			
Sex	Female	55	62.5	35	67.3	1	-	0.263
	Male	33	37.5	17	32.7	1.64	0.68-3.95	
Age (years)	<65	8	9.1	4	7.7	1	-	0.812
	65-74	21	23.9	11	21.2	1.10	0.21-5.60	
	75-84	27	30.7	16	30.8	1.45	0.29-7.09	
	85-90	21	23.9	13	25.0	1.62	0.31-8.40	
	>90	11	12.5	8	15.4	2.6	0.39-18.16	
Barthel Index (level of functional dependence for basic activities of daily living)	Minimal (>60)	35	39.8	13	25.0	1	-	0.007
	Moderate (40-55)	29	33.0	20	38.5	3.76	1.32-10.67	
	Severe (20-35)	14	15.9	11	21.2	6.20	1.45-26.42	
	Complete (<20)	10	11.4	8	15.4	6.76	1.24-36.84	
Pfeiffer questionnaire (cognitive impairment level)	Normal (<2)	9	10.2	4	7.7	1	-	0.558
	Mild (2-4)	25	28.4	13	25.0	1.35	0.30-6.26	
	Moderate (5-7)	32	36.4	21	40.4	2.38	0.53-10.73	
	Severe (8-10)	22	25.0	14	26.9	2.18	0.45-10.57	
Underlying diseases (COVID-19 risk factors)	None	14	15.9	5	9.6	1	-	0.321
	One	27	30.7	16	30.8	2.61	0.68-9.95	
	Two	26	29.5	18	34.6	4.05	1.02-16.00	
	Three	17	19.3	10	19.2	2.57	0.59-11.05	
	Four	4	4.5	3	5.8	5.40	0.43-66.67	
Cardiovascular disease		57	64.8	35	67.3	1.31	0.54-3.17	0.550
Chronic kidney disease		29	33.0	15	28.8	1.57	0.63-3.85	0.324
Type 2 diabetes mellitus		25	28.4	20	38.5	3.87	1.29-11.61	0.012
Obesity (BMI>30)		16	18.2	11	21.1	1.63	0.52-5.28	0.385
Pulmonary disease		14	15.9	11	21.2	2.95	0.76-11.45	0.106
Cancer		6	6.8	2	3.8	0.32	0.05-1.85	0.184

Table 2
Multivariate analyses by Cox.

Variables		B	SE	RR	95% CI	P value
Sex		0.099	0.356	1.10	0.55-2.21	0.781
Age (years)		-0.011	0.015	0.99	0.96-1.02	0.471
						0.006
Barthel Index (level of functional dependence for basic activities of daily living)	Complete dependence	1.25	0.479	3.49	1.37-8.91	0.009
	Severe dependence	1.549	0.499	4.71	1.77-12.51	0.002
	Moderate dependence	1.036	0.385	2.82	1.33-5.99	0.007
						0.408
Pfeiffer questionnaire (cognitive impairment level)	Severe impairment	0.424	0.673	1.53	0.41-5.72	0.529
	Moderate impairment	0.319	0.62	1.38	0.41-4.64	0.606
	Mild impairment	-0.252	0.639	0.78	0.22-2.72	0.694
Cardiovascular disease	Cardiovascular disease	0.113	0.366	1.12	0.55-2.29	0.758
	Chronic kidney disease	-0.281	0.344	0.76	0.39-1.48	0.415
	Type 2 diabetes mellitus	0.528	0.378	1.70	0.81-3.55	0.163
	Obesity (BMI>30)	-0.173	0.434	0.84	0.36-1.97	0.691
	Pulmonary disease	0.694	0.384	2.00	0.94-4.24	0.071
	Cancer	-0.918	0.767	0.40	0.09-1.79	0.231
B=Beta coefficient; SE=Standard error.						

Figure 3
Survival function (SARS-CoV-2 infection-free interval) according to the physical dependence level of the residents, adjusted for sex, age and comorbidities.

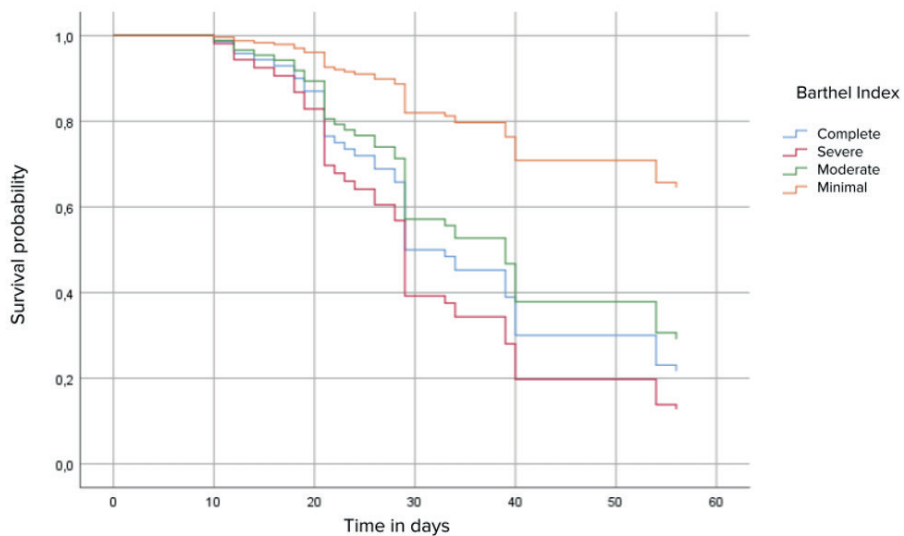
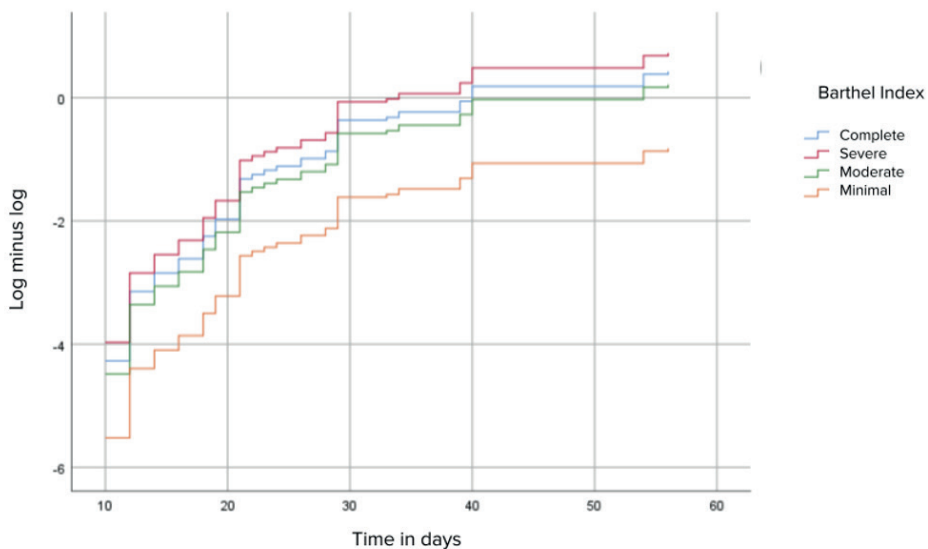


Figure 4
Verification of the hypothesis of proportional risk assumption (*Log-minus-log plot*).



DISCUSSION

Although the epidemiological surveillance of COVID-19 in institutionalized elderly has been highlighted as essential, still limited information has been reported about outbreaks that occurred in nursing homes, especially in Spain, where the impact of epidemic among the institutionalized elderly has been significant^(6,9,11). The contribution of our study to this issue has been to exhaustively describe the characteristics of a COVID-19 outbreak in a Spanish nursing home, and to identify the transmission dynamics of the infection, as well as the factors related to its spread.

The index case corresponded to a health-worker. Although the date of symptoms onset was March 13, 2020, the case was considered as suspicious and then microbiologically confirmed more than a week later (as the clinical presentation of the disease evolved from mild to moderate). Subsequently, numerous cases were detected among the rest of the employees of the center, being the majority of them (56%) asymptomatic at the time of diagnosis. The important role of asymptomatic and pre-symptomatic patients in the dynamics of virus transmission in nursing homes has been demonstrated, as well as the value of the screening strategies to contribute to the outbreaks containment in this settings^(9,17,18,19).

Among residents, a considerable attack rate (59%) and fatality rate (17.3%) were observed, similar to the findings of other outbreaks described in residential facilities^(8,12). The results regarding the clinical manifestation of the disease in residents also coincide with previous studies, and suggest to especially consider the possibility of an atypical clinical presentation of the disease in the elderly^(2,5,9,20).

The progressive increase in infections in the rest of the employees supports the hypothesis of

a cross-transmission process between workers and residents at the origin of the outbreak. The epidemic curve is compatible with a person-to-person transmission, and reflects a high level of intensity in the circulation of the virus during the first phase of the outbreak.

A higher incidence of COVID-19 infection cases was detected among the most dependent residents and it persisted after adjusting for the other study covariates (age, sex, underlying diseases and level of cognitive impairment). In the context of person to person transmission of the virus, the caring tasks for the most dependents imply a closer physical contact and could facilitate the contagion between residents and workers⁽²¹⁾.

Although these risks could be minimized by strictly following the infection prevention and control recommendations for residential settings^(1,13), contextual circumstances and the lack of adequate human and material resources could difficult its compliance.

It is also essential to consider that this study describes events that occurred during the most critical months of the COVID-19 sanitary crisis. In that context, the complex epidemiological, social and human situation experienced by the nursing homes, as recently described by a Doctors Without Borders report⁽⁴⁾, generated a greater difficulty in complying with the preventive measures, which could have disproportionately affected the most dependent residents.

The level of functional dependence was assessed using the Barthel Index. It is one of the most widely used rating scales in health-care settings to measure functional capacity and estimate patients care needs⁽¹⁵⁾. A low value in the Barthel Index has been previously linked with an increased risk of complicated respiratory infections⁽²²⁾. In the case of COVID-19, investigations about the relationship between Barthel

Index and COVID-19 mortality in older patients have shown that higher levels of dependency are associated with a worse prognosis^(23,24).

Limitations. The process of detection, study and control of this outbreak was carried out in a constantly changing epidemiological context. The extreme variability in the official indications, protocols and available resources, experimented during the different phases of the pandemic that the study period covers, may have affected part of the investigation and case classification process. With the exception of hospitalized cases, it was not possible to perform serological tests on the rest of the residents, so the classification of cases had to be based exclusively on the results of molecular tests. A PCR screening test to the residents, as the one performed to employees, was not possible to realize. The results of the rapid antibody tests were not taken into account when classifying the cases, due to inconsistencies detected in the two rounds of the screening, and certain doubts on their reliability. However, as described in other similar situations, the uncertainty generated by them could have negatively affect the center clustering measures aimed at protecting residents from the infection spreading⁽⁴⁾.

As this was a monocentric study, the limited number of subjects included in the analysis may have affected the statistical power for some of the estimated associations between variables.

Conclusions and recommendations. In the context of sustained transmission of the virus, older people living in residential care facilities and nursing homes continue experimenting an increased vulnerability to the infection. Our study indicates that the level of physical dependence of the residents represents a risk factor for person-to-person transmission of the infection. In residential settings where there is a

high percentage of dependent residents, infection prevention and control measures should be intensified, with context-adapted strategies that could guarantee an adequate protection for the residents and for the staff who care for them.

ACKNOWLEDGEMENTS

We want to acknowledge all the Granada Metropolitan Sanitary District team and the staff of the nursing home, for their work and efforts. We are also very grateful to the Director and to the Medical Coordinator of the nursing home, for their invaluable collaboration during the process of investigation and control of the outbreak.

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