

1 **SUPPLEMENTARY TEXT AND TABLE S1: DETAILED DESCRIPTION OF INTERVENTIONS**

2 **Control group**

3 Participants in the control group received 10-minute standardized educational instructions from
4 physiotherapists and an information sheet containing these instructions in written form. They were
5 advised to maintain normal daily activities, avoid excessive bed rest and immobilisation, take part in
6 moderate physical activities such as housework, adhere to a healthy diet and get 6-8 hours of sleep per
7 day. Patients also received advice on basic hand hygiene, physical distancing, and the appropriate use of
8 personal protective equipment such as facemasks.

9 **TERECO group**

10 In addition to the instructions and information sheets received by the control group, the Tereco group
11 took part in a 6-week remotely-monitored home exercise program delivered through a telerehabilitation
12 smartphone application called RehabApp (R PLUS HEALTH, Version 1.1.0, Recovery Plus Inc., Chengdu,
13 China). Participants received a heart rate (HR) telemetry device (Recovery Plus H1, Empsun Medical Co.,
14 Chengdu, China) to be worn on the chest during exercise. The HR telemetry device was connected to
15 RehabApp through the internet. Patients were further equipped with a finger-pulse oximeter and asked
16 to record oxygen saturation before and after exercise. They were instructed to not commence or stop
17 the exercise should SPO_2 be lower than 90% before or during the training, respectively. Physiotherapists
18 with at least 5 years experience in rehabilitation regularly reviewed data on exercise duration as well as
19 HR and oximetry data. Patient feedback on the exercise program was also collected through RehabApp.
20 In addition, consultations via mobile phone or WeChat voice calls were carried out every week. Issues
21 raised by participants related to the exercise program were discussed and the exercise program was
22 adjusted if necessary.

23 The duration of the exercise program was 40-60 minutes per session, with 3-4 sessions per week, for a
24 total of 6 weeks. Initial exercise types and intensity were determined by the physical therapists based on

25 baseline assessment and in accordance with the American College of Sports Medicine's guidelines for
26 exercise preparticipation¹.

27 The telerehabilitation exercise program included (i) breathing control and thoracic expansion (BCTE), (ii)
28 aerobic exercise, and (iii) lower-limb muscle strength (LMS) exercises specified in a three-tiered exercise
29 plan as shown in **Table 1**. If patients met the target criteria for a tier 1 exercise during a particular week
30 and did not report any adverse events, they could advance to tier 2 for this exercise type and so on. (i)
31 BCTE included one diaphragmatic breathing exercise and several exercises aimed at improving thoracic
32 muscle strength and chest mobility. (ii) Aerobic exercise was performed by brisk walking or running
33 outside near the home or on a treadmill at home (if available to the participant) with a 3-minute warm-
34 up and 3-minute stretching cool-down. The target heart rate (THR) for aerobic exercise was calculated
35 with the Karvonen formula², with exercise intensity scheduled to increase from 30-40% of heart rate
36 reserve (HRR) at the beginning of the exercise program to 40-60% of HRR in the final two weeks of the
37 program. Apart from monitoring the actual heart rate, patients were asked to report their rate of
38 perceived exertion (RPE) after the aerobic exercises according to Borg's scale^{3,4}. When this RPE was
39 greater than 14, the current intensity was considered unsuitable and the THR for a participant was
40 lowered. When the reported RPE was below 11, participants were requested to increase their aerobic
41 exercise intensity. When the reported RPE ranged between 11 and 14, participants repeated the
42 exercise at the same intensity and moved to the next tier after 2 weeks. (iii) LMS exercise comprised
43 weight-bearing and resistance exercises⁵ and gradually moved from exercises performed in a sitting
44 position such as seated leg lifting to exercises executed in standing position such as squats and side
45 lunges.

46 Table S1: Parameters of three-tiered exercise program for telerehabilitation of Covid-19

Tier	Exercise type	Exercise names and description	Physiological/anatomical target	Target duration per session	Target intensity	Schedule	Criteria for moving to next tier
Tier 1	Breathing control and thoracic expansion	1.1 Reclined seated diaphragmatic breathing: Step 1. The patient sits down on a chair and relaxes the upper chest and shoulders. Both hands are positioned on the abdomen. The patient should breathe slowly and deeply. Upon inhaling and exhaling, the hands should be felt to move out and in. Step 2. The patient breathes slowly and deeply from the diaphragm and upon inhaling maintains pressure with the hands to provide resistance on the abdomen. 1.2 Open chest, thoracic spine extension (seated): The patient sits up straight and stretches the thoracic spine, keeping hands on the back of the neck and elbows out to the side, and inhales deeply.	1.1 Increase voluntary control of diaphragmatic breathing, strengthen diaphragm 1.2 Increase respiratory muscle strength, mobility and flexibility of thoracic muscles and rib cage	Total: 10 min Effective: 6 min 1.1 Effective: 4 min plus 1 min breaks between sets 1.2 Effective: 2 min plus 1 min breaks between sets	1.1 Step 1. Two sets, 12 reps, 1 min/set. Step 2. Two sets, 12 reps, 1 min/set 1.2. Two sets, 12 reps, 1 min/set	Scheduled for weeks 1-2 at 3-4 sessions per week Minimal criteria for compliance: total app time \geq 52 min/week & effective (aerobic) \geq 28 min/week & at least 2 sessions/week completed	Complete the current exercise without difficulties in execution of movements and adverse effects
	Aerobic	2. Brisk walking or running outside near home or on a treadmill at home with warm up comprising walking at regular speed and cool down comprising seated muscle stretching exercises (2.1-2.3).	2. Increase lung volume, aerobic capacity, leg muscle strength and endurance	Total: 20 min. Effective: 14 min plus 3 min warm up and 3 min cool down	THR at 30-40% HRR		Complete within THR at targeted duration of effective exercise time and RPE 11-13.
	Lower limb strengthening	3.1 Seated unilateral hip and shoulder abduction and adduction: Sitting on a chair, the patient extends the left leg at 45 degrees to the left side with a slight outward twist of the knee while the left arm is extended horizontally with palms facing up. Return to the initial sitting position. Repeat with the right leg and the right arm. 3.2 Seated leg lifting and shoulder abduction: Sitting on a chair starting with knees bent at 90 degrees, the patient lifts the left knee up and as close to the chest as possible without discomfort while both arms are to the sides with elbows bent at 90 degrees, hands up, and palms forward. Return to the initial sitting position. Repeat with the right leg. 3.3 Seated forward toe tap with contralateral punch: The patient sits in a chair with hip and knees bent at 90 degrees. The patient extends the left leg with heel to the ground and toes in the air. Then she taps the floor with the toe of the left foot and punches forward with the right fist at the same time. Return to the initial sitting position. Repeat with the right leg and the left hand.	3.1 Increase abduction and adduction strength of hip (gluteus medius, gluteus minimus, and adductors of hip) and abduction strength of shoulder (deltoid, and supraspinatus) 3.2 Increase hip flexion strength (iliopsoas, rectus femoris) and shoulder abduction strength (deltoid and supraspinatus) 3.3 Increase plantar flexion strength (gastrocnemius and soleus) and shoulder flexion strength (biceps brachii and deltoideus)/	Total: 9 min Effective: 6 min 3.1-3.3 2 min each plus 1 min breaks between sets	3.1-3.3. Two sets each, 12 reps, 1 min/set.		Complete the current exercise without difficulties in execution of movements and adverse effects
Tier 2:	Breathing control and thoracic expansion	1.1 Reclined seated diaphragmatic breathing: same as Tier 1. 1.2 Open chest, thoracic spine extension (seated): same as Tier 1.	Same as Tier 1	Same as Tier 1	Same as Tier 1	Scheduled for weeks 3-4 at 3-4 sessions per week	Complete the current exercise without difficulties in execution of movements and

	Aerobic	2. Brisk walking or running outside near home or on a treadmill at home with warm up comprising walking at regular speed and cool down comprising seated and standing muscle stretching exercises (2.2 and 2.3).	Same as Tier 1	Total: 25 min Effective: 19 min plus 3 min warming up and 3 min cool down	THR at 40-50% HRR.	Minimal criteria for compliance: total app time ≥ 62 min/week & effective (aerobic) ≥ 38 min/week & at least 2 sessions/week completed	adverse effects Complete within THR at targeted duration of effective exercise time and RPE 11-13.
	Lower limb strengthening	3.4 Knee to chest walk: The patient stands straight with weight on the right leg while lifting the left leg and bringing the knee to the chest by bending at the hip and bending the knee. This position is supported by holding the shin of the left leg with both hands. The patient then releases the shin and places the left foot slightly ahead on the floor and returns to standing position. Repeat with the right leg. 3.5 Toe stand and hold: The patient stands straight while facing a wall and lifts both heels as high as possible with both hands on the wall to keep the weight in front of the body to prevent falling or losing balance. Return to standing position. 3.6. Mini squat (with chair): The patient squats with hip and knee bent at approximately 50 degrees and then stands up with hands holding the back of a chair. The knees should not exceed the toes during the squat.	3.4 Increase hip flexion strength (iliopsoas and rectus femoris) 3.5 Increase plantar flexion strength (gastrocnemius and soleus) 3.6 Increase hip and knee extension strength (quadriceps femoris, gluteus maximus and hamstring)	Total: 9 min Effective: 6 min 3.4 to 3.6 each 2 min plus 1 min breaks between sets	3 set interval exercise with 12 repetition for one set 3.4. Two sets, 12 reps, 1 min/set. 3.5. Two sets, 12 reps, 1 min/set. 3.6. Two sets, 12 reps, 1min/set.		Complete the current exercise without difficulties in execution of movements and adverse effects
Tier 3:	Breathing control and thoracic expansion	1.1 Reclined seated diaphragmatic breathing: as Tier 1. 1.3 Open chest, thoracic spine extension (standing position): Standing up straight, the patient stretches the thoracic spine, keeping hands on the back of the neck and elbows out to the side, and inhales deeply. 1.4. Bend over rowing and arm extension (dumbbells): While standing, the torso bends forward and the back is stretched; the upper limbs circle by extending forward and backward with dumbbells to mimic a rowing motion.	Same as Tier 1	Total: 15 min Effective: 9 min 1.1, 1.3-1.4 Three min each plus 1 min breaks between sets	1.1, 1.3-1.4 Three sets, 12 reps, 1 min/set.	Scheduled for week 5-6 at 3-4 sessions per week Minimal criteria for compliance: total app time ≥ 84 min/week & effective (aerobic) ≥ 48 min/week & at least 2 sessions/week completed	n.a.
	Aerobic	2. Brisk walking or running outside near home or on a treadmill at home with warm up comprising walking at regular speed and cool down comprising seated and standing muscle stretching exercises (2.2 and 2.3).	Same as Tier 1	Total: 30 min. Effective 24 min plus 3 minutes warming up and 3 minutes cool down	THR at 40-60% HRR.		n.a.
	Lower limb strength	3.7 Squat: From standing position, the patient squats with hips and knees bent at approximately 50 degrees and then stands up (3.7.1). The knees should not exceed the toes during the squat. The intensity increases slightly from set 1 to 3 by adding upper-limb movements including a shoulder	3.7 Increase hip and knee extension strength (quadriceps femoris and gluteus maximus) and increase shoulder flexion	Total: 15 min Effective: 9 minutes. 3.7-3.9 Three min each plus 1	3.7-3.9 Three sets each, 12 reps, 1 min/set.		n.a.

		<p>press (3.7.2, mimicking pressing a barbell upward with both hands as the torso moves downward) or clapping the hands over the head (3.7.3).</p> <p>3.8 Alternating lunge and shoulder flexion: From standing position, the patient starts to stride forward with the left leg until the left knee is bent between 60 to 90 degrees and then shifts the weight of the upper body over the left leg while lifting hands over the head. Return to standing position. Repeat with the right leg.</p> <p>3.9. Sideward lunge: From standing position, the patient steps sideward to the left and shifts the weight of the upper body over the left leg with the knee bent at about 60 degrees and with hands on the hips. Return to standing position by moving the right foot in. Repeat with the right leg.</p>	<p>strength (biceps brachii and deltoid)</p> <p>3.8 Strengthen quadriceps femoris and hamstring and increase shoulder flexion strength (biceps brachii and deltoideus)</p> <p>3.9 Strengthen quadriceps femoris, hamstring and hip adductors</p>	<p>min breaks between sets.</p>			
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47 See Appendix 2 for screenshots from exercise videos. HRR = Heart rate reserve; n.a. = not applicable; RPE= Borg rate of perceived exertion; THR = Target heart rate

On each day with scheduled exercises, RehabApp reminded the patients to start the exercise and guided them through the process. In the case of BCTE and LMS exercise this was done by displaying videos (see Appendix 2) demonstrating the relevant exercises. During aerobic exercise, information on the patients' HR in relation to the THR was displayed on the smartphone screen. When the monitored HR was within the THR range, RehabApp recorded the duration as effective exercise and illuminated a green light at the bottom of the screen. When the monitored HR was below or over the THR, a yellow or red light appeared, respectively. If the HR exceeded 110% of the target heart rate, the patient received a message to slow down the exercise until the HR returned to resting rate. RehabApp recorded the HR, the total duration of the exercise, the duration of the effective exercise, self-reported RPE and any interruptions if they occurred.

Compliance with exercise protocol

Total exercise time for a given day was determined as the time from opening to closing RehabApp. The time during aerobic exercise within which the monitored HR reached the THR or above was counted as effective exercise time. Having reached at least two thirds (66.7%) of the scheduled total and effective target time as given in Table 1 or modified by the therapist in any given week for at least five of the six weeks according to RehabApp records was considered compliant with the exercise protocol. At least 2 of the minimally scheduled 3 sessions per week had to be completed (in total 12 of 18 sessions). Patients who dropped out of the exercise program before week 6 were considered non-compliant.

References

1. American College of Sports Medicine. *ACSM's Guidelines for Exercise Testing and Prescription* 9th ed. Philadelphia, 2013.
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3. Borg G. Perceived exertion as an indicator of somatic stress. *Scandinavian journal of rehabilitation medicine* 1970;2(2):92-8.
4. Borg GA. Psychophysical bases of perceived exertion. *Medicine and science in sports and exercise* 1982;14(5):377-81.
5. Eckardt N. Lower-extremity resistance training on unstable surfaces improves proxies of muscle strength, power and balance in healthy older adults: a randomised control trial. *BMC geriatrics* 2016;16(1):191.