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Original Article

Applying the WHO ICF framework to long COVID patients with persistent respiratory symptoms

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ABSTRACT

Objectives: The aim of this study was to evaluate long COVID patients with persistent respiratory symptoms through the application of the World Health Organization (WHO) International Classification of Functioning, Disability and Health (ICF) framework.

Patients and methods: This national, prospective, multicenter, cross-sectional study was conducted with 213 patients (118 females, 95 males; median age 56 years; range, 20 to 85 years) with long COVID between February 2022 and November 2022. The ICF data were primarily collected through patient interviews and from the acute medical management records, physical examination findings, rehabilitation outcomes, and laboratory test results. Each parameter was linked to the Component Body Functions (CBF), the Component Body Structures (CBS), the Component Activities and Participation (CAP), the Component Environmental Factors (CEF), and Personal Factors according to the ICF linking rules. Analysis was made of the frequency of the problems encountered at each level of ICF category and by what percentage of the patient sample.

Results: In the ICF, 21 categories for CBF, 1 category for CBS, and 18 categories of CAP were reported as a significant problem in a Turkish population of long COVID patients with persistent respiratory symptoms. Furthermore, eight categories for CEF were described as a facilitator, and four as a barrier.

Conclusion: These results can be of guidance and provide insight into the identification of health and health-related conditions of long COVID patients with persistent respiratory symptoms beyond the pathophysiological aspects, organ involvement, and damage of COVID-19. The ICF can be used in patients with long COVID to describe the types and magnitude of impairments, restrictions, special needs, and complications.

Keywords: Long COVID, International Classification of Functioning, respiratory problems.

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On May 5, 2023, the World Health Organization (WHO) declared that COVID-19 (Coronavirus-Disease 2019) is no longer a "global health emergency" but also emphasized that it is still the cause of many deaths and this does not mean that it is no longer a global threat. Therefore, there continues to be an effect of COVID-19 through deaths and long-term consequences.

Long COVID is a heterogeneous and complex clinical condition, which is thought to be caused by many pathophysiological mechanisms, including immune dysregulation, microbiota disruption, autoimmunity, coagulation activation, endothelial abnormality, occult viral persistence, and dysfunctional neurological signaling.[1-3] Different terms and definitions are used by various international health organizations to explain this situation. The National Institute for Health and Care Excellence (NICE) describes long COVID as "new onset symptoms or ongoing health problems following acute COVID-19 that includes both ongoing symptomatic COVID-19 (from 4 to 12 weeks) and post-COVID-19 syndrome (12 weeks or more)".[4] The Centers for Disease Control and Prevention (CDC) defines long COVID as "new-onset, persistent, or evolving symptoms beyond four weeks following recovery from a documented acute COVID-19 illness or diagnosis, including by patients who had initial mild or asymptomatic acute infection".[5]

More than 200 symptoms have been identified in patients with long COVID. Fatigue, breathing impairment, post exertional symptom exacerbation, peripheral and respiratory muscle weakness, reduced exercise capacity, cardiac abnormalities and orthostatic intolerance, cognitive, swallowing, and voice impairment, pain, sleep disturbances, post-traumatic stress disorder, anxiety, depression, and problems with concentration, memory, and continence may observed in COVID-19 patients after discharge from the hospital, in both those admitted or not admitted to an intensive care unit.[6-12] All these problems are associated with decreased mobility, significant functional loss, reduced independence in activities of daily living (ADL), poor social interactions, difficulty returning to work, reduced health-related quality of life (HRQoL), and varying degrees of disabilities.[6,8,12-19] Approximately 10 to 20% of people infected by SARS-CoV-2 (Severe Acute Respiratory Syndrome Coronavirus 2) experience some of these impairments, which may persist for months or years beyond the initial recovery.[1,20,21] Rehabilitation approaches have been suggested for these patients to improve persistent symptoms, delayed or long-term complications, functional limitations, and disability.[6,8,13] Furthermore, as in chronic lung diseases, comprehensive pulmonary rehabilitation principles are recommended for COVID-19 patients with persistent respiratory problems, such as dyspnea, cough, chest pain and tightness, fatigue, respiratory muscle weakness, decreased exercise capacity, functional limitation, and reduced functional capacity, ADL, and HRQoL.[22-27]

Before preparing patient-specific rehabilitation plans, a classification system that can evaluate all aspects of health with a holistic approach is needed to be able to comprehensively address each health problem and impairment due to COVID-19. The International Classification of Functioning, Disability and Health (ICF) is a framework that provides a standard language and scientific basis for assessing, measuring, and describing health and health-related conditions, including organ disorders, activity and participation, personal and environmental factors. This comprehensive model was established by the WHO and approved for use by the World Health Assembly in 2001. The ICF can be applied to all individuals regardless of their health condition, physical and sociocultural status. It also provides a common language between different users and enables the comparison of data between countries.[28] There are few studies which have evaluated the problems and long-term complications encountered during the COVID-19 pandemic in patients with COVID-19 from an ICF perspective.[29,30] To the best of our knowledge, there are no studies using all the major components of the ICF to describe the extent and magnitude of the problems of long COVID patients with persistent respiratory symptoms. The aim of this study was to evaluate long COVID patients with persistent respiratory symptoms through the application of the WHO ICF framework.

PATIENTS AND METHODS

This national, prospective, multicenter, crosssectional study was conducted with 213 patients (118 females, 95 males; median age 56 years; range, 20 to 85 years) with long COVID. They presented at physical medicine and rehabilitation clinics with persistent respiratory symptoms or were referred by another clinic during this period.

Inclusion criteria

1. Patients aged >18 years with COVID polymerase chain reaction (PCR) (+) and/or high- resolution computed tomography (HRCT) compatible with COVID-19,
2. Patients at 4 weeks –12 months beyond the diagnosis of COVID-19,
3. Patients with persistent respiratory symptoms and problems such as dyspnea, cough, chest pain and tightness, fatigue, respiratory muscle weakness, decreased exercise capacity, functional limitation and reduced ADL,
4. Literate in Turkish

Exclusion criteria

1. Patients aged <18 years,
2. Patients with active COVID-19 infection or uncontrolled systemic problems due to COVID-19 who needed to be hospitalized.
3. Patients with impaired level of consciousness and evidence of gross cognitive impairment (Scored below 10 points in the Mini-Mental State Examination [MMSE]),
4. The presence of an ongoing serious psychological condition that could affect the conduct of the semistructured interview or outcome measures.

Overview of procedures

The definition of long COVID stated by NICE was used in the present study. All the subjects were interviewed and underwent a thorough medical assessment. During that process, the medical history of the patient was questioned including demographic features, comorbid diseases, COVID-related information and medications taken, and the acute medical management records were retrieved from the electronic medical database. A detailed physical examination of all body systems was then conducted, the necessary laboratory measurements were obtained, and rehabilitation outcome measures were also applied to each patient.

Measurements

Vital findings, such as blood pressure, respiratory and heart rate, fever, and body mass index, were recorded. The intensity of pain was assessed using the Visual Analog Scale (VAS), ranging from 0 to 100 mm.[31] Peripheral muscle strength was measured using the Medical Research Council Sum Score (MRC-SS), which ranges from 0 (complete paralysis) to 60 (normal strength).[32] Maximum voluntary muscle strength of the hand was measured with hand-grip dynamometry using a Jamar device. Normal values were accepted as 35 kg in males and 20 kg in females.[33,34] Lower extremity function (balance, lower extremity strength, and functional capacity) was measured with the Short Physical Performance Battery (SPPB)[35] The Modified Medical Research Council (mMRC) dyspnea values of the patients were recorded for the perception of dyspnea.[36]

Pulmonary Function Tests (PFT) were performed, including forced vital capacity (FVC), forced expiratory volume in one second (FEV1), the ratio of FEV1 to FVC, peak expiratory flow rate, and total lung capacity, obtained with the application of the spirometry system procedures (if appropriate for the patient's clinical status and if the spirometry device was available). The PFT results were expressed as a percentage of normal predictive values.[37] Exercise capacity was evaluated using the Six-Minute Walk Test (6MWT). In healthy individuals, 6MWD is usually between 400 and 700 m.[38]

Functional independence was assessed using the Modified Barthel Index, which consists of 10 items measuring daily functioning of an individual, specifically ADL and mobility.[39] The Turkish version of the index was developed by Kucukdeveci et al.[40]

The Mini-Mental State Examination was used to provide a quantitative assessment of mental and cognitive functions. A score of ≥24 points indicates normal cognition.[41]

The severity of depression was evaluated using the Beck Depression Inventory (BDI),[42] and the severity of anxiety with the Beck Anxiety Scale (BAS).[43] The validity and reliability of the Turkish version of the BAS has been tested.[44]

The Medical Outcomes Study Short Form 36 (SF-36) questionnaire was used to measure physical and mental health status.[45]

Data collection according to the main ICF components

The ICF system has approximately 1500 categories. For each level of ICF category, a qualifier scale is used to record the scope of functioning,

TABLE 1
Sociodemographic and clinical characteristics of the patients (n=213)

	n	%	Median	Min-Max
Age (year)			56	20-85
Sex				
Male	95	44.6		
Female	118	55.4		
Body mass index (kg/m^2)			28.7	16-53
Marital status				
Married	167	78.4		
Widow	27	12.7		
Divorced	12	5.6		
Single	7	3.3		
Current employment				
Working right now	66	31		
Retired	69	32.4		
Housewife	68	31.9		
Jobseekers	10	4.7		
Job change during pandemic	39	18.3		
Unemployment in the pandemic	1	0.5		
Smoking				
Non-smokers	117	54.9		
Ex-smokers	71	33.3		
Smokers	25	11.7		
Alcohol consumption				
Non-user	177	83.1		
Former alcohol user	18	8.5		
Alcohol user	18	8.5		
Comorbidities				
Hypertension	112	52.6		
Atherosclerotic heart disease	57	26.8		
Atrial fibrillation	17	8		
Heart failure	17	8		
Diabetes Mellitus	150	70.4		
Dyslipidemia	70	32.9		
Obesity	53	24.9		
Thyroid disease	42	19.7		
Vascular disease	26	12.2		
Chronic renal failure	13	6.1		
Hepatic failure	10	4.1		
Dementia	11	5.2		
Cerebrovascular accident	16	7.5		
COPD	56	26.3		
Interstitial lung disease	18	8.4		
Osteoarthritis	98	46		
Osteoporosis	52	24.4		
Inflammatory rheumatological disease	33	15.5		
SCI	11	5.2		
Multiple sclerosis	11	5.2		
Parkinson's disease	16	7.5		
Cerebral palsy	11	5.2		
Malignity	22	10.2		
Depression	35	16.4		
Caregiver support needs at the study entry				
Wife/husband	31	14.6		
Children	31	14.6		
Relatives	8	3.6		
Friends	1	0.46		
Paid caregiver	12	5.6		
No caregiver need	130	61.0		

COPD: Chronic obstructive pulmonary disease; SCI: Spinal cord injury.

TABLE 2
Clinical characteristics and laboratory variables of the patients (n=213)

	n	%	Median	Min-Max
Patients at the initial evaluation				
PMR Department Inpatient setting	40	18.8		
Outpatient setting	172	80.8		
Other Hospital Clinics Inpatient setting	1	0.46		
NICE Definition for LC				
Ongoing symptomatic COVID-19 (4 to 12 weeks)	104	48.8		
Post-COVID syndrome (12 weeks or more)	109	51.2		
Disease severity classification				
Mild	33	15.5		
Moderate	97	45.5		
Severe	69	32.4		
Critical	14	6.6		
Duration of hospitalization (day)			10	0-121
Duration of ICU (day)			10.5	0-216
Fever			36.4	35.8-37.7
Blood pressure (mmHg)				
Systolic			123	110-170
Diastolic			80	50-103
Heart rate (bpm/min)			82	56-128
Abnormal laboratory results at the study entry				
C-reactive protein	64	29.6		
ESR	68	31.9		
Electrolyte imbalance	8	3.8		
Blood glucose	18	8.5		
Hemoglobin	60	28.2		
Hematocrit	48	22.5		
Leukocyte	28	13.1		
Lymphocyte	56	26.3		
Thrombocyte	18	8.5		
ALT	32	15		
AST	13	6.1		
GGT	40	18.8		
LDH	86	40.4		
BUN	16	7.5		
Creatinine	58	27.2		
Ferritin	67	31.5		
Troponin	13	6.1		
D-dimer	117	54.9		
VAS (0-100 mm)			30	0-100
MRC-SS (0-60)			58	12-60
Hand Grip Strength (kg)			28	3-110
SPPB (0-12)			9	0-12
mMRC Dyspnea Score (1-5)			3	1-5
6 Minute Walking Test (m)			411	10-840
Modified Barthel Index (0-100)			95	9-100
MMSE (0-30)			27	10-30
BDI (0-63)			9	0-60
BAI (0-63)			9	0-54
SF-36 (0-100)				
Physical functioning			55	0-100
Social functioning			50	0-100
Role limitations attributed to physical problems			25	0-100
Role limitations attributed to emotional problems			45	0-100
Mental health			24	0-100
Energy and fatigue			45	0-100
Pain			55	0-100
General health perception			40	0-95

PMR: Physical Medicine and Rehabilitation; NICE: National Institute for Health and Care Excellence; LC: Long COVID; COVID-19: Coronavirus disease 2019; ICU: Intensive care unit; ESR: Erythrocyte sedimentation rate; ALT: Alanine aminotransferase; AST: Aspartate aminotransferase; GGT: Gamma-glutamyl transferase; LDH: Lactate dehydrogenase; BUN: Blood urea nitrogen; VAS: Visual Analog Scale; MRC-SS: Medical Research Council Sum Score; SPPB: Short Physical Performance Battery; mMRC: Dyspnea Score: Modified Medical Research Council Dyspnea Score; MMSE: Mini Mental state; BDI: Beck Depression Inventory; BAS: Beck Anxiety Inventory; SF-36: Short Form 36.

health, and disability in a patient. A same five-point generic scale (0=no and 4=complete problem) is used to assess the presence and severity of the problem in the categories of the components of body functions, body structures, and activities and participation. An environmental factor acts as a barrier or a facilitator on a patient's health, which is quantified with a negative (number between −1 to −4) and positive (number between +1 and +4) scale. If an environmental factor is not a barrier or facilitator, a value of 0 is used to express neutrality. The ICF qualifiers 1 to 4 were recorded as 1 (presence of the problem) or 0 (absence of the problem) in the present study. The ICF data for this study were primarily collected in patient interviews and from the acute medical management records, physical examination findings, rehabilitation outcome measures, and laboratory measurements. Each of these parameters was linked to the main ICF components (body structures and body functions, activities and participation, environmental factors, and personal factors) according to the ICF linking rules.[46] This stage was performed by two investigators (BST and NKOG) and cross-checking for consensus was made by a single physician (BFK) who was trained and specialized in the areas of application and principles of the ICF. Those training activities were funded by the government of Türkiye in collaboration with the WHO in 2008. A threshold of 10% was applied to evaluate the content validity based on the protocol developed by the WHO ICF research branch.

Statistical analysis

Data obtained in the study were analyzed statistically using IBM SPSS version 20.0 software (IBM Corp., Armonk, NY, USA). Descriptive statistics were given as frequency and percentage for categorical variables. The normality of the distribution of numerical variables was evaluated with the Shapiro-Wilk test, and results were presented as mean ± standard deviation (SD) for normally distributed variables and median (min-max) for

TABLE 3
Clinical features of respiratory problems and pulmonary function test results of the patients

	n	%	Mean±SD	Median	Min-Max	Mean±SD	Median	Min-Max
The five most common problems expressed in the initial evaluation								
Dyspnea	202	94.8						
Fatigue	185	86.9						
Reduced physical endurance (exercise intolerance)	174	81.7						
Anxiety/depression	128	60.9						
Pain in joints	125	58.7						
Oxygen support at the initial evaluation								
Supplemental oxygen via nasal cannula or face mask	46	21.6						
High-flow oxygen therapy	3	1.4						
Total lung capacity (L), (n=21)			3.2±1.2			68.9±21.3		
Forced vital capacity (L), (n=74)			2.8±1.0			85.1±19.6	83.5	16-145
Forced expiratory volume in one second (L) (n=74)			2.2±0.8			82.7±22.3		
FEV1/FVC (%)				83.5	12-128			
Peak expiratory flow rate (L/sn), (n=71)				5.0	0.7-13.4	87.6±32.6		18-169
Patients (n=74)								
Ventilatory pattern								
Normal	27	12.6						
Restrictive ventilatory defect	8	3.7						
Mild	8	3.7						
Moderate	0	0						
Severe	0	0						
Obstructive ventilatory defect	16	7.5						
Mild	7	3.3						
Moderate	3	1.4						
Severe	6	2.8						
Mixt ventilatory defect	23	10.7						

SD: Standard deviation; FEV1/FVC: Forced expiratory volume in 1 sec/forced vital capacity.

TABLE 4
Frequency of impairments in the components of ICF categories (Body functions and body structures)

	n	%
Body functions		
b 460 Sensations associated with cardiovascular and respiratory functions-dyspnea	202	94.8
b 130 Energy and drive functions	185	86.9
b 4552 Fatiguability	175	82.2
b 455 Exercise tolerance functions	174	81.7
b 440 Respiration functions	47 (n=74)	63.5
b 152 Emotional functions-anxiety	128	60.9
b 28016 Pain in joints	125	58.7
b 134 Sleep functions	119	55.9
b 2800 Generalized pain	105	49.3
b 4551 Aerobic capacity	95	47.3
b 450 Additional respiratory functions-coughing	91	42.7
b 7300 Power of isolated muscles and muscle groups hand	43	42.6
b 28010 Pain in head and neck	75	35.2
b 2401 Dizziness	65	30.5
b 4408 Respiration functions, other specified-sputum	64	30
b 7651 Tremor	60	28.2
b 255 Smell function	34	16
b 144 Memory functions	33	15.5
b 420 Blood pressure functions	31	14.5
b 250 Taste function	30	14.1
b 430 Hematological system functions	25	11.7
b 140 Attention functions	21	9.9
b 730 Muscle power functions	16	7.5
b 620 Urination functions	16	7.5
b 310 Voice functions	11	5.2
b 525 Defecation functions	9	4.2
b 210 Seeing functions	9	4.2
b 545 Water, mineral and electrolyte balance functions	8	3.8
b 610 Urinary excretory functions	7	3.3
b 4150 Functions of arteries	7	3.3
b 510 Ingestion functions	7	3.3
b 4152 Functions of veins	6	2.8
b 4101 Heart rhythm	6	2.8
b 265 Touch function	4	1.9
b 4102 Contraction force of ventricular muscles	4	1.9
b 710 Mobility of joint functions	2	0.9
Body structures		
s 4301 Lungs	122	57.3
s 610 Structure of urinary system	7	3.3
s 560 Structure of liver	6	2.8
s 810 Structure of areas of skin	5	2.3
s 4100 Heart	4	1.8

ICF: International Classification of Functioning.

TABLE 5
Frequency of impairments in the components of ICF categories (Activities and participation and environmental factors)

	n	%
Activities and participation		
d 230 Carrying out daily routine	156	72.9
d 9205 Socializing	91	67.4
d 640 Doing housework	139	65.6
d 240 Handling stress and other psychological demands	128	60.9
d 920 Recreation and leisure	127	59.9
d 470 Using transportation	119	55.9
d 460 Moving around in different locations	115	54.2
d 845 Acquiring, keeping and terminating a job	101	48.3
d 910 Community life	92	43.4
d 850 Remunerative employment	91	43.3
d 455 Moving around	90	42.5
d 450 Walking	65	30.7
d 410 Changing basic body position	60	28.2
d 415 Maintaining body position	60	28.2
d 770 Intimate relationships	43	20.4
d 510 Washing oneself	39	18.4
d 420 Transferring oneself	37	17.4
d 540 Dressing	31	14.6
d 520 Caring for body parts	27	12.7
d 530 Toileting	20	9.4
d 710 Basic interpersonal interactions	20	9.4
d 163 Thinking	14	6.6
d 175 Solving problems	12	5.7
d 550 Eating	12	5.7
d 740 Family relationships	10	4.7
d 560 Drinking	8	3.8
d 315 Communicating with - receiving - nonverbal messages	6	2.8
d 330 Speaking	6	2.8
d 310 Communicating with - receiving - spoken messages	4	1.9
Environmental factors		
Facilitator		
e 1101 Drugs	205	96.7
e 580 Health services, systems and policies	205	96.7
e 310 Immediate family	196	92.9
e 1151 Assistive products and technology for personal use in daily living	189	91.7
e 315 Extended family	170	80.7
e 1201 Assistive products and technology for personal indoor and outdoor mobility and transportation	156	76.1
e 570 Social security services, systems and policies	156	76.1
Barrier		
e 150 Design, construction and building products and technology of buildings for public use	90	42.5
e 515 Architecture and construction services, systems and policies	123	58
e 540 Transportation services, systems and policies	115	54.2
e 155 Design, construction and building products and technology of buildings for private use	65	30

ICF: International Classification of Functioning.

variables not showing normal distribution. Type 1 error rate was taken as 0.05 to test hypotheses.

RESULTS

According to the definition of NICE for long COVID, 104 (48.8%) of the 213 patients had ongoing symptomatic COVID-19 (from 4 to 12 weeks), and 109 (51.2%) had post-COVID syndrome (≥12 weeks). The sociodemographic and clinical characteristics of the patients are shown in Tables 1 and 2.

During the acute COVID-19 stage, 100 (46.94%) patients were followed up at home, and of the 113 hospitalized patients, 58 (28.4%) were admitted to an intensive care unit. The remaining 55 (51.2%) were treated in the hospital clinics. According to the WHO COVID-19 disease severity classification,[6] 33 (15.5%) patients were classified as having mild disease, 97 (45.5%) moderate disease, 69 (32.4%) severe disease, and 14 (6.6%) critical disease.

During the hospitalization due to COVID-19, 75 (40.1%) patients received oxygen support, 12 (6.4%) required invasive ventilation, 49 (26.2%) non-invasive ventilation, and tracheostomy was performed on five (2.7%) patients.

The clinical features, respiratory problems, and pulmonary function test results of the patients are shown in Table 3. The rates of impairments in the components of ICF categories are illustrated in Tables 4 and 5.

DISCUSSION

The results of this study showed that a Turkish population of long COVID patients reported significant problems (>10%) in 21 ICF categories of the CBF, 1 category for the CBS, and 18 categories of the CAP. Moreover, 8 categories for the CEF were identified as facilitators and 4 as barriers.

A high manifestation of typical impairments in CBF was observed in the categories of b460 sensations associated with cardiovascular and respiratory functions, b130 energy and drive functions, b4552 fatiguability, b 455 exercise tolerance functions, b440 respiration functions, b152 emotional functions, b28016 pain in joints, and b134 sleep functions, respectively. These were present in more than 55 % of the current study patients.

Shortness of breath, chest pain or tightness and cough are the common respiratory symptoms reported across hospitalized, nonhospitalized, and mixed patients with long COVID.[1,6,9,47,48] As a long-term complication, about 44.9% of COVID-19 survivors have pulmonary fibrosis following severe respiratory inflammation and injury.[2,49,50] The underlying causes of long-term respiratory system problems are considered to be lung fibrosis, pulmonary vasculature damage, potentially leading to pulmonary hypertension, inappropriate ventilation regulation, resulting from damage to the autonomic nervous system, pulmonary abnormalities, such as air entrapment, abnormal gas exchange, and lung perfusion.[2,3,7,9,49,51] In the current study, the most frequent impairment in CBF was b460 sensations associated with cardiovascular and respiratory functions *(shortness of breath-dyspnea)*. Although 74.6% of the patients reported dyspnea subjectively during the interview, the rate of dyspnea detected using the MRC score was 94.83%. This result indicated that some of our patients did not report mild dyspnea during the interview. The Pulmonary Function Test could be performed in 74 of the current study patients, with the results showing that b440 respiration functions was a problem in 47 (63.51%). The b450 additional respiratory functions (coughing) was impaired in 42.7%, and b4408 respiration functions, other specified *(sputum)* was identified in approximately 30%. A recent review reported that survivors of SARS-CoV-2 infection had residual radiological abnormalities, such as ground-glass opacity and fibrotic-like changes (21%), bronchiectasis (10%), interlobular septal thickening (8%), reticular opacity (6%), and consolidation (3%) at 12 months after recovery.[51] Structural lung abnormalities (s4301 Lungs) were determined in 57.27% of the current study patients using HRCT. Consistent with previous reports in literature,[1,6,9,47,48,51] these prominent impairments regarding breathing problems, lung functions, and lung structure were considered normal as the patient group consisted of patients with long COVID with persistent respiratory symptoms.

Fatigue is the subjective perception of tiredness, and lack of energy and motivation that is not proportional to activity and exertion, and is not relieved by sleep and rest. It has been reported to be the most prevalent symptom of long COVID regardless of the severity of the initial infection.[1,6,52-54] Alterations in specific neural circuits, dysautonomia, neuroinflammation, reduced cerebral blood flow, brain hypo metabolism, small fiber neuropathy, musculoskeletal impairment, and psychological factors have been suggested as

the possible mechanisms of fatigue symptom in long COVID patients.[1,2,55] Similar to the previous literature, fatigue was reported as a huge problem by 86.9 % of the current study patients.

Reduced exercise capacity is also a common symptom among individuals with long COVID.[54,56-58] Many mechanisms, including elevated inflammatory markers, chronotropic incompetence, autonomic dysfunction, peripheral and respiratory muscle weakness, and deconditioning, have been proposed as leading to reduced exercise tolerance.[57,58] Although more than 80% of the current series reported exercise intolerance and susceptibility to fatigue at any level of exertion during the interview, objective aerobic capacity assessed by 6MWD indicated that only 47.3% had reduced exercise capacity.

In the categories of CAP, d230 carrying out daily routine, d9205 socializing, d640 doing housework, d240 handling stress and other psychological demands, d920 recreation and leisure, d470 using transportation, d460 moving around in different locations, d845 acquiring, keeping and terminating job, d910 community life, d850 remunerative employment, and d455 moving around were documented as fundamental problems experienced by more than 40% of the current study patients.

The combined effects of persistent symptoms and impairments, such as fatigue, dyspnea, peripheral and respiratory muscle weakness, reduced exercise capacity, pain, sleep disturbances, anxiety and depression, and cognitive problems, have a negative impact on activity and participation and functional ability following acute COVID-19. It has been reported that long-term consequences of COVID-19 impair the performance of ADL, including work, social, leisure, and home life, and ultimately reduce HRQoL.[6,8,12,14-19] In a previous study, at four months after discharge, 40% of previously hospitalized COVID-19 survivors reported persistent impairments and limitations in activity and participation affecting daily life requiring multi-professional rehabilitation assessment.[15]

Walle-Hansen et al.[14] stated that at six months following hospital discharge, there was a negative change in HRQoL in more than half of the patients, and one in three experienced persistent impairment in mobility and the ability to perform ADL. Another study showed that low-risk individuals with mild COVID-19 also have a diversity of long-term symptoms disrupting work, social, and home life.[17] The patients in the current study were found to have significant persistent symptoms and impaired functions due to COVID-19. It was thought that these problems, including dyspnea, fatigue, reduced exercise tolerance, sleep disturbance, anxiety, muscle weakness of hand, tremor, and pain, may contribute to the limitation of self-care, home, work, and social activities, and participation in these patients.

Considering environmental factors, the most frequent facilitators (specified by more than 90% of the participants) were e1101 drugs, e580 health services, systems and policies, e310 immediate family, and e1151 products and technology for personal use in daily living. The Ministry of Health carried out a successful organization in managing the COVID-19 pandemic in Türkiye. Diagnosis and treatment services were provided at home with mobile teams, in addition to the hospitals. Patients with serious conditions were admitted to the hospitals in a short time. All inpatient or outpatient treatments and services, such as drugs, vaccines, home ventilation devices, portable oxygen concentrators, orthoses, walking aids, wheelchairs, and other assistive technology devices, were provided to the patients free of charge. Therefore, it was an expected result that more than 90% of the patients described such environmental factors as facilitators. e515 architecture and construction services, systems and policies, e540 transportation services, systems and policies, e150 design, construction and building products and technology of buildings for public use and e155 design, construction and building products and technology of buildings for private use were determined as barriers in this study population. Although there have been rapid developments and improvements in Türkiye, the building design, architecture, construction, and transportation services and systems are not optimal for the use of the disabled. Thus, it was not surprising that such environmental factors were identified as barriers by these patients.

There are few studies that have investigated COVID-19 from the perspective of the functional status. The term of functional status encompasses physical, cognitive, and social functioning. Although functional status is impaired in patients with COVID-19, most of the studies of this disease have focused on pathophysiology, organ involvement and damage, and disease screening.[59,60] Moreover, studies assessing the functional status of COVID-19 patients

have used a wide variety of functional status tests for different requirements, different levels of disease severity, and timings, thereby making it difficult to make comparisons and interpretations between studies.[59,60]

Norrefalk et al.[30] applied an ICF-based online questionnaire to a group of 100 post-COVID-19 patients. The study group consisted of mild COVID-19 patients, of which only a few were treated in a hospital, and no patients were hospitalized in intensive care. It was seen in that study population that 23 body functions and 15 activity and participation categories were impaired. Other main ICF components of environmental factors and body structures were not included in that study. It was concluded that there is a lack of studies using ICF to investigate and assess the long-term effects of COVID-19 on health, to provide the optimal rehabilitation measures, and to compare disabilities between these patients and other chronic conditions. Furthermore, there was also emphasized to be a lack of studies in which ICF codes should be used in this disease.[30]

In another study, Patel et al.[29] applied the WHO ICF framework to the outcome measures used in the follow-up studies of severe acute respiratory distress syndrome (SARS), Middle East respiratory syndrome (MERS) and COVID-19 and showed that 33 different outcome measures were used in the 36 follow-up studies. It was suggested that it is difficult to analyze the long-term consequences of COVID-19 and to make future plans for survivors, caregivers, and society as a whole by comparing the different outcome measures. The use of the ICF framework was recommended as an assessment method that can evaluate and capture all aspects of the disease.

Long COVID has more than 200 symptoms related to the respiratory, cardiovascular, neurological, gastrointestinal, and musculoskeletal systems, and it is also associated with significant functional loss, reduced independence in ADL, and impaired HRQoL. Currently, there are no standard methods to identify and evaluate long-term consequences of COVID-19. In general, a wide variety of disease screening tests, assessment tools, single-dimensional generic and disease-specific measures are used. Although many health and health-related areas are restricted due to long COVID and a complex interaction exists between the disease and bodily systems, activities and participation, environmental and personal factors, these widely-used measurement and evaluation methods are scarcely assessed health and health-related conditions from a multiperspective approach. Given the worldwide population affected by COVID-19 and the multiplicity of long COVID symptoms, a classification system that can define and evaluate survivors' long-term health is needed in order to facilitate the structuring, organization and documentation of the potential problems, to reveal patient and caregiver needs, to plan the most appropriate treatment and rehabilitation interventions, to maximize functional return, and to optimize outcomes. Therefore, the ICF system can be considered suitable for use in long COVID patients, as it can identify and measure the spectrum of impairment types and the burden of disability with a multidimensional approach (bio-psychosocial model).

To the best of our knowledge, this is the first study to have used four main components of ICF to describe and measure the extent and magnitude of the problems of long COVID patients with persistent respiratory symptoms. The application of ICF, with a single classification system, can be considered to provide a unique capability for the assessment of every aspect of disability, health, and functioning of long COVID patients.

There were several limitations to this study. Although it was a multicentre, cross-sectional study, the sample size was small and cannot be considered representative of the general population of long COVID patients. As it was cross-sectional in design, only a single time point can be evaluated so this limited some of the conclusions. Although the conclusions of the study are based on sound data and methodologies, there is a need for further studies of a large group of patients to be able to generalize the conclusions of this study.

In conclusion, the findings of this study demonstrated the types and magnitudes of impairments, restrictions, special needs, and complications in long COVID patients with persistent respiratory symptoms. The ICF can be considered for use in patients with long COVID to identify and measure all aspects of functioning, disability, and health with a holistic approach. This information will provide a perspective and some guidance to professionals in the assessment of patients beyond the pathophysiological aspects and organ involvement and damage of COVID-19.

Ethics Committee Approval: The study protocol was approved by the TOBB University of Economics and Technology Clinical Research Ethics Committee (date: 26.01.2022, no: 093). The study was conducted in accordance with the principles of the Declaration of Helsinki.

Patient Consent for Publication: A written informed consent was obtained from each patient.

Data Sharing Statement: The data that support the findings of this study are available from the corresponding author upon reasonable request.

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