

Physical function measures in ICU survivors, where to now? A Scoping Review

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Supplemental Table 1: Studies included in scoping review and measurement instruments used

Author and title	Country	Measurement tool	Measurement instruments used at follow up timeframes									
			1 month	2 months	3 months	6 months	12 months	13-24 months	25-36 months	37-48 months	>49 months	Un-known
Studies using measurement instruments related to body structure and function												
Leijten et al. (1995) The role of polyneuropathy in motor convalescence after prolonged mechanical ventilation	Netherlands	EMG					√					
Hund et al. (1996) Critical illness polyneuropathy: Clinical findings and outcomes of a frequent cause of neuromuscular weaning failure	Germany	EMG							√			
Zifko (2000) Long-term outcome of critical illness polyneuropathy	Austria	EMG MRC						√				
Angel et al. (2007) Neuromuscular function in survivors of the acute respiratory distress syndrome	Canada	EMG MRC					√					
Poulsen et al. (2013) Biomechanical and nonfunctional assessment of physical capacity in male ICU survivors	Denmark	EMG Muscle strength dynamometry					√					
Semmler et al. (2013) Long-term neuromuscular sequelae of critical illness	Germany	EMG MRCSS					√					
Batterham et al. (2014) Effect of supervised aerobic exercise rehabilitation on physical fitness and quality-of-life in survivors of critical illness: an exploratory minimized controlled trial (PIX study)	England	Anaerobic threshold		√			√					
Koch et al. (2014) Long-term recovery in critical illness myopathy is complete, contrary to polyneuropathy	Germany	EMG MRCSS					√					
McWilliams et al. (2016) Outpatient-based physical rehabilitation for survivors of prolonged critical illness: A randomized controlled trial	England	Anaerobic threshold Oxygen uptake (Vo2 peak)			√							
Vitacca et al. (2016) Does 6-Month Home Caregiver-Supervised Physiotherapy Improve Post-Critical Care Outcomes?: A Randomized Controlled Trial	Italy	MEP MIP MRCSS PFT				√						
Dinglas et al. (2017) Muscle Weakness and 5-Year Survival in Acute Respiratory Distress Syndrome Survivors	USA	MRCSS			√	√	√	√	√	√		

Millet et al. (2022) Cardiorespiratory Fitness and Neuromuscular Function of Mechanically Ventilated ICU COVID-19 Patients	France	Muscle strength dynamometry Oxygen uptake (Vo2 peak) PFT		✓								
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Studies using measurement instruments related to activity and participation

Garland et al. (2004) Outcomes up to 5 years after severe, acute respiratory failure	USA	Katz				✓						
Delle Karth et al. (2006) Outcome and functional capacity after prolonged intensive care unit stay	Austria	Barthel Index				✓						
Elliott et al. (2011) Health-related quality of life and physical recovery after a critical illness: a multi-centre randomised controlled trial of a home-based physical rehabilitation program	Australia	6MWT	✓	✓		✓						
Denehy et al. (2012) Quantifying Physical Activity Levels of Survivors of Intensive Care: A Prospective Observational Study	Australia	6MWT Accelerometer PASE TUG		✓								
Sidiras et al. (2013) Short and long term outcomes of ICU acquired weakness	Greece	FIM					✓					
McNelly et al. (2016) An exploratory study of long-term outcome measures in critical illness survivors: construct validity of physical activity, frailty, and health-related quality of life measures	England	Accelerometer						✓				
Fossat et al. (2018) Effect of in-bed leg cycling and electrical stimulation of the quadriceps on global muscle strength in critically ill adults: A randomized clinical trial	France	Barthel Index				✓						
Hsieh et al. (2018) Recovery of pulmonary functions, exercise capacity, and quality of life after pulmonary rehabilitation in survivors of ARDS due to severe influenza A (H1N1) pneumonitis	Taiwan	6MWT PFT	✓		✓	✓						

Sosnowski et al. (2018) A feasibility study of a randomised controlled trial to examine the impact of the ABCDE bundle on quality of life in ICU survivors	Australia	FIM PFIT			✓							
Wilson et al. (2018) Long-Term Return to Functional Baseline After Mechanical Ventilation in the ICU	USA	Barthel Index					✓				✓	
Tang et al. (2020) Functional Status in Older Intensive Care Unit Survivors	Taiwan	Katz Index	✓		✓	✓						
Bottom-Tanzer et al. (2021) High occurrence of postintensive care syndrome identified in surgical ICU survivors after implementation of a multidisciplinary clinic	USA	6MWT AM-PAC TUG			✓	✓						
Kim et al. (2021) Using Consumer-Grade Physical Activity Trackers to Measure Frailty Transitions in Older Critical Care Survivors: Exploratory Observational Study	Canada	CFS Step counter Katz Index	✓									
Cuerda et al. (2022) Impact of COVID-19 in nutritional and functional status of survivors admitted in intensive care units during the first outbreak. Preliminary results of the NUTRICOID study	Spain	Barthel Index			✓	✓	✓					
Estrup et al. (2022) Health-related quality of life, anxiety and depression and physical recovery after critical illness – A prospective cohort study	Denmark	CPAX			✓		✓					
Morelli et al. (2022) Patients Surviving Critical COVID-19 have Impairments in Dual-task Performance Related to Post-intensive Care Syndrome	USA	6MWT CFS SPPB TUG TUG (Dual Task)	✓		✓							
Rousseau et al. (2022) Adequacy of Nutritional Intakes during the Year after Critical Illness: An Observational Study in a Post-ICU Follow-Up Clinic	Belgium	Barthel Index	✓		✓		✓					
Rudra et al. (2022) Investigating inpatient rehabilitation outcomes of patients with intensive care unit-acquired weakness, and identifying comorbidities associated with unfavorable outcomes	USA	FIM	✓									
Martínez et al. (2023) Post intensive care syndrome in survivors of COVID-19 who required mechanical ventilation during the third wave of the pandemic: A prospective study	Argentina	Barthel Index		✓								

Proffitt et al. (2023) Cognitive Impairment, Physical Impairment, and Psychological Symptoms in Intensive Care Unit Survivors	USA	Katz Index	√									
Zupancet et al. (2023) Health-related quality-of-life during rehabilitation in patients with critical illness neuropathy/myopathy after severe coronavirus disease 2019	Slovenia	6MWT DEMMI FIM		√								
Studies using measurement instruments related to body structure and function as well as activity and participation												
Fletcher et al. (2003) Persistent neuromuscular and neurophysiologic abnormalities in long-term survivors of prolonged critical illness	England	EMG MRC								√		
		Barthel Index								√		
Herridge et al. (2003) One-Year Outcomes in Survivors of the Acute Respiratory Distress Syndrome	Canada	PFT			√	√	√					
		6MWT			√	√	√					
Van der Schaaf et al. (2004) Functional outcome in patients with critical illness polyneuropathy	Nether-lands	MRC				√						
		Barthel Index Jebsen HFT RMI TUG				√	√					
Guarneri et al. (2008) Long-term outcome in patients with critical illness myopathy or neuropathy: the Italian multicentre CRIMYNE study	Italy	EMG MRC			√	√	√					
		Chair sit-stand and walk 50m			√	√	√					
Van Aswegen et al. (2008) Effect of penetrating trunk trauma on the recovery of adult survivors: A pilot study	South Africa	Muscle strength dynamometry PFT Vo2 peak	√		√	√						
		6MWT	√		√	√						
Brunello et al. (2010) Usefulness of a clinical diagnosis of ICU-acquired paresis to predict outcome in patients with SIRS and acute respiratory failure	Switzerland	MRC	√			√						
		Barthel Index	√			√						
Van Aswegen et al. (2010) The effect of penetrating trunk trauma and mechanical ventilation on the recovery of adult survivors after hospital discharge	South Africa	Muscle strength dynamometry PFT Vo2 peak	√		√	√						
		6MWT	√		√	√						
Novak et al. (2011) Rehabilitation of critical illness polyneuropathy and myopathy patients: an observational study	Slovenia	MRC										√

		6MWT 10MWT FIM										√
Needham et al. (2013) Physical and cognitive performance of patients with acute lung injury 1 year after initial trophic versus full enteral feeding EDEN Trial follow-up	USA	Grip strength dynamometry MIP MRCSS PFT				√	√					
		4MWT 6MWT				√	√					
Fan et al. (2014) Physical Complications in Acute Lung Injury Survivors: A Two-Year Longitudinal Prospective Study	USA	Grip strength dynamometry MIP MRC MRCSS			√	√	√	√				
		6MWT			√	√	√	√				
Needham et al. (2014) Risk factors for physical impairment after acute lung injury in a national, multicenter study	USA	Grip strength dynamometry MIP MRCSS				√	√					
		4MWT 6MWT				√	√					
Borges et al. (2015) Physical activity, muscle strength, and exercise capacity 3 months after severe sepsis and septic shock	Brazil	Grip strength dynamometry MIP Muscle strength dynamometry			√							
		6MWT Accelerometer			√							
Ehlenbach et al. (2015) Physical function and disability after acute care and critical illness hospitalizations in a prospective cohort of older adults	USA	Grip strength dynamometry					√					
		10 foot walk test Chair-sit to stand speed					√					
Comini et al. (2016) Impact of clinical and quality of life outcomes of long-stay ICU survivors recovering from rehabilitation on caregivers' Burden	Italy	MEP MIP PFT				√						
		6MWT Barthel Index Chair-sit to stand speed Takahashi test				√						
Pfroh et al. (2016)	USA	MRCSS			√	√	√	√	√	√	√	

Physical declines occurring after hospital discharge in ARDS survivors: a 5-year longitudinal study		6MWT			✓	✓	✓	✓	✓	✓	✓	
Solverson et al. (2016) Assessment and predictors of physical functioning post-hospital discharge in survivors of critical illness	Canada	Muscle strength dynamometry			✓							
		6MWT			✓							
Duarte et al. (2017) Characteristics and Outcomes of Intensive Care Unit Survivors: Experience of a Multidisciplinary Outpatient Clinic in a Teaching Hospital	Brazil	MEP MIP MRC PFT			✓							
		6MWT			✓							
Battle et al. (2018) Supervised exercise rehabilitation in survivors of critical illness: A randomised controlled trial	Wales	Grip strength dynamometry		✓		✓	✓					
		6MWT Berg Balance		✓		✓	✓					
Kiriella et al. (2018) Quantitative Evaluation of Muscle Function, Gait, and Postural Control in People Experiencing Critical Illness After Discharge From the Intensive Care Unit	Canada	Muscle strength dynamometry			✓	✓						
		6MWT Force plates Instrumented carpet			✓	✓						
Chan et al. (2018) Evaluating muscle mass in survivors of acute respiratory distress syndrome: A 1-year multicenter longitudinal study	USA	Grip strength dynamometry MIP MRCSS				✓	✓					
		4MWT 6MWT				✓	✓					
Berry et al. (2019) The relationship between self-report and performance-based measures of physical function following an ICU stay	USA	Muscle strength dynamometry		✓		✓						
		SPPB		✓		✓						
Sdiras et al. (2019) Long term follow-up of quality of life and functional ability in patients with ICU acquired Weakness - A post hoc analysis	Greece	Grip strength dynamometry MRCSS			✓	✓						
		FIM			✓	✓						
Wollersheim et al. (2019) Muscle wasting and function after muscle activation and early protocol-based physiotherapy: an explorative trial	Germany	MRCSS Grip strength dynamometry					✓					
		FIM 6MWT					✓					
Ámundadóttir et al. (2020)	Iceland	MRCSS			✓	✓	✓					

Predictive variables for poor long-term physical recovery after intensive care unit stay: An exploratory study		6MWT			✓	✓	✓					
Parry et al. (2020) The fear and risk of community falls in patients following an intensive care admission: An exploratory cohort study	USA	Muscle strength dynamometry		✓	✓	✓						
		SPPB		✓	✓	✓						
Van Aerde et al. (2020) Five-year impact of ICU-acquired neuromuscular complications: a prospective, observational study	Belgium	Grip strength dynamometry MIP MRCSS Muscle strength dynamometry									✓	
		6MWT Barthel Index									✓	
Berney et al. (2021) Functional electrical stimulation in-bed cycle ergometry in mechanically ventilated patients: a multicentre randomised controlled trial	International	Grip strength dynamometry MRCSS				✓	✓					
		6MWT Katz Index Lawton IADL SPPB				✓	✓					
Blanjean et al. (2021) Quadriceps strength in intensive care unit survivors: Variability and influence of preadmission physical activity	Belgium	MRCSS Muscle strength dynamometry	✓									
		Barthel Index PFIT	✓									
Cox et al. (2021) The impact of sarcopenia and acute muscle mass loss on long-term outcomes in critically ill patients with intra-abdominal sepsis	USA	Grip strength dynamometry			✓	✓	✓					
		SPPB Zubrod Score			✓	✓	✓					
Mayer et al. (2021) Muscle Power is Related to Physical Function in Patients Surviving Acute Respiratory Failure: A Prospective Observational Study	USA	Grip strength dynamometry Leg press MRCSS Muscle strength dynamometry		✓								
		6MWT CFS SPPB		✓								
Rousseau et al. (2021) Post-intensive care syndrome after a critical COVID-19: cohort study from a Belgian follow-up clinic	Belgium	Grip strength dynamometry Muscle strength dynamometry			✓							
		Barthel Index			✓							

Van Aerde et al. (2021) Aerobic exercise capacity in long-term survivors of critical illness: secondary analysis of the post-EPaNIC follow-up study	Belgium	Anaerobic threshold Grip strength dynamometry MIP MRCSS Muscle strength dynamometry PFT									√	
		6MWT									√	
Van Aerde et al. (2021) Five-year outcome of respiratory muscle weakness at intensive care unit discharge: Secondary analysis of a prospective cohort study	Belgium	Grip strength dynamometry MIP MRCSS									√	
		6MWT Barthel Index									√	
Warner et al. (2021) Anemia in Critically Ill Patients With Acute Respiratory Distress Syndrome and Posthospitalization Physical Outcomes	USA	MRCSS				√						
		6MWT Katz Index				√						
Hashem et al. (2022) Six-month and 12-month patient outcomes based on inflammatory subphenotypes in sepsis-associated ARDS: Secondary analysis of SAILS-ALTOS trial	USA	Grip strength dynamometry MIP MRCSS PFT				√	√					
		4MWT 6MWT				√	√					
Jaquet et al. (2022) Neurologic Outcomes of Survivors of COVID-19-Associated Acute Respiratory Distress Syndrome Requiring Intubation	France	MRCSS			√							
		Modified Rankin Scale IADL			√							
Kattainen et al. (2022) Lung function and exercise capacity 6 months after hospital discharge for critical COVID-19	Finland	PFT				√						
		6MWT				√						
Kodati et al. (2022) Long-term Survival and Quality of Life among Survivors Discharged from a Respiratory ICU in North India: A Prospective Study	India	MRCSS PFT			√	√						
		6MWT			√	√						
Mayer et al. (2022) Acute kidney injury contributes to worse physical and quality of life outcomes in survivors of critical illness	USA	MRCSS			√							
		6MWT SPPB			√							
Nanwani-Nanwani et al. (2022) Prevalence of post-intensive care syndrome in mechanically ventilated patients with COVID-19	Spain	Grip strength dynamometry PFT			√							

		Barthel Index			✓							
Wiertz et al. (2022) Life after COVID-19: the road from intensive care back to living - a prospective cohort study	Netherlands	Muscle strength dynamometry PFT	✓		✓		✓					
		6MWT USER-P PROMIS	✓		✓		✓					
Dusart et al. (2023) Pulmonary Functional Outcomes at 3 Months in Critical COVID-19 Survivors Hospitalized during the First, Second, and Third Pandemic Waves	Belgium	MIP MEP PFT			✓							
		6MWT			✓							
Major et al. (2023) Course of recovery of respiratory muscle strength and its associations with exercise capacity and handgrip strength: A prospective cohort study among survivors of critical illness	Netherlands	Grip strength dynamometry MIP MEP	✓		✓	✓						
		2 Min step test	✓		✓	✓						
Patel et al. (2023) Effect of early mobilisation on long-term cognitive impairment in critical illness in the USA: a randomised controlled trial	USA	MRCSS					✓					
		FIM					✓					
Piva et al. (2023) Long-term physical impairments in survivors of COVID-19-associated ARDS compared with classic ARDS: A two-center study	Italy	Grip strength dynamometry MRCSS				✓	✓					
		6MWT Barthel Index				✓	✓					
Taranet al. (2023) Association of Days Alive and at Home at Day 90 after Intensive Care Unit Admission with Long-term Survival and Functional Status among Mechanically Ventilated Patients	Canada	MRCSS			✓	✓	✓					
		6MWT FIM			✓	✓	✓					
Teixeira-Vazet al. (2023) Surviving critical COVID-19: How functionality, physical, mental and cognitive outcomes evolve?	Portugal	MRCSS				✓	✓					
		Berg Balance FIM Hauser Ambulation Index				✓	✓					

4MWT= 4 Meter Walk Test; 6MWT= 6 Minute Walk Test; 10MWT= 10 Meter Walk Test; AM-PAC= Activity Measure for Post-Acute Care; CFS= Clinical Frailty Scale; CPAX= Chelsea Critical Care Physical Assessment Tool; DEMMI= de Morton Mobility Index; EMG= Electromyography; HFT= Hand Function Test; IADL= Incremental Activities of Daily Living; FIM= Functional Independence Measure; MEP= Maximal Expiratory Pressure; MIP= Maximal Inspiratory Pressure; MRC= Medical Research Council Scale; MRCSS= Medical Research Council Scale Sum Score; PASE= Physical Activity Scale for the Elderly; PFT= Pulmonary Function Testing; PFIT= Physical Function in Intensive Care Test; PROMIS= Patient-Reported Outcomes Measurement Information System; RMI= Rivermead Mobility index; SPPB= Short Physical Performance Battery; TUG= Timed Up and Go Test; USER-P= Utrecht Scale for Evaluation of Rehabilitation-Participation

Measure instrument	Body function					Body structure	Activity and Participation															General tasks and demands (d2)	Self-Care (d5)	Domestic Life (d6)	Community, Social and Civic Life (d9)			
	Muscle Functions (b730-b749)	Functions of the respiratory system (b440-b449)					Mobility (d4)																					
		Respiration Functions (b440)	Respiratory Muscle Function (b445)	Add. functions of the respiratory system (b450)	Exercise Tolerance Functions (b455)		Changing basic body position (d410)					Maintaining a body position (d415)			Transferring Oneself (d420)	Fine Hand Use (d440)	Hand and arm use (d445)	Walking (d450)	Moving around (d455)							Moving around in different locations (d460)	Moving around using equipment (d465)	
							Lying Down (d4100)	Sitting (d4103)	Standing (d4104)	Bending (d4105)	Shifting the Body's Centre of Gravity (d4106)	Rolling Over (d4107)	Maintaining a Lying Position (d4150)	Maintaining a Sitting Position (d4153)					Maintaining a Standing Position (d4154)	Climbing (d4551)	Running (d552)							Walking, Other Specified (d4508)
Impairment level measurement instruments																												
Anaerobic Threshold																												
Dynamometry - Peripheral muscle strength																												
Dynamometry- Grip strength																												
Electromyography (EMG)																												
Leg press																												
Medical Research Council Scale (MRC)																												
Medical Research Council Sum Score (MRC-SS)																												
Oxygen uptake (VO2 peak)																												
Pulmonary Function Testing (PFT)																												
Respiratory muscle strength (MIP)																												
Respiratory muscle strength (MEP)																												
Activity and participation level measurement instruments																												
Scales/scores																												
4 Meter Walk Test (4MWT)																												
10 Meter Walk test (10MWT)																												
2 Minute Step Test (2MST)																												
6 Minute Walk Test (6MWT)																												
Accelerometry																												
Berg Balance Scale																												
Chelsea Critical Care Physical Assessment Tool (CPAX)																												
Chair sit to stand speed																												
Chair sit-stand and walk 50m unaided																												
De Morton Mobility Index (DEMMI)																												
Dual Task Timed up and go Test																												
Hauser Ambulation Index																												
Jebsen hand function test																												
Physical Function in Intensive Care Test (PFIT)																												
Short Physical Performance Battery (SPPB)																												
Spatiotemporal gait parameters																												
Step counter																												
Unsupported Upper Limb Test (Takahashi test)																												
Timed 10 feet walk test																												
Timed up and go Test (TUG)																												
Postural control force plates																												
ECOG/WHO/Zubrod Performance Scale																												
Questionnaires																												
Activity Measure for Post-Acute Care (AMPAC)																												
Barthel Index (BI)																												
Clinical Frailty Scale																												
Functional Independence Measure (FIM)																												
Katz Index of Independence in Activities of Daily Living																												
Lawton Instrumental Activities of Daily Living Scale																												
Modified Rankin Scale																												
Physical Activity Scale for the Elderly (PASE)																												
Patient reported outcomes measurement information system (PROMIS) 8b																												
Rivermead Mobility Index (RMI)																												
Utrecht Scale for Evaluation of Rehabilitation-Participation																												

