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Effects of COVID-19 Lockdown on Nutritional, Functional and Frailty Biomarkers of People Living in Nursing Homes. A Prospective Study

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Abstract

Background: Nursing home residences suffered a lockdown from the beginning of the COVID-19 pandemic. The present study prospectively evaluates the frailty, functional, and nutritional statuses of nursing home residents. **Methods:** Three hundred and one residents from three nursing homes took part in the study. Frailty status was measured using the FRAIL scale. Functional status was evaluated using the Barthel Index. Additionally, Short Physical Performance Batter (SPPB), SARC-F, hand-grip strength, and gait speed were also evaluated. Nutritional status was determined using the mini nutritional assessment test (MNA) and several anthropometrical and biochemical markers. **Results:** Mini Nutritional Assessment test scores decreased in 20% throughout the confinement ($p < .001$). Barthel index, SPPB and SARC-F scores also decreased, although to a lesser extent, reflecting a decrease in functional capacity. However, both anthropometric parameters, hand grip strength and gait speed, remained stable throughout confinement ($p > .050$ in all cases). Morning cortisol secretion significantly decreased by 40% from baseline to post-confinement. A significant reduction in daily cortisol variability was observed, which may suggest increased distress. Fifty-six residents died during the period of confinement (81.4% survival rate). Sex, FRAIL and Barthel Index scores were significant predictors of resident survival. **Conclusion:** After the first COVID-19 blockade, several alterations in residents' frailty markers were observed, which were small and potentially reversible. However, many of the residents were pre-frail after the lockdown. This fact highlights the need for preventive strategies to reduce the impact of future social and physical stressors on these vulnerable individuals.

Keywords

confinement, functional status, sarcopenia, nutritional status, anthropometric parameters, cortisol

Introduction

Two years after the first reported case of COVID-19 in China at the end of 2019 (worldwide) and in Spain at the end of January 2022 (WHO, 2020), SARS_CoV2 highlighted the fragility of older patients; in this population group, COVID-19 was characterized by higher mortality and morbidity rates, probably related to age, previous comorbidities (Wu et al., 2020), and other factors such as increased functional impairment, increased frailty, and increased sarcopenia (She et al., 2021). In Spain, the indicator of growth and structure of the population shows an exponential growth in the range of >65 years (Instituto Nacional de Estadística, n.d.), which has modified health systems, such as with the increased number of residents living in nursing homes. It is estimated

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that by the year 2050, there will be countries in Europe with an increase of up to 127% of older people in residences (O'Neill et al., 2020).

From social and health perspectives, this phenomenon leads to the need to analyse the structural and organizational factors of a health system to respond to the vulnerability of bio-sociological factors in older people that can predict greater or lesser frailty within this context. The aging process (including frailty and functional impairment) can increase by 20% in institutionalized patients due to SARS_CoV2 (Greco et al., 2021). It is important to understand the definition of frailty as a syndrome resulting from multiple multidimensional factors, not from an isolated factor that triggers vulnerability. For example, nutritional status, which influences the presence of malnutrition or overweight, or a sedentary lifestyle and/or loss of skeletal muscle mass (low skeletal muscle index, 80%), are factors associated with functional impairment (Dent et al., 2016).

Attending to these circumstances, it is worth asking whether confinement as a prevention strategy against COVID-19 can promote the development of frailty in this population group; unfortunately, few prospective studies have evaluated these aspects. Confinement can also have a "rebound" effect and appears as a factor that enhances the vulnerability of frailty, as has been described in the changes observed in the biochemical parameters of confined patients. In this sense, a previous study identified that during a 6-week confinement, patients failed to comply with the physical activity guidelines, leading to a significant increase in total cholesterol, LDL cholesterol (LDL-c), and triglycerides, and a reduction in HDL cholesterol. Low levels of plasma albumin reflect poor nutritional status and are related to greater frailty and severity of COVID-19, which is considered an analytical prognostic marker (Lippi & Plebani, 2020). During lockdown, restrictions in family visits and social activities might cause an increase in residents' anxiety and stress levels, as shown by an increase of salivary cortisol levels. (Hopf et al., 2022).

The WHO reinforces that older people living in nursing homes are a vulnerable group (J. Wang et al., 2020b). Confinement was a health necessity, but it is important to analyse its effects, which can directly and negatively influence the health of older people, leading to a sedentary lifestyle, loneliness, and frailty (H. Wang et al., 2020a).

For this reason, the present study prospectively estimates the frailty and functional and nutritional status of nursing home residents to evaluate the evolution of functional markers, as well as to analyse the possible functional factors that may influence the survival during confinement of these residents.

Material and Methods

Participants and Study Design

To determine the influence of COVID-19 lockdown on nursing home residents, a prospective study was designed. The study was conducted from the beginning of the COVID-19 lockdown in Spain, in March 2020, to the start of the third wave of the epidemic, in February 2021. The confinement was the way in which the health authorities tried to minimize social interactions between the community environment and the elderly. This implied an isolation that prevented the elderly from leaving their own rooms for several weeks (Oliveira et al., 2023). Three different nursing homes from the "Amigos de la Paz" association took part in the study. The three residences were located in Murcia (southeast Spain). There were no statistical differences in age or sex distribution among residences.

For the present study, the selection criteria included being >65 years and living in one of the nursing homes at the beginning of the lockdown. Those residents with marked cognitive and functional decline were also included as being representative of the studied population. Cognitive status was evaluated by means of the Global Deterioration Scale (GDS) and the Mini-mental State Examination (MMSE). The presence of chronic diseases and chronic treatments were obtained from the nursing homes' medical records. Two experienced physiotherapists, one psychologist, four nurses, and one geriatrician collected the data. Three hundred and one residents were included in the baseline evaluation.

The present study was conducted after approval by the Ethics Committee of the Universidad Católica de Murcia. A Clinical Board of the Nursing Homes also reviewed and approved the ethical aspects of the present study. Oral and written consent was requested from those participants with normal cognitive status. For those participants with marked cognitive impairment, permission was requested from their legal representative.

Nutritional Status

All patients followed a balanced diet, adjusted to their daily energy expenditure, with a nutrient distribution of 50% carbohydrates, 20% protein, and 30% fat. Energy requirements and diet menus were designed by registered dietitians. Patients with specific metabolic pathologies, such as type 2 diabetes or hyperlipemia, followed therapeutic diets according to medical prescriptions.

The long form of the mini nutritional assessment test (MNA), which includes both screening and evaluation sections, was used. The MNA has been broadly employed to evaluate older adults' nutritional status, and it is considered the gold standard to determine the necessary dietary intervention in older people (Vellas et al., 1999).

Anthropometric and Biochemical Parameters

Height was measured with a Harpender stadiometer. Weight was evaluated with a SECA scale, when possible. Those people unable to stand were weighed on a wheelchair, and their weight was calculated by the difference between the total weight minus the weight of the wheelchair. In these patients, height was estimated using knee height. From these parameters, the body mass index was also estimated.

Blood samples were obtained after a 12-hour overnight fast. Minimum blood samples (1 mL) were extracted and immediately kept on ice and delivered to the reference hospital for later analysis. Albumin, total cholesterol, and lymphocyte count were analysed following standard methods, with an automated HITACHI blood analyser (Model 7180, Hitachi High-Tech Corporation, Tokyo, Japan). There parameters were included to reinforce the malnutrition diagnostic, since as commented in the ESPEN guidelines, visceral proteins like serum albumin concentrations are good indicators of disease severity and outcome (Cederholm et al., 2015). Laboratory value reference ranges are provided on the supplemental material.

Functional Status

Barthel's index was used as a gold standard to measure the ability of the patients to carry out basic daily living activities. This test evaluates the patients' ability to carry out several basic activities, such as bathing, feeding, dressing, etc. The Spanish adaptation of this test has a great internal reliability (>.70; González et al., 2018).

The hand grip strength of the strongest hand was assessed with a hand-held digital ergometer (Smedley Digital, RMS Ltd., UK). At baseline, both hands were evaluated to confirm the strongest hand. The assessments were performed 3 times (consecutively) with an interval between measurements of 3 minutes. Peak force was automatically recorded by the ergometer for each trial, and the median value was considered the exact value (Merchant et al., 2021). Participants were stratified according to the normative values for Spanish population described by Sánchez Torralvo et al. (2018), who define malnutrition for hand-grip strength values below 26 kg/m^2 for men and 14 kg/m^2 for women. All participants performed an evaluation of gait speed using the 5-meter walk test. The speed was recorded as metres/second (m/s). A gait speed lower than 1.0 m/s was considered a slow gait speed, and ≥1.0 m/s were considered normal (Cesari et al., 2005). Assessments were carried out by a physiotherapist with clinical experience in older adults' care.

Frailty Status

For the purpose of the present study, the FRAIL scale proposed by Morley et al. (2012) was employed. This questionnaire evaluates five frailty-related dimensions: fatigue, resistance, ambulation, illnesses, and loss of weight. In this scale, each dimension is valued with one point and patients are classified as frail when they sum up to 3–5 points. The Spanish validation was carried out by Rosas-Carrasco et al. (Parra-Rodríguez et al., 2016). As a secondary evaluation of physical frailty, a Short Physical Performance Batter (SPPB or Guralnik's test) was also used. This test consists of three physical performance tests: balance (in three positions: feet together, semi-tandem, and tandem), walking speed (over 4 m), and getting up and sitting down in a chair 5 times. The average administration time was between 6 and 10 minutes. The score and assessment of the total result of the SPPB results from the sum of the three sub-tests, and ranges between 0 (worst) and 12 (best); changes in one point have clinical significance (Fielding et al., 2017). Normative values for the Spanish population of the SPPB test were described by Cabrero-García et al. (2012). Attending to these authors, a score below 10 points indicates frailty and a high risk of disability. Finally, the SARC-F test was determined at baseline and at the end of the study. This is a fast tool to screen sarcopenia with simple measurements (strength, assistance in walking, rise from a chair, climb stairs, and falls). The Spanish version was adapted by Parra-Rodriguez et al. (2016), showing high reliability (α = .641) and consistency (CCI = .80). A score equal to or higher than four points indicates a high probability of sarcopenia.

Cortisol Measurement

Salivary cortisol was determined at wake-up and before sleep to determine morning, night, and the variability of cortisol levels between these points. A testing device consisting of a small cotton swab (Salivette®, Sarstedt, Nümbrecht, Germany) was delivered to residents for salivary collection. According to the manufacturer's instructions, cotton swabs were placed in the mouth for 1 minute. Salivettes were centrifuged for 2 min at 3500 rpm to collect a volume of 50 μL. A Neo-Biotech® (Nanterre - France) ELISA kit (Ref# NB-06–0217) was used to determine salivary cortisol concentration. Intraindividual cortisol variability was calculated as the difference between morning (awake) and evening (sleep) cortisol levels (García-Prieto et al., 2007).

Statistical Analysis

The Kolmogorov–Smirnov test was used to assess the normality of the continuous variables. To evaluate changes along the confinement period, a repeated measures ANOVA was conducted. For multiple comparisons, the post hoc Sidak test was used. Residents' age, sex, and clinical antecedents were included as covariates. Survival analysis was conducted though Kaplan-Meyer survival analysis. Considering the reduced number of COVID-19-related deaths, all causes of death were considered. Cox regression analysis was also carried out to evaluate the influence of baseline characteristics on survival. From this analysis, hazard ratios and their respective 95% confidence intervals were estimated. All statistical analyses were performed with SPSS 25.0 (IBM SPSS Software, Chicago, IL). Several graphics were drawn with GraphPad Prism 7 software. A statistical significance value of $p < .05$ was set.

Results

Baseline Characteristics

The participants were 301 residents (225 women, 75%), with a mean age of 85 years. The mean duration of the stay on the residence before the lockdown was 48.4 months (CI95%: 43.4 – 53.4). The data regarding residents' characteristics at the beginning of the lockdown are shown in Table 1. The nutritional status, as measured by the MNA test, indicated that the population was at risk of malnutrition; however, BMI was over the normal range (Table 1). The biochemical parameters associated with nutritional status (plasma albumin, lymphocyte count, and total cholesterol) were also within the normal range. The mean Barthel index score indicated that initial functional status was of severe dependency. Moreover, the FRAIL scale placed the participants in the range of pre-frail. This was associated with a hand grip strength below the normal range. In this line, SARC-F also showed that the population was at high risk of sarcopenia.

Table 1. Characteristics of the Nursing Home Residents at the Beginning of Lockdown.

	Total Participants (n = 301)
Age (years)	85 ± 8
GDS (score)	4 ± 2
MMSE (score)	16 ± 9
MNA (score)	21.7 ± 3.8
Plasma albumin (g/dl)	3.6 ± 1.2
Lymphocyte count (x10^3/µl)	2.51 ± 0.99
Total cholesterol	178 ± 46
Body weight (kg)	63.4 ± 22.9
Body mass index (kg/m^2)	25.42 ± 9.44
Body fat (%)	29.75 ± 11.67
Fat free mass (kg)	47.16 ± 8.57
Barthel index (score)	40.7 ± 34.4
FRAIL scale (score)	2 ± 1
SPPB (score)	2 ± 3
SARC-F (score)	6 ± 3
Hand-grip strength (Nw)	13.3 ± 6.2
Gait speed (m/s)	1.21 ± 1.28
Morning cortisol (ng/ml)	36.3 ± 7.5
Night cortisol (ng/ml)	31.1 ± 7.9
Cortisol variability (ng/ml)	5.1 ± 9.3

Note. Data represent mean ± sd. GDS = Reisberg Global Deterioration Scale, MMSE = Mini mental state examination, MNA = Mini nutritional assessment, SPPB = Short Physical Performance Battery, SARC-F = Strength, assistance with walking, rising from a chair, climbing stairs, and falls questionnaire.

Effect of Lockdown on Nutritional Status

The evolution of MNA and biochemical parameters related to nutritional status during COVID-19 confinement is shown in Figure 1. The MNA screening test scores were characterized by a progressive decrease over time (Figure 1A). The biochemical parameters of lymphocyte count and total cholesterol (Figures 1C and 1D) also showed a decrease at the end of confinement compared to baseline data, but interestingly, plasma albumin levels were lower at the beginning of confinement (Figure 1B). To evaluate the influence of sex, age, and baseline cognitive status on the obtained results, a covariate analysis was performed. In this regard, our data showed a significant interaction between sex and MNA score (p = .048), since men always had higher MNA scores than women. There was also a significant interaction between cognitive status and MNA (p < .001), characterized by lower MNA score in those with dementia. In contrast, age had no effect on the data obtained (p = .060). These changes were not reflected in the anthropometric parameters, since these parameters remained stable during this period, and only slight variations were observed, as evidenced by the lack of statistically significant differences (Supplementary Figure S1 and Table S1).

Effect of Lockdown on Functional Status

The Barthel index was employed to measure residents' functional status. Hence, as shown in Figure S2, there was no statistically significant changes of functional status throughout confinement (Figure S2a). Moreover, hand grip strength and gait speed were also evaluated as an additional evaluation of participants' functional status. In this regard, as with Barthel index, both parameters remained stable along the study (Figure S2b and 2c).

As with MNA, baseline cognitive status showed a significant interaction with functional status (p = .038), characterized by lower functionality in those with dementia. However, in this case, sex, and age showed no effect on Barthel index data. On the other hand, there was no other significant covariate effect on hand-grip strength and gait speed.

Effect of Lockdown on Frailty Status

The evolution of frailty during the study was evaluated using the FRAIL scale (Figure 2). Attending to the data obtained, the score derived from FRAIL scale was maintained throughout the confinement period (Figure 2A). These results were independent of age (p = .363) and sex (p = .217), but not of baseline cognitive status (p = 0.041). On the contrary, there was a significant decrease in the SPPB scale score (Figure 2B), which indicates a decrease in physical performance during confinement. The increase on the risk of sarcopenia, as shown by the SARC-F data (Figure 2C), also reinforced these observations.

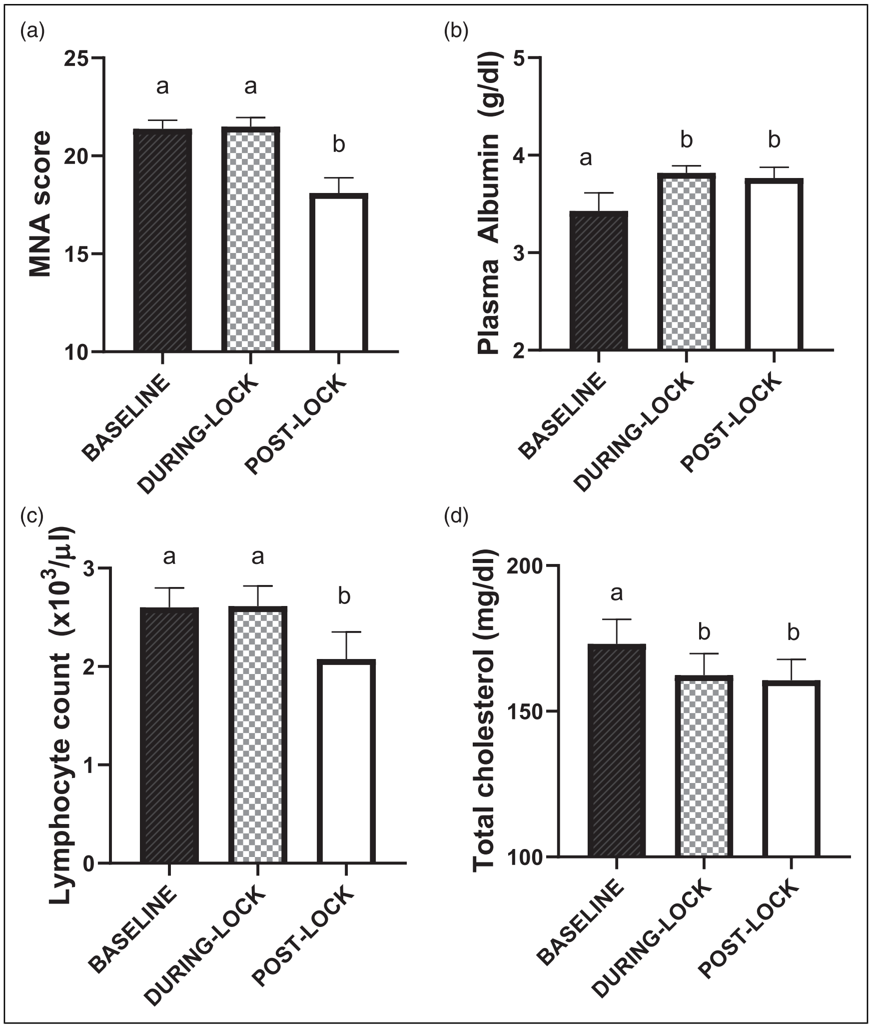


Figure 1. Changes in MNA (A) and biochemical markers of nutritional status (B) albumin, (C) lymphocyte count, and (D) total cholesterol) before confinement (PRE-LOCK) and at the beginning (BASELINE), at the middle (DURING-LOCK), and at the end of confinement. Data represent mean ± SD. Statistical differences were evaluated by a repeated measures general linear model. *Post hoc* evaluation of differences among time periods was performed with Sidak's test for multiple comparison. Different letters represent statistically significant differences. (For MNA: $F = 80.852$, gl = 224, partial $\eta^2 = .520$, $p < .001$; For Albumin: $F = 2.923$, gl = 72, partial $\eta^2 = .109$, $p = .040$; For Lymphocyte count: $F = 8.575$, gl = 75, partial $\eta^2 = .255$, $p < .001$; For total cholesterol: $F = 7.779$, gl = 78, partial $\eta^2 = .230$, $p < .001$).

Effect of Lockdown on Salivary Cortisol

Figure 3 shows the values obtained in this variable. As shown in this figure, morning cortisol was statistically significantly reduced at the end of confinement. Similarly, night cortisol also showed the lowest values after confinement, but in this case, an abrupt increase of saliva cortisol was observed during the lockdown. The change in morning to night cortisol levels significantly decreased, which reflects an impairment of cortisol physiology throughout the study.

Survival Predictors During COVID-19 Lockdown

Of the 301 residents who took part in the study, 56 died during the confinement period (survival rate of 81.4%), of which 9 died due to COVID-19. Only one nursing home experienced COVID-19 cases, with a total of 65 positive cases during confinement (86% survival rate of COVID-19 cases).

A survival analysis following the Kaplan-Meyer method was conducted to determine those variables that may be involved in residents' survival during the COVID-19 lockdown. In this regard, significant differences were observed attending to frail status, since those with pre-frailty or frail status had a significantly higher probability of death than non-frail subjects (Log-Rank $\chi^2 = 10.553$, $p = .001$). Nutritional status was also related, with higher mortality observed in the malnourished group ($\chi^2 = 10.424$, $p = 0.005$). Similarly, the survival rate was higher in those subjects with higher independency level ($\chi^2 = 25.427$, $p < .001$). Finally, to determine the relative influence of these

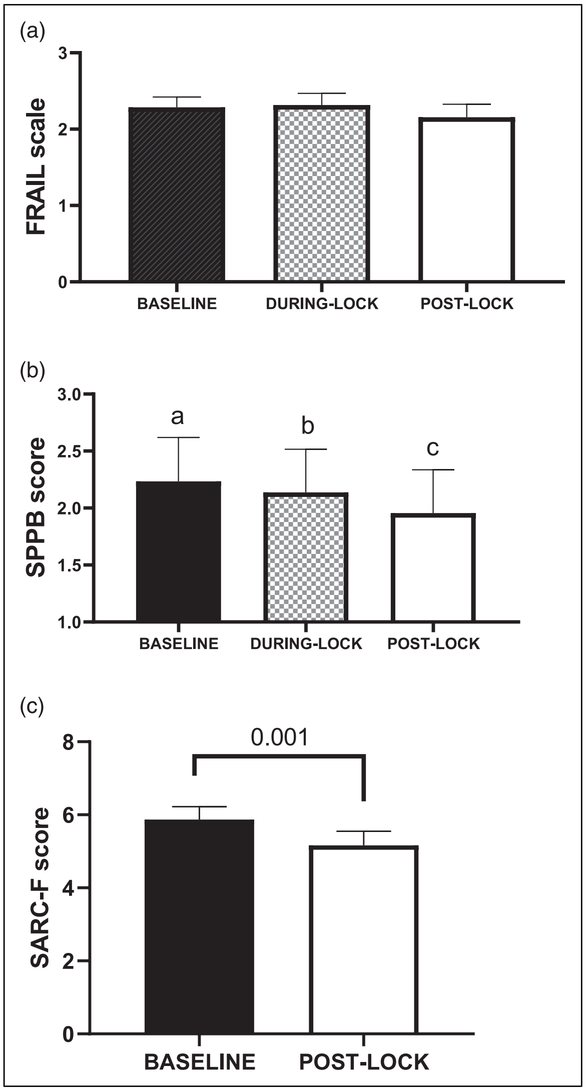


Figure 2. Changes in FRAIL scale (A), SPPB (B), and SARC-F (C) before confinement (PRE-LOCK) and at the beginning (BASELINE), at the middle (DURING-LOCK), and at the end of confinement (there is no SPPB data before lockdown). Data represent mean ± SD. Statistical differences were evaluated by a repeated measures general linear model. *Post hoc* evaluation of differences among time periods was performed with Sidak's test for multiple comparison. Different letters represent statistically significant differences. (For FRAIL: F = 16.718, gl = 265, partial η^2 = .159, p < .001; For SPPB: F = 4.910, gl = 258, partial η^2 = .037, p = .021). As the FRAIL scale was an ordinal variable, an additional statistical analysis was conducted using Friedman's tests, which confirmed the statistically significant differences among the different times (χ^2 = 40.921, p < .001).

and other independent variables evaluated in the present study, a Cox regression analysis was conducted (Figure 4). According to the data, men had a higher hazard ratio than women, showing a more than 2-fold probability of death than women. The FRAIL and Barthel scales also significantly predicted the hazard ratio. Concretely, for each step that was increased in these scales, the probability of death increased by 50%.

Discussion

In this study, residents' frailty changes throughout the first COVID wave lockdown were analysed. Although there are different models and definitions of frailty, some consensus is that frailty involves an increased risk of negative health outcomes (Hogan, 2018). Frailty is associated but is not synonymous with aging, co-morbidity, and dependency (Hamerman, 1999). Fried et al. (2001) proposed a frailty phenotype that includes unintentional weight loss, exhaustion, weakness (lower grip strength), slow gait, and reduced physical activity. In addition, frail subjects have a higher vulnerability to stressors (Rockwood, 2005). For the elderly, stressors linked to the COVID-19 pandemic and lockdown (higher risk of hospitalization and death, extreme isolation, and increasing unmet needs) have had an impact more elevated than other people (Taylor, 2022; United Nations, 2020). In this sense, older adults' frailty is expected to rise. A previous report suggested that frailty was higher at the beginning of the lockdown (Garner et al., 2022). We show differences among the trajectories of frailty measures and their impact on residents' survival.

Among the markers of nutritional deficiencies in older adults reported in the literature are weight loss, low serum albumin, total lymphocyte count, and total cholesterol (Monarque-Favard et al., 2002; Robinson, 2015). In the current study, contrary to previous reports (Garner et al., 2022), changes in anthropometric measures were not found. The initial increase in lymphocyte concentration and total cholesterol did not support the existence of an initial nutritional risk. In addition, a small, transient reduction in albumin levels was observed at the beginning of the lockdown. This feature might indicate, as lymphocyte concentration rises, the co-existence of infectious or inflammatory diseases (Ceciliani et al., 2005; Teixeira et al., 2011). In any case, at the beginning of COVID lockdown, the risk of malnutrition was low since mean levels of albumin, lymphocyte, and total cholesterol levels were held into the reference intervals (Kubota et al., 2012). In addition, most subjects have a BMI within the "desirable" BMI range (Ritz, 2009). Only after the lockdown was the mean BMI below 25, which has been related to frailty and mortality (Babiarczyk & Turbiarz, 2012). In concordance with these findings, MNA scores remained stable until the end of the lockdown. This time, a reduction in MNA scores indicated the need for a dietary intervention. This fact was particularly relevant, since malnutrition was associated with shorter survival, as previous studies showed (García-Gollarte et al., 2020).

Measures of physical performance showed a progressive decline, a fact that was made clear by the increased risk of frailty (according to the FRAIL scale) and sarcopenia, due to the decrease in the SARC-F scale score;

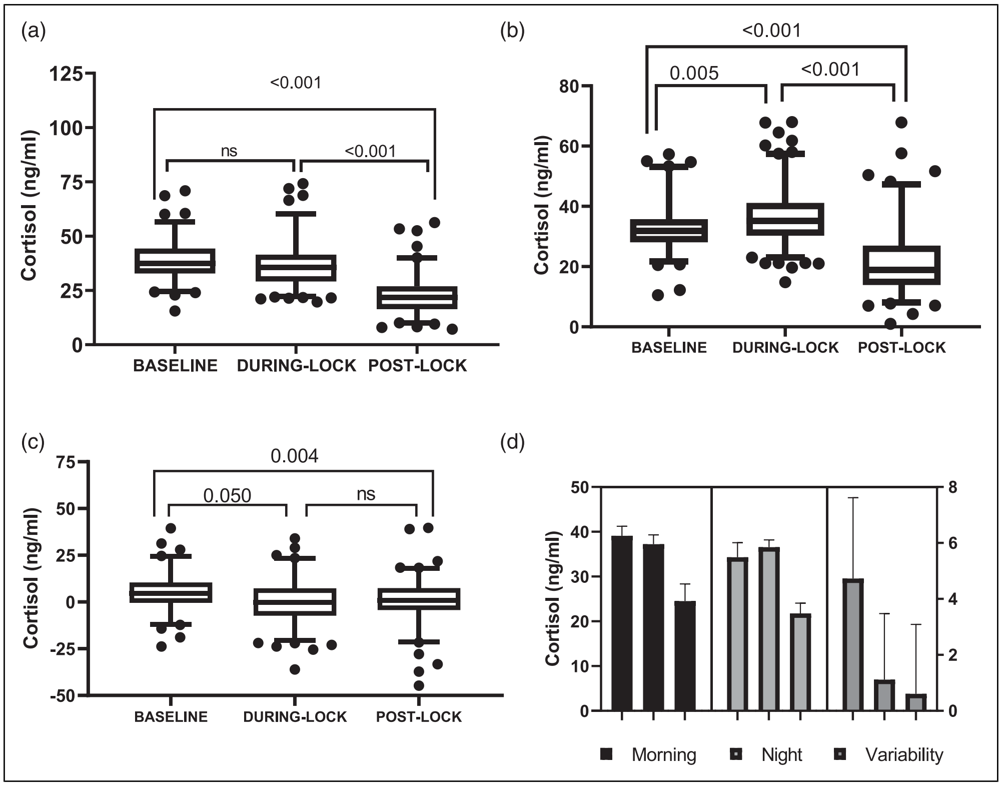


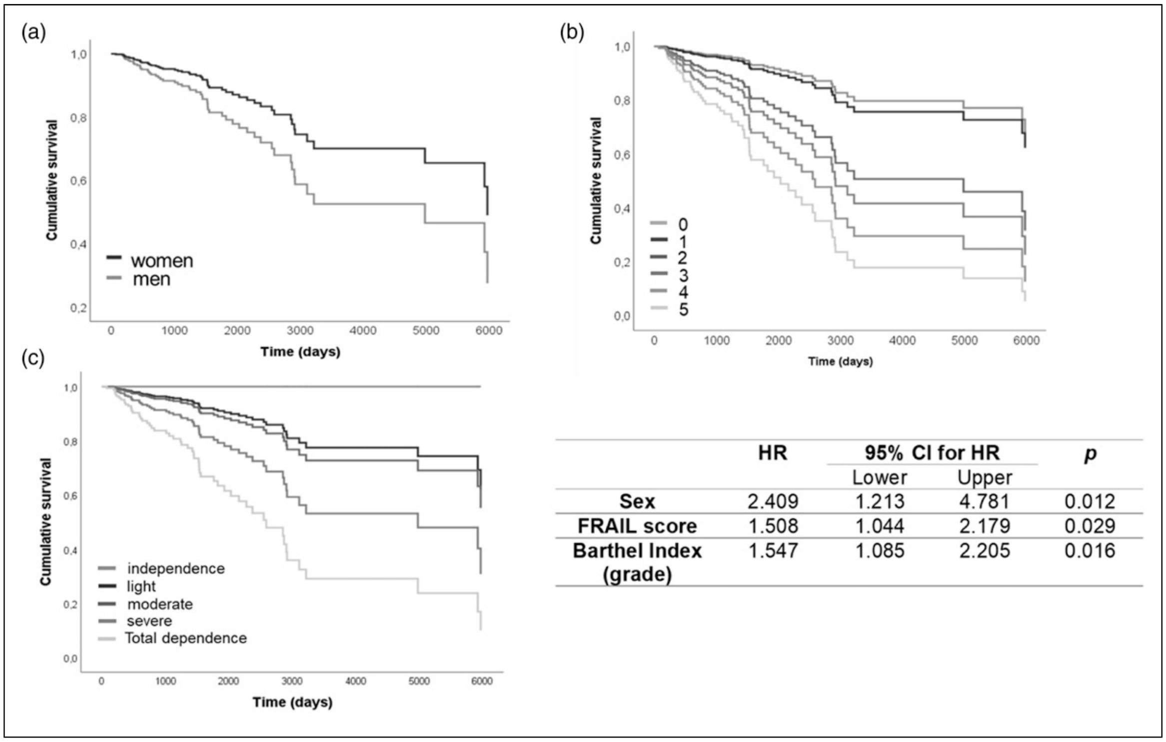
Figure 3. Changes in plasma levels of morning cortisol (A), night cortisol (B), and cortisol variability (C) at the beginning (BASELINE), at the middle (DURING-LOCK), and at the end of confinement (there is no cortisol data before lockdown). Figure d represents all the determinations together. Data represent mean ± SD. Statistical differences were evaluated by a repeated measures general linear model. *Post hoc* evaluation of differences among time periods was performed with Sidak's test for multiple comparison. Different letters represent statistically significant differences. (For morning cortisol: $F = 43.755$, gl = 39, partial $\eta^2 = .692$, $p < .001$; For night cortisol: $F = 17.692$, gl = 36, partial $\eta^2 = .496$, $p < 0.001$; For cortisol variability: $F = 4.784$, gl = 35, partial $\eta^2 = .215$, $p = .015$).

Similarly, a statistically significant decrease in SPPB-score was observed, which indicates, as commented, an impairment of physical performance during lockdown. Such changes might be explained by either lower daily physical exercise due to the lockdown restriction or higher fatigue (Thiel et al., 2021). Besides, higher comorbidity and a lower nutritional intake by the end of the lockdown might make these changes worse (Rizka et al., 2021). Furthermore, physical performance, particularly balance impairment and problems in the coordination of movements, is related to swallowing disorders and the risk of malnutrition (Jukic Peladic et al., 2019).

As to cortisol levels are concerned, a reduction in both morning and night levels was observed, with the lowest decrease being at morning. Among the circumstances explaining altered morning cortisol levels are chronic stress exposure (Gaffey et al., 2016), cognitive impairment (Gardner et al., 2019), and frailty (J. Wang et al., 2019). In that regard, altered cortisol awakening response (CAR) has been observed in elderly with chronic stress (Fries et al., 2009) or generalized anxiety disorder (Hek et al., 2013). Moreover, in both cases a flatter morning-to-evening diurnal cortisol slope has been found (Adam et al., 2006; Hek et al., 2013). Besides, elderly with lower social support show a reduction in CAR (Heaney et al., 2010). In our study, chronic stress exposure and isolation during the lockdown might have caused prolonged HPA axis activation leading a circadian dysregulation (Karin et al., 2020).

On the other hand, during the lockdown, an accelerated cognitive decline in elderly with memory problems has been reported (Bakker et al., 2023). There are controversial findings in the studies about the association between CAR and cognition in the elderly (Evans et al., 2011; Hidalgo et al., 2016). In any case, in the current study, changes in cognition have not been assessed so that we cannot rule out an impact of cognitive decline on cortisol measures.

Finally, some evidence is about a lower diurnal variability of cortisol has been associated with frailty in older adults (Johar et al., 2014). Besides, older adults with a dysregulation of the hypothalamic-pituitary-adrenocortical (HPA) axis has been suggested to reduce lean body mass (Roubenoff & Rall, 1993). In fact, in elderly, a reduced cortisol wakening response is associated to a slower speed gait (Pulopulos et al., 2016). However, several studies shown contrasting results about the relation between cortisol levels and frailty (J. Wang et al., 2019). Some of the potential explanations for this discrepancy



	HR	95% CI for HR		p
		Lower	Upper	
Sex	2.409	1.213	4.781	0.012
FRAIL score	1.508	1.044	2.179	0.029
Barthel Index (grade)	1.547	1.085	2.205	0.016

Figure 4. Survival curves for the different groups attending to their (A) cognitive status or (B) type of confinement during COVID-19 lockdown. The horizontal axis refers to the time in the number of days since lockdown.

are the high intraindividual variability, the seasonal influence on cortisol measures and differences in subjects' comorbidities. All things considered, we think our findings about cortisol levels might reflect both a chronic stress and isolation during the lockdown and a higher risk of frailty in the post-lockdown time.

Study Limitations

Every study contains some limitations. Firstly, many of the biochemical markers evaluated, such as serum albumin, are affected by factors other than malnutrition, such as inflammation, liver disease, and kidney disease. Therefore, while biochemical parameters can be a useful tool for diagnosing malnutrition in elderly patients, they should be interpreted in conjunction with other clinical signs and symptoms, such as unintentional weight loss, loss of muscle mass, and decreased functional status (Cederholm et al., 2017). Secondly. the study has been limited to a specific stage of the pandemic; however, the current rates of mortality and morbidity have allowed to cancel the lockdown. Therefore, the interpretation of our data should be limited to more severe stages of the COVID-19 pandemic. Finally, depression and other psychological traits were not measured in this study, and they could be contributory to some of the biomarker, frailty, and functional outcomes. However, our previous study did not show a significant modification of psychological well-being of nursing home residents during this lockdown (Oliveira et al., 2023).

Conclusion

In summary, after the first COVID-19 lockdown, several alterations in residents' frailty markers have been observed. Concretely, the worsening of the nutritional status, which was associated with a decrease of physical performance and an increased risk of sarcopenia, should be emphasized. Similarly, an impairment on stress regulation, as indicated by a blunted cortisol secretion pattern, was observed. To note, an elevated degree of dependence, measured both by functional capacity and frailty status, was associated with higher mortality during confinement. Although, in our opinion, the prompt response of nursing homes to COVID-19 disease-related stressors and social restrictions, as we were able to show previously (Oliveira et al., 2023), could have allowed such changes to be small and potentially reversible, it will be necessary to develop new prevention strategies centred on the person in order to avoid the harmful effect of confinement on elderly population. These interventions may require of having more spaces for the free movement of the resident to prevent loss of functional capacity in future pandemics. It would be advisable to improve nursing home financing to increase quality regarding service delivery via optimal nurse staff qualifications and nurse-to-patient ratios as well as structural improvements to facilitate physical mobility and cognitive function, restorative care, and rehabilitation.

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Author Contributions

De Souza Oliveira, AC contributed to design contributed to interpretation drafted manuscript critically revised manuscript gave final approval agrees to be accountable for all aspects of work ensuring integrity and accuracy Gomez Gallego, M contributed to design contributed to analysis drafted manuscript critically revised manuscript gave final approval agrees to be accountable for all aspects of work ensuring integrity and accuracy Gomez Martinez, C contributed to conception and design contributed to acquisition drafted manuscript critically revised manuscript gave final approval agrees to be accountable for all aspects of work ensuring integrity and accuracy Lopez Mongil, R contributed to conception contributed to acquisition drafted manuscript critically revised manuscript gave final approval agrees to be accountable for all aspects of work ensuring integrity and accuracy Moreno Molina J contributed to conception contributed to analysis drafted manuscript critically revised manuscript gave final approval agrees to be accountable for all aspects of work ensuring integrity and accuracy Hernandez Morante, JJ contributed to conception and design contributed to analysis and interpretation drafted manuscript critically revised manuscript gave final approval agrees to be accountable for all aspects of work ensuring integrity and accuracy Echevarria Perez, P contributed to conception and design contributed to acquisition, analysis, and interpretation drafted manuscript critically revised manuscript gave final approval agrees to be accountable for all aspects of work ensuring integrity and accuracy.

Declaration of Conflicting Interests

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Ethical Approval

The present study was conducted after approval of the Ethics Committee of the Universidad Católica de Murcia. A Clinical Board of the Nursing Homes also reviewed and approved the ethical aspects of the present study. Oral and written consent was requested to those participants with normal cognitive status. In those participants with marked cognitive impairment, permission was requested from their legal representative.

Data Availability Statement

The datasets generated during and/or analysed during the current study are available in the Mendeley Data repository, https://data.mendeley.com/datasets/7pr8b8j92m/2

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Supplemental Material

Supplemental material for this article is available online.

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