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Functioning issues in inpatients affected by COVID-19-related moderate pulmonary impairment: a real-practice observational study

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Abstract

Objective: To investigate the correlations between clinical, functional, and radiological outcomes in inpatients with coronavirus disease 2019 (COVID-19).

Methods: In this observational study, we recruited inpatients affected by moderate COVID-19 disease. The clinical evaluation comprised the Cumulative Illness Rating Scale (CIRS), numerical rating scale (NRS), modified Rankin scale (mRS), and the modified Borg dyspnea scale (mBDS). Respiratory involvement was assessed with computed tomography (CT) and graded with a CT-severity score (CT-SS). We retrospectively assessed functioning using the International Classification of Functioning, Disability and Health (ICF) codes of the Clinical Functioning Information Tool (ClinFIT) COVID-19 in the acute phase. Correlation analysis was performed 1) between clinical, instrumental, and functional parameters and 2) between ICF categories.

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Results: The data showed statistically significant moderate correlations between CT-SS and the following categories: b152 "emotional functions" and b440 "respiratory functions".
Conclusion: This is the first study to use the ICF framework in people with a moderate form of COVID-19 in the acute phase. Considering the correlations between some ICF categories and radiological findings, our results support the use of the ClinFIT COVID-19 for a comprehensive assessment of COVID-19 patients.

Keywords
Coronavirus disease 2019 in COVID-19 and severe acute respiratory syndrome coronavirus 2 in SARS-CoV-2, coronavirus, International Classification of Functioning, disability and health, physical and rehabilitation medicine

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Introduction

In December 2019, a novel coronavirus (severe acute respiratory syndrome coronavirus 2; SARS CoV-2) causing coronavirus disease 2019 (COVID-19) emerged in Wuhan, China. Owing to transmission through human-to-human contact, SARS CoV-2 spread rapidly across the world, causing a pandemic.[1] Several SARS CoV-2 variants have been identified and these have led to different clinical manifestations of COVID-19, with variable transmissibility, morbidity, and mortality.[2,3] The common clinical findings of COVID-19 are respiratory signs and symptoms, namely cough, shortness of breath, and chest pain, as well as other physical and psychological disorders. Mild, moderate, or severe forms of COVID-19 have been described, and the latter comprise severe pneumonia, acute respiratory distress syndrome (ARDS), sepsis, and septic shock.[4,5]

Hospitalized COVID-19 patients require isolation to avoid propagation of the virus. This intervention, with few environmental stimuli, may cause psychological issues that range from depression to anxiety, and eventually may lead to cognitive decline.[6] In this context, rehabilitation represents the mainstay of care in the post-intensive care unit for enhancing functional recovery, reducing the length of stay (LOS), and preventing possible long-term consequences.[7,8] This approach also reduces COVID-19-related disability, thus leading to less disease burden and lower costs for healthcare systems.[7,8] The pandemic has highlighted the huge need for specific rehabilitation services in COVID-19 patients, from early acute to post-acute care.[9,10]

Rehabilitation is defined by the World Health Organization (WHO) as "a set of interventions designed to optimize functioning and reduce disability in individuals with health conditions in interaction with their environment".[11] The comprehensive assessment of body functions and structures, activities and participation, and environmental and personal factors of an individual is the starting point of the person-centered rehabilitation process. The International Classification of Functioning, Disability and Health (ICF) represents the universal framework for this assessment.[12] To address the growing need for the evaluation of changes in functioning related to COVID-19, a task force of the

International Society of Physical and Rehabilitation Medicine (ISPRM) developed the Clinical Functioning Information Tool (ClinFIT), which, as ClinFIT COVID- 19, is used for the assessment and reporting of functioning in COVID-19 patients in acute, post-acute, and long-term care settings.[13]

The aim of this real-practice study was to correlate clinical and instrumental parameters with changes in functioning of inpatients with a moderate form of COVID-19 in a hospital in southern Italy.

Materials and methods

Participants

We collected clinical, instrumental, and functional data for inpatients with a moderate form of COVID-19, who were hospitalized in the COVID-19 Unit of the San Giovanni Bosco Hospital in Naples, Italy, from 1 January 2021 to 31 May 2021. We enrolled both men and women older than 18 years with 1) positive results for nasal and pharyngeal swabs for SARS-CoV-2, evaluated by the real-time reverse transcriptase-polymerase chain reaction (RT-PCR) assay; 2) diagnosis of moderate illness (evidence of lower respiratory disease during clinical assessment or imaging, with oxygen saturation (SpO_2) $\geq$94% on room air at sea level) in accordance with COVID-19 treatment guidelines;[14] and 3) absence of cognitive impairment (Short Portable Mental Status Questionnaire (SPMSQ) score $\geq$8). All patients' details were de-identified to protect their privacy, and all patients provided written informed consent, in accordance with the guidelines of the Helsinki Declaration. The Ethical Committee of the University of Campania Luigi Vanvitelli approved the study (approval number: 0017390/2020).

This study was performed in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) reporting guidelines.[15]

Outcomes

Data collection comprised anamnestic and anthropometric data, and the following outcome measures:

- Cumulative Illness Rating Scale (CIRS), which was used to assess physical illness burden through two indices, the Illness Severity Index (SI) and the Comorbidity Index (CI);[16]
- numerical rating scale (NRS), which was used to measure pain intensity; we considered a score of 0 as "absence" of pain; 1–3 as "mild" pain, 4–6 as "moderate" pain, and 7–10 as "severe pain;[17]
- modified Rankin scale (mRS), which was used to evaluate patient disability;[18]
- modified Borg dyspnea scale (mBDS), which was used to measure patient-reported dyspnea.

All patients underwent chest computed tomography (CT), and the images were analyzed by a radiologist who reported the CT severity score (CT-SS), which is an objective method to identify significant radiological differences between severe and mild cases of COVID-19. The overall CT-SS ranges from 0 (no signs) to 25 points, with a cut-off value of 7 (sensitivity: 80.0%; specificity: 82.8%).[19,20]

We also retrospectively assessed the functioning of COVID-19 patients using the ICF codes for COVID-19 identified by the ClinFIT task force.[13] The ClinFIT COVID-19 for the acute phase comprises 13 ICF categories; 10 for "body functions" and 3 for "activity and participation" (Table 1).[13] To rate the severity of a problem, we used the scale provided in the ICF indicated as "qualifiers". The qualifiers are classified as 0 for no problem, 1 for mild problem, 2 for moderate problem, 3 for

Table 1. ICF codes included in the ClinFIT COVID-19 categories for the acute setting.

b130 Energy and drive functions
b134 Sleep functions
b140 Attention functions
b152 Emotional functions
b280 Sensation of pain
b440 Respiratory functions
b445 Respiratory muscle functions
b455 Exercise tolerance functions
b710 Mobility of joint functions
b730 Muscle power functions
d230 Carrying out daily routine
d240 Handling stress and other psychological demands
d450 Walking

severe problem, and 4 for complete problem.[21]

Statistical analysis

The collected data were analyzed using the Statistical Package for the Social Sciences 25 (SPSS 25; IBM Corp., Armonk, NY, USA) software to perform a correlation analysis between the patients' vital signs, disability level, patient-reported dyspnea, CT-SS, and ClinFIT COVID-19 categories. Normality was evaluated using the Shapiro–Wilk test. Correlation analysis was performed using Pearson's correlation coefficient or Spearman's rank correlation, in the case of non-parametric variables. We considered a significance threshold of $p < 0.05$, and we considered the following cut-offs and strengths for the correlation coefficient: 0.2–0.39 as weak, 0.40–0.59 as moderate, 0.6–0.79 as strong, and 0.8–1 as very strong correlation.

Results

The demographic, clinical, and functioning/disability data of the 23 recruited patients are shown in Table 2. Regarding the severity of dyspnea, 8 patients (34.8%) had no dyspnea, 3 (13.04%) had mild dyspnea, 10 (43.5%) had severe dyspnea, 1 (4.3%) had very severe dyspnea, and 1 (4.3%) had critical dyspnea. The CT-SS indicated moderate to severe radiological disease (overall score >7) in 14 patients (60.9%), while 9 patients (39.1%) had mild signs. The severity of each problem in accordance with the

Table 2. Demographic, clinical, and functioning/disability data of our population.

Variable	COVID-19 patients
Age (years)	73.04 ± 7.93
Sex	
Male	8 (34.8)
Female	15 (65.2)
T (°C)	36.4 ± 0.42
HR (bpm)	79.17 ± 15.94
SpO_2 (%)	96.96 ± 1.77
NRS score	2.7 ± 2.4
0	7 (30.4)
1–3	8 (34.8)
4–6	6 (26.1)
7–10	2 (8.7)
CIRS-SI	21.48 ± 3.76
CIRS-CI	
1	3 (13.04)
2	5 (21.7)
3	4 (17.4)
4	7 (30.4)
5	3 (13.04)
6	1 (4.34)
mRS score	
0	18
1	0
2	2
3	1
4	1
5	1
6	0

All variables were normally distributed. Continuous variables are expressed as mean ± standard deviation; discrete variables are expressed as total number (%). COVID-19, coronavirus disease 2019; T, temperature; HR, heart rate; bpm, beats per minute; SpO_2, oxygen saturation; NRS, numerical rating scale; CIRS-SI, Cumulative Illness Rating Scale-Severity Index; CIRS-CI: Cumulative Illness Rating Scale-Comorbidity Index; mRS: modified Rankin scale.

ICF codes identified in the ClinFIT COVID-19 and retrospectively obtained from the information reported in the medical records of our population is shown in Table 3.

The correlations between age, vital signs, disability level, patient-reported dyspnea, CT-SS, and functioning level are shown in Table 4. Specifically, age was moderately correlated with impairment of "mobility of joint functions" (ICF code: b710) ($p = 0.046$), and the CIRS-SI was moderately correlated with ICF code b280 "sensation of pain" ($p = 0.045$) and "walking" (ICF code: d450) ($p = 0.033$). Regarding pain, no correlations were found between the NRS scores and the ICF codes. The mBDS and mRS scores showed moderate correlations with reduced "muscle power functions" (ICF code: b730) ($p = 0.041$ and $p = 0.037$, respectively), and the mBDS score was moderately correlated with "walking" (ICF code: d450) ($p = 0.011$). Regarding the instrumental findings, moderate correlations were found between the CT-SS and impairments in the following ICF codes: b152, "emotional functions" ($p = 0.040$) and b440, "respiratory functions" ($p = 0.004$). Table 5 shows the correlations between the different ICF codes.

Discussion

To the best of our knowledge, this is the first study to use the ICF framework to characterize the functioning level of people with a moderate form of COVID-19 in the acute phase and to correlate clinical, functioning, and instrumental data to better understand the potential role of rehabilitation in this population.

We used the ICF codes identified by the ClinFIT Task Force for the ClinFIT COVID-19 retrospectively and analyzed the correlations between each category and between each category and all other clinical and instrumental data. We found

Table 3. The ICF codes of ClinFIT COVID-19 and their qualifiers obtained retrospectively from the medical records of our population (n = 23).

b130	b134	b140	b152	b280	b440	b445	b455	b710	b730	d230	d240	d450
0	4 (17.4%)	5 (21.72%)	11 (47.82%)	2 (8.7%)	3 (13.05%)	0 (0%)	3 (13.05%)	2 (8.7%)	3 (13.05%)	3 (13.05%)	3 (13.05%)	1 (4.4%)	1 (4.4%)
1	9 (39.13%)	11 (47.82%)	9 (39.13%)	11 (47.82%)	8 (34.78%)	1 (4.4%)	9 (39.13%)	4 (17.4%)	9 (39.13%)	9 (39.13%)	1 (4.4%)	13 (56.52%)	5 (21.72%)
2	9 (39.13%)	6 (26.06%)	3 (13.05%)	8 (34.78%)	6 (26.06%)	5 (21.72%)	10 (43.47%)	16 (69.56%)	6 (26.06%)	3 (13.05%)	11 (47.9%)	8 (34.78%)	2 (8.7%)
3	1 (4.4%)	1 (4.4%)	0 (0%)	2 (8.7%)	6 (26.06%)	8 (34.78%)	1 (4.4%)	1 (4.4%)	5 (21.72%)	8 (34.78%)	8 (34.78%)	1 (4.4%)	8 (34.78%)
4	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	9 (39.13%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	7 (30.43%)

Note: The values are expressed as number (percentage).
ICF, International Classification of Functioning, Disability and Health; ClinFIT, Clinical Functioning Information Tool; COVID-19, coronavirus disease 2019.

Table 4. Correlation coefficients and p-values between age, pain, disability level, comorbidity, patient-reported dyspnea, CT severity score, and the ICF codes included in the ClinFIT COVID-19.

	Age (y)		NRS		mRs		CIRS-SI		mBDS		CT-SS	
	r	p-value	r	p-value	r	p-value	r	p-value	r	p-value	r	p-value
b130	−.228	.295	.288	.182	−.025	.909	.025	.910	.232	.286	.021	.924
b134	−.404	.056	−.105	.632	.038	.864	−.209	.338	.218	.317	.376	.077
b140	.151	.492	.038	.864	−.015	.946	−.216	.322	−.199	.362	−.051	.861
b152	−.106	.631	−.051	.818	.279	.197	.110	.616	.346	.106	.431*	.040
b280	.402	.057	.209	.338	.166	.448	.421*	.045	.366	.086	−.370	.083
b440	−.220	.312	−.299	.165	−.082	.711	−.193	.378	−.103	.640	.572*	.004
b445	−.125	.570	−.194	.374	−.127	.564	−.321	.135	−.264	.223	.361	.091
b455	−.216	.322	.074	.736	.158	.471	.288	.183	.242	.266	.143	.516
b710	.420*	.046	.044	.842	.288	.183	.316	.142	.272	.210	−.260	.230
b730	.250	.250	.148	.500	.437*	.037	.361	.091	.429*	.041	−.035	.873
d230	.039	.859	.055	.804	.149	.498	.134	.541	.208	.341	.030	.891
d240	−.016	.942	.009	.968	.173	.431	.150	.495	.217	.319	.187	.394
d450	.231	.288	.264	.224	.319	.137	.445*	.033	.518*	.011	−.146	.507

*$p < 0.05$.

NRS, numerical rating scale; mRs, modified Rankin scale; CIRS-SI, Cumulative Illness Rating Scale- Severity Index; mBDS, modified Borg dyspnea scale; CT-SS, computed tomography severity score; ICF, International Classification of Functioning, Disability and Health; ClinFIT, Clinical Functioning Information Tool; COVID-19, coronavirus disease 2019.

statistically significant very strong correlations, as expected, between some categories, namely b134, "sleep functions" and d240, "handling stress and other psychological demands", and between b710, "mobility of joint functions" and d450, "walking". We also found strong correlations between "respiratory functions" and "respiratory muscle functions", "mobility of joint functions" and "muscle power functions", and "muscle power functions" and "walking". As expected, we found a correlation between the CT-SS and "respiratory functions", which confirmed the utility of the instrumental tool to evaluate functional lung damage. Moreover, it is key to note the relationship between CT-SS and "emotional functions", suggesting that an impaired clinical and radiological scenario might lead to anxiety, sadness, and anger in the acute setting. This issue has not been as well investigated in acute patients as it has in patients with long-COVID syndrome[22] and discharged patients.[23]

Patients affected by COVID-19 complain of several signs and symptoms involving systems other than the respiratory system. Indeed, since the beginning of the pandemic, the heavy impact of SARS-CoV-2 infection on different body systems has been clear, with a negative influence on body functions, activities, and social participation.[24] To improve and standardize the assessment of functioning in people with COVID-19, the ClinFIT COVID-19 was recently developed for acute, post-acute, and long-term care settings.[13] This tool aims to identify the main clinical and functional issues and rate their severity in patients with COVID-19, a mandatory approach to providing effective and appropriate rehabilitation care.

From the analysis of our data, as expected, the respiratory system was heavily impacted in COVID-19 patients in the acute phase. Approximately half of our patients showed severe to very severe dyspnea. These results are similar to those

Table 5. Correlation coefficients and p-values between the ICF codes included in the ClinFIT COVID-19.

	b130		b134		b140		b152		b280		b440		b445		b455		b710		b730		d230		d240		d450	
	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p	r	p
b130	–	–	−.597*	.003	.538*	.008	.505*	.014	.197	.368	.262	.228	.139	.526	.683*	.000	−.101	.647	.083	.706	.380	.073	.740*	.000	.142	.517
b134	−.597*	.003	–	–	.333	.121	.763*	.000	−.046	.833	.380	.074	.213	.330	.421*	.045	−.67	.763	.066	.765	.492*	.017	.819*	.000	.081	.714
b140	.538*	.008	.333	.121	–	–	.344	.108	.270	.213	−.122	.579	.081	.714	.094	.671	.245	.259	.180	.411	.319	.138	.468*	.024	.064	.770
b152	.505*	.014	.763*	.000	.344	.108	–	–	.149	.498	.357	.094	.237	.277	.522*	.011	.098	.655	.252	.246	.479*	.023	.785*	.000	.235	.281
b280	.197	.368	−.046	.833	.270	.213	.149	.498	–	–	−.327	.128	−.340	.112	.096	.663	.775*	.000	.581*	.004	.276	.202	.292	.177	.739*	.000
b440	.262	.228	.380	.074	−.122	.579	.357	.094	−.327	.128	–	–	.781*	.000	.507*	.014	−.331	.122	−.101	.645	.014	.949	.278	.198	−.239	.272
b445	.139	.526	.213	.330	.081	.714	.237	.277	−.340	.112	.781*	.000	–	–	.386	.069	−.201	.359	−.054	.806	−.136	.536	.134	.543	−.243	.263
b455	.683*	.000	.421	.045	.094	.671	.522*	.011	.096	.663	.507*	.014	.386	.069	–	–	.011	.959	.330	.124	.501*	.015	.566*	.005	.258	.235
b710	−.101	.647	−.067	.763	.245	.259	.098	.655	.775*	.000	−.331	.122	−.201	.359	−.011	.959	–	–	.797*	.000	.408	.053	.142	.518	.804*	.000
b730	.083	.706	.066	.765	.180	.411	.252	.246	.581*	.004	−.101	.645	−.054	.806	.330	.124	.797*	.000	–	–	.530*	.009	.179	.415	.793*	.000
d230	.380	.073	.492*	.017	.319	.138	.473*	.023	.276	. 202	.014	.949	−.136	.536	.501*	.015	.408	.053	.530*	.009	–	–	.503*	.014	.490*	.018
d240	.740*	.000	.819*	.000	.468*	.024	.785*	.000	.292	.177	.278	.198	.134	.543	.566*	.005	.142	.518	.179	.415	.503*	.014	–	–	.267	.219
d450	.142	.517	.081	.714	.064	.770	.235	.281	.739*	.000	−.239	.272	−.243	.263	.258	.235	.804*	.000	.793*	.000	.490*	.018	.267	.219	–	–

*p <0.05.

ICF, International Classification of Functioning, Disability and Health; ClinFIT, Clinical Functioning Information Tool; COVID-19, coronavirus disease 2019.

reported by Al Chikhanie et al, who reported a mean of 4.4 ± 2.3 ("somewhat severe dyspnea") using the modified Borg dyspnea scale in patients undergoing pulmonary rehabilitation, demonstrating severe short-term respiratory sequelae in patients with COVID-19 after ICU discharge.[25]

Aiming to standardize pulmonary involvement in patients with COVID-19, the CT-SS was proposed to aid decision-making for hospital admission. This tool enables localization of lung involvement (parenchymal opacification of each region), but does not provide further information on functional and clinical parameters. The 13 ICF codes included in the ClinFIT COVID-19 for the acute phase provide a comprehensive functioning assessment, which is essential to determine an appropriate rehabilitation approach in this population. The ClinFIT COVID-19 was published in October 2021;[13] however, to date, no study has evaluated this tool, clinically.

Regarding the other outcomes that we investigated, over one-third of our cohort reported moderate-to-severe musculoskeletal pain. This degree was lower compared with two previous studies, which reported a pain prevalence between 70% and 82.5% in COVID-19 patients,[26,27] with a mean visual analog Scale (VAS) score of 4.8 (moderate pain). However, this symptom is poorly studied in people hospitalized with COVID-19 and appears to negatively affect functional recovery.[28] Our findings did not suggest a correlation between pain and other functioning categories; however, this might be because of the small number of people reporting this symptom. In our opinion, the severity and influence of pain on the clinical and functional status of COVID-19 patients should be properly investigated to provide the most appropriate management.

Strength and limitations

Our study is the first to use the ICF codes in the ClinFIT-COVID-19 in real practice in an acute care setting. The main limitation of our study is that the data related to the ICF codes were obtained retrospectively. Other limitations are the limited number of patients and the single-center design, which may affect the external validity of our results.

Conclusions

In inpatients with COVID-19, we demonstrated a correlation between clinical, instrumental, and functional parameters using the ICF categories. In particular, the codes within the ClinFIT COVID-19 may be used to detect functioning changes in patients with COVID-19, providing useful information to formulate an accurate prognosis.

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Author contributions

Authors AM, AB, and GI contributed to the conception and design of the paper; AM and FG contributed to the methodology; AM, SL, and MP performed the data analysis; MB, SL, and MP wrote the original draft of the manuscript; AM, GT, and FG reviewed the second draft of the manuscript; and AB and GI contributed to the study supervision. All authors contributed to manuscript revision and read and approved the submitted version.

Data availability statement

Data will be provided upon reasonable request.

Declaration of conflicting interest

The authors declare that there is no conflict of interest.

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