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Three-month recovery from common negative physical, functional, and psychosocial effects among individuals infected with COVID-19: a single observational group repeated measure study

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Three-month recovery from common negative physical, functional, and psychosocial effects among individuals infected with COVID-19: a single observational group repeated measure study

Abstract

Purpose: We examined three-month recovery from common negative effects of COVID-19 infection on select physical, functional, and psychosocial parameters among infected individuals and their implications for rehabilitation programs. **Methods:** Twenty-one subjects participated in this study. Four standardized questionnaires were used to assess dyspnea, physical, and psychosocial variables in this study. The post-test survey was conducted 90 days following the pre-test survey. Wilcoxon-Signed Rank test and paired *t*-test were used to compare the variables data between pre- and post-testing time points. **Results:** Dyspnea scores decreased from (pre: 2 vs post:1, $Z=-3.276$, $p=0.001$, $r=.50$). Work performance scores increased from (pre: 42 ± 25 vs post: 57 ± 21 , $t_{(20)}=-2.868$, $p=0.010$, $r=.62$). Social functioning increased from (pre: 44 ± 27 vs post: 60 ± 24 , $t_{(20)}=-3.525$, $p=0.002$, $r=.76$) and pain scores from (pre: 42 ± 30 vs post: 53 ± 25 , $t_{(20)}=-2.134$, $p=0.045$, $r=.46$) also increased across the 90 days. **Conclusions:** Long-term symptoms after COVID-19 infection include ongoing physical, functional, and psychosocial deficits. While dyspnea decreased and work performance and social functioning increased, we observed a concomitant increase in pain scores over the 90-day measurement period. Long-term multidisciplinary rehabilitation programs should be designed to address the ongoing deficits among this population.

Keywords

Recovery; Physical; functional; psychosocial; COVID-19

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Introduction

The lasting negative impacts of COVID-19 infection on all aspects of health among the survivors of the virus is important to understand for patient care as many individuals experience persistent symptoms following acute infection. Indeed, an early pandemic report estimated about half of COVID-19 survivors may require rehabilitation programming to offset persist symptoms related to infection.¹ During the course of infection, individuals with COVID-19 present with, but not limited to, chest tightness, dyspnea (most common symptom), cough, fever, headache, diarrhoea, vomiting, general weakness, sputum production, and dizziness.²⁻⁴ Baratto et al.⁵ reported that individuals displayed decreased functional capacity and increased exercise hyperventilation during early recovery from COVID-19. The reduction in functional capacity may be subsequent to muscle weakness and fatigue from hospital stay,^{6,7} with persistent dyspnea, reduced physical activity (PA) and quality of life occurring during the post-acute phase of COVID-19 infection.⁸ Furthermore, fatigue and exertional dyspnea have also reported as the most common symptoms even after 6 months of discharge from hospital among the survivors of the virus.⁹ A study of the medium-term (≈ 3 months) effects of COVID-19 on organ health and exercise capacity also revealed that 64% and 55% of the recovered individuals experienced dyspnea and fatigue, respectively, following 2-3 months from the infection date.¹⁰ Together, these previous reports indicate that a significant number of individuals who become infected with COVID-19 may likely suffer ongoing symptoms that adversely affect quality of life.

Investigations probing the lasting negative impacts of COVID-19 in individuals who are infected with the virus on common quality-of-life parameters, functional status, and ability of performing different intensities of physical activities are scarce. This knowledge gap has impeded the development of evidence-based approaches for rehabilitation. Therefore, we objectively examined three-month recovery from common negative effects of COVID-19 infection on select physical, functional, and psychosocial parameters among infected individuals. We hypothesized that participants infected with COVID-19 will have persistent deficits in physical ability, functional performance, and some psychosocial parameters at three months post-testing time point.

Methods

Study Design and Participants

This was a single observational group repeated measure design that recruited 22 participants (21 completed the pre- and post-tests). Participants were recruited with diagnosis of COVID-19 infection (Positive PCR results/self-reported) through social media (i.e., Facebook) due the policies of strict lockdowns that were in effect at the time of conducting this study. All the participants were unvaccinated at the time of the participation in this study. Information of the study with the link of the survey was posted 2-3 times a week for 3 months (October-December 2020). Thirty-nine participants accessed the survey during the 3-month period. However, only 22 of the participants fully completed the post-test survey. Consenting participants completed online (SurveyMonkey Inc., San Mateo, California, USA) standardized questionnaires (detailed below) as well as information about their infection date, hospitalization status (*i.e.*, hospitalized, non-hospitalized) gender, age, weight, country, and recovery periods (*i.e.*, time between date of infection and pre-testing time point).

The pre-test survey occurred during the months of October and December 2020, while the post-test survey occurred during the months of January and March 2021. The baseline values represented participants' answers for the questionnaires at the time of conducting the pre-test. The baseline values collection date ranged from 1 to 11 month after the date of the positive test with COVID-19 (*i.e.*, during the recovery time) among the participants. This study was approved by the University of Saskatchewan-Research Ethics Board (Bio-REB ID: 2312).

Inclusion criteria of this study were any COVID-19 infected individual (of any sex) between the age of 30-70 years. Participants with pre-existing chronic cardiovascular, pulmonary (other than being infected with COVID-19 and recovered), or musculoskeletal disorders were excluded from participating in this study. We excluded the participants with the aforementioned health conditions to avoid introducing confounding factors that may possibly overshadow the impact of COVID-19 lasting effects.

Scales and Questionnaires

Modified Medical Research Council Dyspnea Scale (mMRC): Similar to the original MRCDS scale,¹¹ the modified (*i.e.*, mMRC) scale¹² uses the same 0-4 descriptors.¹³ The mMRC has been validated to assess dyspneic symptom among chronic obstructive pulmonary disease (COPD) populations.¹³ Since Both COPD and COVID-19 can cause dyspnea among affected individuals,^{4,14,15} we believed

of its suitability to evaluate the deleterious impacts of COVID-19 on lung function among recovered subjects from this disease despite the scale not being exclusively validated for COVID-19 survivors. Further explanation about the use and suitability of this scale can be found in our former study.⁸ For this scale, a change of 0.5 unit represents a minimally important difference (MID).⁸

The International Physical Activity Questionnaire (IPAQ): IPAQ¹⁶ was employed because of its widespread use for attaining health-related physical activity data. The (short version) of the IPAQ is comprised of 7 questions that cover 3 categories of moderate, high, and vigorous activity levels. For IPAQ scoring, the total MET-minutes/week was calculated as walk (METs = $3.3 \times \text{min} \times \text{days}$) + moderate activity (METs = $4.0 \times \text{min} \times \text{days}$) + vigorous activity (METs = $8 \times \text{min} \times \text{days}$).¹⁶ Validity of the moderate and vigorous activity portions were reported as ($r = .430 - .557$) and ($r = .702$) for sedentary behaviors during the weekdays among older adults.¹⁷ No MID values were found for IPAQ.

The Functional Status Questionnaire (FSQ): The FSQ¹⁸ is a short questionnaire widely utilized in primary care settings for functional evaluation (*i.e.*, initial disability screening, and monitoring meaningful changes clinical status) of ambulatory individuals with health conditions over time. Comprehensive information related to the physical function in activities of daily living, psychological, social and role functions and variety of performance measures. The six scales have an internal consistency ranging from 0.64 to 0.82.¹⁸ No MID values were found for FSQ.

The RAND-36 measure of health-related quality of life questionnaire: The RAND-36¹⁹ is a commonly used generic health related quality of life (HrQoL) survey instrument. The questionnaire includes 36 items that examines eight health related concepts: physical functioning, role limitations caused by physical health problems, wellbeing, role limitations caused by emotional problems, social functioning, energy/fatigue, pain, emotional and general health perceptions. Linear transformation method was used to score each item to a 0–100 range (% of total possible score) and then averaged.¹⁹ For this scale, a change of (10, 12.5, 12.5, 10, 10, 8.3, 12.5, and 10 point/100) represents a MID for the physical functioning, role limitations caused by physical health problems, energy/fatigue, pain, emotional wellbeing, role limitations caused by emotional problems, social functioning, and general health perceptions, respectively.²⁰

Statistical Analysis

Statistical analyses were performed using SPSS version 26 (IBM Corp., Armonk, New York, USA). Demographic data and data for variables that met the normal distribution assumption were analyzed using paired *t*-test. Data for variables that did not meet the normal distribution assumption, were analyzed

using the Wilcoxon-Signed Rank test. Data obtained from the questionnaires, are reported as means, standard deviations (SD), medians, and ranges. Statistical significance was determined when $p < 0.05$.

Results

Twenty-two individuals accessed the survey over the period of 6 months (between October 2020 and March 2021). After excluding incomplete responses, the final number of participants was 21 (Table 1). Three participants were male. The dates of infection of the participants in this observational group occurred between January 2 and October 25, 2020. Four of these participants were hospitalized (hospitalization periods ranged from 1-12 days, and no participants were admitted to ICU) due to being infected with COVID-19.

Table 1. Demographics of the participants (n=21) during pre and post time points presented as mean and standard deviation (SD). Paired t -test was used to examine significant differences between the time points. Statistical significance was determined when $p < 0.05$.

Demographics	Pre	Post	p -value
Age (years)	49.0 \pm 6.9	49.3 \pm 6.7	0.010
Weight (kg)	79 \pm 15	78 \pm 18	0.530
BMI (unit)	27 \pm 4	27 \pm 4	0.507
Height (cm)	170 \pm 8	170 \pm 8	0.329

A paired t -test indicated that there were no significant differences between the pre and post-test values for weight, height, and BMI. By design, age increased during the study (Table 1)

mMRC & IPAQ. A Wilcoxon Signed-Ranks Test indicated that post-test mMRC (Mdn = 1) score was significantly lower than pre-test (Md = 2) score, $Z = -3.276$, $p = 0.001$, $r = .50$. There were no significant differences for the IPAQ between the scores of the pre and post-test time points in any of the parameters withing this questionnaire (Table 2).

Table 2. The outcome scores of dyspnea scale of the mMRC and IPAQ parameters of the participants (n=21) during pre and post time points presented as mean, SD, median and range. Paired t-test and Wilcoxon signed-rank tests were used to explore significant differences between the two time points. Statistical significance was determined when $p < 0.05$. Modified Medical Research Council: mMRC. IPAQ: International Physical Activity Questionnaire. Vig. PA: vigorous physical activity, Mod. PA: moderate physical activity, Md: median, Rn: range.

Variables	Value	Pre	Post	<i>p</i> -value
Dyspnea scale (scores,0-4)	Md, Rn	2, 4	1, 3	0.001
IPAQ, Vig PA (MET-min/wk)	Md, Rn	0, 23040	0, 10080	0.283
IPAQ, Mod PA (MET-min/wk)	Md, Rn	0, 2160	240, 3360	0.100
IPAQ, Walking (MET-min/wk)	Md, Rn	396, 2772	495, 6930	0.278
IPAQ, Total PA (MET-min/wk)	Md, Rn	577, 23817	1893, 12852	0.086
IPAQ, Sitting (min-day)	Md, Rn	480, 900	480, 1200	0.710

FSQ. There was significant difference between the pre (42 ± 25) and post-test (57 ± 21) scores, $t_{(20)} = -2.868$, $p = 0.010$, $r = .62$. in work performance favoring post-test scores. No significant differences were found in other parameters within this questionnaire (Table 3).

Table 3. The outcome scores (points/100) of the FSQ parameters of the participants (n=21) during pre and post time points presented as mean, SD, median and range. Paired t-test and Wilcoxon signed-rank tests were used to explore significant differences between the two the time points. Statistical significance was determined when $p < 0.05$. FSQ: Functional Status Questionnaire, Md: median, Rn: range.

Variables	Value	Pre	Post	<i>p</i> -value
Basic ADL	Md, Rn	78, 56	78, 133	0.871
Intermediate ADL	Mean, SD	50 \pm 24	56 \pm 25	0.171
Mental health	Mean, SD	56 \pm 16	59 \pm 15	0.489
Work performance	Mean, SD	42 \pm 25	57 \pm 21	0.010
Social activities	Md, Rn	0, 133	11, 133	0.844
Quality of interactions	Mean, SD	46 \pm 11	48 \pm 10	0.431

The single item questions' answers for both testing time points of the FSQ presented as percentages (Table 4).

Table 4. Single item results of the Functional Status Questionnaire of the participants (n=21) during pre and post time points presented as percentages.

Single Items		Pre	Post
1- Work situation	Working full-time	29%	38%
	Working part-time	9%	5%
	Unemployed looking for work	5%	5%
	Unemployed because of my health	38%	33%
	Retired because of my health	5%	10%
	Retired for some other reason	14%	9%
2- During the past month, how many days did illness or injury keep you in bed all or most of the time?		21% out 31-day period	12% out 31-day period
3- You cut down on the things you usually do for one-half day or more because of your illness or injury?		65% out 31-day period	58% out 31-day period
4- During the past month, how satisfied were you with your sexual relationships?	Very satisfied	5%	10%
	Satisfied	19%	24%
	Not sure	10%	14%
	Dissatisfied	9%	9%
	Very dissatisfied	14%	10%
	Did not have any sexual relationships.	43%	33%
5- How do you feel about your health?	Very satisfied	0%	0%
	Satisfied	5%	14%
	Not sure	9%	5%
	Dissatisfied	19%	43%
	Very dissatisfied	67%	38%
6- During the past month, about how often did you get	Every day	10%	0%
	Several times /wk.	14%	24%

together with friends	About once /wk.	14%	14%
or relatives, such as	2 or 3 times a	33%	14%
going out together,	month		
visiting in each other's	About 1 a month	19%	29%
home, or talking on the	Not at all	10%	19%
telephone?			

RAND-36 HrQoL. The post-test score of social functioning parameter (60 ± 24) was significantly higher than the pre-test score (44 ± 27), $t_{(20)} = -3.525$, $p = 0.002$, $r = .76$. In addition, there was a significant difference in the scores of pain parameter. Pain scores in the post-test (53 ± 25) was significantly higher than the pre-test (42 ± 30), $t_{(20)} = -2.134$, $p = 0.045$, $r = .46$ (Table 5). There were no significant differences between the pre and post-test scores in all of the other parameters in this questionnaire.

Table 5. The outcome scores (points/100) of the RAND-36 questionnaire (HrQoL) parameters of the participants ($n = 21$) during pre and post time points presented as mean, SD, median and range. Paired t-test and Wilcoxon signed-rank tests were used to explore significant differences between the two the time points. Statistical significance was determined when $p < 0.05$. HrQoL: Health related quality of life, Md: median, Rn: range.

Variables	Value	Pre	Post	p-value
Physical functioning	Mean, SD	43 \pm 29	47 \pm 27	0.280
Role limitations due to physical health	Md, Rn	0, 100	0, 100	0.461
Role limitations due to emotional problems	Md, Rn	21, 100	19, 100	0.726
Energy/fatigue	Md, Rn	20, 80	10, 80	0.906
Emotional well-being	Mean, SD	57 \pm 16	60 \pm 15	0.211
Social functioning	Mean, SD	44 \pm 27	60 \pm 24	0.002
Pain	Mean, SD	42 \pm 30	53 \pm 25	0.045
General health	Mean, SD	40 \pm 19	38 \pm 22	0.289

Discussion

Our major novel findings are that in individuals with COVID-19 infection: 1) self-reported dyspnea, work performance and social functioning scores significantly improved in the post-testing time point compared to the pre-testing time point; and 2) pain scores were significantly higher in the post-testing time point compared the pre-testing time point. Based on our findings, we conclude that many negative effects of COVID-19 on select physical, functional, and psychosocial parameters among infected individuals persist for long period after the date of infection with the virus and may in fact worsen over time.

Post-test score of self-reported dyspnea was significantly lower than the pre-test score. This significant improvement might be explained by the non-severe nature of COVID-19 infection among the participants in our study which may be consistent with findings reported by others.⁹ Wu et al., indicated that severely infected individuals with COVID-19 presented significantly higher number of residual abnormal lung lesions (ground-glass and linear opacities) compared to moderately infected individuals.⁹ In addition, the average time (recovery period) from the date of infection to the post-test time point among the participants in our study was (313 ± 76.1 days) which was longer than the recovery periods of (6 months \approx 183 days) and (60-90 days) in the studies conducted by Wu et al.⁹ and Raman et al.¹⁰ The length of time passed between the onset of the infection and testing time point (recovery period) may explain the improvement in self-reported dyspnea scores in our study versus persisting dyspnea symptoms in the latter two studies.

Scores of walking, vigorous, moderate, and total physical activities showed no improvements between the pre and post-test time despite having abnormally lower scores during the pre-test time point as we have previously reported.⁸ The lack of significant improvement in these scores may be occurred due to behavioral reasons and external factors such as lockdowns.^{28,27} In addition, this also may be at least partially explained by the persistent fatigue, and general weakness^{2-4,21-23} as well as dyspnea that was initially present albeit improved by the post-testing time point in the latter variable among the participants. It has been also reported that individuals often suffer from functional and physical limitations over a long period after being infected with viruses such as SARS-1.^{24,25} Furthermore, post-COVID-19 fatigue that results from central, psychological, and peripheral factors could be another reason for this non-significant differences in physical activity scores between the pre- and post-testing time points.²⁶ Therefore, the aforementioned factors may at least be partially contributed to the nonsignificant improvements in physical activities reported among the participants of this study.

In the FSQ, the post-test scores for work performance parameter were significantly higher than pre-test scores. This possibly resulted from the

improvements noticed in dyspnea scores among the participants at the post-testing time point. It has been reported that dyspnea negatively affects perceived health status as well as participation in physical activity.²⁶ The rest of the parameters (Basic ADL, intermediate ADL, mental health, social activities, and quality of interactions) in this questionnaire did not show any significant differences between the two-testing time point. The possible reasons behind the nonsignificant differences may be due to post-COVID-19 fatigue,²⁶ and home confinement associated with public health measures²⁷ the participants experienced during the pandemic.²⁸

For the parameter of social functioning in the RAND-36 HrQoL questionnaire, the post testing-time point scores were significantly higher than the pre-testing time point. This also can at least partially be explained by the improvement noticed of dyspnea scores during the post-testing time point.²⁹ Chronic dyspnea negatively affects the perception of the health status of the person causing decreased physical activity, promoting muscular deconditioning, anxiety, social isolation, and depression.^{30,31} Pain scores were higher during the post-testing compared to the pre-testing time point. This increase may possibly be resulted from lasting muscle pain (*i.e.*, myalgia).³²⁻³³ In addition, repeated lockdowns worldwide (varies from a region to another) led to increased periods of sedentary activities which may cause inhibition of the motor neurons and lead to fatigue^{6,26,34-36} and since fatigue and pain are reported to be associated, this might increase the perception of pain among the infected individuals. Furthermore, negative psychological consequences of being infected with COVID-19 include post-traumatic stress symptoms, anxiety, confusion, depression, and anger may be a significant contributor to fatigue then increase the perception of pain.^{26,37-39}.

Although that pain increase noticed at the 3-month follow up can be at least partially justified by the explanation provided earlier, participants were not able to give further information about the nature and location of the pain at the time of collecting the pre- and post-test data. It is noteworthy to mention that this study was conducted in end of the first year and beginning of the second year of the pandemic. Researchers of this study selected the questionnaires that were later utilized based on the available information about COVID-19 at that time which in turn were not designed to detect these specific features of the pain (*i.e.*, nature and location). As for the other parameters in this questionnaire, (physical functioning, role limitations due to physical health, role limitations due emotional problems, energy/fatigue, emotional well-being, and general health), there were no significant differences between the pre- and post-testing time points. Possible contributing factors to this outcome may include but not limited to repeated policies of home confinement,²⁸ social distancing, lockdowns,²⁷ long lasting post-COVID-19 fatigue,²⁶ reduced physical activity and quality of life⁸ as well as

common consequences of COVID-19 such as anxiety, confusion, anger, depression, and post-traumatic stress symptoms.^{26,37-39}

In this study, we examined three-month recovery from common negative effects of COVID-19 infection on select physical, functional, and psychosocial parameters among infected individuals and their implications for rehabilitation programs in this population. However, this study was not without limitations. The date of the infection of COVID-19 survivors ranged from 1 to 11 month which lends to a varied recovery time - this may be seen as a limitation as well as a strength and demonstrative of prolonged consequences. In addition, we did not have any method to validate the severity of illness during infection, thus, it may be hard to generalize our findings to all COVID-19 survivors, although as with most COVID-19 cases, most (17 out of 21) of the infected participants were never hospitalized while only 4 were hospitalized as result of COVID-19 infection in our cohort. Thus, most of the infected participants of this study can be considered non-severe cases and representative. Similarly, as the majority of the COVID-19 infected participants in this study were not hospitalized, our sample of infected participants does not represent individuals who are severely affected by COVID-19 illness.

Conclusions

In our study, self-reported symptoms from objective measures indicate that COVID-19 survivorship is linked with ongoing and persistent physical, functional, and psychosocial deficits. Scores of dyspnea, work performance and social functioning improved significantly during the post-testing time point. However, pain scores were significantly higher and increased during the post-testing compared to the pre-testing time point. Our data have important implications on the multidisciplinary rehabilitation programs in that it objectively demonstrates long-lasting physical deficiencies as well as social and emotional concerns for first time in non-severe COVID-19 infected individuals. Therefore, designing mid- and long-term rehabilitation programs as well as providing up-to-date information about the short- and long-term effects of COVID-19 infection should be the proper approach to address these demonstrated deficits, and allay uncertainty and anxiety concerns individuals might experience in the future.

Clinical Messages

- 1- Three months recovery time was enough to notice significant improvements in dyspnea, work performance and social functioning scores. However, pain scores increased among individuals infected with COVID-19.

- 2- Longer recovery time and rehabilitation programs may lead to more improvements in physical, functional, and psychosocial variables among COVID-19 infected individuals.

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Author's Contribution

HA contributed substantially to the research design, recruiting participants to the study, participated in the acquisition of data, wrote the first draft of the manuscript, and edited the manuscript after feedback from the co-authors SB, CT, and DM. The co-authors contributed substantially to the research design and provided substantial revision to the manuscript. CT oversaw statistical analyses performed by HA. All authors read and approved the final manuscript.

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Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics Approval and Consent to Participate

This study was approved by the University of Saskatchewan Research Ethics Board (Bio-REB ID: 2312) and informed consent was obtained digitally from all participants.

Consent for Publication

Not applicable.

Competing Interests

The author(s) declare no competing interest with respect to the research, authorship, and/or publication of this article.

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