The Multisystem effects of Long COVID Syndrome and Potential Benefits of Massage Therapy in Long COVID Care

Elias Wheibe, BSc,[1] Benjamin H. Dalkin, BSc[1], Haley C. Meltzer, BSc,[1] Rebecca Russ-Sellers, PhD,[2] Jennifer T. Grier, PhD[1*]

[1]*Department of Biomedical Sciences, University of South Carolina School of Medicine Greenville, Greenville, SC,* [2]*Premier Neurology, Greer, SC, USA*

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Background: A major complication of infection with Severe Acute Respiratory Coronavirus 2 (SARS-CoV-2), the virus responsible for COVID-19, is the potential for Long COVID Syndrome. While the pathophysiology of Long COVID Syndrome has yet to be described, the disease presentation is characterized by long-term symptoms with debilitating effects on human health. A better understanding of Long COVID symptomology may open up new avenues for patient treatment such as massage therapy.

Methods: From the PubMed database, cohort studies that examined post-infection COVID sequelae published between January 1st, 2021 and April 30th, 2021 were selected to investigate patient demographics and symptoms. A review of massage therapy literature since 2000 in conjunction with identified Long COVID symptoms was performed.

Results: This systematic review identified 17 cohort studies across the world that investigated the symptomatology of patients suffering from post-COVID sequelae in multiple organ systems. We identified the pulmonary and nervous systems to be the organ systems most affected with post-COVID sequelae, with PTSD, fatigue, dyspnea, cough, sleep disturbances, loss of smell, abdominal pain, and decreased appetite as the most common symptoms reported by >20% of Long COVID patients. Massage therapy was historically found to provide benefits to patients experiencing similar symptoms to those identified in Long COVID.

Conclusions: Recognizing the need for new approaches to treatment for Long COVID Syndrome, we identify massage therapy as a potential therapeutic treatment to positively impact the organ systems affected by Long COVID, especially the high-incident symptoms, and improve patient quality of life.

KEYWORDS: Long COVID Syndrome; massage therapy; systematic review; post-acute COVID-19; multi-systemic; symptomology

INTRODUCTION

The COVID-19 pandemic has plagued the world for over three years and has been the center of public health attention. While the acute symptoms of COVID-19 are well known,[1] the long-term effects of SARS-CoV-2 infection are still being investigated. Up to 54% of patients who get infected with SARS-CoV-2 experience prolonged or worsening symptoms even after the acute infection has resolved.[2] These long-term symptoms have collectively been referred to by names such as “chronic COVID-19,” “post-COVID syndrome,” “Long COVID Syndrome,” or “post-acute COVID syndrome,” and these patients have been called the “Long haulers of COVID.” While the appropriate terminology is still up for debate, the constellation of symptoms which occur after SARS-CoV-2 infection will herein be referred to as “Long COVID Syndrome.”

Long COVID Syndrome, first identified in Italy, is defined by symptoms beyond three-to-four weeks after initial SARS-CoV-2 infection, and includes either persistent or novel symptoms that result from organ impairment post-SARS-CoV-2 infection.[3,4] As patients experiencing either mild or severe acute COVID-19 can develop Long COVID Syndrome, it is hypothesized that Long COVID Syndrome is associated with a different pathophysiological process

than initial infection.[5,6] Due to the detrimental physical and emotional effects of Long COVID Syndrome, many patients experience a significant decrease in their quality of life.[2] This can lead to a reduced ability to carry out activities of daily life and contribute to many types of stress for the patient.[7] To treat Long COVID patients, physicians have mainly relied on the alleviation of symptoms and management of pulmonary function. These treatments are not curative, and many patients seek out additional over-the-counter medications to control their symptoms.[8] Thus, there is a need for complementary treatment options that supplement the supportive treatments currently offered.

Massage therapy could serve as an effective treatment for Long COVID Syndrome with many potential benefits in patient quality of life. Massage therapy consists of application of massage, a patterned and purposeful soft tissue manipulation, with the intent of therapeutic change. It includes, but is not limited to, deep tissue manipulation, trigger point activation, reflexology, and hot stone therapy.[9,10] Massage therapy can have a direct beneficial impact on cardiovascular,[11,12] musculoskeletal,[13] psychological,[14] and even lymphatic health.[15] Numerous studies have also linked the benefits of massage therapy to decreasing pain levels related to musculoskeletal complaints,[16–18] cancer,[19] labor,[20] and post-operative pain,[21,22] even after only one session, and have recommended massage therapy as an alternative to opioids as initial treatment for musculoskeletal pain.[23] Despite the ability of massage therapy to improve the function of multiple organ systems, the potential of massage to provide benefits for patients experiencing Long COVID Syndrome has not been explored.

Through a systematic review of cohort studies released from January to April of 2021, we characterize the reported symptoms of Long COVID Syndrome to pinpoint predominant symptoms and affected organ systems. Building upon the data collected from 17 cohort studies, we examine massage therapy as a model system for Long COVID treatment based on documented uses of various massage therapy techniques. We propose that targeted massage therapy may improve the holistic well-being of patients experiencing symptoms of Long COVID Syndrome by providing benefits in addition to current treatment modalities, and improving their quality of life.

METHODS

Systematic Review Search Strategy and Study Selection

NCBI PubMed was used as the database for study identification. Studies published between January 1st, 2021 and April 30th, 2021 were selected so as to include the most recent studies at the time that the search was conducted. The search terms used to identify relevant studies were "Long COVID", "Long Haulers", "post-acute COVID" or "Long COVID Syndrome". Retrieved articles were screened by two authors independently (BD and EW).

Exclusion criteria included review articles, commentaries, letters, and cohort studies which did not present primary data, or primary research articles with fewer than 30 patients. Exclusion criteria also included cohort studies that were not available in English. Studies that focused on only one organ system without documenting symptoms in at least one other organ system were also excluded to avoid skewing the data regarding organ system involvement.

Inclusion criteria included cohort studies from any location with greater than 30 patients which included patient demographics and symptoms. Post-infection symptoms selected for inclusion in the analysis required at least three weeks of follow-up after initial infection. Study selection was not restricted based on age, race, severity of initial infection, or site of treatment. Included studies are listed in Table 1.

Data Extraction

Extracted descriptive variables were site, sample size, follow-up method, symptoms post-infection, baseline characteristics, and factors associated with severity of initial SARS-CoV-2 infection as provided by the articles (performed by BD and EW). Authors relied on the explicit mention of desired variables from original primary articles. However, due to heterogeneity of the included articles, not all variables could be extracted equally. If a primary work did not mention a desired variable recorded in other sources, it was left empty to indicate a gap in data (Table 2).

Symptoms were classified according to organ system involved (Table 3). Symptoms without localized organ system involvement, such as fatigue or fever, were catego-

TABLE 1. Index of Papers Selected For Systemic Review (N=17)

Primary Author	*Title,* Publication
Graham et al.[24]	Persistent neurologic symptoms and cognitive dysfunction in non-hospitalized Covid-19 "long haulers." *Wiley Online Library*.
Carvalho-Schneider et al.[28]	Follow-up of adults with noncritical COVID-19 two months after symptom onset. *Clinical Microbiology and Infection*.
Huang et al.[29]	6-month consequences of COVID-19 in patients discharged from hospital: a cohort study. *The Lancet*.
Iqbal et al.[31]	The COVID-19 Sequelae: A Cross-Sectional Evaluation of Post-recovery Symptoms and the Need for Rehabilitation of COVID-19 Survivors. *Cureus*.
Jacobson et al.[32]	Patients With Uncomplicated Coronavirus Disease 2019 (COVID-19) Have Long-Term Persistent Symptoms and Functional Impairment Similar to Patients with Severe COVID-19: A Cautionary Tale During a Global Pandemic. *Clinical Infectious Diseases*.
Cortes-Telles et al.[33]	Pulmonary function and functional capacity in COVID-19 survivors with persistent dyspnoea. *Respiratory Physiology & Neurobiology*.
Buonsenso et al.[34]	Preliminary evidence on long COVID in children. *Acta Paediatrica, International Journal of Paediatrics*.
Xiong et al.[35]	Clinical sequelae of COVID-19 survivors in Wuhan, China: a single-centre longitudinal study. *Clinical Microbiology and Infection*.
Cheng et al.[36]	Clinical characteristics and outcomes of adult patients admitted with COVID-19 in East London: a retrospective cohort analysis. *BMJ Open Respiratory Research*.
Bellan et al.[37]	Respiratory and Psychophysical Sequelae Among Patients With COVID-19 Four Months After Hospital Discharge. *JAMA Network Open*.
Moreno-Perez et al.[38]	Post-acute COVID-19 syndrome. Incidence and risk factors: A Mediterranean cohort study. *The Journal of Infection*.
Sykes et al.[39]	Post-COVID-19 Symptom Burden: What is Long-COVID and How Should We Manage It? *Lung*.
Sudre et al.[40]	Attributes and predictors of long COVID. *Nature Medicine*
Osikomaiya et al.[41]	"Long COVID": persistent COVID-19 symptoms in survivors managed in Lagos State, Nigeria. *BMC Infectious Diseases*.
Guedj et al.[42]	18F-FDG brain PET hypometabolism in patients with long COVID. *European Journal of Nuclear Medicine and Molecular Imaging*.
Halpin et al.[43]	Post discharge symptoms and rehabilitation needs in survivors of COVID-19 infection: A cross-sectional evaluation. *Journal of Medical Virology*.

Table 2 (Part 1 of 2). Demographics and Characteristics of Cohort Studies Investigating Long COVID Between January1st, 2021 and April 30th, 2021

	Graham et al.	*Osikomaiya et al.*	*Sudre et al.#*		*Sykes et al.*	*Moreno-Perez et al.*	*Bellan et al.*	*Halpin et al.*	*Cheng et al.*	*Xiong et al.*
Site	Chicago, IL, USA	Lagos State, Nigeria	UK (88.2%), US (7.3%), Sweden (4.5%)	UK (88.2%), US (7.3%), Sweden (4.5%)	Yorkshire, England	Mediterranean	Novara, Italy	West Yorkshire, England	London, UK	Wuhan, China
Number of patients	50	274	558	189	134	277	238	100	113	538
Follow-up	Tele visits and in-person	Clinical history and physical assessment	Self-reported	Self-reported	In-person clinical assessment	In-person evaluation	Telephone follow-up	Telephone follow-up	In-person follow-up	Telephone follow-up survey
Symptoms post-infection	4.7 months	2 weeks after Covid Isolation	28 days	56 days	76 – 167 days	8-12 weeks	3-4 month	29-71 days	6-12 weeks	97 days
Baseline Characteristics										
Age (mean)	43	42	50	52	60	62	61	65	73	52
Female (%)	70.0%	33.9%	79.7%	85.1%	34.3%	47.3%	40.3%	46.0%	42.1%	54.5%
Initial Disease Severity										
Hospitalized			175 (31.5%)	83 (43.9%)	134 (100%)	182 (65.7%)	238 (100%)	100 (100%)		538 (100%)
Not Hospitalized	50 (100%)									
Asymptomatic		21 (7.7%)								
Mild/did not require oxygen		139 (50.7%)				54 (19.5%)	66 (27%)			331 (61.5%)
Moderate/ nasal canula or noninvasive		107 (39%)			107 (80%)	41 (14.8%)	151 (63.4%)	68 (68%)		180 (33.5%)
Severe/ mechanical ventilation and ICU		7 (2.6%)			27 (20%)	24 (8.7%)	28 (11.8%)	32 (32%)		27 (5%)

TABLE 2 (Part 2 of 2). Demographics and Characteristics of Cohort Studies Investigating Long COVID Between January1st, 2021 and April 30th, 2021

	Buonsenso et al.	*Cortes-Telles et al.*	*Jacobson et al.*	*Iqbal et al.*	*Guedj et al.*	*Venturelli et al.*	*Huang et al.*	*Carvalho-Schneider et al.*[a]	
Site	Rome, Italy	Yucatan, Mexico	Standford, CA, USA	Karachi, Pakistan	Marseille, France	Bergamo, Italy	Wuhan, China	Tours, France	Tours, France
Number of patients	129	186	118	158	35	767	1733	150	130
Follow-up	Phone questionnaire and outpatient assessment	Questionnaire	Self-Reported Survey	Self-Reported and telephone	Clinical evaluation	Self-reported	Physical exam and questionnaire	Retrospective Chart Review and Telephone	Retrospective Chart Review and Telephone
Symptoms post-infection	60-120 days	30-90 days	3-4 months	20-58 days	3 weeks	68 days (51-92)	186 days (175-199)	30 days	60 days
Baseline Characteristics									
Age (mean)	11	47	43	32	55	63	57	49	49
Female (%)	48.1%	39.0%	46.6%	55.1%	57.0%	32.9%	48.0%	56.0%	56.0%
Initial Disease Severity									
Hospitalized	6 (4.7%)		22 (18.6%)		0.39	678 (88.4%)	1733 (100%)		
Not Hospitalized	123 (95.3%)		96 (81.4%)		0.51				
Asymptomatic									
Mild/did not require oxygen		51 (27.4%)		112 (70.9%)			439 (25%)	116 (77.3%)	116 (77.3%)
Moderate/ nasal canula or noninvasive		26 (14%)		33 (20.9%)			1172 (68%)	116 (77.3%)	116 (77.3%)
Severe/ mechanical ventilation and ICU		109 (58.6%)		13 (8.2%)	12 (39%)	66 (8.6%)	122 (7%)	34 (22.7%)	34 (22.7%)

[a]Data were collected at two different time points in these studies and reported symptoms from each time point were evaluated as separate data sets.

TABLE 3 (Part 1 of 2). Long COVID Symptoms of Patients in Each Cohort Study Investigated

	Graham et al.	*Osikomaiya et al.*	*Sudre et al. 28 days*	*Sudre et al. 56 days*	*Sykes et al.*	*Moreno-Perez et al.*	*Bellan et al.*	*Halpin et al.*	*Cheng et al.*	*Xiong et al.*
Number of patients	50	274	558	189	134	277	238	100	113	538
General Sequelae										
Fatigue	42 (84%)	35 (12.8%)	545 (97.7%)	183 (96.6%)	53 (39.6%)	96 (34.8%)		64 (64%)	69 (61%)	152 (28.3%)
Fever		17 (6.2%)	351 (62.9%)	111 (58.7%)	14 (10.4%)	0 (0%)	0 (0%)			
Muscular pain	30 (60%)	24 (8.8%)	357 (64%)	122 (64.6%)	69 (51.5%)	54 (19.6%)	14 (5.9%)	19 (19%)		24 (4.5%)
Joint pain							14 (5.9%)			41 (7.6%)
Night sweats/ chills		10 (3.7%)								152 (28.2%)
Respiratory Sequelae										
Dyspnea	19 (38%)	26 (9.5%)	395 (70.80%)	143 (75.7%)	80 (59.7%)	95 (34.4%)	13 (5.5%)	50 (50%)	41 (36%)	140 (26.1%)
Cough		25 (9.2%)	383 (68.6%)	118 (62.4%)	47 (35.1%)	59 (21.3%)	6 (2.5%)		19 (17%)	38 (7.1%)
Sore throat		11 (4.0%)	296 (53%)	116 (61.4%)	17 (12.7%)		0 (0%)		8 (7%)	17 (3.2%)
Nasal congestion										
Cardiovascular Sequelae										
Chest pain/distress/tightness	14 (28%)	27 (9.8%)	335 (60%)	119 (63%)	24 (17.9%)		1 (0.4%)			142 (26.4%)
Palpitations	9 (18%)	20 (7.4%)								60 (11.2%)
Neuropsychiatric Sequelae										
Anxiety/depression	20 (40%)				64 (47.8%)			23 (23%)		67 (23.7%)
Sleep disturbances	18 (36%)	27 (9.8%)			47 (35.1%)					95 (17.7%)
Loss of smell	37 (74%)	5 (1.8%)	395 (70.8%)	143 (75.7%)	13 (9.7%)	59 (21.4%)	11 (4.6%)			
Loss of taste	32 (64%)	7 (2.6%)			12 (9.0%)		12 (5.0%)			
Headache	32 (64%)	35 (12.8%)	509 (91.2%)	117 (93.7%)		49 (17.8%)	0 (0%)			
Cognitive/memory	41 (82%)	14 (5.2%)	169 (30.3%)	73 (38.6%)	84 (62.7%)	42 (15.2%)		40 (40%)	6 (6%)	
Dizziness	20 (40%)	8 (2.9%)								14 (2.6%)
Blurred vision	9 (18%)	6 (2.2)				15 (5.4%)				
PTSD							136 (57.1%)	31 (31%)		
Gastrointestinal Sequelae										
Constipation	14 (28%) not specified									
Diarrhea		11 (4%)	285 (51.1%)	103 (54.5%)	29 (10.5%)	29 (10.5%)	3 (1.3%)			
Nausea		6 (2.2%)								
Vomiting		2 (0.73%)								
Loss of appetite		24 (8.8)	332 (59.5%)	126 (66.7%)				8 (8%)		
Abdominal pain		17 (6.2%)	246 (44.1%)	93 (49.2%)						
Dermatologic Sequelae										
Hair loss									6 (6%)	154 (28.6)
Skin rash					25 (18.6%)	23 (8.3%)				

rized as general symptoms. Anxiety and depression were grouped together, as they were combined in neurologically focused studies of Long COVID Syndrome.[24] Cognitive deficiencies and memory impairment were also combined due to their association in "brain fog", a state of cognitive blunting.[25]

TABLE 3 (Part 2 of 2). Long COVID Symptoms of Patients in Each Cohort Study Investigated

	Buonsenso et al.	*Cortes-Telles et al.*	*Jacobson et al.*	*Iqbal et al.*	*Guedj et al.*	*Venturelli et al.*	*Huang et al.*	*Carvalho-Schneider et al. 30 days*	*60 days*
Number of patients	129	186	118	158	35	767	1733	150	130
General Sequelae									
Fatigue	14 (10.9%)	125 (67%)	36 (30.8%)	131 (82.9%)		186 (24.2%)	1038 (63%)	54 (36.0%)	28 (21.5%)
Fever			1 (0.9%)	54 (34.2%)		4 (0.52%)	2 (1<%)	5 (3.6%)	0 (0%)
Muscular pain	13 (10.1%)	60 (32%)	21 (17.9%)		23 (66%)	29 (3.78%)	39 (2%)		
Joint pain	9 (6.9%)			75 (47.5%)	23 (66%)		154 (9%)	13 (9.8%)	21 (16.3%)
Night sweats/ chills		32 (17%)	1 (0.9%)						
Respiratory Sequelae									
Dyspnea		71 (38%)	31 (26.5%)	79 (50%)	28 (80%)	167 (21.7%)		16 (10.7%)	10 (7.7%)
Cough	7 (5.4%)	56 (30%)	10 (8.5%)	70 (44.3%)		23 (2.99%)			
Sore throat		32 (17%)	3 (2.6%)				69 (4%)		
Nasal congestion	16 (12.4%)		8 (6.8%)						
Cardiovascular Sequelae									
Chest pain/distress/tightness	12 (9.3%)	56 (30%)	16 (13.7%)	56 (35.4%)	23 (66%)	24 (3.1%)	75 (5%)	27 (18.0%)	17 (13.1%)
Palpitations	5 (3.8%)		7 (6.0%)			30 (3.9%)	154 (9%)	9 (6.5%)	14 (10.9%)
Neuropsychiatric Sequelae									
Anxiety/depression				84 (53.2%)		82 (11.3%)	367 (23%)		
Sleep disturbances	28 (21.7%)			89 (56.3%)	16 (46%)		437 (26%)		
Loss of smell	6 (4.6%)	20 (11%)	25 (21.4%)	75 (47.5%)	10 (29%)	23 (2.99%)	176 (11%)	40 (27.8%)	29 (22.7%)
Loss of taste	4 (3.1%)	20 (11%)	25 (21.4%)		9 (26%)	23 (2.99%)	120 (7%)		
Headache	13 (10.1%)	28 (15%)	7 (6.0%)	57 (36.1%)	23 (66%)	4 (0.52%)	33 (2%)		
Cognitive/memory	13 (10.1%)		20 (17.1%)	30 (19.0%)	17 (49%)	23 (2.99%)			
Dizziness							101 (6%)		
Blurred vision		7 (4%)		30 (19%)					
PTSD									
Gastrointestinal Sequelae									
Constipation	8 (6.2%)								
Diarrhea	2 (1.5%)	6 (3%)	8 (6.8%)			8 (1.0%)	80 (5%)	26 (17.3%)	15 (11.5%)
Nausea			8 (6.8%)						
Vomiting			8 (6.8%)						
Loss of appetite							138 (8%)		
Abdominal pain	3 (2.3%)								
Dermatologic Sequelae									
Hair loss		20 (11%)	14 (12.0%)	63 (39.9%)			359 (22%)		
Skin rash	9 (6.9%)	22 (12%)					47 (3%)	21 (15.4%)	15 (11.5%)

Analysis of Symptom Prevalence

The overall prevalence of each symptom was calculated as the number of patients reporting a symptom across all studies that evaluated the given symptom, relative to the total number of patients evaluated in those same studies. To calculate the preva-

lence of system dysfunction, the number of patients who suffered from symptoms within a specific system was divided by the summed patients of studies reporting symptoms for that system. All calculations and graphing functions were performed in R 3.4.3 (The R Foundation for Statistical Computing, Vienna, Austria) using the packages Tidyverse and ggplot2.[26,27]

Literature Review of Massage Therapy in the Treatment of Long COVID-Associated Sequelae

A massage-based framework was used to address the Long COVID symptomology identified in the systematic review of sequelae. In NCBI PubMed, a series of searches were conducted (by HM) to identify applications of massage therapy in relation to symptoms of Long COVID Syndrome or, when known, their underlying pathophysiology. The search terms used to identify relevant studies were "massage" or "massage therapy," along with the specific symptom or mechanism (Table 4). Studies published between January 1st, 2000 and November 15th, 2022 were included to encompass relevant research from the last two decades while correcting for the barriers to research during the height of the COVID-19 pandemic. Review articles, commentaries, and meta-analyses which did not present primary data were excluded. Additionally, studies whose participants were children or non-human were not included, so that findings would be applicable to the populations identified in this study. Studies were manually filtered to exclude irrelevant topics, including invasive massage techniques such as carotid sinus massage, techniques that did not fall under the definition of massage therapy, studies that were not evaluating massage therapy in relation to the symptoms searched, or studies that were not available in English. Study selection was not restricted based on gender, race, or whether findings were in support of massage therapy.

RESULTS

Systematic Review Study Selection and Symptom Inclusion

In NCBI PubMmed, a total of 246 studies using the terms "Long COVID", "Long Haulers", "post-acute COVID", and "Long COVID Syndrome" were identified (Figure 1). Of those, 93 papers fell outside of the established time frame for study, January 1st, 2021, to April 30th, 2021. A further 95 review articles, commentaries, and letters were excluded as they did not provide primary data. One cohort study with fewer than 30 participants was excluded as studies with a larger sample size would provide more statistical confidence. To avoid skewing of the data, 40 papers that only focused on only one organ system were excluded. The remaining 17 cohort studies which reported multi-systemic effects of Long COVID Syndrome were analyzed (Table 1).[24,28–43] Notably, cohort studies by Sudre *et al*.[40] and Carvalho-Schneider *et al*.[28] evaluated patients at two different time points. Reported symptoms from each time point were evaluated as separate data sets in this analysis. The total patient count across all studies was 5,877 patients, with studies conducted around the globe on cohorts ranging from 35 to 538 patients. The weighted mean age was 53 years old; 49.7% (2,921) of patients were women and 50.3% (2,956) were men (Table 2). Acute disease severity ranged from asymptomatic to requiring ventilation during hospitalization, highlighting the prevalence of Long Covid Syndrome regardless of severity of initial infection.

To minimize bias from single-study reporting, symptoms were only included in our analysis if they were assessed in two or more of the included studies. The resulting symptoms evaluated in each study set are listed by organ system in Table 3.

Long COVID Syndrome Symptom Reporting and Prevalence

Assessment of symptoms was variable across the studies, with some symptoms reported in nearly all data sets while others were only reported in a few studies (Table 3, Figure 2). The most commonly assessed symptoms were queried in 13 or more of the study sets, and include fatigue [17], dyspnea [17], chest pain/discomfort [16], loss of smell [16], muscular pain [15], cough [13], headache [13], and cognitive/memory impairment [13]. Less commonly assessed symptoms were described in 7 to 10 of the studies, such as loss of taste [10], palpitations [9], sore throat [9], fever [9], joint pain [8], sleep distribution [8], anxiety/depression [7], and skin rashes [7]. Infrequently described symptoms were evaluated in

TABLE 4 (Part 1 of 2). Literature References to Massage Therapy in Treatment of Symptoms or Pathophysiology, 2000–2022

System	*Symptom*	*Pathophysiology*	*Search Terms: "massage" OR "massage therapy"*	*Total Retrieved*	*Excluded*	*Relevant*
General	Fatigue		AND "fatigue"	488	395	93
		Hypoxia (during acute infection)	AND "hypoxia"	143	142	1
	Fever		AND "fever"	62	62	0
	Muscular Pain		AND "muscle pain"	41	24	17
	Joint Pain		AND "joint pain"	52	37	15
	Night Sweats/Chills		AND "night sweat" OR "chills"	5	5	0
Respiratory	Dyspnea		AND "dyspnea"	46	37	9
		Pulmonary Scarring	AND "pulmonary scar"	0	0	0
	Cough		AND "cough"	40	38	2
	Sore Throat		AND "sore throat"	4	3	1
	Nasal Congestion		AND "nasal congestion"	3	3	0
Cardiovascular	Chest Pain/ Distress/ Tightness		AND ("chest pain" OR "chest distress" OR "chest tightness")	27	25	2
		Ang II Increases	AND ("Ang II" OR "Angiotensin II")	8	8	0
		High CRP/Creatine Levels	AND ("CRP" OR "c-reactive protein")	30	26	4
			AND "creatine"	59	58	1
	Palpitations		AND "palpitation"	8	8	0
Neuropsychiatric	Anxiety/Depression		AND ("anxiety" OR "depression")	1,139	889	250
		IL-6 & TNF-α	AND ("IL-6" OR "TNF")	92	86	6
	Sleep Disturbances		AND "sleep disturbance"	52	45	7
	Loss of Smell		AND "loss of smell"	0	0	0
	Loss of Taste		AND "loss of taste"	0	0	0
	Headache		AND "headache"	457	228	29
	Cognitive/Memory Impairment		AND ("cognitive impairment" OR "memory impairment" OR "brain fog")	42	40	2
	Dizziness		AND "dizziness"	84	81	3
	Blurred Vision		AND ("blurred vision" OR "blurry vision" OR "visual impairment")	19	19	0
	PTSD		AND ("PTSD" OR "post traumatic stress disorder")	18	13	5

TABLE 4 (Part 2 of 2). Literature References to Massage Therapy in Treatment of Symptoms or Pathophysiology, 2000–2022

System	*Symptom*	*Pathophysiology*	*Search Terms: "massage" OR "massage therapy"*	*Total Retrieved*	*Excluded*	*Relevant*
Gastrointestinal	Constipation		AND "constipation"	161	115	46
	Diarrhea		AND "diarrhea"	51	45	6
	Nausea		AND "nausea"	138	118	20
	Vomiting		AND "vomiting"	102	86	16
	Loss of Appetite		AND ("loss of appetite" OR "anorexia")	33	32	1
	Abdominal Pain		AND "abdominal pain"	60	49	11
Dermatologic	Hair Loss		AND ("hair loss" OR "alopecia")	20	20	0
	Skin Rash		AND ("rash" OR "atopic dermatitis")	35	35	0
Immune	Inflammatory Response	Dysautonomia	AND "dysautonomia"	3	3	0
			AND "autonomic dysfunction"	16	16	0
		Cytokine Storm	AND "cytokine storm"	1	1	0

only two to six of the included studies and were limited to hair loss [6], loss of appetite [5], blurred vision [5], dizziness [4], sweats [4], abdominal pain [4], vomiting [2], nausea [2], PTSD [2], and nasal congestion [2]. These numbers represent how often a symptom was assessed across the subset of articles reviewed here rather than the within-population prevalence of each symptom. By examining the pooled data from the studies reporting a specific symptom, we were able to evaluate the prevalence of each symptom in Long COVID Syndrome.

Patients across nearly all included studies reported multisystemic or general sequelae. Fatigue was reported as a symptom by 32.35% of patients. Other general sequelae were also common, with night sweats or chills, generalized muscular pain, fever, and joint pain all reported by more than 10% of patients evaluated.

Respiratory symptoms were also frequently present in the selected studies, with 34.27% of patients reporting dyspnea. Cough was reported by 23.40% of patients, while sore throat and nasal congestion were reported by 14.01% and 9.71% of patients, respectively.

The greatest number of individual symptoms was reported in regard to neuropsychiatric sequelae. The symptom reported in the greatest percentage of patients who were evaluated was PTSD, with 49.41% of patients reporting this symptom across two studies that assessed the symptom. Sleep disturbances, loss of smell, anxiety or depression, cognitive defects or memory deficiencies, and headache were all recorded in 15–25% of patients who were asked about these symptoms. In fewer than 10% of patients assessed, loss of taste, blurred vision, and dizziness were reported.

Symptoms associated with the gastrointestinal (GI) system were less likely to be assessed; however, some symptoms were quite common in the study populations. Although it was only assessed in four studies, abdominal pain was reported by 31.22% of patients who were asked. Loss of appetite and diarrhea were frequently reported, with 22.0% and 12.39% of patients indicating they experienced these symptoms, respectively, whereas nausea and vomiting were only associated with Long COVID in fewer than 4% of patients.

Cardiovascular symptoms made up only a small number of the total symptoms assessed with consistency, with only chest

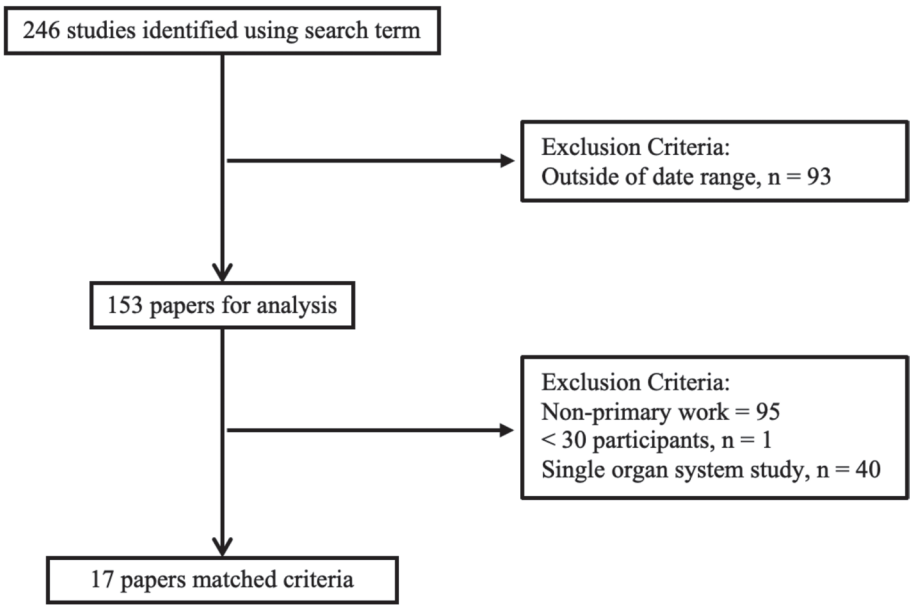

Figure 1. Attrition diagram: A total of 246 articles were identified using search terms related to Long COVID Syndrome in NCBI PubMed as of June 2021; based on exclusion criteria, 17 cohort studies consisting of 19 data sets were chosen to serve as a basis of a systemic review of the symptoms associated with Long COVID Syndrome.

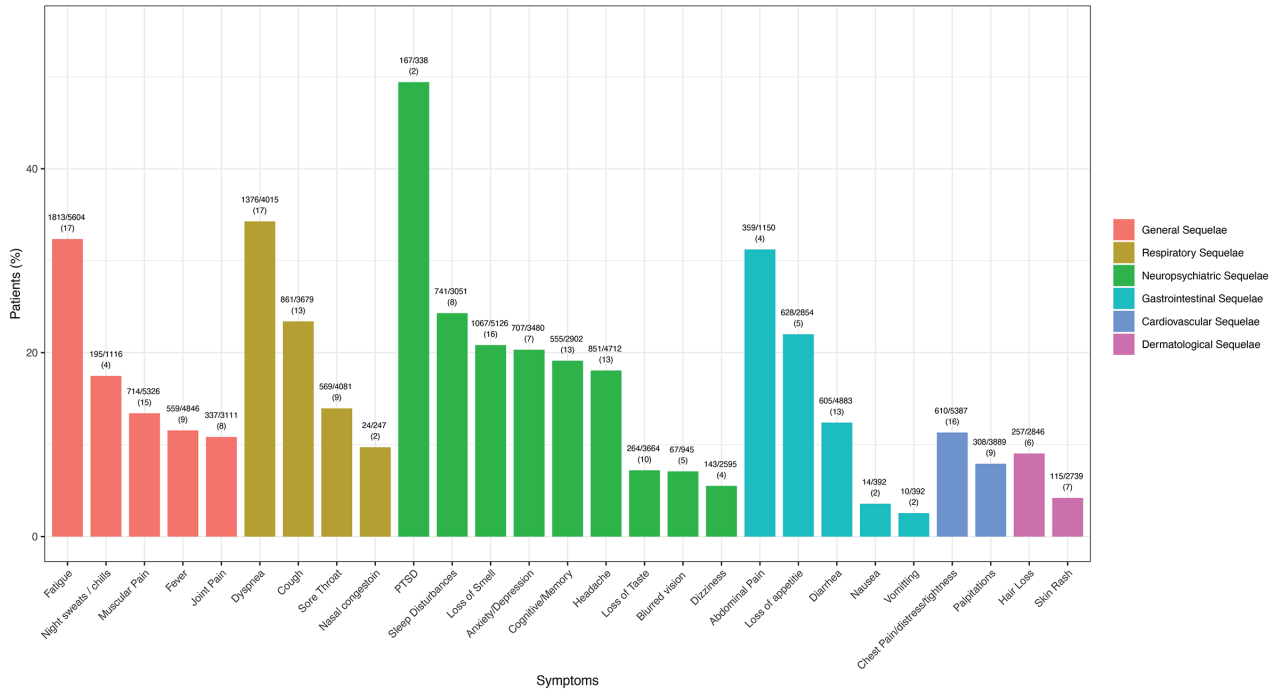

Figure 2. Symptom prevalence in patients suffering from Long COVID Syndrome is shown as the number of patients presenting with the specific symptom relative to the total number of participants that mentioned any symptoms across all studies that documented the specific symptom. The number within parenthesis is indicative of the number of studies that reported each symptom.

pain/tightness and heart palpitations recorded in multiple studies. Chest pain or discomfort was experienced by 11.3% of patients across 16 studies, while 7.9% of included patients from nine studies experienced heart palpitations.

Additionally, several patients evaluated for Long COVID reported dermatological symptoms, with 9% of patients reporting hair loss and 4.2% of patients reporting rashes of the skin.

Organ System Dysfunction Prevalence in Long COVID Syndrome

By calculating the mean prevalence of symptoms in each organ system, it was possible to determine the relative incidence of organ system dysfunction in Long COVID Syndrome. Across all studies and symptoms, 23.54% of patients dealing with Long COVID Syndrome suffered from pulmonary sequelae. General sequelae were reported on average by 18.10% of patients. An average of 17.01% of patients reported neuropsychiatric sequelae, while 16.71% reported GI sequelae, 9.90% described cardiovascular sequelae, and dermatological sequelae were experienced by an average of 6.66% of patients (Figure 3).

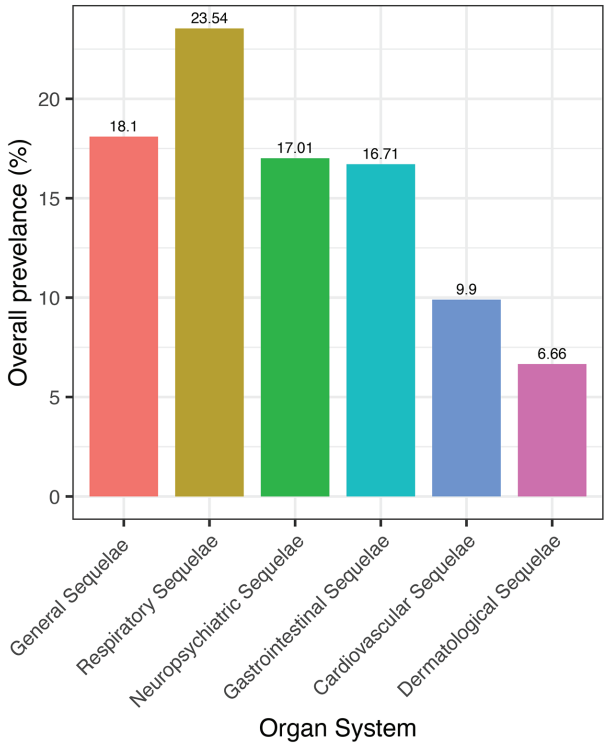

Figure 3. Prevalence of organ specific sequela in patients suffering from Long COVID Syndrome in each organ system were averaged to determine the organ systems most affected.

Massage Therapy Treatment of Long COVID Syndrome Sequelae and Underlying Pathophysiology

The pathophysiology of Long COVID Syndrome is largely hypothetical, due to the wide range of mechanisms that could result in associated symptoms. The identified pathophysiology of Long COVID symptoms discussed in this review, as well as the number of studies within our inclusion criteria that investigated their relationship with massage therapy, are listed in Table 4. General sequelae such as fever, night sweats, and chills do not have identified pathophysiology in the context of Long COVID Syndrome, and there were no studies within our criteria that examined their relationship with massage therapy. However, muscular and joint pain has shown improvement following massage therapy.[44,45] Although some studies found that participants experienced no change or minor increases in fatigue following massage therapy,[46–48] multiple studies demonstrated that it was successful in reducing measures of fatigue.[49–51]

Massage therapy is also effective in managing respiratory symptoms identified in this study, including dyspnea,[52] cough,[53] and sore throat.[54] There were no studies within our selection criteria demonstrating the relationship between massage therapy and nasal congestion. While a few studies saw no change in measures of dyspnea, none implied that massage resulted in harm to the participants.[55,56]

Specific cardiovascular sequelae of Long COVID Syndrome may benefit from massage therapy, which can ameliorate chest pain;[57,58] however, there were no studies within our selection criteria demonstrating the relationship between massage therapy and palpitations. While the exact mechanism of chest pain in the context of Long COVID Syndrome is not yet clear, elevated concentrations of C-reactive protein (CRP) and creatine during acute COVID-19 infection have been associated with prolonged cardiovascular symptoms.[59] Massage therapy has resulted in decreased CRP[60] and creatine[61] levels when used to complement pharmacological treatments for musculoskeletal conditions.

Furthermore, massage therapy may alleviate some neuropsychiatric sequelae of Long COVID Syndrome. Numerous studies found that measures of anxiety and depression were significantly improved following massage therapy.[62–64] One proposed pathway for the devel-

opment of anxiety and depressive symptoms in Long COVID Syndrome patients is elevated levels of inflammatory cytokines, specifically interleukin-6 (IL-6) and tumor necrosis factor-α (TNF-α).[65] Massage therapy decreases both IL-6 and TNF-α levels;[66] thus, it has the potential to be an effective treatment for this mechanism of neuropsychiatric symptom development. Additionally, massage therapy is effective in improving neuropsychiatric sequelae such as sleep disturbances,[67] headaches,[68] cognitive impairment,[69] dizziness,[70] and PTSD.[71] There were no studies within our selection criteria demonstrating the relationship between massage therapy and blurred vision or loss of smell and taste.

Massage may be beneficial in alleviating gastrointestinal symptoms associated with Long COVID Syndrome. It has been implicated in the management of constipation and abdominal pain,[72] as well as diarrhea, nausea, and vomiting.[73] While some studies found no significant relationships between massage therapy and aforementioned gastrointestinal symptoms, there was no evidence of harm or worsened symptoms.[56]

There were no studies within our selection criteria that investigated the effectiveness of massage therapy in the treatment of hair loss or skin rashes.

DISCUSSION

Long COVID Syndrome consists of a set of ongoing symptoms, ranging from mild to severe, experienced by patients following an acute SARS-CoV-2 infection. Sequelae may either be novel to the individual or residual from the primary infection, though the specific pathophysiology of Long COVID Syndrome is not yet clear. Current treatment of Long COVID Syndrome relies on supportive therapeutic strategies to treat patients' symptoms, and benefits have been limited to marginal improvement of dyspnea and control of tachycardia.[74,75] Here, we provide a systematic review of Long COVID Syndrome studies to determine the prevalence of organ system involvement and gain understanding of Long COVID Syndrome-associated symptoms in the general population. With this understanding of the symptomology of Long COVID Syndrome, we can explore massage therapy and non-pharmaceutical techniques associated with relief of these symptoms.

We analyzed a total of 17 multi-system cohort studies published between January 1st, 2021 and April 30th, 2021 that reported on the long-term symptoms of COVID-19 to determine the prevalence of symptoms, as well as the organ systems most affected. Fatigue, dyspnea, cough, PTSD, sleep disturbances, loss of smell, abdominal pain, and decreased appetite were experienced by more than 20% of patients. Many of these symptoms are associated with a decreased quality of life, especially fatigue, dyspnea and PTSD, which were the most common symptoms identified.[76–79] While PTSD was the most prevalent symptom in our analysis, it was only assessed in two studies of Long COVID Syndrome. On an organ system level, respiratory sequelae were the most frequently experienced type of symptom, followed by general sequelae, then neuropsychiatric and GI. Cardiac and dermatological sequelae were the least prevalent.

Current treatments for Long COVID Syndrome are limited, evolving, and non-standardized, and primarily rely on pharmacologic treatments. Multiple countries have produced clinical guidelines for treatment of Long COVID Syndrome; however, these guidelines rely on expert opinion and have not yet been scientifically verified.[80–82] Within these guidelines, recommended therapies consist primarily of drugs for symptomatic relief. Symptom-only focused treatments may include steroids for symptomatic relief of dyspnea,[83] or arrhythmia-controlling medication and anticoagulants for the management of cardiac and hematological sequelae of dysrhythmia and hypercoagubility.[84,85] This pharmacological approach for treatment of Long COVID Syndrome presents a set of secondary problems for patients, such as drug interactions or side effects, that can further complicate the patient's medical situation.[86]

Application of Massage Therapy as a Non-Pharmaceutical Option for Treatment of Symptoms Associated with Long COVID Syndrome

Massage therapy has a long history within the United States of being the most accepted complementary medicine with therapeutic applications.[87] It has been commonly applied in the manage-

ment of pain and stress, but has also been shown to be beneficial in other medical conditions including rheumatoid arthritis,[88] anxiety,[89,90] sleep disorders,[91,92] and musculoskeletal disorders.[93] Based on these benefits, massage therapy has been integrated into hospital care for long-term hospitalized patients,[94] post-surgery recovery,[95] and during labor and childbirth.[96–98]

While there is a lack of direct clinical evidence for the application of massage therapy for in the treatment of Long COVID Syndrome, there is ample support for massage in treatment of individual symptoms and conditions with shared symptomology. Considering the wide-ranging benefits of massage therapy and its availability in both inpatient and outpatient settings, we propose that massage therapy could be utilized as a supplemental approach, in an addition to current treatment options, to ease symptoms in patients experiencing Long COVID Syndrome. This is not the first time that holistic approaches have been proposed as a treatment for COVID-19. Traditional Chinese medicine, which also involves the purposeful manipulation of tissue, had beneficial effects on COVID-19 patients when coupled with Western medicine remedies, providing further support for complementary medicine as a therapeutic avenue to pursue in the future.[99]

Respiratory sequelae were most frequently reported by patients experiencing Long COVID Syndrome, and dyspnea was the most commonly reported symptom. Massage therapy may provide some relief for these patients. In addition to management of dyspnea,[52] massage therapy has demonstrated benefits for patients with cystic fibrosis, improving mood and facilitating better peak airflow readings.[100] Furthermore, massage therapy has been linked to improvements in pediatric asthma symptoms, including decreased cortisol levels and asthma-associated anxiety.[101,102] As anxiety is a known potential contributor to dyspnea,[103] these studies suggest that massage therapy could provide beneficial outcomes to patients struggling with respiratory sequelae of Long COVID Syndrome. Furthermore, active breathing exercises with light active stretches directed by a breathing specialist have been associated with improved respiratory function as they contribute to increased expansion range of the chest wall,[75] which has also been observed following deep tissue massage therapy.[104] Thus, breathing or stretching exercises could be implemented instead of massage for treatment of dyspnea, or incorporated alongside or within a massage therapy treatment plan, to further increase potential beneficial effects. More aggressive complementary therapy interventions could also incorporate chest wall vibration or acupuncture.[103]

One aspect of Long COVID Syndrome with a significant negative impact is the emergence or persistence of multiple neural symptoms such as migraine-like headaches,[105,106] prolonged loss of taste and smell,[7,107] and difficulties with memory, concentration, and executive language, collectively referred to as "brain fog."[108,109] Our data and other neurologically-focused Long COVID studies identified PTSD, anxiety and depression, and sleep disturbances as commonly reported symptoms.[110,111] In an analysis of 62,354 patients across 54 health-care organizations, the approximate incidence of first or recurrent psychiatric disease at 90 days post-SARS-CoV-2 infection was 18.1%, significantly higher than matched control cohorts of patients diagnosed with influenza or other respiratory infections.[112] Multiple studies have reported COVID-19 to be a risk factor for developing PTSD; however, there is some discrepancy on the role of ICU hospitalization in development of PTSD, so the relative contributions of infection or hospitalization to PTSD risks in Long COVID patients is not yet clear.[43,113,114] In Western medicine, treatments for neuropsychiatric symptoms have often relied on pharmacological interventions.[65,115,116] Sadly, these treatments may have limited success due to common medication-associated side effects and drug–drug interactions,[117] highlighting the need for non-pharmacological interventions such as massage therapy. As the body of literature continues to grow, it is clear that massage therapy offers benefits to patients suffering from mental health disorders; notably, it has shown to be effective in alleviating many of the neuropsychiatric symptoms that are also common to Long COVID Syndrome.[90,118–121] Massage therapy can improve sleep quality,[67,122] enhance trauma-related psychotherapeutic outcomes,[71] reduce anxiety and depression,[14,64,67,120] and relieve stress, with increased dopamine and serotonin and decreased cortisol levels.[67,121,123] Thus, massage therapy should be considered for

implementation as a non-pharmacological, complementary treatment, in conjunction with other accepted neuropsychiatric treatment approaches, to benefit patients experiencing neuropsychiatric sequelae of Long COVID Syndrome.

Fatigue and muscular pain/myalgia were also commonly reported by patients with Long COVID Syndrome. While fatigue is normal and expected during viral infections, the longevity of these symptoms is of great concern, as ongoing fatigue could have far-reaching implications on family life, job stability, overall health, and quality of life.[44,45,49–51] Massage therapy has been effective at reducing fatigue in cancer patients,[119,124] and its role in the treatment of patients suffering from chronic fatigue or muscular pain has been documented extensively.[44,45,49–51] It has been proposed that massage therapy may dampen nociception and trigger release of oxytocin, which can lead to decreases in muscle pain and promote a relaxation response that reduces high cortisol levels routinely associated with stress and sleep disruptions.[45,49] While the mechanisms of Long COVID Syndrome pain and fatigue are not yet known, a small study found that lymphatic drainage massage reduced fatigue and pain in patients with Long COVID Syndrome,[125] suggesting that patients experiencing fatigue or muscle pain associated with Long COVID Syndrome could gain similar benefits by incorporating massage therapy into their treatment regimen.

Some patients reported dermatological symptoms of Long COVID Syndrome such as hair loss and skin rashes. Appearance of new, non-infectious rashes or sudden hair loss is most likely to occur following an extremely stressful event, either emotional or physical.[126] Acute COVID-19 infection can contribute to multiple stressors, from the emotional trauma of a severe infection to nutritional deficiencies during the illness. While it is not yet clear if massage therapy could provide benefits to patients experiencing atopic rashes, for patients with stress-related hair loss, light scalp movement combined with the use of specific oils and additives could stimulate hair growth.[127] Additionally, massage may contribute to increases in blood flow, skin softening, and cellular repair and regeneration,[128,129] which have been implicated in increased hair density.[130] Thus, massage therapy techniques, particularly those that incorporate scalp stimulation, may be beneficial to patients struggling with hair loss related to Long COVID Syndrome.

While gastrointestinal symptoms were only reported in a few of the included studies, abdominal pain is a concerning symptom of Long COVID Syndrome as it can significantly diminish a patient's quality of life. While we were unable to pinpoint the type or location of the described pain due to reporting limitations within source studies, we observed that more than 30% of patients assessed reported abdominal pain as a symptom of Long COVID Syndrome. Multiple mechanisms have been proposed as potential reasons for gastrointestinal symptoms or pain associated with COVID-19, including altered GI flora due to antimicrobials or an imbalance between pathological and beneficial microbes, effects of proinflammatory cytokines following acute COVID-19 infection, or loss of mucosal tissue integrity triggering immunological activation.[131,132] While complementary therapies may not directly treat these conditions, massage or acupuncture could reduce pain in patients and improve GI motility to relieve constipation for Long COVID patients with symptoms that are not fully remedied by other therapies, leading to an overall improvement in patient quality of life.[72,133–135] While patients experiencing Long COVID Syndrome are likely to benefit from massage therapy, care to patients suffering from GI symptoms should be limited to light touch around the abdomen, and include comfortable positioning for the patient.

The renal system is heavily affected by COVID-19 and is used as a prognostic factor of survival, but was not captured in our systematic review.[136,137] COVID-19 infection is associated with decreased kidney function,[138,139] and one study reported that 14.3% of sick patients required dialysis for survival.[140] Examination of the kidneys postpartum COVID-19 patients found severe acute tubular necrosis and lymphocyte infiltration.[141] While there is limited research discussing the effects of massage therapy on renal function, evidence supports massage therapy as a means of improving quality of life in patients receiving hemodialysis.[142] Further research is needed to determine how massage therapy might impact the renal system sequelae, particularly within the context of Long COVID, once more information is available concerning renal symptomology.

Massage Therapy and Immunomodulation in Long COVID Syndrome Pathophysiology

While the complete pathophysiology of Long COVID has not been elucidated, many studies have explored immunological aspects of COVID-19 that correlate with prolonged symptoms. Long-term COVID-19 symptoms were associated with high titers of IgG and IgM antibodies against SARS-CoV-2 circulating in serum over a prolonged period of time.[143] It has been proposed that autoimmune antibodies developed during COVID-19 infection could trigger an inflammatory response and cause extensive damage in the lungs, contributing to development of Long COVID symptoms.[144] Immune hyperactivation has also been proposed as a potential driver of the progression from acute to post-acute COVID, with elevated levels of inflammatory cytokines and highly activated innate immune cells found in patients experiencing Long COVID.[145,146] In addition, compared to patients with only acute symptoms, Long COVID Syndrome patients had lower levels of regulatory T-cells and PD-1 expression on CD4 and CD8 T-cells.[147] Both regulatory T-cells and PD-1 expression are important for regulating immune responses and impact cytokine expression, suggesting that patients who are experiencing Long COVID Syndrome are also likely to be experiencing unregulated inflammation.

There is extensive history and evidence connecting massage therapy with immunomodulatory effects. Massage therapy was associated with increasing T helper cell counts in HIV-infected children, which can include regulatory T cells,[148,149] decreasing cortisol levels in pregnant patients,[150] and reducing inflammatory signaling due to high intensity exercise[66,151] or rheumatoid arthritis.[66,151,152] For patients with SARS-CoV-2-induced inflammation as a component of Long COVID Syndrome,[146] massage therapy could provide a potential method for decreasing proinflammatory molecules.[66,151,152] However, the frequency of massage therapy sessions may influence their effectiveness, particularly in the context of immunomodulation. A single session of Swedish massage therapy decreased inflammatory cytokines and markers in the blood,[153] while two sessions a week resulted in a minor increase in inflammatory cytokines.[153,154] This suggests that implementing massage sessions too often may reduce their therapeutic potential, although further research is needed to determine the optimal number or frequency of sessions. It is also important to highlight that massage therapy had no effect on inflammatory markers associated with prolonged wake cycle and unbalanced circadian rhythm, so with these symptoms, massage is likely to be most effective when used in combination with other therapeutic interventions.[155] While it is not yet possible to determine if massage therapy could be employed to prevent or eliminate Long COVID Syndrome, given the evidence supporting an association between a proinflammatory state and long-term COVID symptoms, coupled with the immunomodulatory benefits of massage therapy, it is feasible that massage therapy could alleviate aspects of the pathophysiology at the root of Long COVID Syndrome.

Limitations

In the present study, we were unable to investigate all organ systems involved with Long COVID Syndrome or assemble a complete symptomology due to limited data reported in studies that met inclusion criteria. As such, we may have missed important symptoms that were rarely investigated or only reported in single-system Long COVID studies. This may further be compounded by the fact that the systematic review was completed in 2021 which was an early period in the reporting of Long COVID Syndrome. Despite the significant time that has passed since those initial investigations and ongoing growth of Long COVID knowledge, the symptoms and systems highlighted in these studies still provide an important framework for identifying potential new therapeutics. An additional limitation of our study is that our search was only focused on SARS-CoV-2. It is possible that the constellation of symptoms following infection observed in this analysis are not unique to SARS-CoV-2, but rather are general chronic findings after viral infections. However, regardless of the specificity of the symptoms, massage therapy techniques may still provide relief to patients with chronic post-viral disease.

Lastly, in the absence of direct evidence for massage therapy in the symptomatic relief of Long COVID Syndrome, potential benefits are suggested based upon studies in patients with shared symptoms.

Prior research into the effect of massage on other health issues with similar symptomology does not guarantee that massage therapy will be successful in the treatment of symptoms associated with Long COVID Syndrome. In addition, in the absence of understanding of the pathophysiology of Long COVID Syndrome, it is not yet possible to clearly demonstrate the mechanisms by which massage therapy could offer relief from symptoms. The intention of this work is to propose that non-pharmacological interventions such as massage therapy have the potential to benefit patients experiencing Long COVID Syndrome and should be an important avenue of investigation for future research into complementary therapeutics for Long COVID Syndrome.

CONCLUSION

Massage therapy has a strong history as an effective holistic intervention for chronic diseases. This study presents a systematic review of Long COVID Syndrome as reported in multi-system cohort literature from early 2021, to identify common symptoms and frequently affected organ systems. A review of therapeutic massage literature suggests that patients experiencing symptoms associated with Long COVID Syndrome—such as muscular and joint pain, fatigue, dyspnea, cough, sore throat, chest pain, anxiety, depression, sleep disturbances, headaches, cognitive impairment, dizziness, PTSD, constipation, abdominal pain, diarrhea, nausea, and vomiting—may benefit from massage therapy. For patients with symptoms such as fever, night sweats, chills, nasal congestion, palpitations, blurred vision, loss of smell and taste, and skin rashes, the effects of massage therapy to complement pharmacological treatment are not yet clear. Massage therapy has also been effective in reducing inflammatory markers which are often observed in patients with Long COVID Syndrome. Consequently, the implementation of massage therapy techniques may mitigate the hyperinflammatory state, and thus reduce the symptom presentation or severity of Long COVID symptoms. Future work should focus on elucidating the benefits of massage therapy techniques on a broad range of patients experiencing Long COVID Syndrome. For example, as fatigue is one of the most common symptoms of Long COVID and there is extensive research regarding the benefits of massage therapy on fatigue associated with many conditions, patients may be well served by future investigations into the effect of massage therapy on Long COVID fatigue. We hope that current and future studies will open further avenues for treatment and symptomatic relief, with the goal of improving quality of life for patients with Long COVID Syndrome.

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CONFLICT OF INTEREST NOTIFICATION

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Corresponding author: Jennifer T. Grier, PhD, University of South Carolina School of Medicine Greenville, 607 Grove Road, Greenville, SC, USA 29605
E-mail: JGRIER@greenvillemed.sc.edu