A worldwide look into long COVID-19 management: an END-COVID survey

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Shareable abstract (@ERSpublications)
Heterogeneity in standard operating procedures related to the management of long COVID-19 is appreciable worldwide. Geographic differences, national income levels, healthcare professionals involved and inclusion of paediatric patients might play a role. https://bit.ly/3UuSApQ

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Abstract

Background Long COVID is a heterogeneous clinical syndrome characterised by a variety of reported symptoms and signs. Its clinical management is expected to differ significantly worldwide.

Methods A survey-based study investigating long COVID-related standard operating procedures (SOPs) has been conducted by the European Respiratory Society (ERS) END-COVID clinical research collaboration with the support of other international societies (ALAT, APSR, CHEST, ESCMID and PATS). A global analysis of the results is provided here, alongside sub-population analysis based on continents, national income levels, type of involved healthcare professional and inclusion or exclusion of paediatric patients.

Findings 1015 healthcare professionals from 110 different countries worldwide participated in this study, the majority of them being respiratory physicians (60.6%). A dedicated long COVID programme was present in 55.4% of the investigated institutions, with hospital admission during the acute infection being the main inclusion criteria to access them. Consistent differences in long COVID-related procedures were identified among centres, mainly regarding the multidisciplinary approach, the availability of telemedicine and psychological support, the type of requested exams and the total amount of visits in the centre.

Interpretation Long COVID management shows important differences related to geographical areas and national income levels. SOPs were significantly different when centres were managed by a pulmonologist or when paediatric patients were included.

Introduction

SARS-CoV-2 is responsible for both an acute interstitial pneumonia, sometimes requiring hospitalisation and ventilatory support, and a debilitating, multisystemic chronic syndrome [1]. The "post-COVID-19 condition", also-called either "post-COVID-19 syndrome", "post-acute sequelae of COVID-19" or "long COVID", has been variously defined based on the persistence or new onset of symptoms after a probable or confirmed infection by SARS-CoV-2, lasting for a minimum of 2–3 months and not explained by an alternative diagnosis [2, 3]. Long COVID is associated with a large number of symptoms and signs,

including respiratory symptoms, but also alterations in cardiovascular, neurocognitive, psychological, dermatological or gastrointestinal function associated with dysregulated inflammation, blood clotting and autoimmunity [4, 5]. Fatigue, dyspnoea, cough, headache, and smell and taste dysfunctions are the most frequently recorded symptoms and signs [4]. According to an estimate performed by the Global Burden of Disease collaborators, about 6.2% of survivors experience long COVID 3 months after a symptomatic SARS-CoV-2 infection, and 15.1% of this proportion still suffers from persisting symptoms after 12 months [6]. Other researchers have highlighted substantial heterogeneity across cohorts enrolled in various studies and countries, with a reported prevalence of long COVID ranging from 9% to 81% [7]. The prevalence might be relevant in children and teenagers as well, as an English matched-cohort study demonstrated a persistence of symptoms in about 14% of adolescents 3 months after the acute infection [8]. Considering that >760 million individuals have contracted the infection since the beginning of the pandemic, long COVID represents a global health issue with a potentially extraordinary impact on healthcare systems worldwide [9].

The wide spectrum of symptoms and signs, the existence of different diagnostic criteria and the clinical heterogeneity of the population described by the disease ICD-10 dedicated code make the definition of standard operating procedures (SOPs) even more challenging [10]. A European Respiratory Society (ERS) task force recently published a statement on long COVID to identify optimal follow-up strategies for patients suffering from the disease [11]. Nonetheless, the identification of a standardised pathway for long COVID is still a research priority identified by both patients and clinicians [12]. A recent survey-based study identified considerable heterogeneity in practice for the management of long COVID across different European centres, particularly regarding inclusion criteria, multidisciplinary approach, use of telemedicine and rehabilitation availability [13]. Even greater heterogeneity might be expected by the extension of this analysis at a global level, especially considering differences in healthcare resources among countries, the management of the disease by different healthcare professionals (HCPs) and the inclusion or exclusion of paediatric patients in long COVID services.

The present study aims at exploring current clinical practice related to the management of long COVID across different continents and countries worldwide.

Materials and methods

A survey was conducted by the ERS European Respiratory Network for Data sharing on COVID-19 (END-COVID) clinical research collaboration in February 2023. The survey was designed to investigate the existence of programmes or clinics caring for patients with long COVID, to explore the inclusions criteria to access them and to assess the most common SOPs performed in the programmes at a global level. Furthermore, the survey studied the availability and execution of several diagnostic tests investigating symptoms associated with long COVID both at the enrolment and during follow-up. The survey was elaborated by the END-COVID Clinical Research Collaboration (CRC) and validated with suggestions provided by representatives of other international societies (see below). The final version of the questionnaire contained 26 questions and is reported in table 1. The study was led by the ERS with the support of other international societies, including the Asociación Latinoamericana de Tórax (ALAT), the Asian Pacific Society of Respirology (APSR), the American College of Chest Physicians (CHEST), the European Society of Clinical Microbiology and Infectious Disease (ESCMID) and the Pan African Thoracic Society (PATS), which allowed coverage of every continent and a targeting of a variety of different HCPs. The survey was initially formulated in English but was translated into 13 additional languages (Arabic, Bulgarian, Chinese, Danish, German, Dutch, French, Greek, Hungarian, Italian, Portuguese, Russian and Spanish) to facilitate understanding. The survey was uploaded on SurveyMonkey in February 2023. ERS and the other involved international societies shared the initiative among their members through newsletters, website advertisement and forwarding the invitation to affiliated national societies. Only one completed survey from each healthcare professional was allowed.

Sub-population analyses based on the geographical areas, national income levels, involved HCPs and inclusion or exclusion of paediatric patients have been conducted. A continent-based separation has been used for the geographical analysis, with Oceania being considered together with Asia for the purpose of the analysis. The 2023 World Bank classification has been used for income division [14]. Countries were considered to have a low income if they belonged to either the World Bank “low-income” or “lower-middle-income” economies groups; middle-income and high-income groups were defined based on the “upper-middle-income” and “high-income” economies World Bank groups. Venezuela was considered as a low-income country for the purpose of this analysis [15]. Hypothesising that different HCPs might have different approaches in the management of the disease, two groups were defined based on the healthcare professional primarily involved in the management of the programme (pulmonologists *versus*

TABLE 1 END-COVID survey questions on the management of long COVID

1)	Do you have a specific programme or a dedicated clinic in your institution for patients' follow-up after COVID-19 acute infection and for the management of long COVID?
2)	If yes, which healthcare professional is running it?
3)	Is there a multidisciplinary team working in the programme?
4)	If yes, which healthcare professionals are part of the multidisciplinary team?
5)	Which type of patients are included in this COVID-19 follow-up/long COVID programme?
6)	Do you include paediatric patients (<18 years old) in your COVID-19 follow-up/long COVID programme?
7)	What are the criteria used to include patients in this COVID-19 follow-up/long COVID programme?
8)	How many times do you usually run the clinic within the programme?
9)	How many visits do you usually perform in your programme per month, including virtual visits?
10)	Do you use telemedicine in your COVID-19 follow-up/long COVID programme?
11)	If you use telemedicine, how many virtual visits do you usually perform per month?
12)	Which healthcare professional manages the telemedicine assessment?
13)	Which patients do you usually consider suited for telemedicine evaluation?
14)	When do you organise the first follow-up visit after discharge?
15)	According to which criteria do you individualise the time for first visit?
16)	Averagely speaking, is the first follow-up visit in your programme for patients that have been discharged from the hospital a face-to-face evaluation or a telemonitoring?
17)	Which of the following services do you usually manage to offer inside your institution for patients that have recently had an acute COVID-19 infection?
18)	Which kind of assessment do you usually perform for the majority of your patients during their first visit in your programme?
19)	Which kind of assessment do you usually perform for the majority of your patients within the first month in your programme?
20)	Which kind of assessment do you usually perform for the majority of your patients within the first 3 months in your programme?
21)	Which kind of assessment do you usually perform for the majority of your patients within the first 6 months in your programme?
22)	Do you run a rehabilitation programme within the COVID-19 follow-up/long COVID programme?
23)	Do you offer psychological support within the COVID-19 follow-up/long COVID programme?
24)	If yes, please describe the psychological support that you offer
25)	If you do not have a neurologist in your MDT, are patients with persistent neurological disorders referred to a neurologist?
26)	If you do not have a cardiologist in your MDT, are patients with persistent cardiological or cardiovascular disorders referred to a cardiologist?

MDT: multidisciplinary team.

non-pulmonologists). Similarly, two groups were defined based on the inclusion or exclusion of paediatric patients in the programmes.

Qualitative and quantitative variables are represented by relative proportions (using the number of respondents as denominator) and median (IQR), respectively. Chi squared test and Fisher's exact test were used for comparisons of nominal variables across groups, while Kruskal–Wallis H-test or Mann-Whitney U-test were used for continuous variables, when appropriate. All the analysis and plotting were carried out using RStudio, version 2023.03.0+386.

Results

A total of 1015 responses from 110 countries were collected: the geographical distribution of centres participating in the survey is depicted in figure 1. Among those interviewed, general respiratory physicians were the most represented HCPs (51.1%), followed by respiratory physicians specialising in interstitial lung disease (ILD) (9.5%), physiotherapists (7.8%), internal medicine physicians (5.1%), nurses (3.2%) and infectious disease physicians (3.2%). Almost half of the participants (46.8%) worked in a university hospital, while HCPs working in regional hospitals and private practice were 24.1% and 19.3%, respectively. HCPs and type of institution are reported in figure 2.

Long COVID management: a worldwide view

A dedicated long COVID programme or clinic was present in 562 (55.4%) of investigated institutions. Pulmonologists were the HCPs most commonly involved in the management of those programmes (71.7%), followed by infectious disease physicians (8.0%), internal medicine physicians (4.4%) and

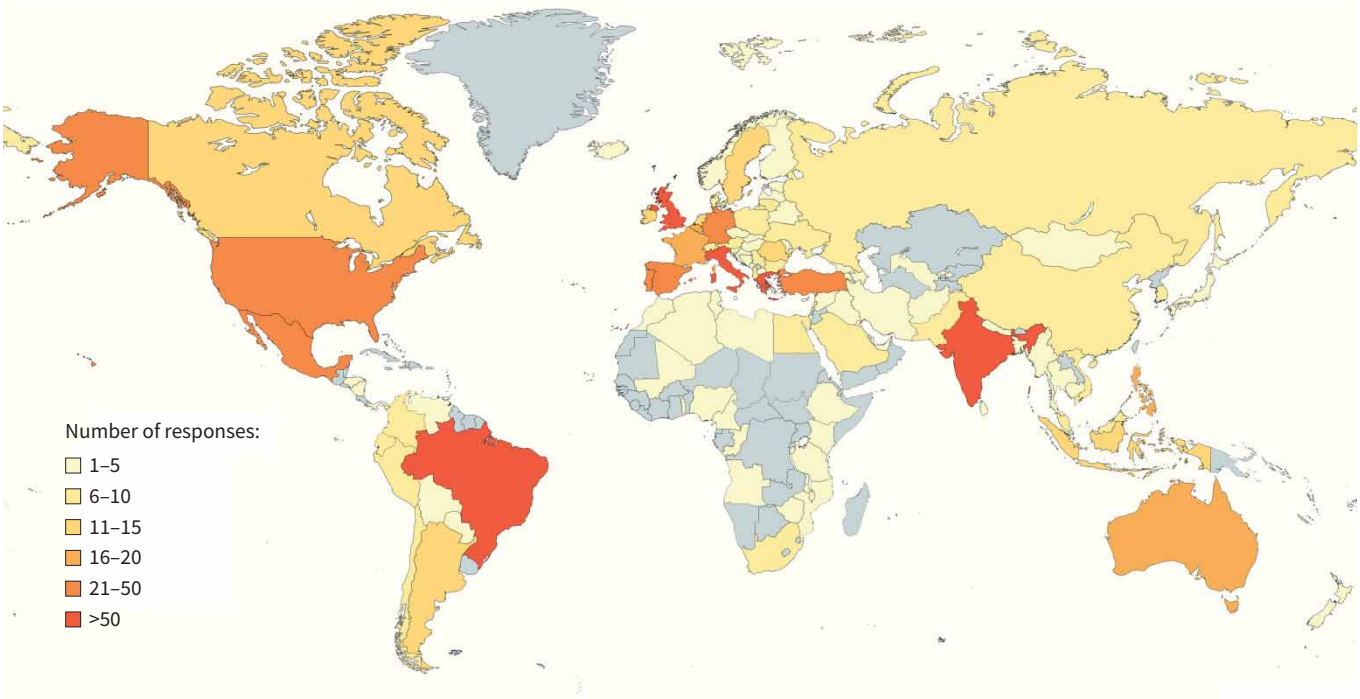

FIGURE 1 Geographical distribution of the participants considered for the final analysis (n=1015). The following countries (number of responses) have been included – Europe (550): Albania (6), Austria (7), Belarus (1), Belgium (20), Bosnia-Herzegovina (3), Bulgaria (9), Croatia (4), Cyprus (1), Czech Republic (2), Denmark (7), Estonia (1), Finland (4), France (18), Georgia (3), Germany (39), Greece (53), Hungary (4), Iceland (3), Ireland (11), Italy (79), Latvia (3), Lithuania (6), Malta (3), Montenegro (1), Netherlands (15), Norway (5), Poland (6), Portugal (31), Republic of Moldova (3), Romania (14), Russian Federation (10), Serbia (8), Slovakia (1), Slovenia (3), Spain (26), Sweden (13), Switzerland (6), the former Yugoslav Republic of Macedonia (2), Turkey (24), Ukraine (8), United Kingdom (87); America: Argentina (11), Bolivia (1), Brazil (101), Canada (14), Chile (6), Colombia (6), Ecuador (9), Honduras (1), Mexico (21), Nicaragua (3), Panama (3), Paraguay (1), Peru (6), Trinidad and Tobago (1), United States of America (25), Venezuela (3); Asia: Afghanistan (1), Armenia (1), Azerbaijan (1), Bangladesh (2), Brunei Darussalam (1), Cambodia (2), China (9), India (51), Indonesia (11), Iran (2), Iraq (5), Israel (2), Japan (4), Kuwait (1), Lebanon (9), Malaysia (7), Maldives (1), Mongolia (2), Myanmar (1), Nepal (2), Pakistan (10), Philippines (18), Qatar (2), Republic of Korea (8), Saudi Arabia (10), Sri Lanka (2), Syrian Arab Republic (2), Thailand (3), United Arab Emirates (4), Uzbekistan (1), Vietnam (6); Africa (53): Algeria (5), Angola (3), Burundi (1), Cabo Verde (1), Cameroon (1), Congo (1), Egypt (9), Ethiopia (1), Kenya (1), Libya (3), Malawi (1), Mali (1), Morocco (3), Mozambique (1), Nigeria (4), South Africa (10), Togo (1), Tunisia (4), United Republic of Tanzania (1), Zimbabwe (1); Oceania (19): Australia (16), New Zealand (3). Created with mapchart.net.

physiotherapists (3.3%). The presence of a multidisciplinary approach was reported in the majority (79.1%) of the investigated centres, with pulmonologists (77.3%), respiratory physiotherapists (55.5%), cardiologists (41.9%), nurses (40.0%) and infectious disease physicians (39.1%) being the most represented HCPs in the multidisciplinary teams (MDTs) (see figure 3a).

The majority of dedicated long COVID programmes (86.1%) declared that they usually enrolled previously hospitalised patients who did not require admission to the intensive care unit (ICU). The proportion of centres that usually included patients admitted to the ICU and those that included patients managed in the community was 79.7% and 61.6%, respectively. Notably, only 19.4% of the programmes included paediatric patients. The most used criteria for inclusion of patients in the long COVID programmes were: evidence of acute respiratory failure (ARF) requiring ventilatory support in the form of noninvasive mechanical ventilation or continuous positive airway pressure during the hospital stay (51.6%), hospital admission during the acute phase (50.5%), ARF treated with oxygen only (49.7%) and admission to the ICU with endotracheal intubation and mechanical ventilation (48.8%). 24.2% of the centres considered immunodeficiency as an inclusion criterion in this context (see figure 3b). Large heterogeneity was found in the frequency of long COVID programmes across centres, as 37.0% of participants stated that they usually run the clinic once a week, 28.7% more rarely than that and 34.3% more frequently than that. The median (IQR) of the number of visits performed per month within the programmes was 5 (2–20).

Telemedicine was used by 46.3% of the study population. Half of them (50.0%) used phone monitoring for evaluation of patients and 43.7% a proper virtual clinic, while the remaining 6.3% performed

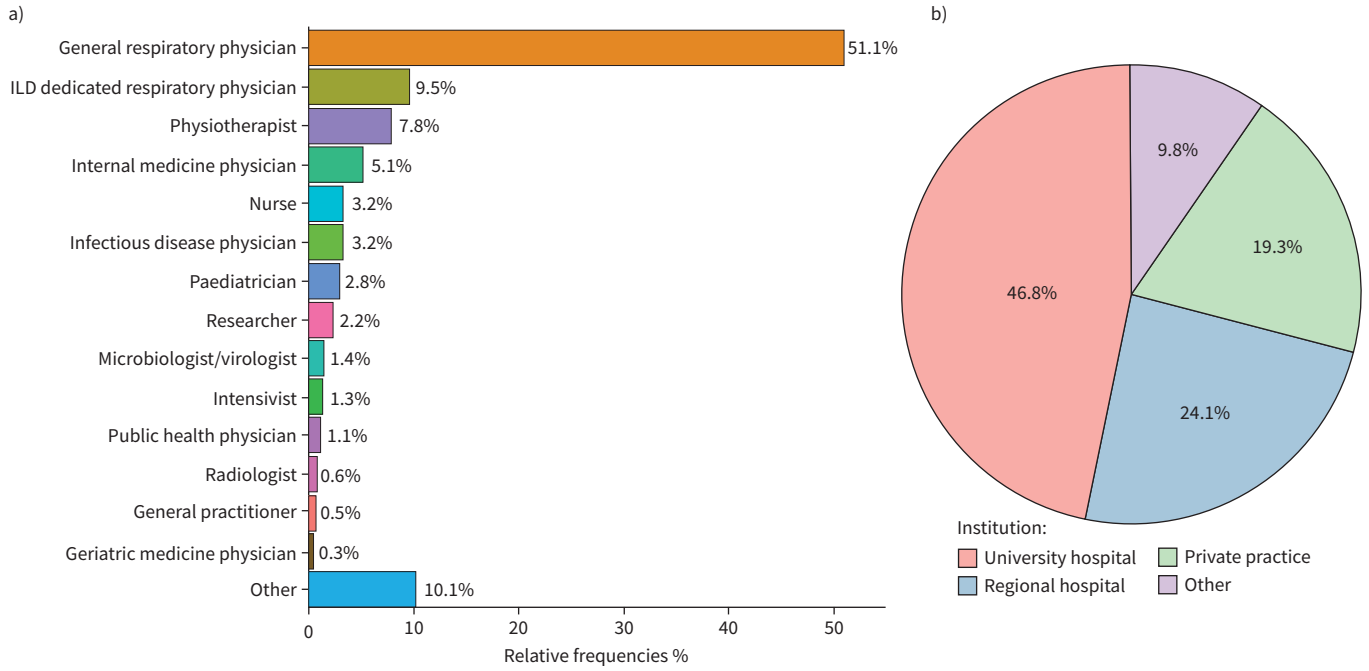

FIGURE 2 Characteristics of the interviewed a) healthcare professionals and b) institutions. The category "Other" in part a included: biologists, cardiologists, clinical pharmacologists, clinical technicians, data managers, dentists, environmental health officers, epidemiologists, equipment manufacturers, general surgeons, immunologists, managers, med techs, medical communications officers, medical sales officers, medical students, nurse practitioners, obstetricians, occupational health physicians, pharmaceutical consultants, physiatrists, physician assistants, physiologists, physiotherapy students, polysomnographers, project coordinators, teachers, technicians, therapeutic architects and thoracic surgeons. The category "Other" in part b included: academic institutions, charity organisations, government offices, homecare offices, non-profit organisations, pharmaceutical companies, primary care, prisons, rehabilitation centres, research institutes, training institutes, schools and vaccination units. ILD: interstitial lung disease.

telemedicine in a more individualised context. The median (IQR) of the number of virtual visits performed per month was 5 (2–20). HCPs involved in the telemedicine assessment were mainly pulmonologists (49.1%), followed by nurses (13.7%), respiratory physiotherapists (13.0%), internists (6.0%) and infectious diseases physicians (5.0%). Milder course of the disease (55.6%), limitations in patient mobility (54.9%) and persistence of symptoms in people not admitted to the hospital during the acute phase (51.6%) were considered the main criteria for a telemedical evaluation (see figure 3c).

The first follow-up visit in the long COVID programme was organised within 2 weeks from hospital discharge in 18.3% of centres, between 2 and 4 weeks in 27.5% of centres, between 4 and 8 weeks in 21.2% of centres, between 8 and 12 weeks in 18.3% of centres and after a period >3 months in the remaining 14.7% of centres. This was a face-to-face visit in 90.4% of cases. Presence of pulmonary complications such as pulmonary fibrosis (67.1%), ARF during the acute phase (59.0%), need for oxygen after hospital discharge (59.0%) and admission to the ICU during the acute phase (52.4%) were the main criteria used to individualise time of first evaluation (see figure 3d). Blood tests, questionnaires for the assessment of dyspnoea and cough, pulmonary function tests (PFTs), 6-min walking test, chest radiograph and chest computed tomography (CT) scan were the most used diagnostic tests within the programmes. Figure 4 depicts a heatmap of those tests in terms of availability and prescription for most patients both at the time of enrolment in the long COVID programme and during follow-up.

Rehabilitation was included in the long COVID programme in 70.0% of the centres, including on-site rehabilitation (86.9%) and tele-rehabilitation service (13.1%). Psychological support was available in 69.6% of centres and consisted of psychologist evaluation in 69.0% or a psychiatrist evaluation in the remaining 31.0%. External referral to HCPs not included in the MDT was common, as 96.5% of centres not having a cardiologist in the MDT reported that they usually refer patients with persisting cardiovascular problems to a cardiologist, while 92.3% of centres not including a neurologist in their MDT reported the habit to perform a referral to an external neurologist in case of persisting neurocognitive symptoms.

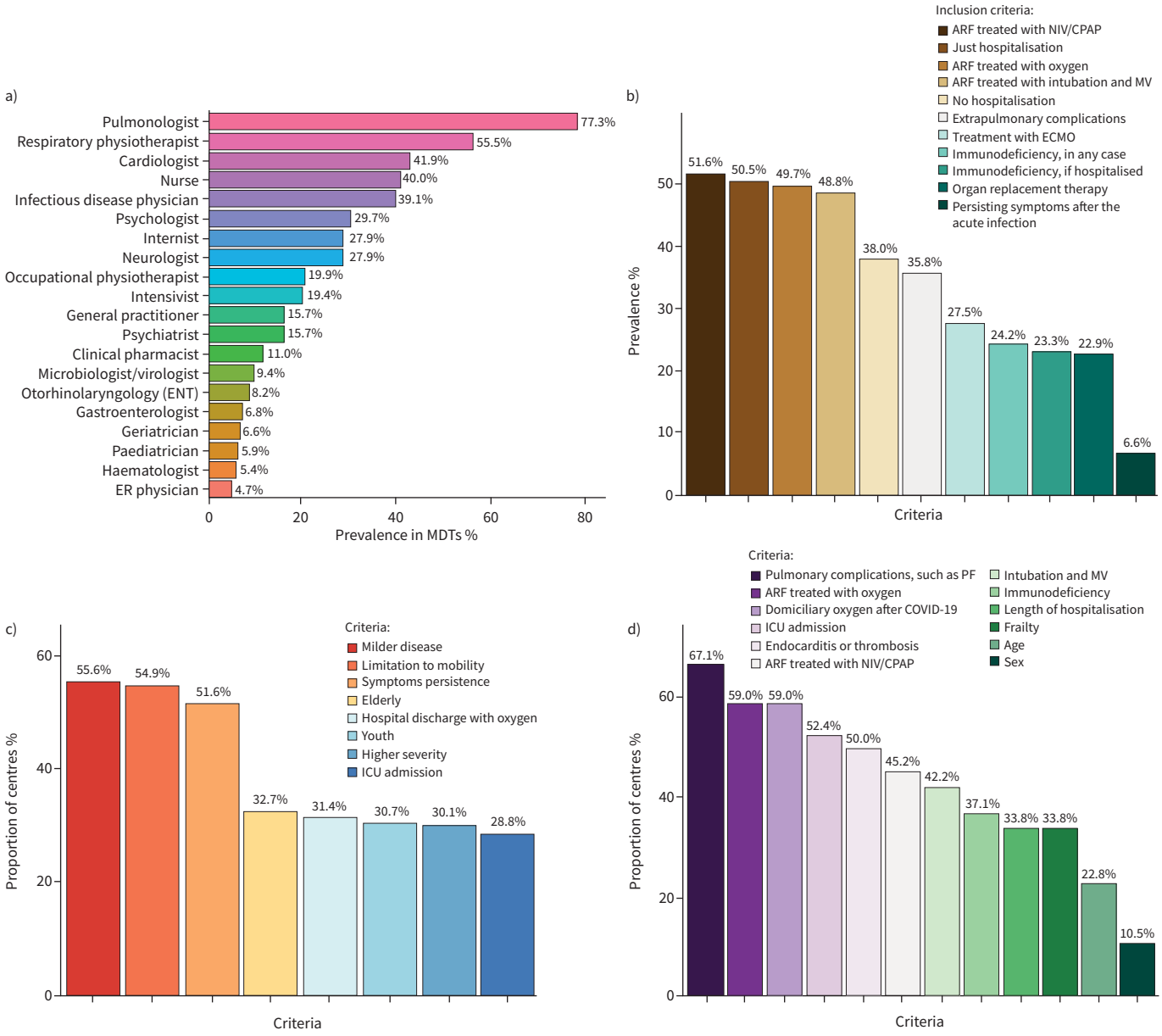

FIGURE 3 Standard operating procedures of the long COVID programmes analysed in the survey. a) Composition of the multidisciplinary teams in terms of healthcare professionals. b) Inclusion criteria for the long COVID-dedicated programmes. c) Criteria used for selecting patients suited for a telemedical evaluation. d) Criteria used for individualising the time for the first visit within the programmes. ENT: ear-nose-throat; ER: emergency room; ARF: acute respiratory failure; NIV: noninvasive mechanical ventilation; CPAP: continuous positive airway pressure; (I) MV: (invasive) mechanical ventilation; ECMO: extracorporeal membrane oxygenation; ICU: intensive care unit; PF: pulmonary fibrosis.

Long COVID management: differences across continents

Among the collected responses, 550 (54.2%) were from European centres, 212 (20.9%) from the American continent, 200 (19.7%) from Asia and Oceania and the remaining 53 (5.2%) from Africa. Significant differences were detected neither in the availability of an MDT nor in the type of included patients. A lower proportion of European centres included paediatric patients compared to America, Asia/Oceania and Africa (13.8% *versus* 23.1% *versus* 32.6% *versus* 25.0%, p=0.001). The median number of visits per month (10 *versus* 8 *versus* 4 *versus* 4, p<0.001) and the timing for the first evaluation (p<0.001) differed significantly among geographical areas. The availability of psychological support was different across Europe, America, Asia/Oceania and Africa (62.0% *versus* 73.1% *versus* 79.7% *versus* 100.0%, respectively, p=0.003), with a greater proportion of psychiatric evaluations in Asia/Oceania (46.8%) compared to Europe (24.5%), America (31.6%) and Africa (21.4%) (p=0.04). No differences were

	Availability % [#]	1st visit % [¶]	Within 30 days % [+]	Within 3 months % [+]	Within 6 months % [+]
Blood tests	83.5	71.3	63.9	60.4	55.8
Questionnaire for cough assessment	43.3	41.7	35.8	33.3	33.0
Questionnaire for dyspnoea assessment	72.0	69.8	54.2	54.8	54.5
Questionnaire for gastro-oesophageal reflux	16.8	12.1	12.1	13.7	14.3
Questionnaire for chronic sinusitis assessment	15.6	12.5	12.1	12.5	12.5
Travel and immunisation history	NA	24.6	17.8	14.6	14.3
Sputum evaluation	31.8	10.9	9.0	9.7	7.5
Induced sputum evaluation	12.8	3.4	2.8	2.8	3.4
Bronchoscopy with BAL	22.1	2.8	3.4	4.0	4.7
ECG	53.3	27.4	31.2	25.2	22.7
Heart ultrasound at rest	42.4	16.5	18.7	21.2	22.1
Heart ultrasound during stress	9.7	1.2	2.8	2.2	5.3
Heart MRI	11.8	0.6	0.9	2.8	2.2
Simple spirometry	48.6	38.3	33.0	33.3	33.6
Spirometry with plethysmography	48.0	32.1	26.8	32.1	34.3
D_{LCO}	59.5	41.1	35.8	42.4	44.9
Spirometry with reversibility test	45.2	23.7	23.4	24.0	23.1
Methacholine test	8.7	1.9	2.5	2.2	2.8
6 min walking test	64.5	39.6	38.0	43.0	42.4
Cardiopulmonary test	26.5	8.4	6.5	10.9	11.8
Blood gas analysis	45.2	20.9	19.3	15.3	16.5
Chest radiograph	64.8	41.4	37.7	27.4	26.5
Encephalic CT scan	9.7	0.9	1.2	0.9	1.6
Encephalic MRI	8.7	0.6	1.6	1.2	2.2
Thoracic CT scan	46.4	16.8	16.8	22.7	21.5
Thoracic CT scan with contrast	24.9	3.7	5.9	7.5	7.8
Thoracic high-resolution CT scan	47.0	20.6	18.7	25.2	28.7
Thoracic ultrasound	21.2	5.6	5.6	5.0	5.3
PET scan	8.4	0.6	1.2	0.9	1.9
Abdomen ultrasound	20.2	1.6	3.1	2.8	3.7
Faecal evaluation	5.3	0.6	0.6	0.9	0.6
Gastroscopy	12.1	0.3	0.6	0.9	0.9
Colonoscopy	11.2	0.3	0.6	0.3	0.9
Electromyography	11.2	2.5	2.2	2.8	3.4
Electroneurography	6.5	0.6	0.9	0.9	2.2
Evoked potentials	4.7	0.3	0.6	0.9	1.6
Ophthalmology evaluation	12.1	1.9	1.9	2.2	3.4

FIGURE 4 Heatmap representing the use of several diagnostic tools and tests within the programmes. NA: not applicable; BAL: bronchoalveolar lavage; ECG: electrocardiogram; MRI: magnetic resonance imaging; D_{LCO}: diffusing capacity of the lung for carbon monoxide; CT: computed tomography; PET: positron emission tomography. [#]: proportion of centres able to provide a given service in their own institution; [¶]: proportion of centres that usually perform a given test for the majority of patients at the moment of enrolment in the long COVID programme; [+]: proportion of centres that perform a given test for most patients within 1 month, 3 months or 6 months from enrolment.

detected in both the availability of telemedicine and in the number of telemedical evaluations performed per month, alongside the availability of rehabilitation. A full comparison of SOPs across different continents is reported in supplementary table S1.

Long COVID management: differences across low- versus middle- versus high-income countries

A total of 178 answers (17.5%) were received from centres in low-income, 265 (26.1%) in middle-income and 572 (56.4%) in high-income countries. No differences among low- *versus* middle- *versus* high-income countries were detected in the type of included patients, but the use of telemedicine in any form (60.0% *versus* 52.3% *versus* 39.4%, p=0.004), the inclusion of paediatric patients (38.0% *versus* 24.8% *versus* 12.2%, p<0.0001) and the availability of psychological support in any form (88.9% *versus* 71.4% *versus* 62.3%, p=0.001) were significantly greater in low-income country centres compared to those in middle- and high-income countries. No significant difference was present among low- *versus* middle- *versus* high-income countries in terms of multidisciplinary management in long COVID programmes (87.5% *versus* 79.7% *versus* 76.5%; p=0.08) (see figure 5). The median number of both regular (4 *versus* 5 *versus* 10, p=0.005) and virtual (3.5 *versus* 8.5 *versus* 6, p=0.01) visits per month was different in low- *versus* middle- *versus* high-income countries. Finally, the timing for the first evaluation was significantly different across economic regions. Supplementary table S2 shows comparisons for additional variables across income-defined areas.

Long COVID management: differences across HCPs

387 long COVID programmes were primarily managed by a pulmonologist, while 153 were managed by a different HCP. The MDT of the non-pulmonologist group included infectious disease physicians (35.9% *versus* 46.5%, p=0.04), psychologists (26.2% *versus* 38.0%, p=0.02) and paediatricians (3.4% *versus* 11.6%, p=0.001) more frequently. Moreover, paediatric patients were more frequently included in the

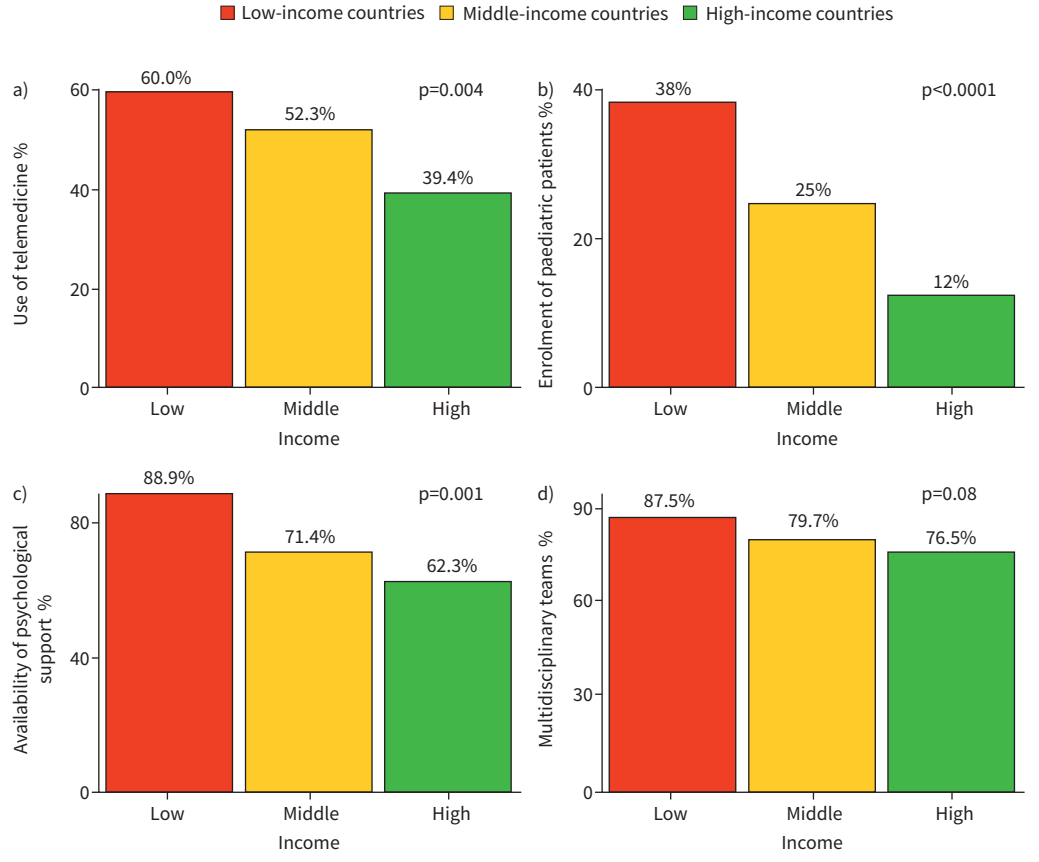

FIGURE 5 Bar plots representing the proportion of centres offering four clinically relevant procedures divided by the income of the country. The y-axes of the four plots represent the proportion of centres: a) using telemedicine in any form; b) that include paediatric patients in the long COVID programmes; c) that include any kind of psychological support; d) that share a multidisciplinary approach in the evaluation of patients.

non-pulmonologist group (16.7% *versus* 27.2%, p=0.01). No differences were detected in the availability of telemedicine and in the number of virtual visits performed per month, but the professionals involved in the telemedicine assessment were different (p<0.001), with pulmonologists being the main one in the first group (67.9%), and nurses (21.2%) and respiratory physiotherapists (15.4%) being dominant in the second group. A greater proportion of lung assessments were regularly performed in the pulmonologist group during the first evaluation compared to the other group, especially spirometry with plethysmography (27.3% *versus* 10.4%, p<0.001), diffusing capacity of the lungs for carbon monoxide (D_{LCO}) (34.8% *versus* 13.6%, p<0.001), reversibility test (20.0% *versus* 8.0%, p=0.003), 6-min walking test (30.6% *versus* 20.8%, p=0.046), thoracic CT scan (14.5% *versus* 4.8%, p=0.005) and thoracic high-resolution CT (HRCT) (17.3% *versus* 7.2%, p=0.007). Additional comparisons are available in supplementary table S3.

Long COVID management: a look into paediatric care

367 of the investigated centres excluded, while 88 included, paediatric patients. A higher proportion of ICU-admitted patients was regularly included in the non-paediatric group (82.8% *versus* 67.0%, p=0.001). Telemedicine in any form was more frequently available in the paediatric group, and the professional involved in the virtual evaluation was more frequently different from a pulmonologist compared to the non-paediatric group. A higher availability of psychiatric evaluation was recorded in the paediatric group (53.5% *versus* 24.7%, p<0.001). A higher proportion of questionnaires were performed in the paediatric group during the first evaluation (cough: 27.2% *versus* 38.6%, p=0.04; reflux: 6.5% *versus* 17.0%, p=0.003; chronic sinusitis: 6.5% *versus* 18.2%, p=0.001), while PFTs and radiological exams were more frequent in the non-paediatric group (spirometry *plus* plethysmography: 25.3% *versus* 11.4%, p=0.007; D_{LCO}: 33.2% *versus* 11.4%, p<0.001; 6-min walking test: 30.2% *versus* 18.2%, p=0.03; thoracic HRCT: 16.9% *versus* 4.5%, p=0.003). Further comparisons are available in supplementary table S4.

Discussion

Our findings highlight some differences across centres in the management of patients suffering from long COVID. To begin with, almost half of the interviewed HCPs declared that no specific long COVID programme exists in their own institution. This might either reflect the modification in the epidemiology of SARS-CoV-2 infection, with fewer patients reported to have severe disease after lower virulence viral strains became predominant and vaccines and therapeutics became widely available [16], or the underestimation of a global health problem [17].

Pulmonologists appear to be the most involved HCPs in the management of long COVID. A recent cluster analysis conducted on a database of people suffering from long COVID identified three different symptom-based clinical phenotypes: patients with ongoing respiratory symptoms, those with neurocognitive problems and those with persistent fatigue [6]. Similarly, a machine learning clustering-based approach identified four different sub-phenotypes of long COVID based on the presence of cardio-renal dysfunction, respiratory impairment with anxiety and sleep alterations, neurological and musculoskeletal symptoms, and respiratory signs associated with gastrointestinal disturbances [18]. These findings highlight once more the possibility of a multisystemic involvement in long COVID. Our results confirm that pulmonologists appear as the most involved HCPs dealing with people suffering from persistent cough or breathlessness, with more PFTs, thoracic imaging assessments and 6-min walking tests regularly performed in pulmonologist-led programmes. However, pulmonologists might find other long COVID phenotypes difficult to approach, as patients might need referral to other HCPs, such as cardiologists, neurologists or immunologists. In this context, the choice of most centres with a dedicated programme to share a multidisciplinary approach in the management of patients appears appropriate.

Telemedicine was part of the SOPs in less than half of the centres. Interestingly, centres in low-income countries use more telemedicine than those in high-income countries. Although this may appear counterintuitive, possible interpretations may be linked to the greater travelling difficulties in low-income countries and to the minor economic burden telemedicine carries compared to standard clinic, which has already been proven in other contexts [19]. In confirmation of this, the median number of both regular and virtual visits performed was lower in low-income countries centres compared to high- and middle-income ones. However, the effectiveness of telemedicine in long COVID has not been demonstrated yet and whether economic sustainability is accompanied by the same level of healthcare is difficult to say. In a similar fashion, the greater proportion of paediatric care and psychological support offered in low-income countries might be linked to the existence of specialised second or third level centres in high-income countries fully dedicated to infants/teenagers or people suffering from psychiatric disorders. Therefore, telemedicine is not necessarily associated with greater quality of care. Finally, centres in low-income countries that answered the survey were lower in absolute number than centres in middle- and high-income countries, suggesting that some countries might be difficult to reach even with an initiative like the current one.

The inclusion criteria for patients' enrolment were mainly linked to the severity of the acute phase of the disease; however, more than one third of the centres included people who had not been previously hospitalised, suggesting that a proportion of patients might develop some symptoms after the acute phase or regardless of its severity. Different cohort studies have demonstrated a high prevalence of long COVID in home-treated people months after the acute infection, suggesting that severe SARS-CoV-2 infection requiring hospitalisation might represent just the tip of the long COVID iceberg [20]. Although long-standing inflammation has been advocated as the main pathological mechanism of long COVID, home-treated patients are expected to show a minor inflammatory burden compared to those requiring hospital admission [21, 22]. Whether these patients might have long COVID due to a separate endotype or long COVID may represent the worsening of pre-existing symptoms triggered by SARS-CoV-2 infection and therefore they should follow a dedicated workup is difficult to say and should be addressed by upcoming studies.

PFTs, thoracic imaging exams, assessment of cough and dyspnoea, 6-min walking test and blood gas analysis are among the main requested diagnostic tests at every time point. Although these findings might be affected by the majority of respondents being pulmonologists, it also demonstrates that most enrolled patients might suffer from persisting respiratory symptoms. Interestingly, chest radiograph is the most used radiological exam for thorax evaluation during the very first phase of workup, but at 6 months high-resolution CT (HRCT) scan takes the lead. This is consistent with both UK real-life observational data and the British Thoracic Society (BTS) guidelines, which recommend a 3-month chest radiograph assessment and, only in case of persisting radiological alterations in symptomatic patients, to perform an HRCT scan [23, 24]. In a similar fashion, the use of echocardiography and chest CT scan with contrast starts to rise after 3–6 months, in agreement with the recommendations provided by the ERS Task Force [11].

This is, to our knowledge, the largest international survey on the management of long COVID with data coming from >1000 centres from 110 different countries across five different continents. In our opinion, this work provides an optimal, cross-sectional representation of the global landscape in the management of this condition. However, we acknowledge that Africa is less represented than other continents, despite the PATS supporting this initiative, and that centres from low-income countries are less common than those from middle- and high-income countries. Furthermore, pulmonologists are far more represented than infectious disease physicians and other HCPs; whether this could be true in the real world or is linked to the design of the current study, with just one infectious disease society involved, should be addressed by further research. Moreover, the questionnaire was not tested in an HCP population before delivering it, and this may have led to incorrect interpretation of the questions in some areas of the globe, possibly influencing the results. Finally, another limitation is linked to the absence of patients' input in the elaboration of the survey.

The burden of long COVID on worldwide healthcare systems is massive and should be addressed with an organised effort by international societies. Harmonisation of different healthcare approaches towards standardised diagnostic and therapeutic algorithms will be required to achieve a better comprehension of such a complex disease and to aid the development of more effective treatments.

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