Original Research Article

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Knowledge and perceptions regarding pulmonary rehabilitation amongst Ecuadorian physicians following COVID-19 outbreak

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ABSTRACT

Background: Pulmonary rehabilitation is already an established technique for patients with chronic respiratory disease, aimed at improving breathlessness, exercise capacity, health status, and well-being. The aim of this study was to assess the knowledge and perceptions about pulmonary rehabilitation post-COVID-19 infection among Ecuadorian physicians. **Methods:** We conducted a cross-sectional online survey-based study using a 27-item questionnaire to assess the knowledge about specific topics related to pulmonary rehabilitation. The sample comprised Ecuadorian physicians who were currently enrolled to an active medical practice that included care to COVID-19 patients. Descriptive statistics were applied for demographic variables of interest. A chi-square goodness of fit test was used to determine whether the observed frequencies of each of the answers per query were within or outside of the expected frequencies by chance. **Results:** In total, 295 participants answered the survey, out of which 57.3% were general practitioners. Most agreed that COVID-19 infected patients must be followed-up with some measurement of respiratory function (81.4%, p=0.000), but only 18.3% (n=54, p=0.000) were aware of specific guidelines related to rehabilitation. 93.6% (n=276, p=0.000) considered that pulmonary rehabilitation provides a benefit, of any kind, to patients with past COVID-19 infection. **Conclusions:** Most physicians considered pulmonary rehabilitation beneficial following COVID-19. However, there is uncertainty on how to adequately follow up patients, complementary tests, and specific guidelines outlining rehabilitative interventions.

Key words: COVID-19, Knowledge, Latin America, perception, physicians, pulmonary rehabilitation

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Introduction

Coronavirus disease 2019 (COVID-19) is a contagious infectious disease that may lead to respiratory, physical, and generalized systemic dysfunction [1]. Asymptomatic infection, moderate illness, or severe pneumonia can cause respiratory failure and mortality [2]. Due to the many respiratory symptoms that can cause severe respiratory distress requiring extended mechanical ventilation, many COVID-19 patients are hospitalized [3,4]. In acute and recovery phases, severely and critically ill COVID-19 patients have pulmonary insufficiency, cognitive impairment, and dyskinesia, according to the Handbook of COVID-19 Prevention and Treatment [5]. Pulmonary rehabilitation may assist these patients by improving respiratory, mental, and physical symptoms, and minimizing consequences [5].

The American Thoracic Society (ATS)/European Respiratory Society (ERS) Statement on pulmonary rehabilitation was first published in 2006 and defined pulmonary rehabilitation as "a comprehensive intervention based on a thorough assessment of the patient followed by patient-centric therapies that include, but are not limited to, exercised training, behavior change, and education designed to improve the physical and mental condition of people with respiratory disease and to promote the long-term adherence to health-enhancing behaviors" [6,7].

It is likely that patients with COVID-19 will need pulmonary rehabilitation during or directly after the hospitalization period, an approach recommended by the World Health Organization [8]. However, there is limited data on the safety and efficacy of pulmonary rehabilitation measures among post-COVID-19 patients. Similarly, healthcare providers may be unaware of the follow up after COVID-19 pneumonia, goals, benefits, indications, and procedural administration of rehabilitative interventions in daily practice, while the burden of COVID-19 patients continues to rise daily [9]. With this study our aim was to assess the knowledge and perceptions about pulmonary rehabilitation post-COVID-19 infection among Ecuadorian physicians.

Methods

Study design and participants

We conducted a cross-sectional online survey-based study using a non-probability convenience sampling method where 295 physicians where recruited. The sample comprised Ecuadorian physicians who, regardless of their specialty, were currently enrolled to an active medical practice that includes care to COVID-19 patients. Physicians who expressed no interest in participating in the study, physicians whose informed consent could not be obtained and/or physicians who initially consented but subsequently revoked their consent were excluded. The participants anonymously answered a non-validated 27-item questionnaire, designed by an expert panel of pulmonologists, to assess what they knew about specific topics of pulmonary rehabilitation after a COVID-19 infection based on the current literature and evidence-based recommendations [4-7,10-15].

Questionnaire

The first part of the questionnaire consisted of demographic information of each participant. The second part included 27 items which were grouped in domains regarding specific topics about pulmonary rehabilitation. The items were grouped as follows:

1. Follow up after COVID-19 pneumonia: Q1-Q4
2. Goals of pulmonary rehabilitation: Q5-Q6
3. Benefits of pulmonary rehabilitation: Q7-Q12
4. Indications of pulmonary rehabilitation: Q13-Q23
5. Procedure and administration of pulmonary rehabilitation: Q24-Q27.

For questions Q1-6 and Q19-26 participants could choose "true", "false" or "I don't know", while for questions Q7-18 and Q27 the answers were eithers "yes", "no" or "I don't know". Each question, grouped by topic, with its correct answers can be visualized in the Supplementary Table S1.

Statistical analysis

This study applies descriptive statistics for demographic variables of interest. Continuous data is presented as means and standard deviations if normality

is determined, whereas median and interquartile range are selected if the data does not follow a normal distribution; nominal data is presented as frequencies and percentages. Prior to be analyzed, participants were categorized according to the answers provided as "answered correctly" (if participant's answer matched the correct answer as per seen in Supplementary Table S1) or "answered incorrectly" (if participant's answer did not match the correct answer as per seen in Supplementary Table S1, including if participant chose "I don't know"). We also analyzed the correlation between specialty and years of experience on number of correct answers overall and per domain (Supplementary Table S2). We used the chi-square goodness of fit test to determine whether the observed frequencies of each of the answers per query were within or outside of the expected frequencies by chance. A Fisher's exact test was applied in the case of assumption violation. The statistical analyses were conducted using SPSS for Windows (version 25.0; SPSS Inc, Chicago, Illinois). A $p<0.05$ was regarded as statistically significant.

Results

Descriptive statistics of demographics

Out of the 295 participants, 52.5% (n=155) were males. Most physicians were general practitioners (57.3%, n=169), while 42.7% (n=126) had specialized in a medical field. Regarding specialties, the most common were pulmonary medicine and critical care (10.2%; n=30) and internal medicine (8.5%, n= 25). The sample's average years of experience was 13.0 (SD, 11.6). Table 1 summarizes sample's demographics. With respect to the questionnaire, the median percentage of correct answers was 67.0% (IQR, 20.0%). The general percentual score did not follow a normal distribution as revealed by Shapiro-Wilk test ($p=0.000$). The left skewed (S_{KP} = - 0.688) distribution for total percentage score of correct answers is depicted in Figure 1. The median general and domain scores are included in Table 1. The response rate was of 59%.

Table 1. Demographic information of surveyed population (n=295).

Characteristics	% (n)
Gender	
Male	52.5 (155)
Female	47.5 (140)
Years of practice (mean, SD)	13.0 (11.6)
Medical specialty	42.7 (126)
Pulmonary medicine and critical care	10.2 (30)
Internal medicine	8.5 (25)
Pediatrics	7.8 (23)
Allergology	2.4 (7)
Cardiology	1.4 (4)
Anesthesiology	1.4 (4)
Physical medicine and rehabilitation	0.7 (2)
Other	24.6 (31)
Answered correctly (median, IQR)	18.0 (5.0)
Follow up after COVID-19 pneumonia (Q_1-Q_4)	2.0 (1.0)
Goals of pulmonary rehabilitation (Q_5-Q_6)	2.0 (0.0)
Benefits of pulmonary rehabilitation (Q_7-Q_{12})	4.0 (1.0)
Indication of pulmonary rehabilitation (Q_{13}-Q_{23})	7.0 (2.0)
Procedure and administration of pulmonary rehabilitation (Q_{24}-Q_{27})	3.0 (1.0)

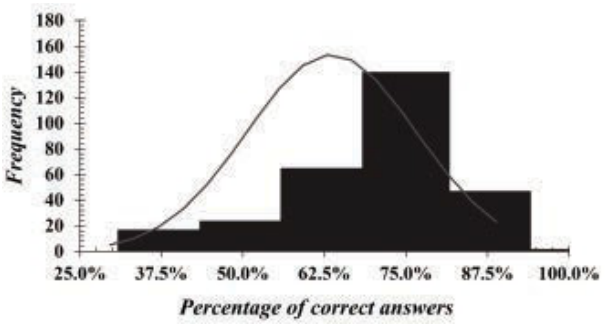

Figure 1. Distribution of total percentage score of correct answers.

Follow up after COVID-19 pneumonia

Most participants agreed that COVID-19 infected patients must be followed up with a measurement of respiratory function (81.4%, n=240; $\chi^2(1) = 116.017$, p=0.000) and exercise capacity (78.0%, n=230; $\chi^2(1) = 92.288$, p=0.000) at 12 weeks after hospital discharge (Figure 2, Supplementary Table S1). However, less than half (43.4%, n=128; $\chi^2(1) = 5.156$, p=0.000) of the sample asserted that radiological features in community acquired pneumonia are followed-up sooner than that for COVID-19 pneumonia. It was also worth noting that 18.3% (n=54; $\chi^2(1) = 118.539$, p=0.000) assumed that there are specific guidelines to follow up for rehabilitation after hospitalization for COVID-19 infection according to disease severity.

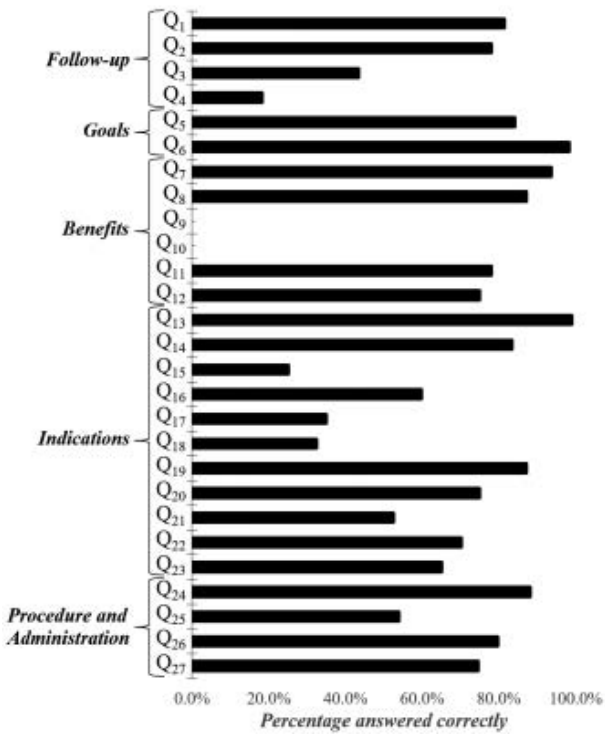

Figure 2. Percentage of participants who "answered correctly" each query per domain.

Goals of pulmonary rehabilitation

About 8 out of 10 (84.1%, n=248; $\chi^2(1) = 136.953$, p=0.000) physicians were certain that the short-term goal of pulmonary rehabilitation is to improve dyspnea, and nearly all the sample (98.3%, n=290; $\chi^2(1) = 275.339$, p=0.000) were acquainted with the fact that improvement in the patient's quality of live is the long-term goal (Figure 2, Supplementary Table S1).

Benefits of pulmonary rehabilitation

In general, 93.6% (n=276; $\chi^2(1) = 223.895$, p=0.000) physicians considered that pulmonary rehabilitation provides a benefit, of any kind, to patients with past COVID-19 infection. Roughly 9 in 10 (87.1%, n=257; $\chi^2(1) = 162.580$, p=0.000) participants claimed that pulmonary rehabilitation reduces morbidity in these patients. It is noteworthy, however, that when asked by disease severity groups, all the sample incorrectly assumed that this reduction in morbidity is observed in asymptomatic (100%, n=295) and mildly ill subjects (100%, n=295). Nevertheless, most physicians were conscious that this reduction in morbidity would indeed benefit patients with moderate (78%, n=230; $\chi^2(1) = 92.288$, p=0.000) and severe disease (74.9%, n=221; $\chi^2(1) = 73.251$, p=0.000) (Figure 2; Supplementary Table S1).

Indications of pulmonary rehabilitation

Nearly all the respondents considered complementary test to be useful to identify which patients with COVID-19 infection require pulmonary rehabilitation (99.0%, n=292; $\chi^2(1) = 283.122$, p=0.000); spirometry (83.4%, n=246; $\chi^2(1) = 131.556$, p=0.000) and the six-minute walk test (59.7%, n=176; $\chi^2(1) = 11.014$, p=0.001) were the best rated parameters in this regard. In contrast, a third or less reflected maximal

inspiratory pressure (34.9%, n=103; $\chi^2(1) = 26.851$, p=0.000), maximal expiratory pressure (32.5%, n=96; $\chi^2(1) = 35.963$, p=0.000) and DL_{CO} (25.1%, n=74; $\chi^2(1) = 73.251$, p=0.000) as useful methods to serve as indicators for referral to pulmonary rehabilitation. Also, if pulmonary rehabilitation was to be delivered in an inpatient setting, 65.1% (n=192; $\chi^2(1) = 26.851$, p=0.000) agreed that a focused pulmonary assessment needs to be conducted. Concerning specific scenarios, 87.1% (n=257; $\chi^2(1) = 162.580$, p=0.000) physicians asserted that COVID-19 infected patients with a moderate or severe course should receive pulmonary rehabilitation until 12 weeks after hospital discharge, 74.9 % (n=221; $\chi^2(1) = 73.251$, p=0.000) agreed that an associated pulmonary or neuromuscular comorbidity warrants physiotherapy for airway clearance even in mild disease and 70.2% (n=207; $\chi^2(1) = 48.003$, p=0.000) reaffirmed that hospitalized patients should receive rehabilitation at the bedside until safe for discharge to the home environment.

Procedure and administration of pulmonary rehabilitation

As a complex and long-term therapy, 88.1% (n=260; $\chi^2(1) = 171.610$, p=0.000) were thoughtful on how pulmonary rehabilitation requires administration by an interdisciplinary team. In terms of remote pulmonary rehabilitation, half of the participants (53.9%, n=159; $\chi^2(1) = 1.793$, p=0.181) were informed that the recommended goal of remote pulmonary rehabilitation is 2-3 on the Borg dyspnea scale score or mild to moderate breathlessness with exercise. Most of the sample recognized that pulmonary rehabilitation can be done at home with appropriate tools (79.7%, n=235; $\chi^2(1) = 103.814$, p=0.000) and that various exercises are recommended multiple times a week (74.6%, n=220; $\chi^2(1) = 71.271$, p=0.000).

Discussion

Due to COVID-19, the awareness and overall knowledge of pulmonary rehabilitation has become a topic of recent interest across several areas of medicine from primary care to highly specialized fields. In our study, the goal was to evaluate the knowledge and perceptions physicians had about the role of pulmonary rehabilitation in patients previously infected with COVID-19. In general, most participants agreed that COVID-19 patients should be followed after the initial infection with some measurement of respiratory function and exercise capacity, but very few were aware of the existence of specific guidelines on the subject. In a previous study exploring the perceptions of physicians towards pulmonary rehabilitation referrals in China conducted pre pandemic, Hao and colleagues found that while most of the respondents had previously heard about pulmonary rehabilitation and many knew the practice, very few referred patients for rehabilitation [9]. Therefore, raising awareness about the role of pulmonary rehabilitation and increasing the diffusion of evidence-based guidelines on the topic is an important area to begin addressing this issue.

Pulmonary rehabilitation has the goal to improve respiratory dynamics, counteract musculoskeletal immobilization, reduce the onset of subsequent complications/disabilities, and improve the quality of life [13]. In the case of COVID-19 survivors, a previous study found an improvement in the 6 minute walk test (6MWT), functional vital capacity (FVC), and the mental component of the SF-36 health survey among patients who completed a 3-week pulmonary rehabilitation program [16]. Another study by Zampogna and colleagues reported improvement in the short physical performance battery (SPPB) and six-minute walking distance assessed with the Barthel index among COVID-19 patients that required assisted ventilation or oxygen, and underwent pulmonary rehabilitation [17]. Consistent with existing literature, a majority of participants in our study agreed that the goals of pulmonary rehabilitation include improving patient's dyspnea and quality of life, while also reducing the morbidity associated with the virus.

Perhaps one area that is unclear at the moment is related to complementary testing to identify which patients are more likely to benefit from pulmonary rehabilitation. In our study, a majority considered assessing the physiological function of the respiratory system through spirometry, and the waking distance as useful indicators. However, less than a third considered the diffusing capacity for carbon monoxide (DL_{CO}) as a useful test. Earlier systematic reviews and meta-

analyses have found considerable lung dysfunction in COVID-19 patients after infection [18]. Among these patients, 39% showed altered DL_{CO}, while 15% presented restrictive respiratory patterns. Additionally to spirometry and DL_{CO}, the 6MWT may be useful to monitor changes in pulmonary function [19]. It is a simple, reproducible, and inexpensive test. Patients with severe pneumonia after recovery from COVID-19 had a non-statistically significant shorter mean 6MWT, according to a previous prospective study [20]. It is still unclear which role the 6MWT will play in following up COVID survivors, but it may provide information on a patient's ability to accomplish daily activities, and its correlation with peak oxygen uptake might help identify alterations in lung function [21].

Finally, most respondents in our study considered that pulmonary rehabilitation requires an interdisciplinary team but can also be done at home given the appropriate conditions. However, there are concerns about the lack of access to rehabilitative programs, either in-hospital, at the primary care, or community care level that have been documented in the past. In Portugal, it was estimated that roughly 0.5-2% of residents had access to pulmonary rehabilitation services, and this situation only aggravated since the beginning of the pandemic in 2020 [14]. Many programs were affected following international and national recommendations related to social distancing and contact prevention, while some shifted to remote care using telehealth solutions. This is an interesting area to explore in the future, where self-management or education modules in the realm of telerehabilitation may be adopted for both patients and healthcare providers [17,22]. Whether pulmonary rehabilitation is delivered remotely or inperson, it should preserve the basic components, including i) exercise training; ii) education; and iii) behavior change, and an essential understanding of the selection criteria, emergency plans, outcome measures, intervention design, and technology/equipments [14].

Strengths and limitations

In light of our findings, there are several limitations worth mentioning. Our study assessed knowledge and perceptions towards pulmonary rehabilitation using a non-validated survey. Since the survey is based on physicians' self-declaration, there may be differences in perceiving and expressing their current understanding on pulmonary rehabilitation for post-COVID-19 patients. Since the majority of participants had no specialization in any medical field, and roughly 10% were specialized in pulmonary medicine or critical care, familiarity with pulmonary rehabilitation may have been limited in the sample. Therefore, our results may not be generalizable to all physicians, and can differ from the perceptions expressed in other regions. However, to the best of our knowledge, our study is one of the first to assess specific perceptions and knowledge towards pulmonary rehabilitation among Ecuadorian physicians, providing valuable insight for designing future interventions.

Conclusions

COVID-19 has put under pression and will continue to challenge healthcare systems globally, including rehabilitation provision. Most physicians in our research considered pulmonary rehabilitation effective, however, patient follow up, supplementary testing, and rehabilitative therapeutic protocols are unclear. Increasing healthcare professionals' understanding and use of pulmonary rehabilitation may improve COVID survivors' symptoms and quality of life. Therefore, we encourage international societies to review and establish patient rehabilitation programs and promote awareness and expertise among healthcare personnel who will manage these patients.

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Online supplementary material

Supplementary Table 1. Percentages and frequencies of participants who "answered correctly" and "answered incorrectly" on each of the questions per domain.

Supplementary Table 2. Correlation between specialty and years of experience on number of correct answers overall and per domain.

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