

## Cardiopulmonary Exercise Testing in Post-COVID-19 Patients: New Insights Into the Exercise Intolerance

Marina Petersen Saadi<sup>1,2</sup>  and Anderson Donelli da Silveira<sup>1,2,3</sup> 

Serviço de Cardiologia Hospital de Clínicas de Porto Alegre,<sup>1</sup> Porto Alegre, RS – Brazil

Programa de Pós-Graduação em Cardiologia: Ciências Cardiovasculares da Universidade Federal do Rio Grande do Sul,<sup>2</sup> Porto Alegre, RS – Brazil  
Hospital Moinhos de Vento,<sup>3</sup> Porto Alegre, RS – Brazil

Short Editorial related to the article: *Cardiopulmonary Exercise Testing in Post-COVID-19 Patients: Where Does Exercise Intolerance Come From?*

COVID-19 has affected thousands of people worldwide, and a considerable percentage of those complain of persistent exercise limitation, unrelated to the disease's severity and persisting even months after the infection.<sup>1,2</sup> It is well known that the severe form of COVID-19 predominantly involves the respiratory system, presenting with acute respiratory distress syndrome. One could speculate that the persistent functional limitation seen after infection may originate in the respiratory system, a fact reinforced by studies that showed ventilatory limitation in spirometry after hospital discharge.<sup>3,4</sup>

Cardiopulmonary Exercise Test (CPET) allows a complete assessment of the cardiorespiratory system. It is the gold standard exam to define prognosis in several heart and lung diseases and can discriminate the underlying mechanisms associated with reduced functional capacity.<sup>5,6</sup>

In this *Arquivos Brasileiros de Cardiologia*, Milani et al.<sup>7</sup> evaluated 144 patients without a prior cardiovascular or pulmonary disease, with persistent symptoms after COVID infection, on average 11.5 weeks after infection, who were compared with 144 healthy adult matched controls. Most of the patients (92%) had the CPET test limited by peripheral muscle fatigue, with minimal pulmonary (6%) and cardiovascular (2%) limitation. The frequency and magnitude of the reduction in functional capacity were related to the severity of the disease, with 56% of patients with severe COVID presenting a reduction in functional capacity with a lower  $VO_2$  compared to the less severe

groups. The  $VO_2$  at ventilatory thresholds was also reduced in the sickest individuals.<sup>7</sup>

The authors also made a different approach for a subgroup analysis where patients who had undergone CPET before covid for another reason had pre- and post-COVID tests compared. In the moderate covid group, there was a reduction of 0.4 km/h in the maximum speed and a small increase in the percentage of predicted maximum HR. In the moderate/severe group, there was a greater reduction in maximum speed (1 mk/h) and a significant reduction in peak  $VO_2$  (7.4%), eliciting a reduction in physical capacity in the same patients after COVID.<sup>7</sup>

The main mechanism of functional limitation after COVID seems to have a peripheral muscular etiology, although dysfunctional breathing and chronotropic insufficiency have also been described as possible causes.<sup>8</sup> The reduction in functional capacity because of muscle fatigue due to abnormal extraction of oxygen in the periphery by muscle catabolism does not seem to be related only to periods of rest and isolation but to the COVID disease itself, a fact verified by studies that showed a reduction in associated peak  $VO_2$  poor peripheral  $O_2$  extraction with normal cardiac index.<sup>9</sup>

Because of these findings, it is likely that cardiopulmonary rehabilitation with physical exercises prescribed and executed by qualified professionals could improve symptoms and objective measures of functional capacity. However, randomized clinical trials with exercise or cardiopulmonary rehabilitation are needed.<sup>10</sup>

### Keywords

Post-Covid-19/complications; Lung Diseases; Pandemics; Respiratory Distress Syndrome Adult/rehabilitation; Spirometry/methods; Exercise Test; Lung Volume Measurements; Physical Activity

**Mailing Address: Anderson Donelli Silveira** •

Serviço de Cardiologia – Hospital de Clínicas de Porto Alegre – Ramiro Barcelos, 2350. Postal Code 90410-004, Porto Alegre, RS – Brazil  
E-mail: adsilveira@hcpa.edu.br

**DOI:** <https://doi.org/10.36660/abc.20230058>

## References

1. Groff D, Sun A, Ssentongo AE, Ba DM, Parsons N, Poudel GR, et al. Short-term and long-term rates of post-acute sequelae of SARS-CoV-2 infection: a systematic review. *JAMA Netw Open*. 2021;4(10):e2128568. doi:10.1001/jamanetworkopen.2021.28568.
2. Xie Y, Bowe B, Al-Aly Z. Burdens of post-acute sequelae of COVID-19 by severity of acute infection, demographics, and health status. *Nat Commun*. 2021;12(1):6571. doi:10.1038/s41467-021-26513-3.
3. Huang Y, Tan C, Wu J, Chen M, Wang Z, Luo L, et al. Impact of coronavirus disease 2019 on pulmonary function in early convalescence phase. *Respir Res*. 2020;21(1):163. doi: 10.1186/s12931-020-01429-6.
4. Telles AC, Romero SL, Hurtado EF, Aguilar YN, Wong AW, Milne KM, et al. Pulmonary function and functional capacity in COVID-19 survivors with persistent dyspnea. *Respir Physiol Neurobiol*. 2021;288:103644. doi: 10.1016/j.resp.2021.103644
5. Adachi H. Cardiopulmonary exercise test: The most powerful tool to detect hidden pathophysiology. *Int Heart J*. 2017; 58(5):654–65. doi: 10.1536/ihj.17-264
6. Vogiatzis I, Zakynthinos G, Andrianopoulos V. Mechanisms of physical activity limitation in chronic lung diseases. *Pulm Med*; 2012. doi: 10.1155/2012/634761.
7. Milani M, Milani JGPO, Cipriano GFB, Cahalin LP, Stein R, Cipriano Jr G. Cardiopulmonary Exercise Testing in Post-COVID-19 Patients: Where Does Exercise Intolerance Come From? *Arq Bras Cardiol*. 2023; 120(2):e20220150.
8. Durstenfeld MS, Sun K, Tahir P, Peluso MJ, Deeks SG, Aras MA, et al. *JAMA Network Open*. 2022;5(10):e2236057. doi: 10.1001/jamanetworkopen.2022.36057
9. Singh I, Joseph P, Heerdt PM, Cullinan M, Lutchmansingh DD, Gulati M, et al. Persistent Exertional Intolerance After COVID-19: Insights From Invasive Cardiopulmonary Exercise Testing. *Chest*. 2021;161(1):54-63. doi: 10.1016/j.chest.2021.08.010
10. Besnier F, Bérubé B, Malo J, Gagnon C, Grégoire CA, Juneau M, et al. Cardiopulmonary Rehabilitation in Long-COVID-19 Patients with Persistent Breathlessness and Fatigue: The COVID-Rehab Study. *Int J Environ Res Public Health*. 2022;19(7):4133. doi: 10.3390/ijerph19074133

