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ORIGINAL RESEARCH

Safety and Physical Outcomes of a Novel Australian Multidisciplinary Long COVID Clinic That Incorporates Exercise: A Prospective Observational Study

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Background: Exercise therapy remains somewhat controversial in those with Long COVID (symptoms lasting >3 months), due to concerns for safety and the potential for harm.

Purpose: This study describes the safety and physical outcomes of an Australian multidisciplinary Long COVID Recovery Clinic that incorporates personalised exercise prescription including respiratory and peripheral muscle strengthening, carefully monitored cardiovascular training and pacing of activity.

Patients and Methods: Prospective observational study of adults (≥18 years) engaging with a single site Long COVID Recovery Clinic (March 2022 to June 2023). Clinic eligibility required symptoms >12 weeks which impaired activities of daily living. Safety was pre-defined as <10% of participants experiencing a minor adverse event, and no serious disability or death as a result of participation in exercise. Physical outcomes included Modified COVID-19 Yorkshire Rehabilitation Scale, changes in exercise capacity (6-minute-walk-test), inspiratory muscle strength (maximum inspiratory pressure), Timed-Up-and-Go and ten-metre-walk-test. Data analysis included repeated measures Multivariate Analysis of Variance (MANOVA) to explore assessment and reassessment measures collectively, and repeated measures *t*-test.

Results: Of 207 consumers referred, (62% male, median age 45, range 18–84), 119 (57% of the total referred) enrolled to participate in the program. Of these, 72 (61%) completed the program, median participation duration 112 days (range 5–384). There were no adverse events as a result of participation in exercise. Consumers who completed the program showed improvement in Modified COVID-19 Yorkshire Rehabilitation Scale *Other Symptoms* (MD −1.5, p=0.003), *Overall Health Score* (MD1.3, p<0.001), *Total Score* (MD −6.5, p=0.02); maximum-inspiratory-pressure (MD 11.7 cmH_2O, p=0.002); Timed-Up-and-Go (MD −1.0 sec, p<0.001); ten-metre-walk-test comfortable speed (MD 0.7 m/sec, p=0.006) and fast speed (MD 0.2 m/sec, p<0.001); and 6-minute-walk-test distance (MD 63.0 m, p<0.001).

Conclusion: This multidisciplinary therapy program that incorporates exercise was safe and associated with improvements in physical and functional outcomes for participants who completed the program.

Plain Language Summary: Few studies in Australia have investigated the impact of exercise in people with Long COVID. This observational study describes the safety and physical outcomes of 72 adults who completed an Australian multidisciplinary Long COVID clinic that incorporates supervised cardiovascular and strength training over several weeks. For those who completed the program, there were no adverse events, while multiple physical outcome measures improved relative to baseline. This study shows that exercise can be safely incorporated in a multidisciplinary clinic for people recovering from Long COVID.

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Introduction

Over 750 million cases of COVID-19 have been reported to the World Health Organization[1] since 2019, when the first case of novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection was detected.[2] While there has been a decline in weekly COVID-19 cases worldwide (4.2 million December 2022, 5.1 thousand in April 2025),[1] 43% continue to experience symptoms 3 months after infection.[3] This prolongation of illness is known as post-COVID condition or Long COVID.[4] The global disease burden of Long COVID has been well-described.[5–7] In Australia the prevalence of Long COVID is estimated to be 5–10% of COVID cases.[8] Long COVID symptoms often include dyspnoea, extreme fatigue and cognitive dysfunction.[4] Post-exertional symptom exacerbation (PESE) has recently been reported as a common feature of Long COVID.[9]

Used appropriately, exercise is not generally considered a controversial therapy in the treatment of other diseases, illnesses or following injury. As a preventative measure, exercise reduces morbidity and mortality from chronic disease.[10] The benefits of exercise for chronic cardiac and pulmonary conditions in particular are well documented.[11,12] Intriguingly, multidisciplinary coordinated care, including exercise, is not yet standard practice for Long COVID. Exercise guidelines for people living with Long COVID are conservative in nature.[13,14] A recent systematic review of eight randomised controlled trials showed that exercise in Long COVID may be indeed beneficial and tolerable in this population.[15]

Critically, there is very limited Australian-specific data regarding exercise-based interventions for Long COVID recovery. The only Australian study of multidisciplinary follow-up of people living with Long COVID did not describe the role of personalised prescription of exercise therapy for participants.[16] While several international studies have explored clinics to support Long COVID recovery[17–21] and exercise therapy for Long COVID,[22,23] the outcomes of these studies cannot necessarily be applied in the Australian context given Australia's high rate of vaccination compared with other countries[24] as well as the differences in access to publicly funded healthcare.

In March 2022, we established the first multidisciplinary Long COVID Recovery Clinic in the Australian Capital Territory.[25] The model of care includes personalised assessment and specific prescription of tailored progressive exercise therapy.[25] The clinic was public, and freely accessible for those who met criteria. This model is unique in Australia in that it includes both general and inspiratory strength training and cardiovascular exercise therapy in combination with pacing and education strategies. The consumer experience of this clinic model was overwhelmingly positive, with 93% reporting it to be acceptable and something they would recommend to others.[26] We wished to ascertain whether this positive subjective experience of the clinic echoed more objective measures of physical outcomes and safety.

The aim of this study was to explore the physical outcomes and safety of an Australian multi-disciplinary, individualised exercise-based programme for consumers with Long COVID. Based on our clinical experience and positive consumer feedback, we hypothesised that outcomes would improve in measures of both physical function and inspiratory muscle strength, without any signals of harm or deterioration.

Methods

Design & Setting

This prospective observational study was conducted at a single centre where the newly established Long COVID Recovery clinic was the only service of its kind in the Australian Capital Territory. In March 2022, the Territory's population over 16 years old was 322, 037 and the vaccination rate against COVID-19 was >95%.[27] In contrast, a 2022 study of worldwide data reported a vaccination rate against COVID-19 of 43%.[3] The clinic has been comprehensively described elsewhere,[25] but briefly it involves a multidisciplinary team (rehabilitation specialists, physiotherapists, occupational therapists, exercise physiologists, dieticians and other allied health staff) providing comprehensive, individualised assessment and tailored rehabilitation intervention to consumers in both individual and group formats. Typical attendance was 1–2 times per week for 1–2 hours, 2 to 3 months in an outpatient rehabilitation setting. This study complies with the Declaration of Helsinki and was approved by the ACT Health Human Research Ethics Committee (ETH00369) and the University of Canberra Human Ethics Committee (11722) including a waiver of consent for quantitative data. The study was registered with the Australian New Zealand Clinical Trials Registry, ACTRN12622000719730.

Data Collection

Data was recorded by clinicians in the clinic and extracted directly into a bespoke REDCap electronic database.[28,29] Data collected from the records included the participant's age, sex, COVID-19 diagnosis and hospital admission details (as relevant), past medical history, and attendance at clinic or non-attendance. Any deaths, re-hospitalisations or adverse events were also collected.

Participants

Consumers were eligible for the study if they were aged 18 or over, reported that they had been infected with COVID-19 and were experiencing residual symptoms that impaired their activities of daily living for more than 12 weeks beyond the initial infection. Detailed referral and triage criteria of the clinic model are available elsewhere.[25]

Consumers were ineligible for the study due to any of the following: experiencing acute or unstable medical conditions; severe behavioural disturbances and/or requiring specialised mental health services; were unable/unwilling to follow instructions; were a resident of an aged care facility with access to allied health review via alternate means.

Intervention

The Post COVID Recovery Clinic was public, and freely accessible for those who met specific criteria. This model is unique in Australia in that it includes both peripheral and inspiratory muscle strength training and cardiovascular exercise therapy in combination with pacing and education strategies. On initial assessment, consumers underwent comprehensive medical assessment and screening by a respiratory or rehabilitation specialist, and where indicated, assessment of cardiopulmonary exercise capacity (VO_2max and anaerobic threshold), and lung function (spirometry, maximum inspiratory pressure (MIP)). Such tests are safe in patients following COVID-19.[30] The medical specialist then advised the rehabilitation team of any specific exercise limitations based on this testing (eg SpO_2 targets).

A detailed description of the clinic intervention has been previously published,[25] but briefly, the exercise elements encompass individually tailored exercise and advice, and when safe to progress, participation in group therapies including both exercise and education (twice weekly sessions of 60 minutes duration). To manage the risk of post-exertional symptom exacerbation (PESE), consumers were screened at baseline assessment for PESE triggered by participation in activities of daily living. Once consumers were able to participate in the exercise group, clinicians checked in weekly regarding PESE and modified advice and exercise prescription accordingly. Exercise included strength training of both peripheral and inspiratory muscle training (IMT) as well as whole-body cardiovascular training. Peripheral strength training was prescribed at a submaximal threshold, due to the risk of PESE, using Borg Rating of Perceived Exertion Scale[31] 4–6/10 as a baseline, and included 4–6 functional exercises in global muscle groups 3 days per week. Progression was guided by symptom monitoring to further minimise the risk of PESE in peripheral strength training.

IMT reduces dyspnoea and improves quality of life and exercise endurance (distance covered in the six-minute-walk-test) in people living with Long COVID as described in a recent systematic review and meta-analysis of 7 studies and 527 participants.[32] IMT was prescribed to consumers experiencing dyspnoea affecting their activities of daily living, and involved assessing inspiratory muscle strength (MIP, cmH_2O), then prescribing a high intensity interval training programme with a handheld inspiratory muscle trainer (5 sets of 6 breaths, at least 50% of their maximal inspiratory pressure, 5 days per week) (Figure 1).

Figure 1 Inspiratory Muscle Training with a mechanical threshold loading device (with consent for image publication).

Measures

The main outcome measure for this study was safety. Safety was defined as the occurrence of adverse events between initial and final clinical assessments (eg deterioration in presenting symptoms during course of program; worsening of physiological status during exercise; injury, serious disability or death during rehabilitation activities), and was determined a priori as <10% of participants who experienced minor adverse events, and no serious disability or death occurring as a direct result of rehabilitation activities. Participant progress during the program was also captured using the following outcome measures, as appropriate to their presenting symptomatology: Modified COVID-19 Yorkshire Rehabilitation Scale, exercise endurance (6 minute walk test); inspiratory muscle strength (MIP); spirometry; walking speed (ten-metre-walk-test); function and mobility (Timed-Up-and-Go, Functional Gait Assessment); peripheral muscle strength (Oxford score and dynamometry); and balance (Step Test, Modified Clinical Test of Sensory Interaction in Balance).

Analysis

Descriptive statistics were used to describe the cohort, and feasibility was calculated using aggregate data as per a priori definitions. We visualised the data using boxplots and histograms and conducted Kolmogorov–Smirnov normality tests for initial and completion measures, as well as mean differences. Repeated measures MANOVA was used to explore the differences between all measures collectively. Analysis of mean differences between assessment and reassessment of individual measures of physical outcomes were completed using repeated measures *t*-test or Related Samples Wilcoxon Signed Rank test as appropriate using the program IBM SPSS Statistics (Version 30.0.0.0 (172)). The Modified COVID-19 Yorkshire Rehabilitation Scale *total score* was obtained by the sum of scores from questions 1 to 15, *physical score* by the sum of scores provided in questions 1, 2, 3, 4, 5, 7, 8, 10, 12, 13 and 14. Analyses were completed for all variables where participants completed the final assessment at the end of the program (n=72). Individual outcome measures with data from fewer than 10 participants were not analysed.

Results

Participants and Adherence

The participant characteristics are described in Table 1. A total of 207 consumers were referred to the Long COVID Clinic. Of those 119 (57% of the total) commenced the program and completed an initial assessment, and adherence was

Table 1 Consumer Characteristics

Characteristic	Total (n=119)	Completers (n=72)	Non-Completers (n=47)
Age (years), median (SD) [min, max]	45 (16) [18, 84]	45 (16) [19, 83]	44 (17.9) [18, 84]
Sex (male), n (%)	128 (62%)	27 (38%)	13 (28%)
BMI, median (SD) [min, max]	26.8 (7.5) [17.4, 54.8]	26.2 (7.5) [17.4, 45.9]	26.8 (6.0) [19.2, 42.7]
Country of birth, n (%)			
Oceania (Australia, New Zealand, Papua New Guinea)	91 (71%)	49 (68%)	23 (49%)
Asia (Bangladesh, China, Pakistan, Sri Lanka, Russia, Philippines)	8 (6%)	4 (6%)	2 (4%)
Europe (Belgium, Germany, Italy)	3 (2%)	2 (3%)	0 (0%)
United Kingdom (England, Ireland, Scotland)	9 (7%)	4 (6%)	4 (9%)
Unknown	18 (14%)	6 (8%)	18 (38%)
Identifies as Aboriginal and/or Torres Strait Islander, n (%)	4 (2%)	4 (8%)	0 (0%)
Vaccinated against COVID-19 infection, n (%)	94 (82%)	59 (82%)	27 (57%)
Long term health conditions (LTC), n (%)			
0 LTC	11 (10%)	2 (3%)	6 (13%)
1 LTC	20 (17%)	18 (25%)	1 (2%)
>1 LTC	84 (73%)	52 (72%)	27 (57%)
Admitted to hospital due to COVID-19 infection, n (%)	10 (7%)	4 (6%)	3 (6%)
Severity of COVID-19 infection, n (%)			
Mild illness	69 (63%)	46 (64%)	17 (36%)
Moderate illness	20 (18%)	14 (19%)	6 (13%)
Severe illness	5 (5%)	3 (4%)	2 (4%)
Critical illness	5 (5%)	1 (1%)	1 (2%)
Not documented	10 (9%)	6 (8%)	4 (9%)
COVID-19 infections, n (%)			
1 infection	102 (86%)	66 (92%)	26 (55%)
2 infections	12 (10%)	6 (8%)	6 (13%)
3 infections	1 (1%)	0 (0%)	0 (0%)
Unknown	3 (3%)	0 (0%)	14 (30%)
Current smoker, n (%)	4 (3%)	3 (4%)	1 (2%)
Falls (1 or more falls in last 12 months), n (%)	39 (5%)	2 (3%)	4 (9%)
Working (full-time, part-time, casual), n (%)	101 (80%)	62 (86%)	25 (53%)
Studying (full-time, part-time), n (%)	20 (16%)	10 (14%)	9 (19%)
Exercise per week prior to COVID-19 infection (self-reported), n (%)			
No regular exercise	14 (11%)	5 (7%)	6 (13%)
<150 min	21 (17%)	12 (17%)	9 (19%)
≥150 min	61 (49%)	45 (63%)	14 (28%)
Unclear/not documented	28 (23%)	10 (14%)	5 (11%)
Exercise per week following COVID-19 infection (self-reported), n (%)			
No exercise	53 (43%)	25 (35%)	23 (49%)
<150 min	38 (31%)	30 (42%)	6 (13%)
≥150 min	10 (8%)	6 (8%)	3 (6%)
Unclear/not documented	20 (17%)	11 (15%)	2 (4%)
Referral source, n (%)			
General Practitioners	182 (89%)	62 (86%)	41 (87%)
Public healthcare	11 (5%)	3 (4%)	3 (6%)
Other (ComCare, specialist other than CHS, cardiologist)	3 (1%)	1 (1%)	1 (2%)
Unknown	8 (4%)	6 (8%)	2 (4%)
Wait time for clinic assessment (days), median (SD) [min, max]	111 (67) [3, 293]	101 (60.7) [3, 293]	139 (73.7) [21, 285]
Time spent attending the clinic (days), median (SD) [min, max]	112 (65) [5, 384]	125 (54.2) [35, 302]	93 (79.7) [1, 384]
Referred to services outside of the Long COVID Clinic, n (%)			
Public	57 (47%)	32 (44%)	19 (40%)
Private	14 (12%)	9 (13%)	5 (11%)

(*Continued*)

Table 1 (Continued).

Characteristic	Total (n=119)	Completers (n=72)	Non-Completers (n=47)
Exercise risk pre-screening outcome*, n (%)			
Green	3 (5%)	2 (3%)	1 (2%)
Amber	42 (68%)	24 (36%)	18 (38%)
Red	17 (27%)	13 (19%)	7 (15%)
Nutritional status (Mini Nutritional Assessment), n (%)			
Normal nutritional status	18 (38%)	11 (37%)	7 (15%)
At risk of malnutrition	22 (46%)	15 (50%)	7 (15%)
Malnourished	8 (16%)	4 (13%)	3 (6%)

Notes: *Based on medical assessment this was a local grading scale where *green* = no risk present, *amber* = risk identified but medically managed, *red* = risk present with no adequate diagnostic work-up or the risk is unstable (eg chest pain with no cardiac investigations) and the consumer required medical clearance prior to commencing exercise.

61% of the total referred with 72 consumers completing both an initial and final assessment by 30/06/2023. The median duration between referral to the Long COVID Recovery Clinic and commencement at the clinic was 111 days (range 3 to 293), and the mean duration of clinic attendance from initial to final appointment was 112 days. The flow of participants in the program is described in Figure 2, with the main reasons for non-attendance being consumers were uncontactable, the consumer addressing other health priorities or being referred to another service.

Safety

Across the cohort of 119 participants who commenced the program, there were no adverse events reported. One person died, due to a pre-existing non-COVID medical condition, before commencing any interventions. A further 8 participants were hospitalised for management of non-COVID pre-existing medical conditions during the study timeframe.

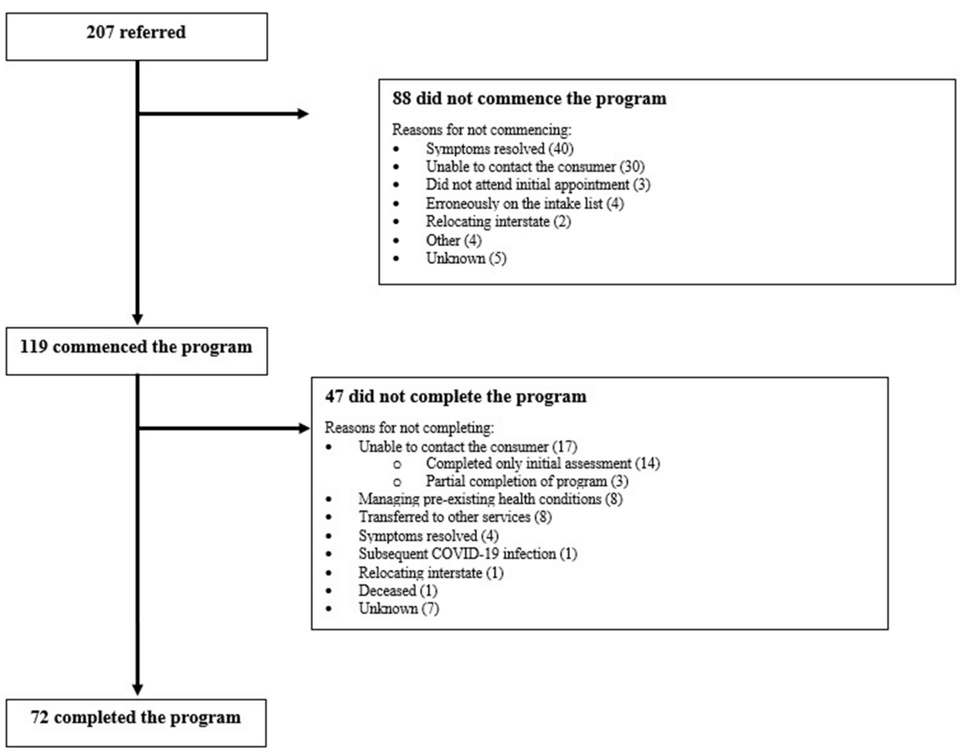

Figure 2 Flow of participants through study.

Table 2 Summary of Outcome Measures at Baseline and at End Intervention Following the Clinic Programme

Outcome Measure	**Baseline**			**End Intervention**			**Mean Difference**	**CI 95%**	**p-Value**
	Mean	**SD**	**Min, Max**	**Mean**	**SD**	**Min, Max**			
Modified COVID-19 Yorkshire Rehabilitation Scale									
Symptom severity (x/30) ^	17	5	3, 28	15	6	1, 25	−1.8	−3.7 to 0.2	0.08
Functional disability (x/10) ^	7	3	1, 12	6	3	0, 11	−0.6	−1.8 to 0.6	0.32
Other symptoms (x/25) ^	5	4	0, 13	4	3	0, 11	−1.5	−2.5 to −0.6	**0.003**
Overall health score (x/10) ^	4	1	1, 10	5	2	3, 8	1.3	0.7 to 2.0	**<0.001**
Total score (x/93) ^*	39	15	0, 83	32	15	3, 60	−6.5	−11.8 to −1.2	**0.02**
Physical score (x/60) ^**	25	10	0, 53	21	10	1, 40	−3.4	−6.9 to 0.1	0.06
Maximum Inspiratory Pressure (cmH_2O)^	72	28	6, 168	84	26	44, 162	11.7	4.5 to 18.8	**0.002**
Timed-Up-and-Go (sec) ^	6.7	2.2	3.6, 13.6	5.8	1.9	2.9, 12.0	−1.0	−1.3 to −0.7	**<0.001**
Ten-Metre-Walk-Test (m/sec)									
Comfortable speed #	1.3	0.3	0.6, 1.9	1.4	0.3	0.5, 2.0	0.7	0.0 to 0.2	**0.006**
Fast speed #	1.8	0.4	0.9, 2.7	2.0	0.6	1.1, 3.9	0.2	0.0 to 0.3	**<0.001**
	461	131	60, 730	524	140	90, 942	63	30.6 to 81.2	**<0.001**

Notes: Bold indicates statistical significance (p<0.05). ^Paired Samples *T*-test. #Related Samples Wilcoxon Signed Rank Test. *Modified COVID-19 Yorkshire Rehabilitation Scale *total score* includes the sum of questions 1–15.**Modified COVID-19 Yorkshire Rehabilitation Scale *physical score* includes the sum of questions 1, 2, 3, 4, 5, 7, 8, 10, 12, 13 and 14.

Participant Progress with Outcome Measures

The repeated measures MANOVA was significant (p=0.005). Table 2 captures the differences between enrolment and completion measures. Relative to baseline, there were statistically significant improvements in the Modified COVID-19 Yorkshire Rehabilitation Scale scores including other symptoms, total score and overall health score; inspiratory muscle strength (MIP); functional speed and agility (Timed-Up-and-Go); exercise endurance (distance covered in the six-minute-walk-test) and walking speed (ten-metre-walk-test comfortable and fast speed conditions) (Figure 3). The magnitude of the change in 6-minute-walk-test and ten-metre-walk-test both exceeded the minimal clinically important differences (MCID), respectively 25m (in populations with coronary artery disease and heart failure)[33,34] and 0.16 m/s (in a subacute stroke population).[35] The changes in the Timed-Up-and-Go and MIP were less than the MCID, respectively 3.4 s (in a population following surgery for lumbar degenerative disc disease)[36] and 18 cmH_2O in a Long COVID population.[37]

There were no significant changes to spirometry forced vital capacity (FVC), fraction expired in 1 sec (FEV1), ratio of FEV1/FVC and peak expiratory flow (Table 3). Insufficient data (n<10) were available to analyse other measures: Oxford scale, dynamometry, Patient Generated Subjective Global Assessment, Functional Gait Assessment, Step Test and Modified Clinical Test of Sensory Interaction in Balance.

Discussion

The main finding of this observational study was that our multidisciplinary Long COVID Recovery Clinic model was safe, with no major adverse events or deterioration in physical function across the 72 participants who completed the program. This is consistent with emerging international evidence, with a recent systematic review of 8 randomised controlled trials[15] finding that exercise therapy in Long COVID populations is safe and not associated with adverse events. These findings should give clinicians confidence that exercise can be safely delivered to people with Long COVID, noting the requirements for individually prescribed and carefully monitored therapy.

Completion of this Long COVID program was associated with improvements in overall health score as measured by the Modified COVID-19 Yorkshire Rehabilitation Scale,[38] inspiratory strength, functional mobility,[39] comfortable and fast walking speeds and physical endurance.[40] However, the absence of a control group precludes conclusions regarding the efficacy of the Long COVID Recovery Clinic for improving strength or enhancing physical outcomes. The proportion of participants who completed the Long COVID Recovery Clinic in this study (61%) was similar to Long COVID clinics overseas (70%),[20,22] but we lack data on those who did not complete the program, largely as they were uncontactable The reasons for non-attendance could be an opportunity for further research to enhance attendance at Long COVID recovery services in Australia.

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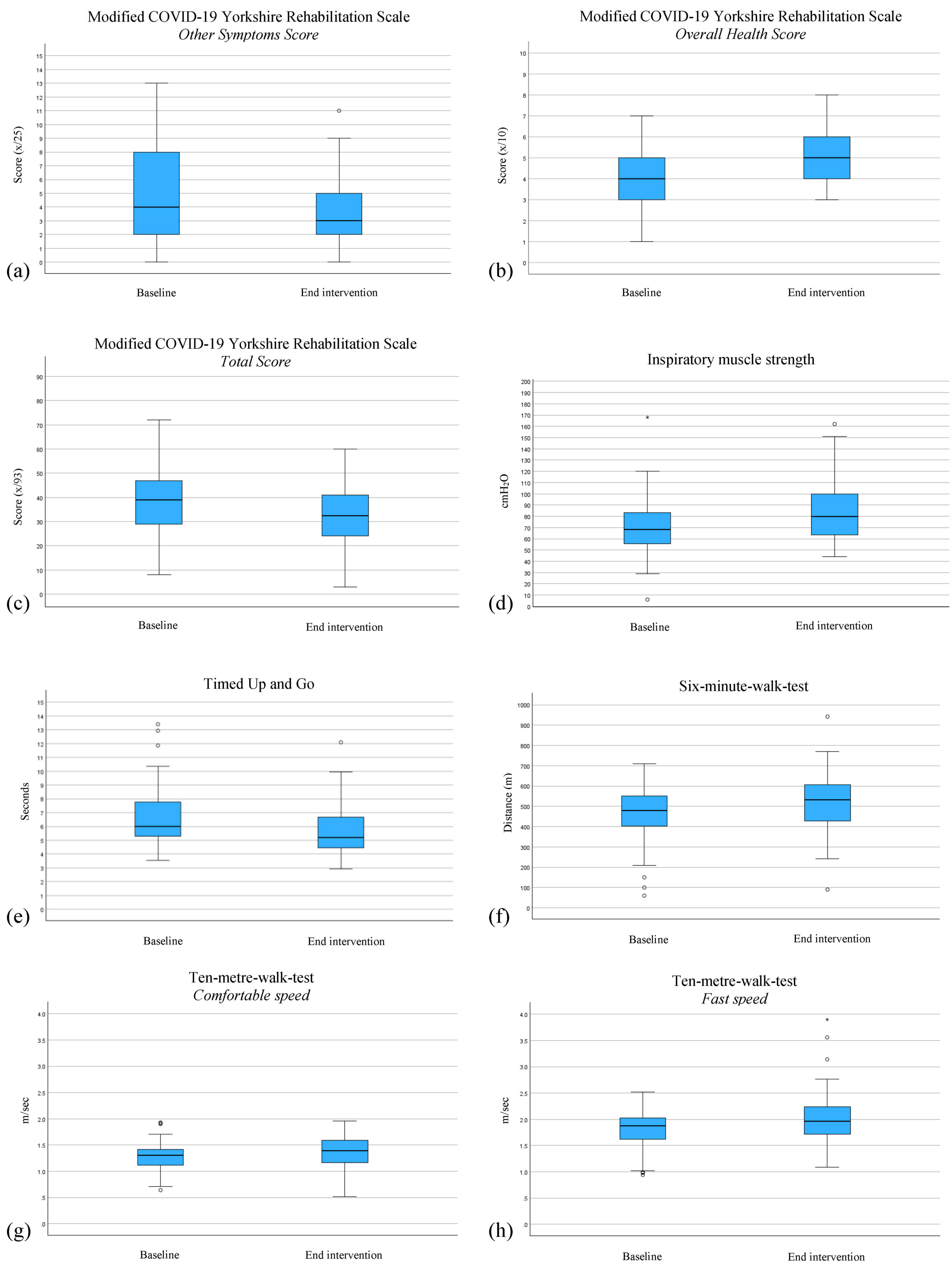

Figure 3 Physical outcome measures at baseline and end-of-intervention: Modified COVID-19 Yorkshire Rehabilitation Scale scores (**a**) Other symptoms (x/25), (**b**) Overall health score (x/10), (**c**) Total score (x/93); (**d**) Maximal inspiratory pressure (cmH2O); (**e**) Time taken to complete the Timed-Up-and-Go (seconds); (**f**) Distance walked in the six-minute-walk-test (metres); ten-metre-walk-test (m/s) (**g**) Comfortable walking speed and (**h**) Fast walking speed. Circles represent outliers.

Table 3 Summary of Spirometry Measures at Baseline and at End Intervention Following the Clinic Programme

Outcome Measure	Baseline			End Intervention			Mean Difference	CI 95%	p-Value
	Mean	SD	Min, Max	Mean	SD	Min, Max			
Spirometry^									
FVC (L)	3.7	1.1	0.9, 6.3	3.8	1.1	1.0, 6.4	0.1	−0.1 to 0.2	0.30
FEV1 (L)	3.3	0.9	0.8, 4.9	3.0	0.9	0.6, 4.7	−0.3	−0.1 to 0.1	0.97
FEV1/FVC (%)	82	8	26, 100	81	7	59, 94	−1.6	−3.6 to 0.4	0.12
PEF (L/min)	7.0	2.2	1.9, 12.6	7.3	2.4	2.2, 13.2	0.3	−0.3 to 0.9	0.32

Notes: ^Paired Samples *T*-test.

Improvement in physical outcomes is consistent with other studies, with a recent systematic review and meta-analysis investigating pulmonary rehabilitation for Long COVID[23] reporting improvement in exercise capacity. Similarly, a Spanish randomised trial[22] comparing exercise therapy (including cardiovascular, inspiratory muscle and high-intensity interval training) to a control group (education on physical exercise and healthy habits) showed that consumers with Long COVID improved across all physical measures including VO_2 max, Post-COVID-19 Functional Status, MIP, lower limb strength, and body fat percentage. Our findings of physical improvement clearly align with emerging evidence from randomised trials that exercise is advantageous for people with Long COVID when carefully prescribed and monitored.

The physical improvements observed in this study may have been enhanced as a function of the group setting and peer support. In our analysis of the consumer experience of this Long COVID Clinic,[26] consumers expressed that supervised exercise and pacing improve confidence with exercise and was viewed as fundamental to recovery. However, many consumers did not completely recover as reflected in the Modified COVID-19 Yorkshire Rehabilitation Scale *physical score*, which only improved by 3.4 points. This lack of complete resolution also echoes our qualitative study[26] in which consumers reported that their recovery was incomplete and additional services were required to augment recovery. These findings are also consistent with another Australian study which highlights that management typically extends beyond current clinic models.[16] While this dataset is promising, clinicians and consumers may need to set realistic expectations of improvement and resolution when engaging with this type of multidisciplinary clinic program for the management of Long COVID. Further, a tapering of Long COVID cases in Australia will have implications for future service design.

Strengths

The main strength of this study is the highly pragmatic and widely inclusive sample. All consumers were screened for safety to participate in exercise, and any concerning issues were investigated by a medical professional prior to exercise participation. This is important as we have not selected a low-risk subgroup but retained broad inclusion criteria to create a heterogenous sample and were still able to demonstrate that the participants were not harmed by participating in exercise therapy. Another strength is that a consumer researcher has been involved in reflecting on the data and the meaning of the results of the current study. These strengths both broaden the generalisability of our findings and ensure our interpretation is meaningful to consumers.

Limitations

This was a single centre cohort study comparing baseline and end intervention findings and lacked a control group. As we only analysed participants who completed the intervention our findings do not apply to those who withdrew early from the program, and the results are therefore vulnerable to survivorship bias. Furthermore, the pragmatic nature of this study meant that measures were recorded by the clinicians, which is another potential source of bias.

Another limitation of this study is that the majority of consumers who did not complete the program were not contactable (Figure 2). This is important as it is not possible to know how to improve adherence to the program for these participants. The findings of this study may not be readily extrapolated to other populations as the cohort is consistent

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with Australia's high vaccination rate.[24] In addition, the results cannot be applied to consumers with an Aboriginal and Torres Strait Islander background due to the small proportion of participants in the study, although it may be worth noting that all people from this cultural background successfully completed the program.

This study focused on safety and physical measures and did not report subjective participant reported outcome measures (eg quality of life, fatigue). These measures are currently under analysis and will be interpreted in a future study. Future research could investigate follow-up beyond discharge to understand the longer-term effects of participation in Long COVID clinics.

Lastly, our analyses were exploratory. We did not present the net improvement in outcomes following exposure to the physical activity programme. A future study could investigate the net effect of the physical activity programme on the outcome measures, controlling for other covariates that may influence the outcome variables (such as depression, anxiety, fatigue, and other demographic factors).

Conclusion

Our multidisciplinary Long COVID Recovery Clinic, which incorporated both exercise and pacing, was safe in a heterogenous groups of consumers with Long COVID. In those who completed the exercise programme, we observed improvements in physical health outcomes without indications of harm or deterioration. Physical improvements were shown in endurance, functional mobility, inspiratory muscle strength and health scores. Our study suggests that individualised and carefully monitored exercise can be safely incorporated into rehabilitation for consumers recovering from Long COVID. The results from this single centre should be further validated in multi-centre studies which include both inspiratory and peripheral muscle exercise training.

Data Sharing Statement

Data sharing is available on reasonable request from the corresponding author, in line with ethical approvals.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

Disclosure

The authors report no conflicts of interest in this work.

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