A global systematic analysis of the occurrence, severity, and recovery pattern of long COVID in 2020 and 2021

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Word count main body text (excl abstract, references, tables and figure legends): 4037

key points: 102

abstract: 421

references: 117

Key Points

Question: What are the extent and nature of the most common long COVID symptoms by country in 2020 and 2021?

Findings: Globally, 144.7 million people experienced one or more of three symptom clusters (fatigue; cognitive problems; and ongoing respiratory problems) of long COVID three months after infection, in 2020 and 2021. Most cases arose from milder infections. At 12 months after infection, 15.1% of these cases had not yet recovered.

Meaning: The substantial number of people with long COVID are in need of rehabilitative care and support to transition back into the workplace or education when symptoms start to wane.

Abstract

Importance: While much of the attention on the COVID-19 pandemic was directed at the daily counts of cases and those with serious disease overwhelming health services, increasingly, reports have appeared of people who experience debilitating symptoms after the initial infection. This is popularly known as long COVID.

Objective: To estimate by country and territory of the number of patients affected by long COVID in 2020 and 2021, the severity of their symptoms and expected pattern of recovery

Design: We jointly analyzed ten ongoing cohort studies in ten countries for the occurrence of three major symptom clusters of long COVID among representative COVID cases. The defining symptoms of the three clusters (fatigue, cognitive problems, and shortness of breath) are explicitly mentioned in the WHO clinical case definition. For incidence of long COVID, we adopted the minimum duration after infection of three months from the WHO case definition. We pooled data from the contributing studies, two large medical record databases in the United States, and findings from 44 published studies using a Bayesian meta-regression tool. We separately estimated occurrence and pattern of recovery in patients with milder acute infections and those hospitalized. We estimated the incidence and prevalence of long COVID globally and by country in 2020 and 2021 as well as the severity-weighted prevalence using disability weights from the Global Burden of Disease study.

Results: Analyses are based on detailed information for 1906 community infections and 10526 hospitalized patients from the ten collaborating cohorts, three of which included children. We added published data on 37262 community infections and 9540 hospitalized patients as well as ICD-coded medical record data concerning 1.3 million infections. Globally, in 2020 and 2021, 144.7 million (95% uncertainty interval [UI] 54.8–312.9) people suffered from any of the three symptom clusters of long COVID. This corresponds to 3.69% (1.38–7.96) of all infections. The fatigue, respiratory, and cognitive clusters occurred in 51.0% (16.9–92.4), 60.4% (18.9–89.1), and 35.4% (9.4–75.1) of long COVID cases, respectively. Those with milder acute COVID-19 cases had a quicker estimated recovery (median duration 3.99 months [IQR 3.84–4.20]) than those admitted for the acute infection (median duration 8.84 months [IQR 8.10–9.78]). At twelve months, 15.1% (10.3–21.1) continued to experience long COVID symptoms.

Conclusions and relevance: The occurrence of debilitating ongoing symptoms of COVID-19 is common. Knowing how many people are affected, and for how long, is important to plan for rehabilitative services and support to return to social activities, places of learning, and the workplace when symptoms start to wane.

Introduction

Much of the attention of disease surveillance of the coronavirus disease 2019 (COVID-19) pandemic has concentrated on the number of infections, the large number of cases requiring hospital care for severe infection, and those who have died from the disease. Less attention has been given to the quantification of those who continue to experience symptoms past the acute infection stage. Terms such as long COVID, COVID long haulers, brain fog, post-COVID-19 condition, or post-acute sequelae of COVID-19 have been used to describe a diverse array of ongoing symptoms. In October 2021, the World Health Organization released a clinical case definition for post-COVID-19 condition as symptoms that are present at three months after SARS-CoV-2 infection with a minimum duration of 2 months and cannot be explained by an alternative diagnosis.[1–6] We will use the term long COVID in this paper.

Post-acute infection fatigue syndromes have been described for other viruses and bacteria.[7–10] An ongoing low-grade inflammation has been postulated to cause these symptoms, but the pathology remains largely unknown and treatments are based on symptom relief.[2,11,12] The impact on affected individuals is substantial, and special clinics dealing with patients of long COVID have arisen to respond to an increasing need for supportive and rehabilitative care.[13–16]

A meta-analysis of 45 follow-up studies of COVID patients, of which only three had a follow-up time greater than three months, found 84 long-term effects of COVID-19, with shortness of breath, fatigue, and sleep disorders or insomnia as the most common symptoms.[17] Studies have most frequently just reported on individual symptoms or counts of symptoms but less on severity, overlap of symptoms and pattern of recovery.[1,18–22]

In this paper, we have collated the information on long COVID into three common clusters of symptoms largely based on joint analyses with custodians of follow-up studies after COVID-19 diagnosis in ten countries, supplemented by published data and medical record databases. From this pooled information on the occurrence of these three symptom clusters, their severity, and the limited information on duration, we derived estimates of incidence, prevalence, and severity-weighted prevalence for 204 countries and territories for the years 2020 and 2021.

This analysis complies with the Guidelines for Accurate and Transparent Health Estimates Reporting (GATHER).[23] The full GATHER checklist is provided in eTable 1.

Methods

Incidence of SARS-CoV-2 infection

We derived estimates of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) infection from the IHME COVID model, a statistical Susceptible-Exposed-Infected-Removed (SEIR) compartmental model fit to data on daily reported deaths, hospitalizations, and infections; seroprevalence; and excess mortality data. Greater detail of the relevant aspects of this model and its data and assumptions is available in the Supplement eSection 3.[24–26]

Incidence of symptomatic infection

We took estimates of new, daily infections from this COVID model and assumed that long COVID only occurs in those with symptomatic infection. From a published review, we selected studies that estimated the proportion of asymptomatic infections in representative screened samples with antibody testing (Supplementary Appendix Data Inputs).[27] We pooled the logit-transformed proportions of asymptomatic cases from six studies in a random effects meta-analysis (eFigure 5) and multiplied one minus the predicted proportion by infections to estimate the incidence of symptomatic infection.

Incidence and prevalence of long COVID

Case definition

We define the incidence of long COVID as newly onset or persisting symptoms three months after an acute episode of COVID-19 which impact daily functioning and were not preexisting symptoms before SARS-CoV-2 infection. This aligns with the WHO clinical case definition of post-COVID condition, their preferred term for long COVID.[5]

Input data

From the long list of persisting symptoms reported by a proportion of COVID-19 cases after the acute phase, we selected three major symptom clusters based on frequency and the ability to quantify their relative severity using health state descriptions and corresponding disability weights (DWs) from the Global Burden of Disease (GBD) study. GBD uses 236 health states and DWs to quantify the non-fatal consequences of diseases and injuries.[28] Table 1 shows the health states, lay descriptions, and disability weights used for long COVID. The three symptom clusters were a) fatigue with bodily pains and/or symptoms of depression or anxiety; b) cognitive problems such as forgetfulness or difficulty in concentrating, commonly referred to as “brain fog”; and c) ongoing respiratory problems with shortness of breath and persistent cough as the main symptoms. We decided to distinguish between two severity levels for cognitive problems and three levels of severity for the ongoing respiratory symptoms. From here on, we refer to the “fatigue”, “respiratory”, and “cognitive” clusters.

We conducted a systematic review of published papers on the long-term consequences of COVID-19 but found that no published study provided enough detail for our quantification purposes. From 7362 unique search hits and additions screened from a living systematic review[29], we included 46 published articles from 44 studies that contain follow-up data of at least one defining symptom included in our defined symptom clusters (Supplementary Appendix Data Inputs). We used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines;[30] our PRISMA checklist is in the appendix (eSection 5), and the search protocol was registered with the International Prospective Register of Systematic Reviews (PROSPERO, CRD42020210101).[31]

Instead of relying on published reports only, we contacted study authors of published studies and ongoing COVID-19 follow-up studies that were registered at the ISRCTN registry.[32] From 23 positive responses of 42 study authors contacted, ten were able to share symptom cluster data in time for inclusion in our study (Table 2). With researchers from the ten follow-up studies, we developed algorithms to define the three symptom clusters by severity level by choosing symptom questions and measures employed in each study that would most closely match the wording of the lay descriptions that were presented to respondents of the GBD DW surveys (Table 1). In the Supplement eSection 5, we present details of the algorithms for each of the included studies. We utilized the cohort data with explicit questions comparing current symptoms to those pre-COVID to adjust the remainder of the cohort data lacking pre-COVID comparisons (Table 2, Supplementary Appendix Data Inputs).

In addition, we received analyses from collaborators at the Veterans Affairs Health Administration and from PRA Health Sciences, a data collection of private health insurance plans, based on ICD codes for the primary symptoms belonging to the three symptom clusters of interest among COVID patients compared to matched non-COVID patients (Supplementary Appendix Data Inputs).[33–35] ICD codes are provided in the Supplement eTable 4.

Modelled symptom cluster recovery patterns and proportions

We first undertook a meta-regression of studies with multiple follow-up measurements to determine the recovery pattern of symptoms. Given the relative scarcity of data, we assumed a similar pattern of recovery for all three symptom clusters. We used separate models for community cases and hospitalized cases using a Bayesian meta-regression tool, MR-BRT (meta-regression—Bayesian, regularized, trimmed), to pool the logit-transformed proportions of cases with any of the three symptom clusters by follow-up time since the end of the acute episode (eFigure 10).[36,37] For community cases, we used data from the Zürich and Faroe studies supplemented with data derived from three published studies.[18–20,38–40] With a dummy in the meta-regression, we adjusted the Cirulli, United Kingdom COVID Symptom Study (CSS), and United Kingdom COVID-19 Infection Survey (CIS) studies as proportions were reported for aggregates of many individual symptoms, rather than only the symptom clusters of our interest.[18–20,40] For hospitalized cases, we used data from the COVID-19 Follow-up care paths and Long-term Outcomes Within the Dutch health care system (CO-FLOW), Sechenov StopCOVID, PronMed ICU, and the Zürich SARS-CoV-2 Cohort studies supplemented with data derived from two published studies in Switzerland and Spain, both adjusted as in the community cases duration model.[38,41] The longest follow-up from these studies was 12 months in the Zürich, Co-FLOW and Sechenov studies. In both models, an exponential decline was assumed in the proportion of cases affected by long COVID. The coefficients on the rate of decline in these initial models were then entered as priors into the models that used all available follow-up data, described below.

Next, we used all the data in models of long COVID in community and hospitalized cases separately. We ran separate models for each of the three clusters and the overlap between clusters and adjusted their outputs proportionally to sum to the values of the models for any of the three clusters of long COVID (eFigures 11-15). We had too few data points to run separate models for ICU-admitted cases; in the hospital models for each symptom cluster, we used a dummy variable for those admitted to ICU in order to predict their proportions, with the coefficient informed by the observed relationship between ICU and non-ICU hospitalized data.[33,35] We also included variables for sex, whether the data were from an administrative source, and indicator variables for individual symptoms reported in the published articles (cognitive dysfunction, shortness of breath, fatigue).

To estimate the severity distributions, we pooled data from cohorts that had enough detail to determine the two levels of severity of cognitive symptoms and the three levels of severity of ongoing respiratory problems using a random effects meta-analysis with a fixed effect on hospitalized data (eFigures 16–17).

Incidence, prevalence, and severity-weighted prevalence of long COVID

To estimate the incidence of long COVID, we first subtracted deceased patients from the incidence numbers of symptomatic COVID infection and then multiplied these surviving patients by the estimated proportions of cases with each symptom cluster at 3 months.[42,43(p19),44–46] Daily incident cases of long COVID at three months post-infection were multiplied by the average duration, estimated separately for community cases and hospitalized cases. We then summed the prevalent days of long COVID for each of the symptom clusters and their overlap by level of severity where applicable across the years 2020 and 2021. Each of these was multiplied by the corresponding DW to get severity-weighted prevalence, equivalent to the GBD metric of years lived with disability (YLDs). For overlapping clusters, we assumed a multiplicative function to constrain the combined DW to a value between zero and one.[47]

We present uncertainty intervals (UIs) for all estimates based on the 25th and 975th values of the ordered 1000 draws of the posterior distributions.

Results

Globally within 2020 and 2021, of 3.92 billion (95% UI 3.77–4.05) infections with SARS-CoV-2 through the end of 2021, 3.7% (1.4–8.0) or 144.7 million (54.7–312.6) persons developed long COVID defined as experiencing one or more of the three symptom clusters three months after infection (Table 3). Of these, 130 million (42.1—301) had experienced mild to moderate acute infections in the community, 11.5 million (4.91—20.5) developed long COVID after severe disease needing hospitalization, and 3.03 million (0.892—7.48) after critical acute disease needing ICU care. We estimated that 6.17% (2.43–13.31) of symptomatic SARS-CoV-2 infections who survived the acute episode developed long COVID. This proportion was greater in those who were admitted to intensive care units (ICU) (43.1% [22.6–65.2]) and general hospital wards (27.5% [12.1–47.8]) than in those with less severe symptomatic infections in the community (5.68% [1.85–13.1]). Note that our estimate of the number of global infections is much higher than reported as diagnosed cases because excess deaths, infection-to-death ratios and seroprevalence surveys suggest many more cases must have occurred. We estimated a median duration of long COVID of 3.99 months (IQR 3.84–4.20) in community infections, while hospitalized cases were estimated to experience a longer median duration of 8.84 months (IQR 8.10–9.78) (eFigure 10). The global prevalence of long COVID in 2020-2021 was 5.11 million (2.31–8.72) cases among more severe, hospitalized patients and 31.4 million (10.2–73.5) cases among those who had milder infections.

The fatigue, respiratory, and cognitive clusters occurred in 51.0% (16.9–92.4), 60.4% (18.9–89.1), and 35.4% (9.4–75.1) cases of long COVID, respectively. In 38.4% (7.94–96.0) of long COVID cases, two or all three of the clusters overlapped (Figure 1).

Globally, among prevalent long COVID cases, 63.2% (59.7–66.3) were female. The risk of long COVID at 3 months follow-up under the age of 20 was lower than in adults in milder community infections, 2.73%

(0.808–6.65) in children versus 4.76% (1.53–11.3) in adult males and 9.88% (3.38–21.2) in adult females (eTable 15a). The peak ages of long COVID cases were between 20 and 29 (Figure 2).

The average level of disability among long COVID cases, estimated as the ratio of overall long COVID severity-weighted prevalence to prevalence, was 0.231 (0.134–0.370)—equivalent to the GBD DWs for severe neck pain, Crohn's disease, or long-term consequences of moderately severe traumatic brain injury.[28]

The age and geographical pattern of incidence and prevalence of long COVID closely follows that of SARS-CoV-2 infections, as we assumed the same risk among survivors of acute infection, severity distributions, and duration in all locations. The counts of incident and prevalent cases of long COVID by country are provided in Table 4.

Among COVID patients who develop long COVID in 2020 and 2021, 15.1% (10.3–21.1) continued to have persistent symptoms at 12 months after COVID infection, or 21.0 million (9.19–41.7) people. In the United States, the Social Security Administration is mandated to financially assist those who are still unable to work after 12 months, corresponding to 946,000 (365,000—2,130,000) people aged 20-64 in the US in 2021 and 2022.

Discussion

A substantial proportion of COVID-19 patients do not recover after the initial infection. We estimated that 144.7 million (54.7–312.6) cases globally in 2020 and 2021 suffered from one or more of three common symptom clusters of long COVID. The risk of long COVID is greater in females and in those with more severe initial infection. The peak ages of those experiencing long COVID were between 20 and 29 years. This pattern by age and sex is distinct from that of severe acute infection, which affects more males and increases with age.[48] From seventeen follow-up studies that included children, we also know that long COVID affects a lower but substantial number of children, while severe acute infection is very uncommon at younger ages.[49–51] These differences suggests that the underlying mechanism of long COVID may be different from that of the severity of acute infection.

A prolonged state of low-grade infection with a hyperimmune response, coagulation/vasculopathy, endocrine and autonomic dysregulation, and a maladaptation of the angiotensin converting enzyme-2 (ACE-2) pathway have been postulated as the underlying pathophysiology of long COVID.[52] Deconditioning due to prolonged immobilization during hospitalization may compound these problems.[53] Direct tissue damage due to COVID-19 has been demonstrated in many parts of the body, including the lung, heart, kidney, and brain.[54–59] Due to the large reserves in capacity of most body organs, tissue damage does not immediately lead to symptomatic disease. It may, however, become apparent over time that COVID-19 will contribute to an earlier onset and greater occurrence of long-term symptomatic major organ disease with increasing age or if these organs become diseased by other mechanisms. The rate of recovery from long COVID, moreover, suggests that less permanent factors may underlie these debilitating symptoms.

We have adopted the WHO case definition which stipulates a minimum period of three months after infection before calling ongoing symptoms long COVID or post-COVID-19 condition. Others have suggested a threshold of three weeks to define a case of long COVID, arguing that no competent virus has been replicated beyond three weeks of infection, but a period of up to 12 weeks has been suggested to define the start of long COVID.[12,52,60] This analysis accounts for COVID infections through the end of 2021 and therefore does not cover the omicron wave, and it is currently unclear what the risk of long COVID is after infection with omicron. The large proportion of asymptomatic infections with omicron and the fact that if symptoms arise they mostly affect the upper airways suggests that the risk of long COVID will be much smaller.

The recovery pattern among community cases for the three symptom clusters quantified suggests that the majority of cases resolve, a sign of hope for those experiencing these debilitating symptoms. It is not yet clear if there is a smaller proportion of patients, especially among those with more severe acute episodes, who develop a more chronic course of long COVID. Given that the longest follow-up time among the studies we examined was 12 months, the true long-term pattern of recovery will only be revealed as studies conduct longer follow-up periods. The time-limited course of long COVID in most cases has led to the advice to provide rehabilitative support in the community, with specialist rehabilitation services required only for those with protracted and more severe problems, particularly when compounded by post-intensive care syndrome.[12,61] Important to patients is that they feel empathy and recognition from health-care workers even if they can only provide symptomatic and supportive care.[62] Quantifying the number of incident and prevalent cases of long COVID will help policy makers ensure adequate access to services to guide patients towards recovery, return to the workplace or schooling, and restoration of their mental health and social life. The attention given to long COVID may also provide greater recognition to patients who suffer from the longer-term consequences of other infectious diseases and who may have received less attention from health services. The large number of people affected by long COVID should also create new opportunities to unravel phenotypical and genotypical characteristics, with an aim to find new treatments and predictors of post-acute disease syndromes including those known to occur after other infectious disease and intensive care for other critical illness.

The main strength of this study is the willingness of researchers from ten follow-up studies to share data and analyses with consistent approaches to deal with the diverse study methods and instruments. This collaborative effort also allowed us to go beyond the reporting of individual symptoms or counts of symptoms reported in the literature. With access to individual patient data, we were able to define clusters of symptoms that frequently occur together and to quantify the overlap among symptom clusters. Importantly, we were able to correct for over-reporting from studies that did not have a comparison with previous health status, leveraging information from the cohort studies that explicitly asked respondents to recall their pre-COVID health status or existence of symptoms. In addition, the very large health insurance databases from the USA allowed us to identify controls matched on demographic and disease characteristics and thus correct for the occurrence of these symptoms unrelated to SARS-CoV-2 infection. This may in part explain why our estimates of long COVID are lower than often reported in the literature. Direct comparisons are not easy, as we have defined clusters of symptoms that are not reported by others. However, we think this is a strength of this analysis in comparison to studies reporting individual symptoms or counts of symptoms.

There are also important limitations to our analysis. First, the uncertainty intervals around the estimates are wide, reflecting as yet limited and heterogeneous data. Second, we had to derive separate algorithms for each contributing study to achieve consistency in case definitions of the three chosen symptom clusters. Efforts to achieve standardization of questions and instruments for studies of long COVID are underway.[5,63] This would make pooling estimates among studies less prone to measurement bias. Third, we assumed that long COVID follows a similar course in all countries and territories. We used data from western European countries, Iran, Russia, India, China, South Africa, Turkey, Saudi Arabia, Israel, Australia, and the USA. Additional reports from Brazil and Bangladesh suggest that long COVID similarly affects other parts of the world.[21,22] As more information becomes available, we can explore whether there is geographical variation in the occurrence or severity of long COVID. We also note that the duration estimates relied on studies from high income countries only. With repeated follow-up being planned in many of the studies and with new studies appearing, it will become clearer over time how generalizable our findings on duration are. Fourth, apart from symptoms and symptom clusters, new diseases have been reported to occur more frequently in patients after COVID-19 diagnosis, including cardiovascular complications like myocarditis, acute myocardial infarction, and thrombo-embolic events as well as kidney, liver, gastrointestinal, endocrine, and skin disorders.[64–66] The data sources to quantify these COVID-19-related changes may not yet be sufficient due to lags in reporting of clinical informatics data, disease registries, or surveys, which form the basis of estimation for such diseases. Fifth, with limited follow-up time available, the pattern of recovery cannot yet be fully described. Importantly, longer follow-up can reveal if there is a subset of cases that go on to have a protracted course of long COVID and need longer care. Sixth, we made the assumption that long COVID only affects those with a symptomatic course of the initial infection. The participating cohorts included few asymptomatic cases: the Faroe Islands, Zurich SARS-CoV-2 Cohort, HAARVI, Rome ISARIC pediatrics and adults cohorts observed 22, 182, 9, 27, and 26 asymptomatic COVID cases, respectively. Long COVID was not identified among asymptomatic cases that were followed in HAARVI and Rome ISARIC cohorts. In the Faroe Islands and Zurich SARS-CoV-2 cohorts, three and five of their asymptomatic cases, respectively, developed at least one long COVID symptom cluster at follow-up. The total number of asymptomatic cases followed in these studies is very low and we chose to be cautious and exclude them from our calculations. In a review of medical records in the University of California COvid Research Data Set (UC CORDS), 32% of those with long COVID symptoms at two months after a positive PCR test reported no symptoms at testing, but it is not clear how many of these developed acute symptoms after testing.[60] Seventh, we chose three commonly reported symptom clusters but have not quantified other common symptoms. The main symptoms of our three symptom clusters are those that reached the highest degree of consensus in the Delphi process WHO used to create a clinical case definition for post COVID-19 condition.[5] In the most complete cohort, the Sechenov StopCOVID cohort, we had information on a wide range of symptoms and general health status with explicit comparison with the pre-COVID-19 status (eSection 5). Among 1309 respondents with PCR-confirmed COVID-19 needing hospitalization, 136 qualified for at least one of our three symptom clusters of long COVID at six months follow-up. Another 62 respondents reported not having fully recovered. Of these, 48 reported at least one symptom of our three symptom clusters but had failed to meet all criteria by reporting either no or slight problems with usual activities or no worsening of this item compared to before COVID-19. Other more common symptoms that were reported by this group included problems with vision, sleep problems, loss of smell, palpitations, and hair loss. Quantifying vision loss requires measurement of visual acuity, which is not measured in long COVID studies. There are no DWs for loss of smell, hair loss, or palpitations. While there is a disability weight for insomnia, it has not been used in any GBD study as sleep disorders are not (yet) included in the GBD cause list. Estimates therefore do not reflect the burden of the full range of long COVID outcomes.

Conclusion

We have quantified the frequency at which common symptom clusters of long COVID have occurred across the world and made an estimate of their severity and expected duration. Many countries and territories have already responded by setting up specialized treatment centers for those affected.[67,68] Understanding the magnitude of the problem will help other countries and territories to respond likewise. Early studies indicate that for most patients with long COVID, there is hope for recovery, but time will tell if all patients recover. The attention given to long COVID during this pandemic should trigger research into the underlying pathology and potential treatment or prevention, the long-term trajectory of long COVID, the potential transition from long COVID into chronic fatigue syndrome, the level of protection from vaccination and the risk of long COVID following more recent omicron variants. Such research may also benefit those who experience similar outcomes following a range of other infectious diseases, an issue that has not received much attention from clinical and global heath communities.

Acknowledgments

Declaration of interests

C Adolph reports support for the present manuscript from the Benificus Foundation. P Bobkova, A Gamirova, A Shikhaleva, and A Svistunov report grants from the British Embassy in Moscow ‘StopCOVID Cohort: Clinical Characterisation of Russian Patients’ 2020-2021” paid to Sechenov University, outside the submitted work. X Dai reports support for the present manuscript from Bloomberg Philanthropies and the Bill & Melinda Gates Foundation, paid to the Institute for Health Metrics and Evaluation. A Flaxman report stock options from Agathos, Ltd., and provides technical advising on simulation modeling for Janssen, SwissRe, Merck for Mothers, and Sanofi, outside the submitted work. R Frithiof reports support for the present manuscript from The Swedish Research Council and the Swedish Kidney Foundation, paid to Uppsala University. N Fullman reports funding from WHO for consultant work in 2019 and funding from Gates Ventures since 2020, outside the submitted work. A Gamirova reports grants and contracts from the British Embassy in Moscow (PI): ’StopCOVID Cohort: Clinical Characterisation of Russian Patients’ 2020-2021, paid to Sechenov University. J Haagsma reports grants from the EuroQol Foundation, outside the submitted work. M Heijenbrok-Kal and R van den Berg-Emons report support for the present manuscript from ZonMW Program COVID-19, Laurens, and Rijndam Rehabilitation, paid to Erasmus MC. M Hultström reports support for the present manuscript from Knut and Alice Wallenburg Foundation, Swedish Heart-Lung Foundation, and Swedish Society of Medicine, paid to Uppsala University. M Lipcsey reports grants or contracts from Hjärt-lungfonden Sweden and is a member of the PROFLO RCT and COVID-19_HBO data safety monitoring boards, outside the submitted work. D Munblit reports report grants from the British Embassy in Moscow ‘StopCOVID Cohort: Clinical Characterisation of Russian Patients’ 2020-2021”, Russian Foundation for Basic Research Grant ‘Cell therapy and prevention of ARDS during COVID infection: from basic science to clinical practice’ 2020-2022, all paid to Sechenov University, and was awarded a UK Research and Innovation/National Institute for Health Research grant, payment for lectures given to Merch Sharp & Dohme and Bayer, and reports unpaid leadership positions as co-chair of International Severe Acute Respiratory and Emerging Infection Consortium (ISARIC) Global Paediatric Long COVID Working Group and co-lead of the PC-COS project aiming to define the Core Outcome Set for Long-COVID in collaborator from WHO, and is a member of the ISARIC working group on long-term COVID follow-up in adults, all outside the submitted work. S Nomura reports support for the present manuscript from the Ministry of Education, Culture, Sports, Science, and Technology of Japan. M S Petersen reports support for the present manuscript from Cooperation’s p/f Krunborg and Borgartun, grants or contracts from the Velux Foundation, special COVID-10 funding from the Faroese Research Council, the Faroese Parkinson’s association, and the Faroese Health Insurance Fund, participation on the Board of the Faroese National Data Protection Authority, and receipt of equipment, materials, drugs, medical writing, gifts, or other services from Wantai Total Ab ELISA, outside the submitted work. M Puhan reports support from the University of Zurich Foundation and the Department of Health, Canton of Zurich. A Shikhaleva reports grants and contracts from the British Embassy in Moscow (PI):’StopCOVID Cohort: Clinical Characterisation of Russian Patients’ 2020-2021, paid to Sechenov University. E Spiridonova reports grants and contracts from the British Embassy in Moscow (PI):’StopCOVID Cohort: Clinical Characterisation of Russian Patients’ 2020-2021, paid to Sechenov University. A Svistunov reports a grant from the Russian

Foundation for Basic Research Grant 'Cell therapy and prevention of ARDS during COVID infection: from basic science to clinical practice' 2020-2022, paid to Sechenov University. R van den Berg-Emons reports support for the present manuscript from ZonMW Program COVID-19, grant for CO-FLOW study project number 10430022010026, Laurens funding for the CO-FLOW study, and from Rijndam Rehabilitation for the CO-FLOW study, all paid to Erasmus MC.

Author access to data

TV and SWH had full access to all the data in the study and took responsibility for the integrity of the data and the accuracy of the data analysis. DB, DaM, DeM, DoM, FS, MeH, MiH, MS, NM, NS, RH, and ZA were responsible for the data collection of the ten collaborating cohort studies. ZA was responsible for the data collection and matching of the administrative data from Veterans Affairs.

Data sharing

All tabulated input data are available upon publication as Supplementary Appendix Data Inputs. Proposals to access de-identified individual-level data up to one year after publication for researchers who provide a methodologically sound proposal for individual participant data meta-analysis should be directed to swulf@uw.edu.

Sources of funding and support

The Institute for Health Metrics and Evaluation received funding from the Bill & Melinda Gates Foundation. The COFLOW study is funded by the COVID-19 Program Care and Prevention of The Netherlands Organization for Health Research and Development (ZonMw, grant number 10430022010026), and Rijndam Rehabilitation and Laurens (both in Rotterdam, The Netherlands). A Ferrari and D F Santomauro D F Santomauro are affiliated with the Queensland Centre for Mental Health Research, which receives core funding from the Department of Health, Queensland Government. C Adolph gratefully acknowledges support from the Benificus Foundation. C Wiysonge's work is supported by the South African Medical Research Council. H Xu received support from the National Institute on Aging (R21AG061142; R03AG064303) and the National Institute on Minority Health and Health Disparities (U54MD012530). R C Reiner's and A Aravkin's work was partially supported by NSF Rapid grant #2031096. N Sarrafzadegan, S Haghjooy Javanmard, and N Mohammadifard report support for the Isfahan cohort study from grant number 199093 from the IUMS, grant number RPPH 20 76 from the WHO/EMR, grant number 996353 from the National Institute of Health Researches of Iran, and grant number 99008516 from the Iran National Science Foundation. M S Petersen reports support for the present manuscript from Cooperation's p/f Krunborg and Borgartun, grants or contracts from the Velux Foundation, special COVID-10 funding from the Faroese Research Council, the Faroese Parkinson's association, and the Faroese Health Insurance Fund. For this work, Lorenzo Monasta received supported from the Ministry of Health, Rome, Italy, in collaboration with the Institute for Maternal and Child Health IRCCS Burlo Garofolo, Trieste, Italy.

Role of the funding source

The funders of the study had no role in study design, data collection, data analysis, data interpretation, or the writing of the report. Members of the core research team for this topic area had full access to the underlying data used to generate estimates presented in this paper. All other authors had access and reviewed estimates as part of the research evaluation process, which includes additional stages of formal review.

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Main text figures and tables

Figure 1. Proportions of incident long COVID symptom clusters and their overlap in 2020 and 2021 globally

Figure 2. Global incident cases, prevalent cases, and severity-weighted prevalence of long COVID by age, sex, symptom cluster, and overlap of symptom clusters in 2020 and 2021

Table 1. Health states, lay descriptions, and disability weights used for the three symptom clusters of long COVID.

Outcome	Health State	Lay description	DW (95% UI)
Mild respiratory symptoms	Chronic respiratory problems, mild	has cough and shortness of breath after heavy physical activity but is able to walk long distances and climb stairs.	0.019 (0.011 – 0.039)
Moderate respiratory symptoms	Chronic respiratory problems, moderate	has cough, wheezing and shortness of breath, even after light physical activity. The person feels tired and can walk only short distances or climb only a few stairs.	0.225 (0.153 – 0.310)
Severe respiratory symptoms	Chronic respiratory problems, severe	has cough, wheezing and shortness of breath all the time. The person has great difficulty walking even short distances or climbing any stairs, feels tired when at rest, and is anxious.	0.408 (0.273 – 0.556)
Mild cognitive symptoms	Cognitive problems, mild	has some trouble remembering recent events and finds it hard to concentrate and make decisions and plans.	0.069 (0.046 – 0.099)
Severe cognitive symptoms	Cognitive problems, moderate	has memory problems and confusion, feels disoriented, at times hears voices that are not real, and needs help with some daily activities.	0.377 (0.252 – 0.508)
Fatigue syndrome	Infectious disease, post-acute consequences	is always tired and easily upset. The person feels pain all over the body and is depressed.	0.219 (0.148 – 0.308)

GBD disability weights (DWs) quantify health loss as a fraction of time lived within a health state. For severe cognitive symptoms of long COVID we use the health state of moderate cognitive problems that is also used in GBD for moderate dementia.

Table 2. Follow-up studies of long COVID, their inclusion of community and/or hospitalized cases, sample size, follow-up period, comparison method, and reported symptoms

Follow-up study	Community sample size	Hospital/ICU sample size	Follow-up since end of acute episode (days)	Comparison group	Outcomes
Cohort studies with individual-level data					
CO-FLOW (Netherlands)[41]		285 adults	81, 171	Self-reported health status one year prior to survey	Fatigue cluster, respiratory cluster by severity, cognitive cluster
Faroe Islands[39]	362 all ages	8 all ages	0, 16, 46, 76	None	Fatigue cluster, respiratory cluster, cognitive cluster
Helbok et al. (Austria)[69]	17 adults	68 adults	81	Self-reported health status one year prior to survey	Fatigue cluster, cognitive cluster
Isfahan COVID Cohort (Iran)[70]		1938 all ages	120	Self-reported pre-COVID health status	Fatigue cluster, respiratory cluster, cognitive cluster
pa-COVID (Germany)[71,72]	29 adults	145 adults	42, 90, 180, 365	None	Fatigue cluster, respiratory cluster by severity, cognitive cluster
PronMed ICU (Sweden)[73,74]		158 adults	121, 166, 346	None	Fatigue cluster, respiratory cluster, cognitive cluster
Rome ISARIC (Italy)[49]	82 children, 52 adults		42 (adults); 56 (children)	Self-reported pre-COVID health status	Fatigue cluster, respiratory cluster, cognitive cluster
StopCOVID Cohort (Russia)[51,75]		885 children, 6908 adults	171, 247, 351	Self-reported pre-COVID health status	Fatigue cluster, respiratory cluster by severity, cognitive cluster
US Longitudinal COVID-19 Cohort HAARVI (USA)[76]	160 adults	17 adults	164 (comm); 143 (hosp)	None	Fatigue cluster, respiratory cluster, cognitive cluster
Zürich SARS-CoV-2 Cohort (Switzerland)[38]	Prospective 888 adults; retrospective 316 adults	Prospective 40 adults; retrospective 74 adults	7, 23, 83, 173, 263, 353 (comm); 3, 63, 153, 243, 333 (hosp/ICU)	Self-reported pre-COVID health status	Fatigue cluster, respiratory cluster by severity, cognitive by severity cluster

Follow-up study	Community sample size	Hospital/ICU sample size	Follow-up since end of acute episode (days)	Comparison group	Outcomes
Administrative data sources					
PRA administrative data (USA)[33]	772,611 all ages	237,274 all ages	87 (comm); 73 (hosp); 101 (ICU)	Matched 1:1 to non-COVID controls	ICD codes for fatigue, respiratory, and cognitive symptoms
Veterans Affairs administrative data (USA)[34,35]	73,435 adults	13,654 adults	143 (comm); 123 (hosp); 150 (ICU)	Matched to 4,990,835 non-COVID controls	ICD codes for fatigue, respiratory, and cognitive symptoms
Published articles					
Anastasio et al. (Italy)[77]		379 adults	135	None	Dyspnoea, memory loss
ANOSVID (France)[78]	233 adults	121 adults	259	None	Fatigue, dyspnoea, any symptom from their symptom list
Arnold D et al. (UK)[79]		110 adults	60 (hosp); 53 (ICU)	None	Fatigue, cough, shortness of breath
Asadi-Pooya et al. (Iran)[80]		58 children	246	None	Fatigue, dyspnoea
Becker et al. (Switzerland)[81]		90 adults	90, 365	None	Fatigue, concentration difficulties, shortness of breath, any symptom from their symptom list
Bellan et al. (Italy)[82]		238 adults	96	None	Dyspnoea
Berg et al. (Denmark)[83]	5106 children		53, 83, 173, 263, 353	Matched COVID-free control group (either not tested or tested negative)	Fatigue, trouble breathing, trouble concentrating
Carfì A et al. (Italy)[84]		143 adults	27	None	Fatigue, dyspnoea
Carvalho-Schneider C et al. (France)[85]	116 adults	34 adults	30	None	Dyspnoea
Chopra N et al. (India)[86]		53 all ages	21	None	Fatigue, exertional dyspnoea
Chopra V et al. (USA)[87]		488 adults	51	None	Cough, shortness of breath, chest tightness, wheezing
Cirulli et al. (USA)[18]	225 adults	8 adults	28, 58, 88	None	Fatigue, cough, dyspnoea.

Follow-up study	Community sample size	Hospital/ICU sample size	Follow-up since end of acute episode (days)	Comparison group	Outcomes
Published articles (cont.)					
CLoCk (England)[88]	3065 children		83	Matched to COVID test-negative controls	Tiredness, shortness of breath, confusion/disorientation/drowsiness, any symptom
COD19 (Italy)[89]	114 adults	189 adults	366	None	Fatigue, respiratory disorders
COMEBAC (France)[90]		478 adults	104	None	Memory loss, mental slowness, concentration problems, fatigue, dyspnoea, cough
Coronavirus Infection Survey (CIS) (UK)[19,91]	3489 children, 21,622 adults		26, 75 (children); 26, 33, 40, 47, 54, 61, 68, 75, 82, 89, 96, 103, 110 (adults)	Matched 1:1 to non-COVID controls	Fatigue, cough
COVID Symptom Study (CSS) App (UK)[20,40]	1734 children, 4182 adults		19, 47, 75	None	Fatigue, cough, shortness of breath
Darcis et al. (Belgium)[92]		101 adults (3-month follow-up), 78 adults (6-month follow-up)	85, 171	None	Fatigue, exertional dyspnoea, confusion
Dryden et al. (South Africa)[93]		1258 adults	19	None	Fatigue, confusion, dyspnoea
Elkan et al. (Israel)[94]		66 adults	261	None	Fatigue, dyspnoea, memory/concentration impairment
García-Abellán et al. (Spain)[95]		104 adults (2-month follow-up), 116 adults (6-month follow-up)	51, 171	None	Fatigue, dyspnoea, respiratory symptoms, any symptom from their symptom list
Garrigues et al. (France)[96]		120 all ages	88 (hosp); 81 (ICU)	None	Fatigue, cough, dyspnoea, memory loss

Follow-up study	Community sample size	Hospital/ICU sample size	Follow-up since end of acute episode (days)	Comparison group	Outcomes
Published articles (cont.)					
Halpin S et al. (UK)[97]		100 adults	39 (hosp); 38 (ICU)	None	Fatigue, breathlessness, concentration problems, short-term memory problems
Heesakkers et al. (Netherlands)[98]		246 young adults and adults	365	None	Fatigue, cognitive failure, dyspnea
Horwitz et al. (USA)[99]		126 adults	171	None	Fatigue, dyspnoea, cognitive fuzziness/brain fog/difficulty concentrating
Huang et al. (China)[54]		1655 adults	171 (hosp); 170 (ICU)	None	Fatigue or muscle weakness, dyspnoea
Jacobson et al. (USA)[100]	96 all ages	22 all ages	112 (comm); 92 (hosp/ICU)	None	Memory problems, fatigue, dyspnoea
Kayaaslan et al. (Turkey)[101]	591 adults	416 adults	113	None	Fatigue, dyspnoea, concentration or memory problems
Klein et al. (Israel)[102]	103 adults		171	None	Fatigue, breathing difficulties
Lerum et al. (Norway)[103]		69 adults	59 (hosp), 55 (ICU)	None	Dyspnoea
Mandal S et al. (UK)[104]		217 all ages	45	None	Fatigue, breathlessness, cough
Moreno-Pérez et al. (Spain)[105]		277 adults	77	None	Fatigue, dyspnoea, cough, amnesic complaints
Naik et al. (India)[106]	523 adults	711 adults	63, 84	None	Fatigue, dyspnea
Peghin et al. (Italy)[107]	502 adults	39 adults	182 (comm); 161 (hosp); 191 (ICU)	None	Fatigue, dyspnoea
Say et al. (Australia)[108]	97 children		128	None	Fatigue
Sibila et al. (Spain)[109]		172 all ages	81	None	Dyspnoea
Sigfrid et al. (UK)[110]		327 adults	192	None	Fatigue, shortness of breath, any symptom

Follow-up study	Community sample size	Hospital/ICU sample size	Follow-up since end of acute episode (days)	Comparison group	Outcomes
Published articles (cont.)					
Søraas et al. (Norway)[111]	676 adults		119	COVID test-negative group	Fatigue, dyspnoea, any symptom
Suárex-Robles et al. (Spain)[112]		134 all ages	81	None	Fatigue, dyspnoea
Taboada et al. (Spain)[113]		183 adults	171 (hosp); 170 (ICU)	None	Dyspnoea
Tleyjeh et al. (Saudi Arabia)[114]		222 adults	122	None	Fatigue, shortness of breath, concentration issues, memory impairment, any persistent symptoms
Venturelli et al. (Italy)[115]		767 adults	72	None	Confusion, dyspnoea
Wanga et al. (USA)[116]	417 adults	48 adults	21	COVID test-negative group	Fatigue, dyspnoea, cognitive problems
Xiong et al. (China)[117]		538 adults	81	COVID-free control group (n=184) with similar demographic attributes	Fatigue, dyspnoea

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Table 3. Incident and prevalent cases of long COVID by sex and severity of initial infection in 2020-2021, in millions.

	Males	Females	Both males and females
Incident cases			
Post-acute fatigue syndrome	26.8 (4.51–84.4)	52.1 (9.60–157)	78.9 (14.4–242)
Respiratory symptoms	33.5 (8.04–84.0)	55.8 (12.7–139)	89.3 (21.1–222)
Cognitive symptoms	18.6 (2.49–61.6)	36.6 (4.93–121)	55.2 (7.40–180)
Any long COVID	52.2 (19.7–115)	92.4 (34.9–199)	145 (55.0–312)
among community cases	45.8 (14.0–109)	84.3 (27.8–190)	130 (42.1–301)
among cases needing hospitalization	4.99 (1.97–9.35)	6.47 (2.92–10.8)	11.5 (4.91–20.5)
among cases needing ICU care	1.39 (0.381–3.54)	1.64 (0.517–3.96)	3.03 (0.892–7.48)
Prevalent cases			
Post-acute fatigue syndrome	6.95 (1.49–20.5)	13.1 (2.91–37.4)	20.0 (4.35–57.7)
Respiratory symptoms	8.55 (2.34–21.0)	13.8 (3.51–34.1)	22.4 (6.08–54.9)
Cognitive symptoms	4.77 (0.798–14.9)	9.05 (1.50–28.9)	13.8 (2.32–43.3)
Any long COVID	13.4 (5.66–28.5)	23.1 (9.55–48.5)	36.5 (15.4–76.6)

924 Table 4. Incident and prevalent cases of long COVID by country, 2020 and 2021.

Location	Incident cases of Long COVID during 2020 (in thousands)	Incident cases of Long COVID during 2021 (in thousands)	Prevalent cases of Long COVID during 2020 (in thousands)	Prevalent cases of Long COVID during 2021 (in thousands)
Global	40500 (15500–88200)	104000 (39400–225000)	6410 (2510–14000)	30100 (12800–63000)
Central Europe, Eastern Europe, and Central Asia	2400 (973–5120)	10400 (4270–22000)	383 (160–807)	2890 (1320–5860)
Central Asia	727 (271–1660)	1790 (678–4060)	106 (41.1–239)	457 (192–1000)
Armenia	31.2 (11.2–72.1)	82.9 (29.7–182)	5.51 (2.01–12.6)	25.3 (10.3–52.5)
Azerbaijan	42.2 (14.3–100)	310 (95.3–738)	7.33 (2.54–17.1)	79.0 (26.5–181)
Georgia	2.96 (0.737–6.86)	124 (33.1–293)	0.247 (0.0534–0.688)	30.1 (8.27–66.9)
Kazakhstan	107 (27.1–278)	363 (97.7–930)	18.2 (4.66–46.6)	77.3 (22.2–190)
Kyrgyzstan	87.2 (30.5–192)	130 (43.9–307)	15.3 (5.33–33.9)	39.6 (15.7–90.7)
Mongolia	0.276 (0.0401–0.917)	61.2 (21.8–141)	0.0621 (0.00862–0.209)	7.89 (2.84–18.8)
Tajikistan	54.7 (18.2–120)	195 (66.7–431)	8.69 (2.97–18.9)	47.1 (17.9–102)
Turkmenistan	30.7 (10.7–68.9)	108 (37.5–243)	4.90 (1.74–10.9)	26.6 (10.5–58.2)
Uzbekistan	371 (99.2–888)	415 (111–1040)	46.2 (12.5–111)	124 (33.8–286)
Central Europe	281 (118–584)	2700 (1130–5710)	39.1 (16.8–81.2)	819 (376–1650)
Albania	22.2 (7.82–48.4)	94.1 (35.2–204)	2.96 (1.03–6.33)	28.9 (12.1–59.3)
Bosnia and Herzegovina	17.6 (6.64–38.9)	103 (41.1–227)	2.32 (0.882–5.16)	30.9 (13.7–66.1)
Bulgaria	15.9 (6.03–34.1)	219 (72.2–500)	2.35 (0.894–5.00)	62.0 (23.4–130)
Croatia	6.53 (2.63–14.7)	90.7 (37.9–197)	0.892 (0.378–1.99)	27.4 (12.3–54.5)
Czechia	25.0 (9.75–54.0)	317 (129–684)	2.28 (0.929–4.93)	103 (46.3–210)
Hungary	13.4 (5.23–28.9)	211 (81.9–456)	1.57 (0.596–3.37)	66.7 (28.6–140)
Montenegro	3.04 (1.20–6.46)	24.5 (9.81–51.8)	0.294 (0.119–0.622)	6.70 (2.93–13.7)
North Macedonia	14.0 (5.48–31.3)	76.3 (29.2–167)	2.19 (0.854–4.93)	21.9 (9.35–46.8)
Poland	60.2 (25.4–129)	794 (322–1750)	8.60 (3.68–18.4)	250 (114–518)
Romania	79.5 (32.0–177)	415 (158–931)	11.2 (4.60–24.7)	121 (50.9–248)
Serbia	18.8 (6.81–42.8)	222 (83.5–478)	3.83 (1.42–8.70)	58.1 (24.0–120)
Slovakia	3.19 (1.05–8.08)	103 (37.2–228)	0.325 (0.102–0.856)	32.2 (12.9–68.4)
Slovenia	1.40 (0.425–3.81)	34.1 (11.6–79.4)	0.211 (0.0620–0.582)	10.1 (3.71–23.4)
Eastern Europe	1390 (577–2930)	5870 (2410–12300)	238 (101–503)	1620 (753–3290)
Belarus	58.5 (14.8–155)	194 (51.1–498)	11.5 (3.09–28.2)	52.9 (14.3–128)
Estonia	0.661 (0.236–1.68)	14.7 (5.74–34.5)	0.144 (0.0526–0.369)	4.08 (1.75–9.58)
Latvia	1.03 (0.295–2.53)	35.4 (11.0–88.0)	0.209 (0.0567–0.513)	10.1 (3.27–24.9)

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Lithuania	1.87 (0.584–4.36)	74.4 (23.9–182)	0.326 (0.100–0.773)	20.8 (7.14–48.8)
Republic of Moldova	34.8 (10.5–79.1)	92.7 (29.4–215)	5.22 (1.59–12.1)	30.8 (11.3–67.6)
Russian Federation	1130 (461–2380)	4450 (1790–9230)	200 (86.0–426)	1200 (555–2400)
Ukraine	161 (50.0–390)	1010 (336–2300)	19.9 (5.92–50.0)	299 (105–688)
High-income	2180 (899–4500)	7720 (3170–15900)	429 (187–877)	2270 (1050–4540)
Australasia	3.62 (1.36–7.80)	6.40 (2.72–13.1)	0.591 (0.242–1.24)	0.940 (0.441–1.86)
Australia	3.49 (1.31–7.54)	6.28 (2.67–12.9)	0.560 (0.231–1.17)	0.917 (0.429–1.81)
New Zealand	0.125 (0.0498–0.272)	0.126 (0.0524–0.256)	0.0307 (0.0133–0.0665)	0.0229 (0.0111–0.0449)
High-income Asia Pacific	40.3 (17.0–82.6)	319 (137–651)	7.34 (3.31–14.8)	79.1 (37.7–153)
Brunei Darussalam	0.0743 (0.0237–0.176)	0.894 (0.318–2.12)	0.0205 (0.00637–0.0492)	0.0618 (0.0234–0.144)
Japan	29.7 (12.9–60.1)	284 (122–576)	5.06 (2.32–10.1)	71.1 (33.6–138)
Republic of Korea	4.57 (1.58–10.9)	31.0 (12.3–67.9)	0.905 (0.326–2.16)	7.03 (2.90–15.1)
Singapore	5.92 (2.20–13.7)	3.47 (1.46–7.25)	1.36 (0.514–3.15)	0.867 (0.398–1.69)
High-income North America	1050 (436–2210)	3780 (1550–7830)	190 (81.4–397)	1100 (506–2210)
Canada	27.9 (10.7–58.3)	167 (66.8–345)	6.01 (2.31–12.5)	47.4 (20.4–95.5)
Greenland	0.00685 (0.00211–0.0157)	0.0622 (0.0225–0.139)	0.00171 (0.000516–0.00406)	0.00726 (0.00281–0.0156)
United States of America	1020 (425–2160)	3620 (1480–7490)	184 (78.5–384)	1050 (485–2130)
Southern Latin America	183 (70.6–393)	533 (202–1180)	22.9 (9.13–48.5)	160 (65.7–334)
Argentina	130 (48.9–286)	388 (140–861)	13.9 (5.44–29.8)	116 (45.5–253)
Chile	52.1 (19.5–114)	112 (42.2–243)	8.89 (3.46–18.9)	35.4 (14.8–73.4)
Uruguay	0.450 (0.142–1.06)	33.1 (13.3–71.3)	0.0931 (0.0290–0.225)	8.64 (3.67–17.8)
Western Europe	898 (371–1840)	3080 (1280–6310)	208 (91.0–423)	928 (436–1820)
Andorra	0.564 (0.206–1.22)	1.21 (0.457–2.86)	0.116 (0.0425–0.250)	0.415 (0.172–0.872)
Austria	7.59 (3.03–16.6)	67.0 (24.9–143)	1.43 (0.607–3.02)	20.6 (8.85–42.5)
Belgium	40.7 (16.4–88.8)	108 (43.3–228)	9.64 (3.97–20.7)	34.0 (15.3–70.4)
Cyprus	0.292 (0.107–0.683)	7.64 (3.11–16.0)	0.0644 (0.0240–0.152)	1.88 (0.822–3.87)
Denmark	6.14 (2.26–13.0)	23.8 (9.61–48.8)	1.44 (0.537–3.05)	7.25 (3.23–14.3)
Finland	3.73 (1.50–7.90)	13.6 (5.53–28.7)	0.935 (0.382–1.95)	3.65 (1.65–7.33)
France	175 (65.0–378)	513 (203–1090)	40.5 (15.3–89.7)	159 (69.6–326)
Germany	55.8 (23.2–114)	424 (173–874)	13.2 (5.67–27.2)	129 (59.3–254)

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Greece	3.11 (1.12–7.10)	56.7 (22.7–120)	0.486 (0.168–1.14)	14.4 (6.40–28.8)
Iceland	0.292 (0.115–0.621)	0.627 (0.256–1.31)	0.0605 (0.0240–0.130)	0.153 (0.0710–0.301)
Ireland	9.48 (3.30–21.3)	30.0 (11.3–65.8)	2.29 (0.819–5.09)	8.23 (3.31–17.7)
Israel	25.7 (10.4–53.8)	67.2 (26.8–146)	2.84 (1.20–6.00)	19.3 (8.79–40.5)
Italy	107 (44.8–219)	433 (180–907)	28.0 (12.3–57.2)	138 (65.1–269)
Luxembourg	1.18 (0.455–2.54)	5.21 (2.07–11.0)	0.253 (0.0976–0.537)	1.62 (0.707–3.28)
Malta	0.349 (0.149–0.743)	2.72 (1.15–5.62)	0.0450 (0.0192–0.0942)	0.823 (0.386–1.61)
Monaco	0.0293 (0.0126–0.0620)	0.268 (0.118–0.541)	0.00534 (0.00225–0.0115)	0.0779 (0.0368–0.152)
Netherlands	42.0 (16.1–92.1)	145 (57.4–302)	9.87 (3.73–21.7)	43.8 (19.5–89.3)
Norway	4.15 (1.57–9.26)	16.3 (6.67–34.5)	1.04 (0.409–2.31)	4.34 (1.94–8.61)
Portugal	13.8 (5.23–30.7)	94.1 (38.0–198)	2.85 (1.10–6.31)	29.3 (13.2–59.7)
San Marino	0.183 (0.0728–0.390)	0.460 (0.188–0.976)	0.0511 (0.0222–0.106)	0.156 (0.0707–0.313)
Spain	168 (73.2–348)	373 (153–797)	35.7 (15.6–73.5)	118 (55.2–228)
Sweden	30.4 (12.0–64.5)	73.7 (31.1–154)	7.50 (3.13–15.6)	25.2 (11.7–49.1)
Switzerland	9.81 (3.93–21.4)	63.0 (25.4–133)	2.25 (0.941–4.76)	18.3 (8.32–36.2)
United Kingdom	191 (78.6–398)	560 (233–1160)	47.1 (20.0–96.7)	150 (69.9–297)
Latin America and Caribbean	5200 (1990–11200)	10100 (3870–22000)	861 (345–1860)	3160 (1360–6650)
Andean Latin America	906 (340–1960)	1090 (409–2480)	152 (59.5–331)	399 (164–857)
Bolivia (Plurinational State of)	223 (79.1–485)	257 (85.5–590)	34.0 (12.5–74.6)	94.2 (36.4–206)
Ecuador	218 (77.8–469)	332 (116–742)	39.6 (14.8–84.6)	111 (43.2–233)
Peru	466 (166–1050)	498 (177–1130)	78.7 (29.7–177)	194 (76.5–424)
Caribbean	147 (48.3–342)	325 (121–747)	24.9 (8.29–57.6)	81.9 (33.2–180)
Antigua and Barbuda	0.0491 (0.0155–0.131)	0.622 (0.209–1.40)	0.0112 (0.00362–0.0291)	0.0969 (0.0352–0.222)
Bahamas	1.22 (0.387–2.85)	3.46 (1.11–8.02)	0.116 (0.0379–0.269)	0.766 (0.260–1.70)
Barbados	0.0779 (0.0290–0.172)	0.964 (0.390–2.11)	0.0199 (0.00756–0.0433)	0.151 (0.0650–0.316)
Belize	0.683 (0.190–1.72)	4.49 (1.11–10.9)	0.0553 (0.0159–0.136)	1.13 (0.305–2.68)
Bermuda	0.0384 (0.0144–0.0842)	0.409 (0.168–0.847)	0.0101 (0.00386–0.0217)	0.0675 (0.0302–0.133)
Cuba	1.67 (0.581–3.97)	88.0 (33.4–197)	0.345 (0.126–0.815)	12.2 (4.84–27.3)

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Dominica	0.0121 (0.00227–0.0349)	0.419 (0.138–1.02)	0.00302 (0.000517–0.00876)	0.0366 (0.0131–0.0817)
Dominican Republic	68.2 (18.5–170)	75.3 (20.6–185)	11.5 (3.20–28.2)	28.4 (8.50–67.5)
Grenada	0.00863 (0.00183–0.0248)	0.999 (0.297–2.53)	0.00231 (0.000499–0.00671)	0.0630 (0.0201–0.156)
Guyana	2.40 (0.632–5.95)	10.3 (2.59–26.6)	0.235 (0.0665–0.569)	2.31 (0.617–5.60)
Haiti	56.9 (10.8–151)	69.8 (10.8–190)	10.5 (2.05–28.1)	20.2 (3.74–52.2)
Jamaica	2.83 (0.938–6.71)	19.4 (5.86–45.9)	0.236 (0.0778–0.591)	4.23 (1.39–9.97)
Puerto Rico	4.42 (1.68–10.2)	16.4 (6.47–35.8)	0.569 (0.218–1.23)	4.91 (2.18–10.3)
Saint Kitts and Nevis	0.0138 (0.00201–0.0482)	0.242 (0.0831–0.601)	0.00384 (0.000527–0.0136)	0.0274 (0.00983–0.0640)
Saint Lucia	0.0179 (0.00450–0.0450)	1.79 (0.581–4.00)	0.00447 (0.00104–0.0111)	0.319 (0.113–0.696)
Saint Vincent and the Grenadines	0.0296 (0.00765–0.0753)	0.606 (0.218–1.47)	0.00692 (0.00181–0.0168)	0.0952 (0.0372–0.215)
Suriname	1.87 (0.537–4.37)	10.1 (2.88–23.9)	0.262 (0.0774–0.624)	1.88 (0.545–4.34)
Trinidad and Tobago	1.43 (0.452–3.53)	9.68 (2.81–22.5)	0.153 (0.0493–0.381)	2.02 (0.637–4.44)
United States Virgin Islands	0.314 (0.106–0.781)	0.796 (0.274–1.99)	0.0459 (0.0145–0.112)	0.190 (0.0767–0.437)
Central Latin America	2110 (798–4480)	4460 (1690–9520)	337 (134–713)	1320 (562–2780)
Colombia	252 (94.0–563)	714 (258–1590)	33.2 (12.8–72.7)	219 (88.7–474)
Costa Rica	18.3 (6.13–41.5)	76.1 (25.4–170)	1.78 (0.596–4.14)	19.1 (7.15–41.8)
El Salvador	24.1 (8.46–53.2)	64.6 (21.3–146)	3.62 (1.35–8.01)	17.1 (6.23–38.0)
Guatemala	149 (51.8–348)	316 (99.6–754)	23.5 (8.42–54.2)	81.3 (29.1–188)
Honduras	99.7 (35.9–231)	254 (92.0–588)	14.5 (5.32–34.5)	67.4 (26.3–152)
Mexico	1290 (496–2750)	2430 (927–5240)	219 (86.6–465)	746 (324–1540)
Nicaragua	44.3 (16.8–98.7)	104 (39.8–230)	6.67 (2.58–14.8)	29.1 (12.1–63.6)
Panama	28.3 (10.3–61.9)	41.9 (15.5–91.5)	4.71 (1.74–10.5)	15.2 (6.24–32.4)
Venezuela (Bolivarian Republic of)	199 (75.6–434)	463 (172–1010)	30.1 (11.8–64.8)	131 (54.4–274)
Tropical Latin America	2040 (779–4430)	4270 (1620–9450)	348 (140–751)	1350 (588–2830)
Brazil	2020 (769–4390)	4110 (1550–9050)	346 (140–747)	1310 (563–2740)
Paraguay	22.7 (8.39–50.1)	165 (57.3–378)	1.79 (0.660–3.99)	45.7 (17.9–103)
North Africa and Middle East	4830 (1800–10900)	9410 (3630–21000)	868 (327–1940)	2740 (1140–5970)

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Afghanistan	428 (118–996)	881 (276–2180)	87.3 (24.2–205)	239 (82.4–555)
Algeria	118 (37.8–297)	194 (56.9–485)	20.5 (6.84–51.2)	56.5 (19.8–135)
Bahrain	9.17 (3.28–20.4)	24.3 (8.27–55.0)	1.35 (0.490–2.97)	7.46 (2.72–16.7)
Egypt	1240 (182–3160)	1330 (193–3380)	243 (35.6–624)	475 (73.3–1150)
Iran (Islamic Republic of)	552 (214–1200)	1750 (673–3730)	97.9 (39.3–209)	447 (187–937)
Iraq	657 (194–1460)	946 (324–2120)	86.5 (25.0–191)	292 (112–641)
Jordan	8.45 (2.88–19.2)	282 (95.5–636)	0.356 (0.116–0.844)	76.1 (27.8–169)
Kuwait	27.4 (7.12–67.9)	57.4 (16.9–129)	4.42 (1.19–11.0)	17.8 (5.61–40.8)
Lebanon	20.8 (7.05–57.6)	137 (48.7–320)	2.92 (0.728–13.1)	41.4 (16.5–93.2)
Libya	45.5 (17.3–100)	211 (76.0–472)	4.12 (1.54–9.23)	54.2 (21.1–117)
Morocco	224 (74.3–506)	933 (273–2240)	26.5 (8.76–64.6)	228 (74.0–515)
Oman	25.8 (8.84–62.9)	49.6 (15.8–119)	3.75 (1.28–9.35)	14.8 (5.20–33.8)
Palestine	21.7 (7.38–50.7)	142 (47.9–325)	2.14 (0.711–4.97)	38.3 (13.9–87.2)
Qatar	37.5 (12.6–86.6)	33.0 (10.7–77.9)	7.46 (2.61–17.1)	12.7 (4.65–28.9)
Saudi Arabia	226 (70.3–542)	104 (29.9–274)	41.5 (13.7–99.6)	49.5 (16.9–126)
Sudan	415 (78.1–1080)	306 (75.6–767)	86.1 (17.5–221)	126 (36.6–306)
Syrian Arab Republic	12.9 (3.64–33.9)	79.9 (19.8–231)	1.31 (0.381–3.32)	20.4 (5.14–56.2)
Tunisia	22.7 (6.88–54.2)	437 (144–1030)	1.40 (0.378–3.62)	108 (37.9–247)
Turkey	475 (105–1360)	1240 (426–2820)	99.8 (20.3–298)	348 (121–784)
United Arab Emirates	22.9 (7.15–53.0)	74.3 (22.8–173)	4.37 (1.37–10.2)	22.4 (7.43–50.8)
Yemen	231 (28.1–574)	179 (31.4–584)	44.1 (5.14–110)	62.2 (14.2–169)
South Asia	15700 (5810–34000)	36700 (13500–79300)	2130 (811–4630)	11200 (4670–23800)
Bangladesh	1550 (508–3700)	3850 (1390–8660)	248 (83.7–603)	1010 (388–2220)
Bhutan	0.145 (0.0299–0.401)	0.664 (0.245–1.54)	0.0253 (0.00505–0.0720)	0.173 (0.0667–0.384)
India	11900 (4500–25800)	27900 (10400–59600)	1430 (556–3160)	8830 (3720–18600)
Nepal	138 (51.9–307)	840 (305–1900)	11.6 (4.42–26.1)	211 (84.2–468)
Pakistan	2100 (726–4800)	4150 (1410–9360)	437 (155–984)	1180 (432–2630)
Southeast Asia, East Asia, and Oceania	1340 (519–2890)	8860 (3360–19100)	188 (76.4–403)	1900 (806–3980)
East Asia	106 (42.3–225)	9.78 (3.86–21.3)	33.0 (13.9–69.4)	8.56 (4.10–16.2)
China	104 (41.8–223)	3.69 (1.49–7.85)	32.6 (13.7–68.8)	7.01 (3.38–13.5)
Democratic People's Republic of Korea	1.06 (0.308–2.70)	2.06 (0.767–4.74)	0.318 (0.0954–0.796)	0.546 (0.214–1.25)

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Taiwan (Province of China)	0.506 (0.0824–1.83)	4.04 (1.46–9.48)	0.133 (0.0222–0.469)	1.00 (0.364–2.40)
Oceania	4.27 (1.31–11.2)	105 (32.9–262)	0.503 (0.157–1.33)	22.9 (7.69–57.2)
American Samoa	0.00352 (0.000102–0.0150)	0.00645 (0.000398–0.0241)	0 (0–0)	0.00197 (0.000102–0.00800)
Cook Islands	0.0211 (0.00760–0.0471)	0.0707 (0.0249–0.165)	0.00236 (0.000851–0.00530)	0.0178 (0.00704–0.0387)
Fiji	0.0831 (0.0221–0.242)	11.0 (3.40–26.1)	0.0185 (0.00436–0.0565)	1.59 (0.509–3.73)
Guam	0.803 (0.293–1.89)	2.02 (0.699–4.66)	0.0865 (0.0292–0.211)	0.491 (0.193–1.08)
Kiribati	0 (0–0)	0.0215 (0.00160–0.0659)	0 (0–0)	0.00474 (0.000353–0.0146)
Marshall Islands	0 (0–0)	0.0183 (0.00264–0.0537)	0 (0–0)	0.00546 (0.000798–0.0155)
Micronesia (Federated States of)	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Nauru	0.0103 (0.00355–0.0240)	0.0346 (0.0116–0.0795)	0.00113 (0.000389–0.00272)	0.00820 (0.00310–0.0187)
Niue	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Northern Mariana Islands	0.0440 (0.0159–0.0989)	0.0324 (0.0116–0.0747)	0.0102 (0.00388–0.0219)	0.0110 (0.00447–0.0248)
Palau	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Papua New Guinea	3.09 (0.782–8.91)	86.3 (25.3–219)	0.359 (0.0921–1.01)	19.6 (6.28–49.5)
Samoa	0 (0–0)	0.0136 (0.00186–0.0423)	0 (0–0)	0.00427 (0.000602–0.0132)
Solomon Islands	0 (0–0)	0.0857 (0.00858–0.330)	0 (0–0)	0.0232 (0.00256–0.0869)
Tokelau	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Tonga	0 (0–0)	0 (0–0)	0 (0–0)	0 (0–0)
Tuvalu	0.0121 (0.00424–0.0277)	0.0403 (0.0138–0.0911)	0.00134 (0.000470–0.00303)	0.00979 (0.00378–0.0216)
Vanuatu	0 (0–0)	0.0947 (0.0189–0.299)	0 (0–0)	0.0257 (0.00528–0.0809)
Southeast Asia	1230 (472–2670)	8750 (3310–18800)	155 (62.0–335)	1870 (790–3920)
Cambodia	0.261 (0.0389–0.899)	127 (39.8–318)	0.0582 (0.00843–0.206)	19.8 (6.58–48.6)
Indonesia	770 (300–1680)	5370 (2010–11700)	95.7 (38.0–208)	1250 (527–2630)
Lao People's Democratic Republic	0.121 (0.00958–0.439)	12.8 (3.18–38.1)	0.0321 (0.00246–0.117)	1.32 (0.278–4.08)
Malaysia	4.71 (1.37–12.1)	343 (124–783)	0.887 (0.259–2.40)	52.5 (19.6–117)

Location	Incident cases of Long COVID during 2020 (in thousands)	Incident cases of Long COVID during 2021 (in thousands)	Prevalent cases of Long COVID during 2020 (in thousands)	Prevalent cases of Long COVID during 2021 (in thousands)
Maldives	1.29 (0.372–3.55)	5.20 (1.82–12.1)	0.189 (0.0568–0.522)	1.38 (0.512–3.22)
Mauritius	0.227 (0.0591–0.614)	2.14 (0.819–4.87)	0.0633 (0.0170–0.169)	0.238 (0.0890–0.547)
Myanmar	53.9 (17.8–127)	585 (177–1360)	1.96 (0.634–4.77)	112 (38.1–252)
Philippines	389 (144–833)	1610 (605–3470)	54.2 (21.2–115)	343 (141–726)
Seychelles	0.0280 (0.00837–0.0684)	1.95 (0.742–4.29)	0.00562 (0.00164–0.0137)	0.433 (0.174–0.933)
Sri Lanka	2.03 (0.302–6.59)	123 (45.8–267)	0.415 (0.0604–1.39)	20.6 (7.59–46.3)
Thailand	2.70 (0.360–9.02)	284 (94.7–693)	0.723 (0.0937–2.43)	36.0 (12.3–89.2)
Timor-Leste	0.0407 (0.00537–0.130)	13.9 (4.17–36.2)	0.00987 (0.00126–0.0319)	2.10 (0.654–5.30)
Viet Nam	1.37 (0.426–3.59)	249 (81.6–578)	0.262 (0.0686–0.755)	26.3 (9.08–60.3)
Sub-Saharan Africa	8840 (3240–19200)	21000 (7610–46400)	1560 (584–3360)	5880 (2390–12700)
Central Sub-Saharan Africa	1350 (465–2980)	2690 (958–6060)	249 (87.7–556)	780 (296–1710)
Angola	189 (61.0–439)	817 (266–1820)	17.8 (5.73–41.2)	190 (68.0–415)
Central African Republic	75.3 (23.8–187)	55.5 (17.8–146)	15.4 (5.01–37.5)	21.6 (8.04–51.4)
Congo	51.0 (17.4–121)	70.1 (24.4–162)	9.44 (3.39–22.1)	21.2 (8.39–47.5)
Democratic Republic of the Congo	987 (319–2260)	1710 (565–3870)	198 (63.2–457)	536 (188–1190)
Equatorial Guinea	25.0 (8.45–58.1)	11.9 (3.24–29.5)	5.12 (1.81–11.8)	4.44 (1.76–9.66)
Gabon	17.7 (4.99–42.2)	25.3 (6.33–62.9)	3.81 (1.09–9.05)	7.23 (2.20–16.4)
Eastern Sub-Saharan Africa	2410 (858–5180)	9470 (3410–20700)	337 (122–738)	2460 (982–5360)
Burundi	8.62 (2.89–19.6)	55.8 (18.3–133)	1.48 (0.495–3.43)	15.1 (5.16–36.4)
Comoros	2.26 (0.404–7.53)	16.2 (5.98–36.2)	0.453 (0.0865–1.46)	5.29 (2.07–11.7)
Djibouti	11.2 (3.67–26.1)	17.2 (5.45–41.9)	2.52 (0.856–5.80)	4.98 (1.70–12.0)
Eritrea	2.86 (0.164–10.2)	57.4 (19.3–126)	0.530 (0.0280–1.95)	14.0 (4.57–30.6)
Ethiopia	845 (308–1860)	2700 (981–5970)	93.4 (34.9–205)	719 (283–1600)
Kenya	375 (134–826)	1430 (518–3140)	53.8 (20.2–119)	363 (146–785)
Madagascar	325 (113–755)	510 (168–1180)	48.4 (16.9–112)	175 (64.1–389)
Malawi	64.0 (18.0–154)	539 (184–1220)	10.3 (2.94–24.7)	129 (47.1–289)
Mozambique	82.7 (25.0–200)	967 (337–2170)	7.69 (2.29–20.0)	231 (85.3–523)
Rwanda	9.69 (2.91–23.4)	212 (62.9–506)	1.30 (0.387–3.36)	43.4 (13.6–101)
Somalia	137 (35.9–341)	478 (154–1120)	31.6 (9.20–75.9)	118 (42.5–266)
South Sudan	88.3 (26.2–230)	107 (30.2–276)	18.2 (5.48–47.5)	38.1 (12.5–95.6)
Uganda	59.5 (20.2–133)	714 (231–1630)	4.60 (1.56–10.5)	164 (60.0–370)

Location	Incident cases of Long COVID during 2020 (in thousands)	Incident cases of Long COVID during 2021 (in thousands)	Prevalent cases of Long COVID during 2020 (in thousands)	Prevalent cases of Long COVID during 2021 (in thousands)
United Republic of Tanzania	282 (102–606)	1150 (417–2530)	45.9 (16.9–99.0)	303 (119–657)
Zambia	119 (38.1–283)	511 (179–1190)	16.7 (5.41–40.2)	131 (49.4–304)
Southern Sub-Saharan Africa	492 (184–1070)	1820 (664–4000)	71.8 (27.4–154)	470 (193–996)
Botswana	1.14 (0.414–2.51)	61.0 (16.1–150)	0.111 (0.0414–0.245)	12.1 (3.21–29.6)
Eswatini	6.20 (2.18–14.3)	26.1 (6.57–68.6)	0.886 (0.318–2.04)	6.40 (1.79–16.8)
Lesotho	7.06 (2.42–16.3)	46.5 (11.0–112)	0.882 (0.305–2.00)	12.1 (3.19–29.3)
Namibia	6.49 (2.28–14.7)	59.0 (17.9–138)	0.734 (0.267–1.66)	13.8 (4.77–32.1)
South Africa	419 (157–898)	1170 (437–2520)	62.1 (24.2–132)	323 (136–686)
Zimbabwe	51.7 (16.4–125)	460 (134–1100)	7.11 (2.26–17.2)	103 (32.8–242)
Western Sub-Saharan Africa	4580 (1680–9970)	6970 (2520–15600)	900 (341–1970)	2170 (887–4710)
Benin	36.7 (10.3–102)	112 (32.1–261)	6.92 (1.98–19.5)	24.5 (7.02–60.1)
Burkina Faso	136 (42.3–350)	378 (134–860)	28.0 (8.14–71.4)	120 (45.6–281)
Cabo Verde	4.69 (1.45–11.8)	10.4 (3.55–24.8)	0.600 (0.164–1.53)	3.22 (1.17–7.57)
Cameroon	189 (19.4–462)	465 (29.9–1320)	40.6 (4.11–98.3)	126 (8.46–355)
Chad	153 (38.5–412)	145 (38.8–356)	32.6 (7.92–88.4)	56.9 (16.6–137)
Côte d'Ivoire	280 (81.3–671)	424 (138–977)	56.6 (17.2–139)	111 (42.6–247)
Gambia	27.8 (9.19–62.7)	44.3 (13.4–106)	3.37 (1.17–7.38)	12.7 (4.51–28.0)
Ghana	273 (94.6–624)	541 (186–1320)	47.2 (17.0–109)	155 (58.9–368)
Guinea	143 (45.2–351)	266 (76.9–628)	26.9 (8.77–66.4)	67.9 (23.9–149)
Guinea-Bissau	27.9 (9.00–67.7)	18.9 (3.13–57.1)	6.00 (1.90–15.0)	5.87 (1.89–15.4)
Liberia	49.2 (15.7–114)	68.5 (21.5–178)	10.2 (3.34–23.2)	17.0 (6.33–39.6)
Mali	195 (52.5–478)	369 (125–886)	43.8 (11.8–107)	121 (43.7–289)
Mauritania	27.1 (9.17–66.0)	75.4 (23.3–180)	5.52 (1.86–13.8)	20.1 (6.66–46.8)
Niger	115 (27.2–295)	233 (76.0–530)	29.4 (6.83–76.0)	78.5 (26.2–182)
Nigeria	2700 (992–5980)	3240 (1160–7100)	519 (192–1160)	1100 (449–2390)
Sao Tome and Principe	2.12 (0.670–5.43)	1.95 (0.396–5.38)	0.487 (0.158–1.25)	0.539 (0.201–1.16)
Senegal	110 (40.1–253)	394 (144–891)	19.1 (7.23–43.9)	105 (40.6–232)
Sierra Leone	87.3 (28.7–211)	39.6 (13.9–94.4)	19.3 (6.27–47.0)	16.5 (6.60–36.6)
Togo	27.9 (9.29–65.4)	145 (49.7–331)	4.27 (1.46–9.71)	32.8 (12.4–72.8)

Figure 1. Proportions of incident long COVID symptom clusters and their overlap in 2020 and 2021 globally

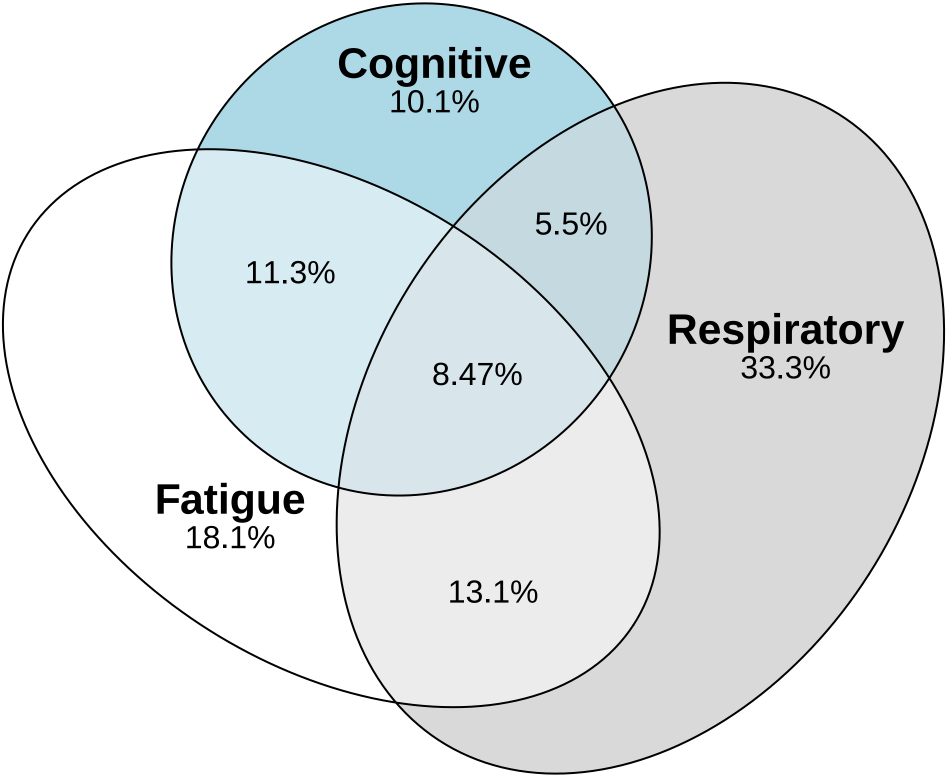

Figure 2. Global incident cases, prevalent cases, and severity-weighted prevalence of long COVID by age, sex, symptom cluster and overlap of symptom clusters in 2020 and 2021