



Musculoskeletal Health Problems among Covid-19 Recovered Patients - A Scoping Review

Vijayshree Singh¹, Dr. Zaki Anwar², Dr. Kanav Khera³

1. Vijayshree Singh, Research Scholar, Department of Physiotherapy, Lovely Professional University, Punjab
2. Dr. Zaki Anwar (Ph.D), Professor, Department of Physiotherapy, Lovely Professional University, Punjab
3. Dr. Kanav Khera (Ph.D), Associate Professor, Dept. Pharmacy Practice/Pharmacology, Lovely Professional University, Punjab

Abstract

Objective: Numerous long-lasting musculoskeletal problems including balance and gait abnormalities have been reported despite resolution of acute coronavirus infection. Therefore, present scoping review aims were to (1) review studies that evaluated musculoskeletal problems including balance and gait abnormalities in Covid-19 recovered patients (2) to review the outcome tools and prevalence of outcome i.e. most frequent musculoskeletal problem after COVID-19 infection

Methods: Articles for scoping reviews were identified by searching in PubMed, Scopus, SCI, Web of Science, and Google Scholar database for items dated 1-May-2020 to 4-Jan-2023. Experimental and observational studies on subjects with post Covid-19 infection manifested with musculoskeletal disorders having follow-up period 4-12 weeks after discharge or after the onset of symptoms meeting inclusion criteria were included. Records were identified by a comprehensive search of three databases as well as grey literature searching and websites. Data extraction was performed independently by teams of two reviewers which included published summary data and assessed methodological quality and risk of bias. Descriptive analysis and qualitative synthesis was performed including thematic summary formation.

Results: we include 27 studies with a follow-up period more than 14 days post-Covid-19. The frequently reported musculoskeletal problems were fatigue (range 25%-89%), myalgia (range 44%-60%), arthralgia (range 15%-57%), restriction of ADL (57.0%), sleeping trouble (50.9%), anorexia (42.6%), chest pain (32.6%), gastritis (32.3%), cough (29.3%), headache (58%) and dyspnea (74%) (PROMIS dyspnea characteristics and PROMIS Global health-10), anxiety (26%), chronic fatigue syndrome (52.6%)

Conclusion: This review focuses on the prevalence of outcomes of musculoskeletal problems including balance and gait abnormalities in post Covid-19 infection. The findings of this review study will help the healthcare organization and professionals to study most frequent long Covid symptoms or on-going Covid-19 symptoms and need to find out any intervention to prevent or cure them.

Key Words: Covid-19, Novel Corona Virus 20, SARS-CoV-2, Post-Covid-19 Syndrome, Long Covid Musculoskeletal Complication

1. Introduction

The coronavirus disease (Covid-19) caused by severe acute respiratory syndrome coronavirus-2 infection, is leading to an unknown and unusual health condition that is challenging to manage. Post-Covid-19 syndrome is one of the challenges, having become increasingly common as the pandemic evolves. The latest estimates suggest that 10 to 20 % of the patients who undergo the acute symptomatic phase are experiencing the effects of the disease beyond 12 weeks after diagnosis. Over the last months after vaccination was done almost everywhere, the after-effects of Covid-19 are becoming more deceptive. The Terms such as “long COVID,” “post-COVID syndrome” and “chronic COVID syndrome” are gaining scientific consideration (1) The UK National Health Service defined post-Covid syndrome as unexplained, persisting signs or symptoms over 12 weeks developed during and after the COVID-19 infection. Prolonged COVID-19 is commonly used to describe signs and symptoms that continue or develop after acute COVID-19 (2) It includes continuous symptomatic COVID-19 called ongoing symptomatic COVID-19 (4 to 12 weeks) and post COVID-19 syndrome (more than a weeks).

Soon after the beginning of the pandemic, it was estimated that symptoms disappeared within approximately two weeks in mild cases and between 3 and 12 weeks in more serious ones. Case reports and cross-sectional studies report a list of more than 200 different symptoms in the evolution of post Covid-19 syndrome. The term called “ongoing COVID-19” continue for 4-12 weeks whereas post-Covid-19 syndrome continues for more than 12 weeks. The true prevalence of postCovid-19 syndrome is still not known yet ^[14]. According to the WHO ICF framework, rehabilitation programs should be directed to improve functional activity at 3 levels: (1) structure and function of the human body (2) physical activity intensity level (3) improvement in quality of life by environmental and personal factors. This study will help healthcare organizations in the implementation of the ICF model in rehabilitation programs. Thus, the study aimed to review studies on post Covid-19 syndrome manifesting musculoskeletal problems so that its prevalence can be known to health workers and necessary intervention can be directed for the prevention and treatment of “long-Covid syndrome”.

2. Methods

2.1 Study design

The methodological framework proposed by Arksey and O'Malley was used to conduct a scoping review. The following 5 steps were used to conduct a study

- a. Identifying the research question
- b. identifying relevant research articles
- c. research articles selection
- d. charting and extracting data
- e. summarizing, discussing, and reporting the result.

2.2 Identifying the review question

The main review question was: “What are musculoskeletal problems including balance and gait abnormalities in Covid-19 recovered patients?”

2.3 Literature search strategies

Relevant studies for scoping review were identified by searching the PubMed, Scopus, Web of Science, and Google Scholar databases for articles dated between 1 May 2020 to 4 Jan 2023. The terms used for the search were (“post Covid-19 syndrome) “OR (“Covid-19 “OR “SARS-CoV-2”), (“long-Covid”) and (“post-Covid musculoskeletal problems’ OR “long-term effect post-Covid-19”)

2.4. Eligibility criteria

The following were the Inclusion and Exclusion Criteria:

Inclusion Criteria:

- Primary data from Original articles including case reports,
- Observational studies,
- Experimental studies,
- Surveys,
- Cross-sectional studies,
- Perspectives,
- Cohort studies, and
- Secondary data from a review that assessed musculoskeletal problems at least 12 weeks (84 days) after Covid-19 infection.

The review includes studies focused on Covid-19 complications among both hospitalized and non-hospitalized patients written in English and published between 1 May 2020- 4 January 2023.

Exclusion criteria:

- Editorial reports,
- Articles that did not address the theme of the main review question,
- Articles that do not explain the full version in the database,
- Incomplete quantitative data,
- Musculoskeletal problems preceding exposure (fatigue, arthralgia, myalgia, dyspnea, chest pain present before Covid-19 infection),
- Unpublished data including case reports or abstracts.

2.5 Identification and Selection of Studies

All studies based on the confirmed diagnosis of Covid-19 in the adult population were included in this review. After searching the literature for the database, a total of 9304 articles were found. On screening, 4652 duplicate articles were removed. The title and abstract of the remaining articles were screened by two independent authors (V.S., Z.A) in two steps. Thereafter, the independent screening by the same two reviewers was done for full texts of studies to verify eligibility criteria. The third author (K.K) was consulted to resolve any disagreement between the two screening authors to reach for final decision. The three authors evaluated the full text of selected articles to confirm that they met the review's inclusion criteria. Finally, after excluding the irrelevant articles based on exclusion criteria, eligible studies were included.

2.6 Data extraction from included studies

The data were extracted from all included studies by two independent reviewers (V.S., Z.A), and are presented in a table. The following information was collected: author's names, study design, country, sample size, age, year of publication, primary outcomes, and prevalence of outcomes.

3. Results**3.1 Search results**

Fig.1 Explains a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart for the process involved in searching the database and selecting final eligible studies. We found 9304 studies by searching relevant articles. 4652 studies were removed as duplicates. Again, screening was done after duplicate studies removal, and 239 studies were found to be eligible based on keywords. Title and Abstract were screened for residual studies (n=239), and 180 studies were excluded based on irrelevant titles and/ or abstracts. 59 studies were left. Full-text screening of 58 studies was done and out of which 32 studies were excluded based on irrelevant full text content. Finally, 27 studies met our inclusion criteria and were included in this review.

3.2 Characteristics of included studies

Characteristics of all studies are shown in Table 1. The total number of participants in all 27 studies was 14,555. The sample size ranges from a case study involving 1 patient to a cross-sectional study of 3492 patients including both males and females. We included Studies done from China, Saudi Arabia, Egypt, Europe, Pakistan, Australia, Bangladesh, India, the United Kingdom, Spain, and Canada. Musculoskeletal problems after Covid-19 infection were assessed using a 4-Point Likert scale, Fibromyalgia Impact Questionnaire, International Physical Activity Questionnaire (IPAQ), 6 Minute Walk Test (6 MWT), Short Physical Performance Battery test (SPPB), Modified Fatigue Impact Scale (MFIS), Borg Scale, Modified Borg scale or 30-sec Chair Stand Test. Physical health status was evaluated in 23 studies and was commonly assessed as myalgia (6 studies), arthralgia (6 studies), fatigue (3 studies), myositis, synovitis, low back pain, and chest pain. Mental health status was assessed in 4 studies. The most frequent mental health symptoms were anxiety (4 studies), depression (4 studies), sleep problems (2 studies), and low feelings (1 study).

3.3 Physical health status

3.4.1 Musculoskeletal symptoms

Arthralgia was reported in 44-57% of individuals after coronavirus infection (3) (4) (5). Have been post-Covid-19 complications were observed in both hospitalized and non-hospitalized patients. Severe Covid-19 infections managed in ICU may lead to post-recovery sequelae including physical, mental, respiratory, and psychological disorders (6) Physical health status was evaluated in 24 studies, among all studies prevalence of post-Covid-19 myalgia was (37-68%), arthralgia (44-57%), myositis (23.2%), low back pain (6.8%), other musculoskeletal diseases (30-44.9%) chest pain (32.6%), gastritis (32.3%), cough (29.3%), and dyspnea (29.2%). One study reported cardinal symptoms of fibromyalgia (FM) in one-third of patients with acute Covid-19 as a part of the complex spectrum of PACS. The Italian version of the Fibromyalgia Impact Questionnaire was used to study the severity of FM (7). Three studies reported that the widespread use of antirheumatic drugs in post Covid-19 patients decreases the risk of arthritis. This supports the risk of Reactive arthritis in Covid-19-recovered patients. (8) . Physical, mental, and cognitive problems were reported in post-Covid-19 patients admitted to ICU. The term used to describe this is post-intensive care syndrome (PICS) (9) Moreover, the pain was reported by the majority of individuals who recovered from Covid-19 infection. Restriction of daily activities was reported in one study as 57% and physical decline with longer duration of hospitalization (6).

Table 1: Musculoskeletal Health Outcome in Post-Covid19 Survivors

First Author	Study design	country	Sample size	Age (years) Mean (SD)	Outcomes (Measurement tools)	Results, Prevalence of Outcomes
Galal et al.[1]	Cross-sectional study	Egypt	430	12-74 (37.4)	Two scores were used which include Acute stage symptoms and post-Covid symptoms. Acute-stage symptoms include 27 symptoms and post Covid symptoms include 29 symptoms including general, upper, and lower respiratory tract, neurological, cutaneous complaints, and symptoms related to other symptoms of the body.	Myalgia (60.0%), arthralgia (57.2%), restriction of daily activities (57.0%), sleeping troubles (50.9%), anorexia (42.6%), chest pain (32.6%), gastritis (32.3%), cough (29.3%) and dyspnoea (29.1%). Mean total score of acute stage symptoms was 31.0 ±16.3. Correlation between symptom score during acute attack and post-COVID-19 stage (p<0.001, r = 0.67)
Everaert et al(2)	Perspective	Belgium, Europe	22	47-61 (54.5)	Physical, mental, and cognition after hospitalization for COVID-19	Anxiety (26%), depression (21%), cognitive dysfunction (68%)
Ghauri et al., 2020 (3)	Case study	Pakistan	1	34	c-reactive protein and serum Ferritin	These patients when treated with NSAID'S resolved symptoms of arthritis completely in 10 days.
Georg et al., 2020 (4)	Prospective cohort study	Australia	78	48-60 (54)	Pro-inflammatory cytokine, inhibiting cytokine	prevalence of joint and muscle pain <10% in coronavirus, arthralgia in 15% of cases, and myalgia in 44% of cases.
Mukarram et al., 2021 (5)	Case report	Pakistan	5	25-65 (45)	SPO ₂ >95%, RA factor and anti-CCP, musculoskeletal ultrasound	Grade 2 synovitis wrist and MCP joints, arthralgia 15%

Kader et al., 2020 (6)	Quasi-experimental study	Bangladesh	118	18-70 (49.5)	Oxygen saturation (SpO ₂), Respiratory frequency (breaths per minute), Heart rate (beats/minute), Need of oxygen (litre/minute)	Spo ₂ (96.7% ±2.1 vs 90.4%±1.5), P<0.01), respiratory rate (20.5±2.4 vs 23.0± 2.2) breaths/minute, P<0.01), and heart rate (80.5±9.2 vs 91.2 ± 8.6) beats/minute P<0.01) for intervention and control group. Oxygen therapy req(lit/min) for intervention gp 0.42±0.98 and 1.4(±2.0, P<0.01) for control group
Ursini F et al., 2021 (7)	Survey	Italy	189	45±12	ACR survey criteria for FM and Fibromyalgia Impact Questionnaire (FIQ-I)	Anxiety (17.5%), Obesity (16.6%), high blood pressure (15.7%), depression (5.8%), inflammatory arthritis's (4.9%), FM (39.2%)
Reem S. Al Omar 2021 (8)	Cross-section study	Saudi Arabia	3492	25-65	Physical Activity Level by International Physical Activity Questionnaire and Musculoskeletal Disorders by Nordic Musculoskeletal Questionnaire.	Low physical activity (63.55%), moderate physical activity (21.68%), high physical Activity (14.78), MSD's (44.59%)
Wu et al., (9)	Case study	China	370	50.5 (13.2)	Anxiety, Depression, Sleep disorder	Anxiety (13.5%), Depression (10.8%), both Anxiety and depression (6.2%), sleep problem (29.5%)
Gupta et al.,2020 (10)	Survey	India	608 , USA participants (58.9%), UK (21.7%)	57 (13.9)	A questionnaire with 25 questions pertained to hygiene and confinement practice, disease status, drug procurance and e-consultations, comorbidities, and prevalent fears.	Dermatomyositis(247,40.6%, myositis (141,23.2%), polymyositis (87,14.3%), anti-Synthetase syndrome (52,8.6%)
Dzuber a A et al., (11)	Case Report	Europe	2	51 &52	Lumber MRI and VAS score for pain assessment	Patient 1: VAS score Pre-COVID-19-1, Peri-COVID-19-9, Post-COVID-19-8, Post-surgery VAS-0 Patient 2: VAS score Pre-COVID-19-3, Peri-COVID-19-7, Post-COVID-19-5, Post-surgery VAS-1
Aly. M, Saber. H (12)	Retrospective cross-sectional study	Egypt	115	>60, 73.18±6.42	The questionnaire included- recovery duration, time, post-recovery general and specific symptoms (neurological, sleep, nasopharyngeal, gastrointestinal, chest, cardiac, musculoskeletal, and nephron-logical)	Post-recovery symptoms (77.4%), chronic fatigue syndrome (52.2%), musculoskeletal symptoms (48.6%), sleep problem (63.4%)
Zalat M.	Cross-	Saudi	385	36.49±5.	The questionnaire, has 4	Musculoskeletal health

and Bolbol .S 2022 (13)	section al survey	Arabia		02	section-sociodemographic data, health problems, telework job satisfaction, and Recuperation.	problems (78.2%), work-related stress (65.9%), visual problems (47%), poor mental health (45.5%), chronic disease (42.6%), feeling of isolation (22.8%)
Leon et al.2022 (14)	Cross-section al observ ational study	Spain	105	66.82 (14.83)	Patient sociodemographic, clinical, laboratory finding, and imaging findings(chest X-rays or scans)	ARD (68.5%), NARD (68.6%)
Gerez J et al., 2021 (15)	Rando mized control trial	Australi a	38	18-75, Interventi on gp (40.79 ± 9.84), Control gp (40.32±1 2.53)	6MWT,MD12,30STST,Borg scale	Intervention gp: post intervention, 6MWT(487.58±133.36), 30S TST(14.00±5.47), MD12 (5.89±3.48), Borg scale (2.95±1.27) Control gp: post intervention 6MWT(399.0±126.07), 30STST(11.11±3.78), MD12(9.79±7.47), Borg scale (4.26±1.85)
An Qi-Jun, De-an Qin, and Jin-Xian Pei 2021 (16)	Case study	China	1	23	ReA factor and MRI findings	ReA positive, MRI findings-moderate knee effusion with synovitis post-CCovid-19 vaccination
Hoong C et al (17)	Cohort study	Singapo re	294	30-45(36)	Arthralgia, myalgia, backache, generalized body aches	Arthralgia (5.7%), myalgia (37.5%), backache (6.8%), body ache (50%)
Liu et al (18)	Cross-section al survey study	China	675	53.94 (18.57)	Anxiety, Depression, PTSD symptoms, Sleep difficulty	Anxiety (10.4%), Depression (19%), PTSD (12.4%), Sleep difficulty (most frequently)
Ostrowska M.et al 2023 (19)	Prospe ctive, Observ ational	Poland	97	60.5 (50.0- 68.0)	Dyspnoea, fatigue, exercise tolerance (6MWT,30 CST), physical fitness (SPPB),	
Hodgson.C et al., (20)	Prospe ctive Cohort Study	Australi a	212	61 (51- 70)	the primary outcome was death or new disability in survivors at 6 months. World Health Organisation Disability Assessment Schedule 2.0-12L (WHODAS) , Hospital Anxiety and Depression Scale (HADS), Impact of Events Scale-6 (IES-6), Montreal Cognitive Assessment (MoCA BLIND), Instrumental Activities of Daily Living	43 patients died and 117 patients were alive 112 WHODAS ,94IADL, 89 HADS, 87 IES, 72 MoCA-BLIND.

Wozniak H. et al.,2021 (21)	Cross-sectional study	Switzerland, Europe	3461 HCW with 352 ICU HCW. (352+3109)	18-60	Generalized Anxiety Disorder 7 items (GAD-7), the Patient Health Questionnaire 9 items (PHQ9), the Peritraumatic Distress Inventory (PDI) and the World Health Organization Well-Being Index (WHO-5) from the 28th May to 7th July 2020	145 (41%) - low well-being, 162 (46%) - anxiety, 163 (46%) - depression, and 76 (22%) - peritraumatic distress
Khosrokiyani .Z et al 2022 (22)	randomized controlled trial	Iran	120	18-65	Effect of PNE in online and face-to-face, NPRS, NDI	
Zheng R et al., (2021) (23)	Cross-sectional study	Wuhan, China	3,228	29-50	questionnaire combining depression and anxiety scale	depression (34.3%) and anxiety (18.1%)
Halpin. J S. et al 2020 (24)	Cross-sectional study	United Kingdom	100	Ward pts-70.5 (20-93), ICU pts 58.5 (34-84)	Likert scale & the domains of mobility, personal care, usual activities, pain, and anxiety/depression were addressed using the EQ-5D-5L Version for Interviewer Administration	fatigue was the most common reported symptom 72% in the ICU group, and 60.3% of ward group. The next most common symptoms were breathlessness (65.6% in the ICU group and 42.6% in the ward group) and psychological distress (46.9% in the ICU group and 23.5% in the ward group)
Weerahandi.H et al 2020 (25)	Cohort study	Italy	161	50-67(52)	the PROMIS Dyspnea Characteristics and PROMIS Global Health-10.	Dyspnoea 113/152 (74%) within the prior week (median score 3 out of 10 [IQR 0-5]) vs 47/152 (31%) pre-COVID-19 infection, 52/148 (35.1% needed home oxygen after hospital discharge; 20/148 (13.5%) - still using oxygen at the time of the survey.
Raman B et al 2021 (26)	Cohort study	United Kingdom	58	55±13 years	(MRI), spirometry, six-minute walk test, cardiopulmonary exercise test (CPET), quality of life, and cognitive and mental health assessments.	64% - breathlessness and 55% -fatigue. On MRI, abnormalities were seen in the lungs (60%), heart (26%), liver (10%), and kidneys (29%).
Lorenzo R et al 2020 (27)	Cohort study	Italy	185	57 (48; 67)	respiratory rate (RR) >20 breaths/min, moderate to very severe dyspnoea, malnutrition, or new-onset cognitive impairment, according to validated scores. Post-traumatic stress disorder	58 (31.3%) -dyspnoea, 41 (22.2%) tachypnoeic, 10 (5.4%) malnourished, 106 (57.3%) were at risk for malnutrition. Forty (21.6%) patients had uncontrolled BP, and 47 (25.4%) had new-onset cognitive impairment.

					(PTSD) - secondary outcome.	PTSD was observed in 41 (22.2%) patients
--	--	--	--	--	-----------------------------	--

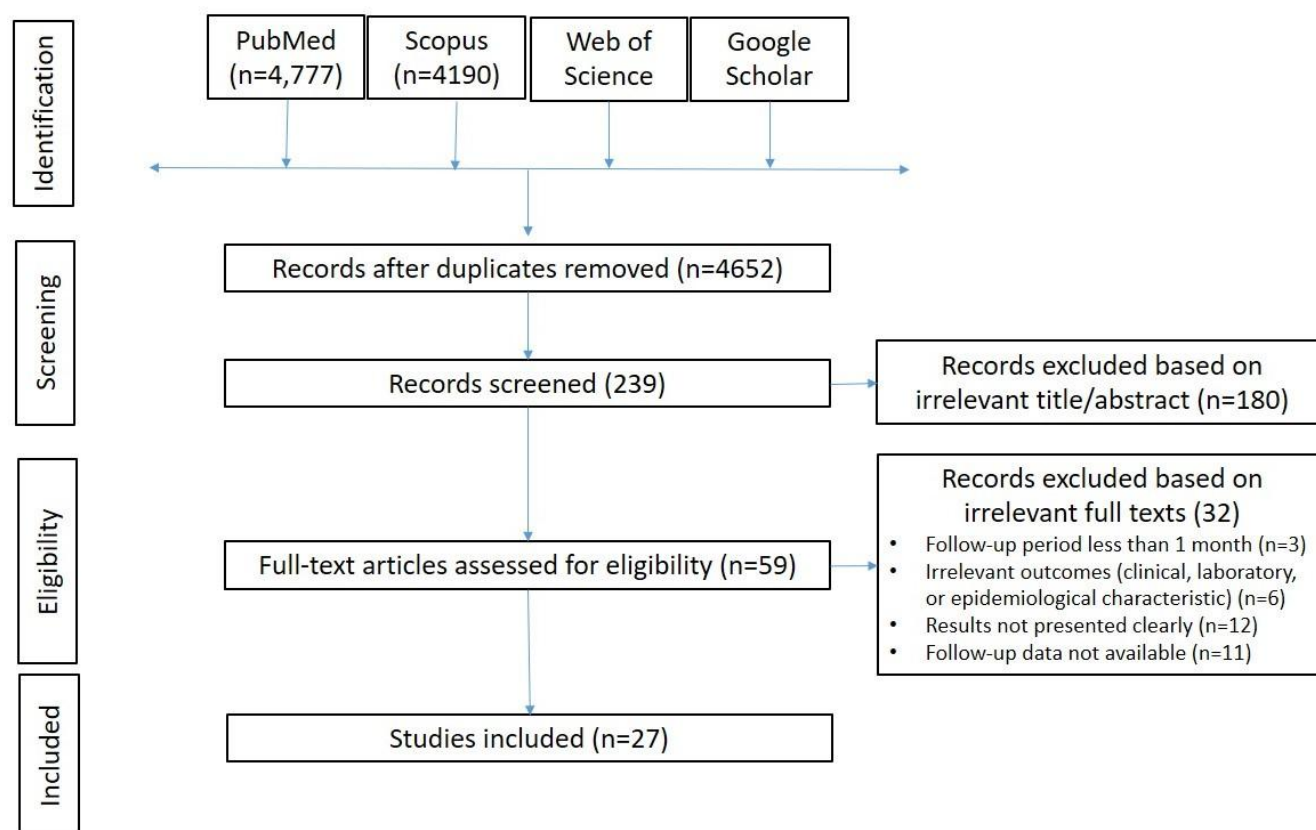


Fig. 1. PRISMA flowchart for the literature review

3.4.2 Multidisciplinary rehabilitation in post-Covid-19 Recovery

Three studies proposed the effectiveness of the use of a telerehabilitation program based on respiratory exercise (breathing exercises) in Covid-19 patients with mild to moderate symptoms in the acute stage (10) (11) Two studies evaluated the effect of multidisciplinary rehabilitation on improvement in long Covid-19. The review study includes the literature work done on the potential benefits of exercise in post-Covid-19 syndrome (12) (12). Exercise work as a psychoactive drug. It improves the quality of life, depression, anxiety, and pain.

4. Discussion

This review highlights the numerous musculoskeletal health problems after Covid-19 infection usually after a follow-up period of 3 months. After reviewing the literature, about 87% of those who recovered from Covid-19 infection were still suffering from at least one symptom 1 to 2 months after the disease onset (3). This study identified post-Covid-19 complications involving respiratory, gastrointestinal, cardiovascular, neurological, musculoskeletal, and psychological problems. Among all the complications, the review paper mainly focuses on musculoskeletal health problems (13). Myalgia and arthralgia are the most frequent symptoms reported in post-Covid-19 patients (3) (2) (4) (14). Viral infections are prone to cause arthritis which ranges from arthralgia to chronic arthritis. Joint and muscle pain occurs in <10% of infected cases. Endemic human coronavirus is at increased risk of developing RA (2) Fatigue is the next common complication affecting the physical capacity of an individual (15) (16) (17) (8) Joint and muscle pain have been reported to be about 10-27% at 4-8 weeks after infection. Residual interstitial abnormalities of COVID-19 pneumonia persist in (12)some patients for 3 months. In others, the severity of chronic obstructive pulmonary disease had become more pronounced over 2 months, indicating that lung damage persists in some discharged

patients. Abnormal results in respiratory function and imaging are included in some studies based on MRI, 6-minute walk test, CPET, and spirometry (18) (19) (14) (20). Among psychological stress-related symptoms developed after Covid-19 infection anxiety, depression, sleep problems, and cognitive dysfunction are common effects to be given attention by health practitioners (9) (7) (21) (13) (22) (23) (24) Behavioral psychotherapy treatment are recommended for improving such mental health problems. Physiotherapy, yoga, and meditation can also bring good results for the management of post-Covid-19 complications. New techniques like Dynamic Neuromuscular Stabilization techniques based on developmental kinesiology can be effective in managing musculoskeletal complications after Covid-19 infection. Use of modern modes of digital communication like internet consultation and smartphone applications can be used under name of telehealth (telerehabilitation and telepsychiatry) (11) Therefore, telehealth along with rehabilitation could be considered as follow-up treatment in post-Covid-19 recovered patients in efforts for preventing long-lasting mental and physical health complications and to eliminate the existence of long-Covid.

5. Implications on physiotherapy practice

Till date, there is no specific pharmaceutical treatment for the management of patients with post COVID-19 syndrome. Majority of research work has mainly focused on prevention and treatment of the acute phase of the infection. Thus, there is need to carry out multidisciplinary rehabilitation program for the treatment of post COVID-19 syndrome. The symptomatic management should be composed of physical and mental rehabilitation. Physical activity, therapeutic education and psychotherapy can improve body composition, dyspnea, fatigue and physical capacity of patients with long COVID-19 (25). Non-pharmaceutical intervention and Physiotherapy rehabilitation includes exercises and electrotherapy modalities. Tailored and supervised training exercise may be an effective multisystemic therapy for the treatment of post COVID-19 complications (26). Apart from conventional exercise protocol focusing on resistance, endurance and balance training, a new approach of Dynamic Neuromuscular Stabilization exercise training protocol should be added in physiotherapy intervention program. The technique is based on developmental kinesiology proposed by Professor Pavel Kolar (27) Although the technique is used for sports and neurological rehabilitation but its implication to COVID-19 recovered patients for treatment of musculoskeletal symptoms can be of potential benefits. DNS exercise can not only be used in the functional treatment of Musculoskeletal system syndrome where patients feel pain but also improves exercise capacity. Based on Integrated Spinal Stabilization system, it improves the spinal stability, trunk control, fear of falling and balance (28). According to evidence, DNS is an effective protocol to decrease pain (28) and improve respiratory functions and core muscle strengthening. In addition, TENS may be potential and effective therapeutic method to relieve acute and chronic pain of long COVID symptoms like arthralgia, myalgia, fatigue (29). Acu-TENS in COVID-19 patients may be useful in improving lung function as it decrease dyspnoea and improves lung volumes and capacities (30). Implication of musculoskeletal physiotherapy telehealth services has shown a feasible and effective alternative services for management of musculoskeletal problems in post COVID-19 syndrome when an individual is unable to access in-person healthcare.+

4.1 Limitations

According to the WHO definition of health, only physical and mental health complications were reviewed in this article but post-COVID-19 social complications affecting society and individuals were not considered in this review. Moreover, only English language studies were restricted for this review.

5. Conclusion

This scoping review highlights the persistence of musculoskeletal health problems after a COVID-19 infection for up to 3 months. Early screening and physiotherapy rehabilitation including new techniques of DNS may be effective to prevent and manage post-COVID-19 complications. It can reduce financial and clinical health burdens by preventing long-term disability.

Funding

This research did not receive any grant or funding.

Declaration of Competing Interest

The authors declare no competing interests to report.

Appendix A

(Covid-19[tiab] OR "novel coronavirus 2019" [tiab] OR SARS-CoV-2[tiab] OR nCoV[tiab]) AND ("post COVID-19 syndrome" [tiab] OR "Long COVID" [tiab] OR "musculoskeletal complications post COVID-19" [tiab] OR "on going COVID-19" [tiab] OR "Long-term Effect" [tiab] or "Long term Effects" [tiab] OR "COVID-19 Complications" [tiab] OR "Follow-up[tiab] OR "post-discharge" [tiab])

References

1. Meena A. E.G.Aly HGS. Long Covid and Chronic Fatigue Syndrome: A Survey of Elderly Female Survivors in Egypt. *International journal of Clinical Practice*. 2021 September;; p. 1-7.
2. Schett Georg BMS. COVID-19 revisiting inflammatory pathways of arthritis. Germany.; medicine; 2020.
3. Islam Galal AARMH. Determinants of persistent post-COVID-19 symptoms:value of a novel COVID-19 symptom score. *Egyptian journal of Bronchology*. 2021.
4. Muhammad Shariq Mukarram MIG. COVID-19 : An Emerging Culprit of Inflammatory Arthritis. Karachi: Jinnah Medical College Hospital, Internal Medicine; 2021.
5. Jer En Lee CWSHa*MNMEAa,TCT. Viral arthralgia a new manifestation of COVID-19 infection? A cohort study of COVID-19-associated musculoskeletal symptoms. *International Journal of Infectious Diseases*. 2021 January; 104: p. 363-369.
6. Islam Galal aAR. Determinants of persistent post-COVID-19 symptoms:value of a novel COVID-19 symptom score. *The Egyptian journal of Bronchology*. 2021.
7. francesco Ursini Jacopo Ciaffi LM. Fibromyalgia: a new facet of the post-COVID-19 syndrome spectrum?Results from a web-based survey. *RMD Open*. 2021 August.
8. George. *Australian Journal of Physiotherapy*, Springer. 2020.
9. stephanie Everaerts aH. COVID-19 recovery:benefits of multidisciplinary respiratory rehabilitation. *BMJ Open Respiratory Research*. 2021.
10. Juan Jose Gonzalez-gerez MH. Short -term effects of a respiratory Telerehabilitation program in confined COVID-19 Patients in acute phase: A Pilot Study. *International journal of Environmental Research and Public health*. 2021.
11. michelle A. Cottrell TGR. Telehealth for Musculoskeletal physiotherapy. *Musculoskeletal Science and practice*. 2020.
12. Amaya Jimeno-Almazan JGp. Post-COVID-19 Syndrome and the potential Benefits of exercise. *International journal of Environmental Research and Public Health*. 2021.

13. Marwa Zalat SB. Telework Benefits and Associate Health Problems during the Long Covid19 Era. WORK-A JOURNAL OF PREVENTION ASSESSMENT & REHABILITATION. 2021 August;; p. 371-378.
14. Manzur Kader MAH. Effects of short-term breathing exercises on respiratory recovery in patients with COVID-19- a quasi-experimental study. Bangaldesh, Sweden ,UK: Institute of Environmental medicine, physiotherapy; 2020.
15. Alomar RS. Level of Physical Activity and Prevalance of Musculoskeletal Disorders among Physician in Saudi Arabia Post Covid 19 Lockdown. An Epidemisisological Cross sectional Anal. Journal of Primary care and Comunity Health. 2021 July; 12: p. 1-8.
16. Małgorzata Ostrowska * ARĆ,ŁP,PMAKO,MJ,MK,JKaAK. Effects of Multidisciplinary Rehabilitation Program in Patients with Long COVID-19: Post-COVID-19 Rehabilitation (PCR SIRIO 8) Study. Journal of Clinical Medicine. 2023 January.
17. at.I. SJH. Postdischarge symptoms and rehabilitation needs in survivors of COVID-19 infection: A cross-sectional evaluation. Journal of Medical Virology. 2020 July;; p. 1013-1022.
18. Andrej D.Zubera JC. Vertebral Algic Syndrome Treatment in Long Covid-cases Reports. Intentionational Journal of Environmental Research and Public Health. 2021 October; 18: p. 1-7.
19. at.I. BR. Medium-term effects of SARS-CoV-2 infection on multiple vital organs, exercise capacity, cognition, quality of life and mental health, post-hospital discharge. EclinicalMedicine. 2021 January; 31: p. 1-13.
20. at.I. RDL. Residual clinical damage after COVID-19: A retrospective and prospective observational cohort study. PLOS ONE. 2020 October; 15: p. 1-16.
21. C. Wu XHJSDY. MEntal Health Status and Related Influencing Factors of Covid-19 Survivors in Wuhan China. Clinical Trans. Medicine. 2020; 10.
22. I. LA. Risk factors associated with mental illness in hospital discharged patients infected with COVID-19 in Wuhan, China. Psychiatry Research. 2020 July; 292: p. 1-7.
23. Wozniak H. Mental health outcomes of ICU and non-ICU healthcare workers during the COVID-19 outbreak: a cross-sectional study. Annals of Intensive Care. 2021.
24. at.I. RZ. Prevalence and associated factors of depression and anxiety among nurses during the outbreak of COVID-19 in China: A cross-sectional study. International Journal of Nursing Studies. 2021 October; 114: p. 1-8.
25. Malgorzata Ostrowska ARCLpPM. Effects of Multidisciplinary Rehabilitation Program in Patients with Long COVID-19;Post-COVID-19 Rehabilitation(PCR SIRIO 8) study. Journal of Clinical Medicine. 2023;; p. 1-10.
26. Amaya Jimeno -almazan JGpABRAMc. Post-COVID-19 Syndrome and the Potential Benefits of Exercise. International Journal of Environmental Research and Public health. 2021;; p. 1-16.
27. Clare frank AKPK. Dynamic Neuromuscular stabilization and Sports Rehabilitatiuon. International Journal of Sports Physical Therapy. 2013; 8: p. 62.
28. Ilbong park CPKkaYC. The Effecest of Dynamic Neuromuscular stability exercise on the Scoliosis and pain control in the youth baseball players. Journal of Mechanics and biology. 2021; 21: p. 1-10.
29. Machado f. Physiotherapy in the management of pain in musculoskeletal Manifestations after COVID-19. CPQ Orthopaedic. 2021;; p. 1-8.
30. Nikhil Aggarwal Nv. Effect of Transcutaneous Electrical nerve Stimulation(TENS) on lung function among COVID-19 patients-A Review Study. Journal of Clinial and Diagnostic Research. 2020; 14.

31. Latika Gupta JLKVAHCRA. Covid19 and Myosities A Uniq Challenges for Patients. *Rheumatology*. 2020 August;; p. 1-4.
32. Leticia Leon IPSAm. Persistant Post Discharge Symptoms after Covid19 in Rheumatic and Musculoskeletal Diseases. *Rheumatology Advances in Proactice*. 2022 Februray;; p. 1-9.
33. Juan Jose GGMSH. Short Term Effects of Respiratory Tele Rehabiliatation Programe in Confined Covid19 Patients in Accute Phase: A pilot Study. *International Journal of Environmental Research and Public Health*. 2021 July;; p. 1-9.
34. Qi-Jun Am DAQaJXP. Reactive Arthritis after Covid19 Vaccination. *Human Vaccines and Immunotherapeutics*. 2021; 17: p. 2954-2956.
35. at.l CLH. Comparison of 6-Month Outcomes of Survivors of COVID-19 versus Non–COVID-19 Critical Illness. *American Journal of Respiratory and Critical care Medicine*. 2022 May; 205(10): p. 1133-P21.
36. Khosrokiani Z. The comparison between the efects of pain education interventions with online and face-to-face exercise and the control group received biomedical education + standardized physical therapy in patients with chronic nonspecifc neck pain during COVID-19: prot. *BMC*. 2022;; p. 3-11.
37. Himali Weerahandi MMal. Post-Discharge Health Status and Symptoms in Patients with Severe COVID-19. *Journal of General Medicine*. 2021 January;; p. 738-745.