

Research article

Assessment of Musculoskeletal Pain in Medical Rehabilitation of POST-COVID-19 patient

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Abstract: Background: Remaining phenomena presented by people who endured COVID-19 at various times after the acute phase of the disease, remain the objectives of the medical and social approaches. Musculoskeletal pain is increasingly reported by patients as one of the persistent symptoms in post-COVID-19 syndrome. The purpose of the study was the qualitative and quantitative assessment of musculoskeletal pain post _COVID 19 in the process of in-hospital medical rehabilitation.

Methods: A group of 124 people who suffered SARS-Cov-2 infection were analyzed and underwent rehabilitation treatment with physiotherapy, halotherapy and electrotherapy sessions in the specialized “Post COVID rehabilitation” ward during a period of 14 days. For the analysis of the pain phenomenon, 103 people who presented musculoskeletal pain, before and after treatment were assessed by the Nordic Musculoskeletal Questionnaire, pain intensity by VAS scale and intensity of fatigue syndrome.

Results. Musculoskeletal pain was present in 84.3% of cases among persons admitted for rehabilitation treatment. Rehabilitation programs applied under inpatient conditions increased the rate of people with moderate and mild pain by 6.8% and decreased the rate of those with severe pain by 13.6% ($p < 0.05$), assessed by the Nordic Musculoskeletal Questionnaire. The proportion of patients with severe pain, assessed by the VAS scale, decreased by 13.8% at discharge from the hospital.

Conclusion. In-hospital medical rehabilitation programs applied to people with musculoskeletal pain post -COVID 19 had a beneficial effect by decreasing the number of painful areas and pain intensity.

Keywords: post-COVID medical rehabilitation, musculoskeletal pain,

INTRODUCTION

The COVID -19 pathology and pandemic situation has been a major challenge for the general population and the health system in every affected country [1]. The remaining phenomena after the acute period of the disease remain targets for medical and social approaches [2,3]. It is already known that people who have suffered SARS Cov-2 infection may experience a number of persistent symptoms over a period of more than 12 weeks, such as marked fatigue, shortness of breath, confusion, diarrhea or other symptoms that cannot be explained by an alternative diagnosis [1,4]. Musculoskeletal pain is increasingly reported by patients as one of the most common symptoms present in post-COVID-19 or Long COVID syndrome, as well as being one of the most common symptoms in this period

[5]. At the moment all symptoms present in the long term after the acute phase converge to the common term Long COVID or persistent COVID [2,6]. From 10% to 20% of convalescent patients experience effects of the disease 12 weeks after infection diagnosis [7] with persistence of symptoms for more than a month, and 1.5-2% of patients may experience deficits for an indefinite period of time [4]. Symptom frequency was reported for the first month 37.2%, the third 21.8% and the sixth 18.2% [8]. Post COVID-19 sequelae are poly-organic in nature with a predominance of respiratory deficits and, no less important for their complexity, extrapulmonary deficits [9].

The most common remaining symptoms are fatigue (15-87%), dyspnea (71%), chest pain (12-44%), cough (17-26%) [9,10,11]. Physical disability caused by the severity of the disease and immobilization is associated with other medical deficits and greatly influences the patient's clinical-functional status [12,13,14]. Numerous studies investigating the prevalence of long-term post-COVID musculoskeletal pain and its risk factors in a large cohort of COVID-19 survivors concluded, that post-COVID musculoskeletal pain is present in 45.1% of COVID-19 survivors and 8 months after hospital discharge. Research in the field has shown the overall prevalence of post-COVID myalgia, joint pain and chest pain to be 5.65% to 18.15%, 4.6% to 12.1% and 7.8% to 23.6%, respectively, at various follow-up periods during the first post-infection year. [15,16]. Musculoskeletal pain and fatigue are highlighted as the most common at the onset of COVID-19 and were observed in 50-80% of patients. Myalgia, arthralgia and fatigue are commonly present in post-COVID-19 patients. Often the incidence of arthralgia is directly proportional to the severity of COVID-19 [17].

At the same time, pain is also a common symptom experienced during a post-COVID phase by people with Long COVID. A meta-analysis reported an overall prevalence of post-COVID musculoskeletal pain of up to 23.6% in the first six months after infection. This prevalence rate was based on studies investigating general post-COVID symptoms.

The prevalence of post-COVID musculoskeletal pain is high in patients reporting post-COVID pain. Yelin et al. defined the so-called "pain syndrome model", a subgroup of subjects with pain as the main post-COVID symptom. Consequently, the design and interpretation of the mechanism of post-COVID pain are crucial [15,18,19].

Estimation and assessment of remaining symptoms and functional sequelae serve as work priorities at various stages of treatment to improve functional capabilities [11,12].

Short-term or irreversible disability caused by the symptoms of post-COVID-19 syndrome is the focus of care teams in nursing and rehabilitation units [20]. Functional impairment, autoimmune processes and severe psychological distress following COVID-19 can cause the development and exacerbation of diseases characterized by chronic pain and fatigue, such as fibromyalgia and chronic fatigue syndrome [21].

The results of some studies have shown that reducing post-COVID-19 sequelae is fundamental to early and multifactorial treatment managed by the multidisciplinary rehabilitation team. [10,12,18]. Comprehensive rehabilitation includes correction of functional impairments, pain control, consistent physical, psychological and social rehabilitation, thereby providing an increase in maximum functional capacity, with improvement of the person's psycho-emotional status in approximately 50% of cases of post-COVID-19 sequelae [22]. The WHO's legislative acts have mentioned the impact of long-term COVID on the individual, society and the economy, with the obvious need to guide and plan the rehabilitation process by determining the need for rehabilitation in relation to the dysfunctions presented. In this context, providing access to multi and interdisciplinary rehabilitation services, assessing functional requirements and desired outcomes in the conduct of post-COVID-19 individuals remains a current direction for health services [23].

Thus, we set out to estimate the post COVID-19 persistent phenomena with the anchoring of musculoskeletal pain evolution in the in-hospital medical rehabilitation process.

Materials and methods.

The study is an analytical and observational descriptive study of people with post-Covid syndrome admitted for medical rehabilitation. Participation in the study was voluntary and participants were provided with information about the research with signed consent. The clinical and functional profile of 124 patients who were referred for medical rehabilitation treatment in the "Post COVID Rehabilitation" ward of the IMSP Clinical Hospital of the Ministry of Health of the Republic of Moldova within 30 days to 18 months after the acute infection was analyzed. All patients were given referral tickets for rehabilitation treatment by the family doctor. The age of patients ranged from 30 to 83 years (mean 63.95 years). Duration of hospitalization 14 days. Patients included in the study followed the treatment protocol composed of three phases: assessment, intervention and post-treatment assessment at discharge from hospital.

On admission all patients were examined clinically (subjective data, examination by organs and systems) and functionally by assessment of fatigue syndrome (0-10 points, where maximum fatigue is assessed by 10 points and no symptoms by 0 points); pain intensity by VAS 0-10 points (Visual Analogue Scale) and musculoskeletal pain by completing the Nordic Musculoskeletal Questionnaire, general part. Medical rehabilitation interventions included individual physiotherapy sessions of 15-30 minutes daily. The main goals of the physiotherapy were respiratory re-education, general mobilization and adaptation to effort. During the sessions the patient's general condition, oxygen saturation, blood pressure, heart contraction frequency were monitored. Sessions were interrupted or stopped whenever a significant change in these indicators was observed. Physical treatment included magnetic field in musculoskeletal pain region, predominantly thoracolumbar region and lower limbs-30 min, halotherapy for 30 min over one day. Drug treatment included vascular preparations, NSAIDs, myorelaxants, metabolic, vitamin therapy. At discharge the clinical and functional evolution was evaluated repeatedly. Data collected in the study were quantitative, with nominal, ordinal, and numerical variables, with variables including participant demographics, intervention process, and assessments.

Data analysis was conducted using SPSS v. 21.0, with description of data and variables using descriptive statistical analysis. Results were expressed either as mean \pm standard deviation (SD) or as number (%). We also tested whether there was an association between symptoms of fatigue, myalgia, joint pain during the Rehabilitation period using generalized estimating equations through a selection of binary logistic regression models. 95% confidence interval (CI) values that did not include 1 indicated statistical significance.

Results

The clinical and functional profile of 124 people with musculoskeletal pain who had sustained SARS Cov-2 infection and referred to specialized medical rehabilitation between 1 month and 18 months after the acute phase of the disease was assessed and analyzed. The mean age of the study group was 63.9 ± 1.08 years, of which 60.49% (n=75) female, 39.51% (n=49) male. According to the territorial distribution, 61.3% (n=76) of the respondents came from urban areas, and 38.7% (n=48) - from rural areas. Following the analysis of medical documentation it was determined that 72% of people suffered from severe form of SARS-Cov-2 infection, medium form -20% cases and mild form - 8% cases.

We were interested in assessing the comorbidities presented in the referral notes. The most common concomitant pathology was interstitial lung disease/pulmonary fibrosis- 72.1% cases, followed by 45.3% - ischemic heart disease, 55.7% - hypertension, 24.2% - diabetes mellitus, 15.7% - dyslipidemia, 12.2% - arthritic disease, 3.7% - obesity, 1.5% - reactive hepatitis, 1% - autoimmune thyroiditis. The most common being interstitial bronchopneumonia - 72.1, ischemic heart disease - 45.3%, hypertension-55.7%. Subjective data (complaints, anamnesis), revealed 9 most common symptoms: fatigue in 93.6% cases, cognitive impairment (decreased memory, decreased attention) - 92.3%, dyspnea (shortness of breath) - 87.2%, chest pain - 85.1%, musculoskeletal pain - 84.3%, non-productive cough - 60.2%, headache - 56.2%, abdominal discomfort - 21.1%, cardiac discomfort -20.2% (Fig.1).

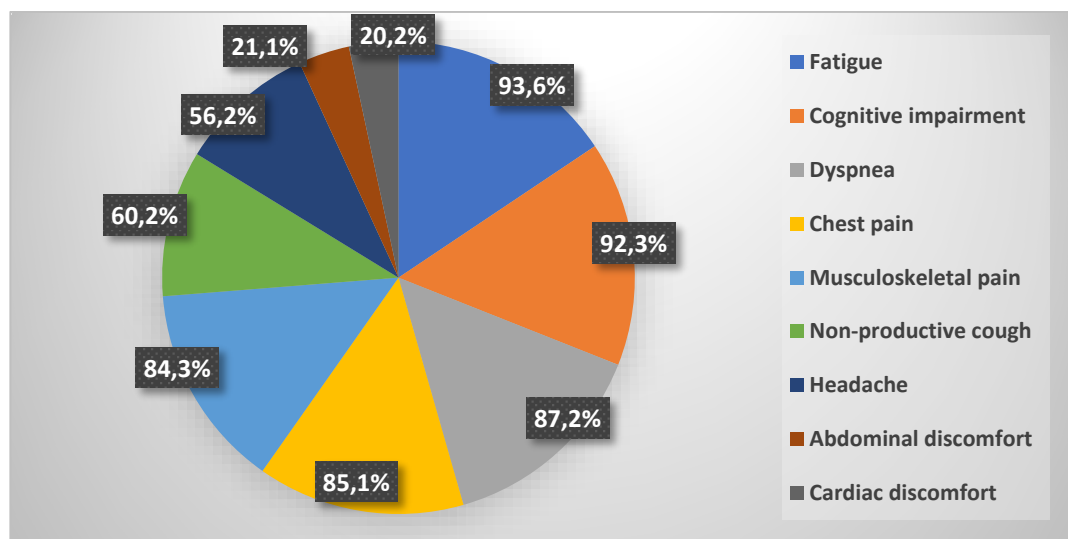


Figure 1. Frequency of post-COVID symptoms in the study group.

The most common symptoms in the patients in the study were estimated by applying the functional assessment scales: pain intensity according to the Visual Analogue Scale (VAS), musculoskeletal pain (84.3%) by completing the Nordic Musculoskeletal Questionnaire (NMQ), general part.

According to the Nordic Musculoskeletal Questionnaire, most patients with musculoskeletal pain experienced pain in the lumbar region (83 persons, constituting 67% of cases), followed by pain in the cervical region (64 patients, 52% of cases) and pain in the shoulder and hand (58 persons (47%) and 57 persons (46%) respectively) (Figure 2).

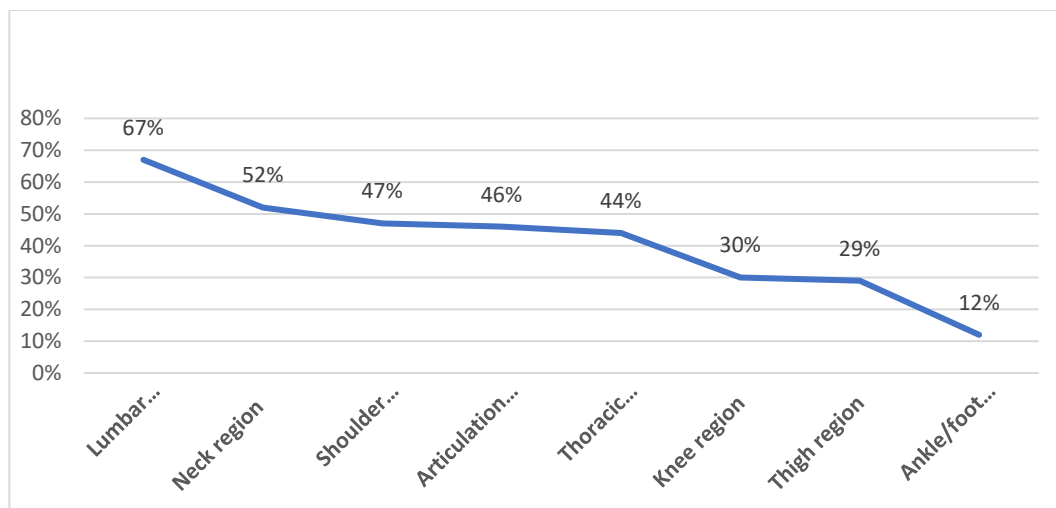


Figure 2. Proportion of musculoskeletal pain by affected area.

Considering that fatigue syndrome was presented by 116 patients (in 93, 6% cases) and musculoskeletal pain in 103 (84.3%) cases studied, from discussions with patients with musculoskeletal pain, confusion in the perception of pain and general fatigue was observed.

Out of 44 (42.7%) patients with musculoskeletal pain, who suffered a severe form of COVID-19, 83.4% (37 persons) marked general fatigue. In people after a mild form of COVID-19 with musculoskeletal pain (47 people (45.3%)) fatigue was presented in 35 (75.2%) cases. Mild form of COVID-19 was for 19 (12%) patients in the study with musculoskeletal pain, for which we marked the presence of fatigue in 4 (21%) cases. (Figure 3.)

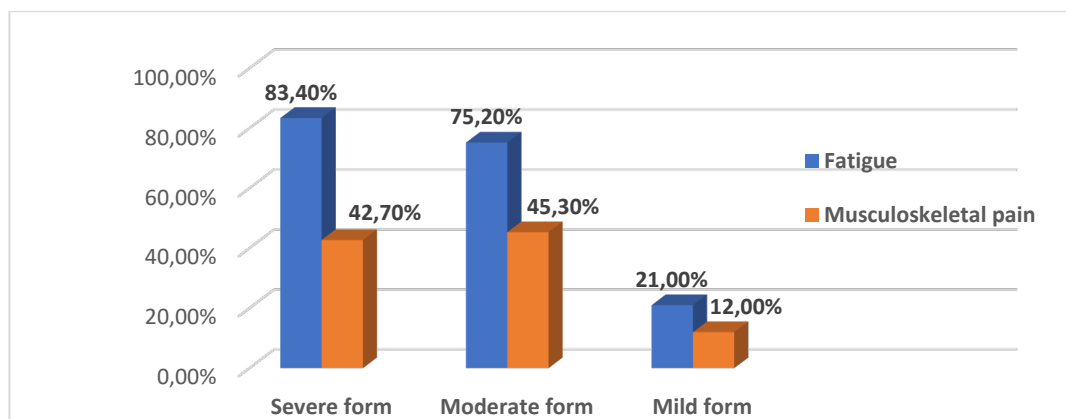


Figure 3. Association of musculoskeletal pain with fatigue.

The Nordic Questionnaire allowed us to estimate the proportion of musculoskeletal pain depending on the number of affected areas. Thus, in the result of the questionnaire, we found that no more than 3 affected areas presented 67 (65.4%) of people with musculoskeletal pain post COVID-19, from 3 to 6 affected areas were experienced by 29 (28.2%) of the persons surveyed and more than 6 affected areas were detected in 7 (6.38%) cases studied. After rehabilitation interventions we found a positive dynamic in the improvement of musculoskeletal pain, thus less than 3 affected areas were in 74.2% cases (76 persons examined), from 3 to 6 affected areas - 22.1% cases (23 persons) and more than 6 affected areas only in 3.7% (in 4 persons) studied cases (Figure 4).

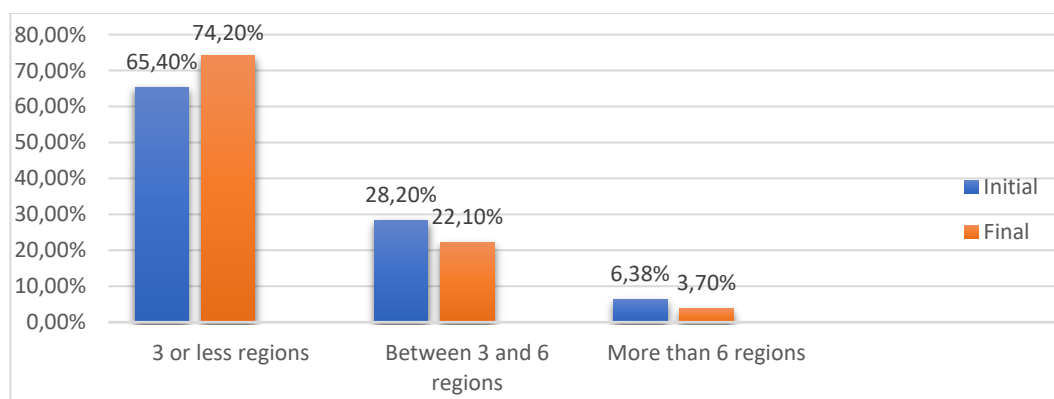


Figure 4. Share of musculoskeletal pain depending on the number of regions affected in the study group.

The evolution of pain, initially according to the Visual Analogue Scale (VAS), in the patients in the study estimated moderate pain in 61.5% cases (64 people), severe pain in 21.8% cases (22 people) and no pain in 16.7% cases (17 people). After medical rehabilitation sessions severe pain was maintained in 8 persons (in 8.2% cases), moderate pain was assessed in 71 persons (in 68.3% cases) and insignificant pain was assessed in 24 persons (23.5% cases) in the study. (Figure 5)

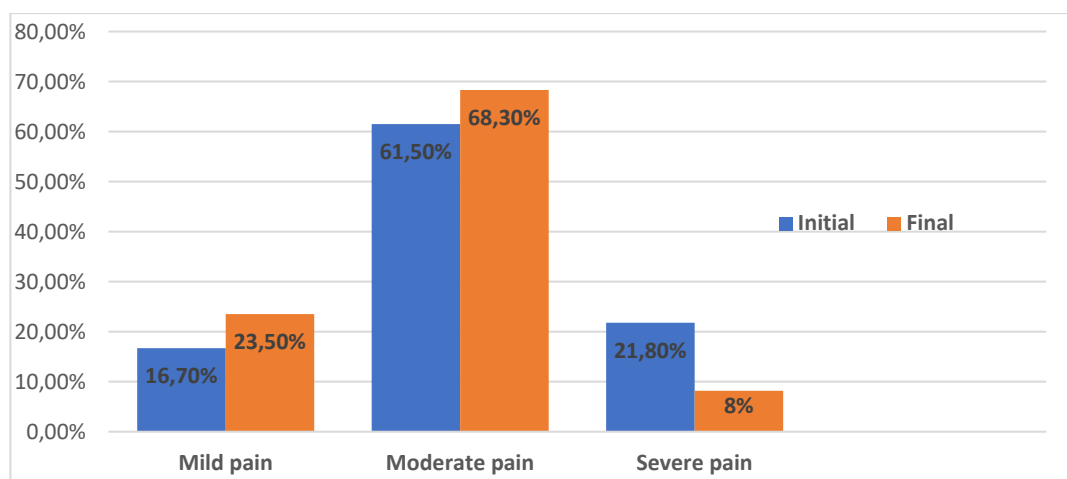


Figure 5. Dynamics of musculoskeletal pain intensity as assessed by the VAS scale

Fatigue syndrome was initially estimated in 93.6% of cases. The descriptive values in the assessment of inpatient fatigue according to the 0-10 fatigue rating scale showed the minimum value of 3.00 conventional points, maximum 8.00 points, with a mean of 5.9274 points at the standard deviation of 1.09078. After the rehabilitation interventions showed the minimum value of 2.00 conventional points, maximum of 5.00 points, with a mean of 3.0887 at the standard deviation of 1.44836. In the study group at admission, non-severe fatigue showed 21 (17.1%) of patients, moderate fatigue - 77 (62.1%) of patients and 26 (20.8%) patients showed severe fatigue. After rehabilitation treatment the fatigue values assessed in 24,1% (30 persons) cases insignificant fatigue, in 67,9% (84 persons) cases moderate fatigue and in 8,0% (10 persons) cases severe fatigue. (Figure 6)

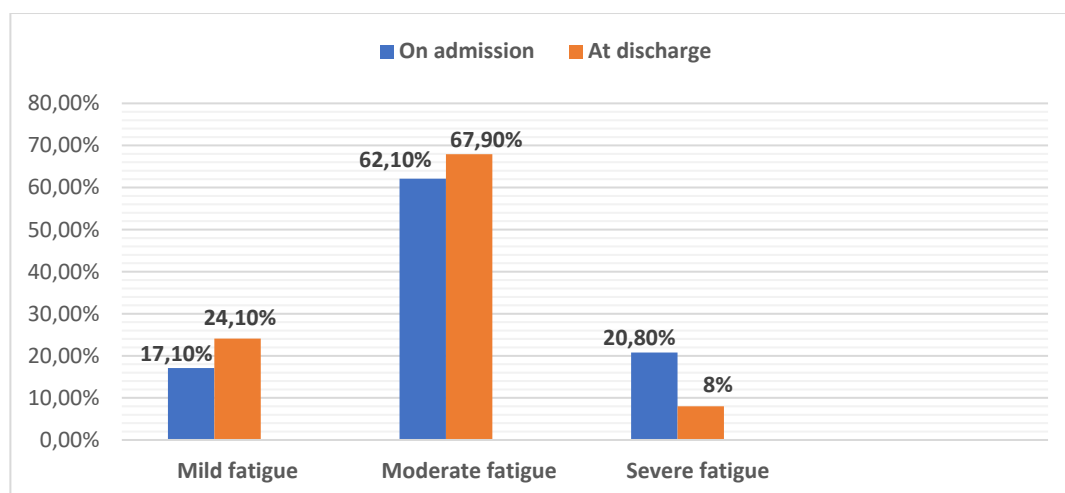


Figure 6. Assessment of fatigue syndrome in the study group.

Discussions.

The presence of post-COVID symptoms is an incentive for world medicine to establish new patterns of treatment and subsequently complex rehabilitation programs. There are already numerous studies on the variety of symptoms caused by COVID. Most studies report investigations of post-COVID musculoskeletal pain, the association of post-COVID pain with SARS-CoV-2 variants, and the intensity of post-COVID musculoskeletal pain in individuals infected with different SARS-CoV-2 variants [16, 24].

Several observational studies have recently evaluated persistent symptoms in COVID-19 survivors admitted over 3 months. Some of these studies have partially described persistent fatigue, but most have reported on the frequency and type of musculoskeletal pain. [25, 26,27].

In our study by analyzing the clinical functional profile of people who suffered COVID-19 pathology at 1 month to 18 months after the acute period (without rehabilitation interventions), we estimated a marked association of musculoskeletal pain and fatigue in people after a severe or moderate form of the disease (83.4% and 75.2% cases respectively). After the mild form of COVID -19 less musculoskeletal pain was accompanied by fatigue in only 4 out of 19 patients (in 21% cases).

Out of 103 (84.3%) people in the study with musculoskeletal pain, every third experienced pain in 3-6 affected areas and about half of the patients shared a painful joint area.

As a result of the rehabilitation treatment 3 patients (2.68%) were reduced from the category with 6 or more affected areas, by 6.1% (19 persons) the group of persons with 3-6 affected joint areas was reduced and the category of persons with less than 3 affected joint areas was increased by 8.8% (11 persons). It was difficult to determine the origin of musculoskeletal pain of post COVID-19 genesis or other pre-existing pain. At the same time, we observed a significant decrease in pain intensity of the patients in the study after the recovery treatment. Thus, severe pain remained persistent in 8 out of 22 people (decrease of 13.6%), and the number of people with moderate pain and no pain increased by 7 people (6.8%) in each group category.

The estimation of fatigue syndrome showed an increase in the number of people with non-manifest fatigue from 21 to 30 people (by 7%) after rehabilitation treatment. The number of people with moderate fatigue increased by 7 (5.8%) and the group of people with severe fatigue decreased by 16 (12.2%).

Musculoskeletal involvement is common after SARS-CoV-2 infection. Fatigue is a "faithful" companion of musculoskeletal pain also for the post-COVID period. Recent studies have highlighted musculoskeletal complications in long COVID-19 syndrome and have marked the obligatory presence of fatigue. Thus, effective rehabilitation interventions in musculoskeletal complications require perfect adjustment and standardization. [28, 29]

According to Romero et al. a multicomponent approach in the rehabilitation of musculoskeletal sequelae of COVID-19 will improve pain, functionality and quality of life.[30] Complex medical rehabilitation programs have a positive impact on the clinical and functional status of individuals in the post COVID-19 sequelae period, rehabilitation interventions decrease the intensity of musculoskeletal pain [31,32].

Conclusions.

Chronic fatigue syndrome and musculoskeletal pain are the most common clinical manifestations presented by people with long COVID syndrome.

In-hospital medical rehabilitation programs have improved clinical and functional status by reducing the severity and number of pain areas in people with musculoskeletal pain.

Author Contributions: For research articles with several authors, a short paragraph specifying their individual contributions must be provided. The following statements should be used “Conceptualization, A.T. and O.P.; methodology, V.C.; software, M.B.; validation, M.B., V.C. and A.T.; formal analysis, A.T.; investigation, M.B.; resources, V.C.; data curation, A.T.; writing—original draft preparation, M.B.; writing—review and editing, V.C.; visualization, A.T.; supervision, O.P.; project administration. All authors have read and agreed to the published version of the manuscript.”

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“Written informed consent has been obtained from the patient(s) to publish this paper”

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References

1. Pérez-González A.; Araújo-Ameijeiras A.; Fernández-Villar A. et al. Long COVID in hospitalized and non-hospitalized patients in a large cohort in Northwest Spain, a prospective cohort study. *Sci Rep* **2022**, *12*, 3369. <https://doi.org/10.1038/s41598-022-07414-x>
2. Ticărau A.; Iancu M. A.; Matei D. Sindromul Long COVID—aspecte generale. *Romanian Journal of Medical Practice*, **2021**, *16*(2) DOI: 10.37897/RJMP.2021.2.12
3. Sleat D.; Wain R.; Miller B. Long COVID: Reviewing the Science and Assessing the Risk. Available at: <https://institute.global/policy/long-covid-reviewing-science-and-assessing-ris>.
4. Jimeno-Almazán A.; Pallarés, J.G.; Buendía-Romero Á.; Martínez-Cava A.; Franco-López F.; Sánchez-Alcaraz Martínez B.J.; Bernal-Morel E.; Courel-Ibáñez J. Post-COVID-19 Syndrome and the Potential Benefits of Exercise. *J. Environ. Res. Public Health* **2021**, *18*, 5329. <https://doi.org/10.3390/ijerph18105329>
5. Khoja O.; Silva Passadouro B.; Mulvey M.; Delis I.; Astill S.; Tan AL; Sivan M. Clinical Characteristics and Mechanisms of Musculoskeletal Pain in Long COVID. *J Pain Res.* **2022** Jun 17;15:1729-1748. doi: 10.2147/JPR.S365026. PMID: 35747600; PMCID: PMC9212788.
6. Emecen A.N.; Keskin S.; Turunc O. et al. The presence of symptoms within 6 months after COVID-19: a single-center longitudinal study. *Ir J Med Sci*, **2022**. <https://doi.org/10.1007/s11845-022-03072-0>
7. Nehme M.; Braillard O.; Alcoba G.; et al. COVID-19 Symptoms: Longitudinal Evolution and Persistence in Outpatient Settings. *Ann Intern. Med.* **2020**. <https://doi.org/10.7326/M20-5926>.
8. Townsend L.; Dyer AH.; Jones K.; et al. Persistent fatigue following SARS-CoV-2 infection is common and independent of severity of initial infection. In: *PLOS ONE* **2020**, *15*(11) <https://doi.org/10.1371/journal.pone.0240784>
9. Carfi A.; Bernabei R.; Landi F.; Gemelli Against. COVID-19 Post-Acute Care Study Group. Persistent Symptoms in Patients After Acute COVID-19. *JAMA.* **2020** Aug 11; 324(6):603-605.
10. Xiong Q.; Xu M.; Li J.; Liu Y.; Zhang J.; Xu Y.; Dong W. Clinical sequelae of COVID-19 survivors in Wuhan, China: a single-centre longitudinal study. *Clin Microbiol Infect.* **2021** Jan;27(1):89-95.
11. Wong AW.; Shah AS.; Johnston JC.; Carlsten C.; Ryerson CJ. Patient-reported outcome measures after COVID-19: a prospective cohort study. *Eur Respir J.* **2020** Nov 26;56(5):2003276.

12. Tăbîrță A.; Bulai M.; Chihai V.; Pleșca S.; Melnic A. Strategii de reabilitare medicală în asistența complexă a persoanelor cu COVID-19. *Sănătate publică, economie și management în medicină*, **2021**, (4 (91)), 16-22.
13. Hammami A.; Harrabi B.; Mohr M.; Krstrup P. Physical activity and coronavirus disease 2019 (COVID-19): specific recommendations for home-based physical training. *Managing Sport and Leisure*, **2020**, 27:1-2, 26-31, DOI: 10.1080/23750472.2020.1757494
14. De Biase S.; Cook L.; Skelton D.A. et al. The COVID-19 rehabilitation pandemic. *Published by Oxford University Press on behalf of the British Geriatrics Society*. **2020**. Aug 24;49(5):696-700. doi: 10.1093/ageing/afaa118.
15. Fernández-de-Las-Peñas C.; de-la-Llave-Rincón AI.; Ortega-Santiago R.; Ambite-Quesada S. et al. Prevalence and risk factors of musculoskeletal pain symptoms as long-term post-COVID sequelae in hospitalized COVID-19 survivors: a multicenter study. *Pain*. **2022** Sep 1;163(9):e989-e996. doi: 10.1097/j.pain.0000000000002564.
16. Fernández-de-Las-Peñas C.; Navarro-Santana M.; Plaza-Manzano G.; Palacios-Ceña D.; Arendt-Nielsen L. Time course prevalence of post-COVID pain symptoms of musculoskeletal origin in patients who had survived severe acute respiratory syndrome coronavirus 2 infection: a systematic review and meta-analysis. *Pain*. **2022**, 1;163(7):1220-1231. doi: 10.1097/j.pain.0000000000002496. Epub 2021 Sep 23. PMID: 34561390.
17. Faghy MA.; Arena R.; Stoner L.; Haraf RH, et al. The need for exercise sciences and an integrated response to COVID-19: A position statement from the international HL-PIVOT network. *Prog Cardiovasc Dis*. 2021 Jul-Aug; 67:2-10. doi: 10.1016/j.pcad.2021.01.004. Epub **2021** Feb 4. PMID: 33549590; PMCID: PMC7859729.
18. Wang L.; Yang N.; Yang J.; Zhao S.; & Su C. A review: the manifestations, mechanisms, and treatments of musculoskeletal pain in patients with COVID-19. *Frontiers in Pain Research*. **2022**, 3:826160. doi: 10.3389/fpain.2022.826160
19. Yelin D.; Margalit I.; Nehme M.; Bordas-Martínez J.; et al. Patterns of Long COVID Symptoms: A Multi-Center Cross Sectional Study. *J. Clin. Med*. **2022**, 11, 898.
20. Fernández-de-Las-Peñas C.; Cancela-Cilleruelo I.; Moro-López-Menchero P.; Rodríguez-Jiménez J.; Gómez-Mayordomo V.; Torres-Macho J.; & Arendt-Nielsen L. Prevalence of Musculoskeletal Post-COVID Pain in Hospitalized COVID-19 Survivors Depending on Infection with the Historical, Alpha or Delta SARS-CoV-2 Variant. *Biomedicines*, **2022**. 10(8), 1951
21. Zhao H.; Xie Y.; Wang C. Recommendations for respiratory rehabilitation in adults with coronavirus disease 2019. *Chin Med J*. **2020**, 133:1595–602. doi: 10.1097/CM9.0000000000000848
22. Karateev A. E.; Amirdzhanova V. N.; Nasonov E. L.; Lila A.M.; Alekseeva L.I.; Pogozheva E. Y.; & Nesterenko V. A. "Post-COVID syndrome": The focus is on musculoskeletal pain. *Rheumatology Science and Practice*, **2021**, 59(3), 255-262.
23. Ponce-Campos SD.; Díaz JM.; Moreno-Agundis D.; González-Delgado AL.; Andrade-Lozano P.; Avelar-González FJ.; Hernández-Cuellar E. and Torres-Flores F.; A Physiotherapy Treatment Plan for Post-COVID-19 Patients That Improves the FEV1, FVC, and 6-Min Walk Values, and Reduces the Sequelae in 12 Sessions. *Front. Rehabil. Sci*. **2022**, 3:907603. doi: 10.3389/fresc.2022.907603
24. Ladds E.; Rushforth A.; Wieringa S.; Taylor S.; Rayner C.; Husain L.; Greenhalgh T. Persistent symptoms after Covid-19: qualitative study of 114 "long Covid" patients and draft quality principles for services. *BMC Health Serv Res*. **2020** Dec 20;20(1):1144. doi: 10.1186/s12913-020-06001-y. PMID: 33342437; PMCID: PMC7750006.
25. Bakılan F.; Gökmen İ.G.; Ortanca B.; Uçan A.; Eker Güvenç Ş.; Şahin Mutlu F.; Gökmen H.M.; Ekim A. Musculoskeletal symptoms and related factors in post-acute COVID-19 patients. *Int. J. Clin. Pract*. **2021**, 75, e14734.
26. Garrigues E.; Janvier P.; Kherabi Y.; Le Bot A.; Hamon A.; Gouze H.; Doucet L.; Berkani S.; Oliosi E.; Mallart E.; Corre F.; Zarrouk V.; Moyer JD.; Galy A.; Honsel V.; Fantin B.; Nguyen Y. Postdischarge persistent symptoms and health-related quality of life after hospitalization for COVID-19. *J Infect*. **2020**, 81:e4–e6. <https://doi.org/10.1016/j.jinf.2020.08.029>
27. González-Hermosillo JA.; Martínez-López JP.; Carrillo-Lampón SA.; Ruiz-Ojeda D.; Herrera-Ramírez S.; Amezcua-Guerra LM.; Martínez-Alvarado MDR. Post-Acute COVID-19 symptoms, a potential link with myalgic encephalomyelitis/chronic fatigue syndrome: a 6-month survey in a Mexican Cohort. *Brain Sci* **2021**. 11(6):760. <https://doi.org/10.3390/brainsci11060760>
28. Fortini A.; Torrigiani A.; Sbaragli S.; Lo Forte A.; Crociani A.; Cecchini P.; InnocentiBruni G.; Faraone A. COVID-19: persistence of symptoms and lung alterations after 3–6 months from hospital discharge. *Infection*. **2021**. <https://doi.org/10.1007/s15010-021-01638-1>
29. Crema CMT.; Hummelgen E.; Demogalski LCB.; Cardoso L.; Bauer C.; Nickel R. Recovery after covid-19: treatment program in an integrated rehabilitation center. *Acta Fisiatr* **2022**, 29(1):50-55
30. Swarnakar R.; Jenifa S.; Wadhwa S. Musculoskeletal complications in long COVID-19: A systematic review. *World J Virol* **2022**, 11(6): 485-495. DOI: [10.5501/wjv.v11.i6.485](https://doi.org/10.5501/wjv.v11.i6.485)
31. Romero E. A. S.; Carnero J. F.; Pérez J. L. A.; Rolando L. M. & Villafañe J. H. Addressing post-COVID-19 musculoskeletal symptoms through telemedicine: A study protocol. *F1000Research*, **2022**, 11(898), 898
32. Rudroff T.; Fietsam A.C.; Deters J.R.; Bryant A.D.; Kamholz J. Post-COVID-19 Fatigue: Potential Contributing Factors. *Brain Sci*. **2020**, 10, 1012. <https://doi.org/10.3390/brainsci10121012>