Characteristics Associated with Hospitalisation for COVID-19 in People with Rheumatic Disease: Data from the COVID-19 Global Rheumatology Alliance Physician-Reported Registry

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Key Messages

What is already known about this subject?

- Data regarding outcomes for people with rheumatologic disease and COVID-19 remain scarce and limited to small case series.
- Due to underlying immune system dysfunction and the common use of immunosuppressants there is concern about poorer outcomes in this population and uncertainty about medication management during the pandemic.

What does this study add?

- Moderate dose glucocorticoids were associated with a higher risk of hospitalization for COVID-19.
- Biologic therapies, NSAIDs and anti-malarial drugs like hydroxychloroquine were not associated with a higher risk of hospitalization for COVID-19.

How might this impact on clinical practice?

- This study demonstrates that most individuals with rheumatologic diseases or on immunosuppressive therapies recover from COVID-19, which should provide some reassurance to patients.

ABSTRACT

Objectives:

COVID-19 outcomes in people with rheumatic diseases remain poorly understood. The aim was to examine demographic and clinical factors associated with COVID-19 hospitalisation status in people with rheumatic disease.

Methods:

Case series of individuals with rheumatic disease and COVID-19 from the COVID-19 Global Rheumatology Alliance registry: March 24,2020 to April 20,2020. Multivariable logistic regression was used to estimate odds ratios (ORs) and 95% confidence intervals (CIs) of hospitalisation. Age, sex, smoking status, rheumatic disease diagnosis, comorbidities and rheumatic disease medications taken immediately prior to infection were analysed.

Results:

A total of 600 cases from 40 countries were included. Nearly half of the cases were hospitalised (277, 46%) and 55 (9%) died. In multivariable-adjusted models, prednisone dose ≥10mg/day was associated with higher odds of hospitalisation (OR 2.05, 95% CI 1.06,3.96). Use of conventional DMARD alone or in combination with biologics/JAK inhibitors was not associated with hospitalisation (OR 1.23, 95% CI 0.70,2.17 and OR 0.74, 95% CI 0.37,1.46 respectively). Non-steroidal anti-inflammatory drug use (NSAIDs) was not associated with hospitalisation status (OR 0.64, 95% CI 0.39, 1.06). Tumour necrosis factor inhibitor (anti-TNF) use was associated with a reduced odds of hospitalisation (OR 0.40, 95% CI 0.19,0.81), while no association with antimalarial use (OR 0.94, 95% CI 0.57,1.57) was observed.

Conclusions:

We found that glucocorticoid exposure of ≥10 mg/day is associated with a higher odds of hospitalisation and anti-TNF with a decreased odds of hospitalisation in patients with rheumatic disease. Neither exposure to DMARDs nor NSAIDs were associated with increased odds of hospitalisation.

INTRODUCTION

The coronavirus disease 2019 (COVID-19) pandemic caused by the Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) virus is of particular concern for people with rheumatic disease or those who are immunosuppressed. Whether having a rheumatic disease or receiving immunosuppressive treatment is associated with severe infection and subsequent poor outcomes is unknown. In general, immunosuppression and the presence of comorbidities are associated with an increased risk of serious infection in people with rheumatic diseases[1] therefore, people with rheumatic disease may be at higher risk for a more severe course with COVID-19, including hospitalization, complications and death. Importantly, some medications used to treat rheumatic diseases, such as hydroxychloroquine and interleukin-6 inhibitors, are being studied for the prevention and/or treatment of COVID-19 and its complications including cytokine-storm.[2-4] At present the implications of COVID-19 for people living with rheumatic diseases remain poorly understood.

To address this knowledge gap, a global network of rheumatologists, scientists, and patients developed a physician-reported case registry of people with rheumatic diseases diagnosed with COVID-19.[5,6] This report aims to (1) describe the demographic and clinical characteristics of the first 600 patients submitted to the COVID-19 Global Rheumatology Alliance (C19-GRA) physician registry, and (2) identify factors associated with hospitalization for COVID-19 in this population.

METHODS

Details of the registry design have been described elsewhere.[5-7] Briefly, C19-GRA data regarding individuals with rheumatic diseases diagnosed with COVID-19 are captured from rheumatology physicians via two parallel international data entry portals for regulatory reasons: one limited to European countries (eular.org/eular_covid19_database.cfm; hosted by The

University of Manchester, UK) and a second for all other sites (rheum-covid.org/provider-global/; hosted by the University of California, San Francisco). Two patients sit on the C19-GRA steering committee and they contributed to the design of the registry, the questions being asked and the analysis of the results. The C19-GRA has a Patient Board, composed entirely of patients. These patients, and others, will be involved in disseminating the results of this analysis once published. No public were involved in the design or analysis of this project.

Physicians indicated whether the diagnosis of COVID-19 was based on PCR, antibody, metagenomic testing, CT scan, laboratory assay, or a presumptive diagnosis based on symptoms only. Data elements for this analysis included physician city, state, and country. Countries were assigned to the six World Health Organization regions (www.who.int); the "Americas" was further divided into north and south. Case information including age, sex, smoking status, rheumatic disease diagnosis, disease activity, and comorbidities was collected. Medications prior to COVID-19 were categorized as: conventional synthetic disease-modifying anti-rheumatic drugs (csDMARDs; antimalarials (hydroxychloroquine, chloroquine), azathioprine, cyclophosphamide, cyclosporine, leflunomide, methotrexate, mycophenolate mofetil/mycophenolic acid, sulfasalazine, tacrolimus); biologic DMARDs (bDMARDs; abatacept, belimumab, CD-20 inhibitors, interleukin (IL)-1 inhibitors, IL-6 inhibitors, IL-12/23 inhibitors, IL-17 inhibitors, tumor necrosis factor inhibitors (anti-TNF)); and targeted synthetic DMARDs (tsDMARDs) namely Janus Kinase (JAK) inhibitors. Physicians reported the approximate number of days from symptom onset to symptom resolution or to death. The primary outcome of interest was hospitalization for COVID-19. As of April 20, 2020, a total of 604 cases were entered in the registry; hospitalization status was unknown for four cases and these were excluded from analysis.

Continuous variables are reported as median (interquartile range, IQR). Categorical variables are reported as number and percentage (%). In univariable analyses, differences in demographic and rheumatic disease-specific features according to hospitalization status were compared using Chi-square tests for categorical variables and Mann-Whitney U tests for continuous variables. The independent associations between demographic and disease-specific features with the odds of COVID-19 hospitalization were estimated using multivariable-adjusted logistic regression and reported as odds ratio (OR) and 95% confidence intervals (CIs); covariates included in the model were age group ($\leq$ 65 years vs. > 65 years), sex, rheumatic disease (rheumatoid arthritis (RA), systemic lupus erythematosus (SLE), psoriatic arthritis (PsA), axial spondyloarthritis (axSpA) or other spondyloarthritis, vasculitis, and other), key comorbidities (hypertension, lung disease, diabetes, cardiovascular disease, and chronic renal insufficiency/end-stage renal disease), smoking status (ever vs. never), physician reported disease activity (remission, minimal/low disease activity, moderate disease activity, or severe/high disease activity; or as a binary variable: remission and minimal/low disease activity versus moderate and severe/high disease activity), DMARD type (no DMARD, csDMARD only, b/tsDMARD only, csDMARD and b/tsDMARD combination therapy), Non-steroidal anti-inflammatory drugs (NSAID) use (yes vs. no), and prednisone-equivalent glucocorticoid use (0 mg/day, 1-9 mg/day, $\geq$10 mg/day). Categories with cell sizes < 10 by hospitalization status were collapsed to ensure sufficient power in the adjusted model. For univariable and multivariable models, patients with more than one of the following diseases recorded were classified as follows: SLE > RA > PsA > vasculitis > axSpA/other spondyloarthritis > other. Cardiovascular disease and hypertension were collapsed as a single comorbidity in the regression model due to significant collinearity between the two variables. Due to concerns regarding the possibility of confounding by indication, disease activity and prednisone-equivalent glucocorticoid use were analysed by including only one of the variables in the multivariable analysis at a time, and by including both variables in the multivariable analysis at the same time. Unknown/missing data

(14% smoking status, 12% NSAIDs, 1% glucocorticoids) were treated as a separate category in multivariable models. In exploratory analyses, the independent association between antimalarials and specific b/tsDMARD therapies with hospitalization status was estimated using multivariable logistic regression.

To assess the robustness of the results, sensitivity analyses were performed. First, we repeated the above analyses after excluding patients with a "presumptive diagnosis," meaning that the patient's physician thought he/she had symptoms consistent with the disease, but there was no evidence of the patient having: a) a confirmatory COVID test; b) documentation of chest imaging showing bilateral infiltrates in keeping with COVID-19 pneumonia; or c) close contact with a known COVID-19 positive patient. Second, we limited the analyses to patients whose COVID-19 outcome was known (resolved/died) or for whom at least $\geq$14 days from symptom onset (or diagnosis date if symptom onset was unknown) had elapsed, as it is unlikely that a patient would be hospitalized more than 2 weeks after onset. Third, we excluded cases with missing/unknown values within the covariate set included in the multivariable analyses. Data were considered statistically significant at $P < 0.05$. Cell counts less than 5 are represented by "n<5" in tables to protect patient anonymity. All analyses were conducted in Stata (StataCorp 16.0).

Data quality was assessed by two data quality teams (one at the University of Manchester, UK, and the University of California, San Francisco) who also confirmed there were no duplicate entries. Due to the deidentified and non-interventional nature of the study it was determined by the IRB that patient consent was not required. C19-GRA physician registry was determined "not human subjects research" by the UK Health Research Authority and the University of Manchester, as well as under United States Federal Guidelines assessed by the University of California, San Francisco and patient consent was not required. We did not systematically

capture how cases were identified before being entered into the registry and therefore we cannot detail this. However, we are aware of a number of large institutions that are systematically collecting all cases in their health system/district and entering them into the registry

RESULTS

The demographic and clinical characteristics of the first 600 cases in the C19-GRA physician registry are shown in Table 1. The majority of cases in the registry were from North America and Europe, female, and in the 50-65 age range, the countries that the cases were reported from are shown in Supplementary Table 1. The most common rheumatic disease was RA (230, 38%), followed by SLE (85, 14%) and PsA (74, 12%). The most common comorbidities were hypertension (199, 33%), lung disease (127, 21%), diabetes (69, 12%), cardiovascular disease (63, 11%), and chronic renal insufficiency/end-stage renal disease (40, 7%). Most cases were never smokers (389, 75%) and either in remission or had minimal/low disease activity (459, 80%). Five patients were pregnant (1%). Nearly half of the cases reported to the registry were hospitalized (277, 46%), and 9% (55) were deceased. COVID-19 diagnoses were predominately made through polymerase chain reaction testing (437, 73%), followed by laboratory assay of unknown type (58, 10%), CT scan (42, 7%), or other (31, 5%) (individuals could be tested using more than one method). Fifty-two (9%) cases had a presumptive diagnosis only (Supplementary Table 2). The median number of days from COVID-19 symptom onset to resolution or death was 13 (IQR: 8-17). Demographic and clinical characteristics stratified by sex are presented in Supplementary Table 3.

Demographic and clinical characteristics stratified by hospitalization status are shown in Table 2. Differences by age group in hospitalization status were observed: most hospitalized patients were over age 65 (43%), compared to 16% of non-hospitalized cases ($P < 0.01$). In unadjusted

analyses, differences in hospitalization status by disease revealed a higher percentage of people who were hospitalized had SLE and vasculitis (17% and 9%, respectively) versus those who were not hospitalized (11% and 5%, respectively), while a lower proportion of patients who were hospitalized had PsA and axSpA or other spondyloarthritis (8% and 6%, respectively) compared to those who were not (16% and 10%, respectively). There were more comorbidities among hospitalized cases, including hypertension (45% vs. 23%), lung disease (30% vs 14%), diabetes (17% vs 7%), cardiovascular disease (14% vs 7%), and chronic renal insufficiency/end-stage renal disease (12% vs 2%) (all $P<0.01$). There was no association between disease activity and hospitalization status ($P=0.49$). NSAID use was reported less frequently among hospitalized patients than non-hospitalized patients (16% vs 25%, $P=0.02$), while there was a higher proportion of patients receiving high doses of glucocorticoids among those who were hospitalized than not hospitalized (16% vs 7% for doses $\geq$10mg/day, $P=0.01$). We found no significant difference in hospitalization status by sex, antimalarial therapy (either monotherapy or in combination with other DMARDs) or reported days from symptom onset to symptom resolution or death.

In a multivariable model, age over 65 years (OR=2.56, 95% CI 1.62, 4.04), hypertension/cardiovascular disease (OR=1.86, 95% CI 1.23, 2.81), lung disease (OR=2.48, 95% CI 1.55, 3.98), diabetes (OR=2.61, 95% CI 1.39, 4.88), and chronic renal insufficiency/end-stage renal disease (OR=3.02, 95% CI 1.21, 7.54) were associated with higher odds of hospitalization (all $P<0.05$). Treatment with b/tsDMARD monotherapy just prior to COVID-19 diagnosis was significantly associated with a lower odds of hospitalization compared to no DMARD therapy (OR = 0.46, 95% CI 0.22, 0.93; $P=0.03$). Glucocorticoid therapy at prednisone-equivalent doses $\geq$10mg/day, however, was associated with a higher odds of hospitalization compared to no glucocorticoid therapy (OR=2.05, 95% CI 1.06, 3.96; $P=0.03$). Neither adding disease activity to the model with glucocorticoids nor replacing glucocorticoids by disease

activity changed the direction, strength or significance of the relationship between the various variables and hospitalization status in a meaningful way (data not shown).

Further analyses were conducted to examine the independent association of antimalarials and specific b/tsDMARDs with hospitalization. A total of 22% of cases were taking antimalarials before hospitalization. The largest subgroup of b/tsDMARD therapies was anti-TNF medications (52%). We found no significant association between antimalarial therapy and hospitalization (OR = 0.94, 95% CI 0.57, 1.57; *P*=0.82) after adjusting for sex, age over 65 years, rheumatic disease, smoking status, comorbidities, other csDMARD monotherapy, b/tsDMARD monotherapy, csDMARD-b/tsDMARD combination therapy (excluding antimalarials), NSAID use, and glucocorticoid dose. A significant inverse association between any anti-TNF therapy and hospitalization was found (OR = 0.40, 95% CI 0.19, 0.81; *P*=0.01), after controlling for sex, age over 65, rheumatic disease, smoking, comorbidities, csDMARD monotherapy, other b/tsDMARD monotherapy, csDMARD-b/tsDMARD combination therapy (excluding anti-TNF), NSAID use, and glucocorticoid dose. Small numbers of non-anti-TNF b/tsDMARDs precluded analysing the association of these individual agents with hospitalisation (Supplementary Table 4)

Our findings remained largely unchanged in sensitivity analyses excluding those with a presumptive diagnosis (n=52; Supplementary Table 5), those with unknown outcomes (n=214; Supplementary Table 6), and those with missing/unknown values (n=142; Supplemental Table 7).

DISCUSSION

This manuscript describes the largest collection of COVID-19 cases amongst patients with rheumatic diseases, with 600 cases from 40 countries. We identified factors associated with

higher odds of COVID-19 hospitalization, including older age, presence of comorbidities, and higher doses of prednisone (≥10mg/day). We did not see an association between prior NSAID use or antimalarials and hospitalization for COVID-19. We did find b/tsDMARD monotherapy to be associated with a lower odds of hospitalization, an effect that was largely driven by anti-TNF therapies. Over half of the reported cases did not require hospitalization, including many patients receiving b/tsDMARDs. The rate of hospitalization was higher than in cohorts of general patients with COVID-19 but this likely reflects the mechanism by which we collected the case information and should not be interpreted as the true rate of hospitalization among rheumatic disease patients infected with SARS-CoV-2.

Prior to this report, there had been several small case series of COVID-19 in patients with rheumatic disease reported from Europe.[8-11] With few exceptions[12-13], prior large descriptive studies of patients with COVID-19 from China, Europe, and the U.S. have not included rheumatic disease in their baseline comorbidities.[14-19] These studies have not allowed for further inference on the characteristics of patients with rheumatic disease and their associations with COVID-19 severity.

In accordance with previous studies of COVID-19 in different populations, we found that patients with comorbidities such as hypertension, cardiovascular disease, and diabetes had higher odds of hospitalization.[18-20] We also found that glucocorticoid use at a prednisone-equivalent dose ≥10 mg/day was associated with an increased odds of hospitalization, which is in agreement with prior studies showing an increased risk of infection with higher dose of glucocorticoids.[21]

We did not find a significant association between antimalarial use and hospitalization in adjusted analyses. The use of hydroxychloroquine for the treatment of COVID-19, which was based on *in vitro* studies, has had mixed results.[2,22] Studies from one group suggested a benefit on the

surrogate outcome of viral clearance among hospitalized patients, but these studies either had inadequate or no comparator groups.[23,24] Two randomized controlled trials of hydroxychloroquine had conflicting findings.[25,26] A phase IIb randomized controlled trial comparing two doses of chloroquine among patients hospitalized with COVID-19 to historical controls from Wuhan detected a negative safety signal - QTc prolongation - but no clinical benefit.[27] Finally, two observational studies using propensity score matching to account for confounding by indication have found no significant benefit with either hydroxychloroquine alone or combined with azithromycin on clinical outcomes including mortality[28,29]; however, these studies were limited by design issues and a high risk of bias due to unmeasured confounding.

We also did not detect a significant association between NSAID use and hospitalization in adjusted analyses. Although no prior data in COVID-19 patients have supported a deleterious effect of NSAIDs on clinical outcomes, early reports cautioned against the use of NSAIDs suggesting harm when used during the clinical course of COVID-19.[30] These observations, while anecdotal, may also relate to confounding by indication, since NSAIDs are also often sold over-the-counter and may not be documented in hospital records with the same accuracy as prescription medications, leading to a reporting bias.

We found a lower odds of hospitalization with b/tsDMARDs monotherapy in our primary multivariable analysis, which was driven largely by anti-TNF therapies. The number of cases taking other biologic drugs or Janus kinase inhibitors was small, and may have been insufficient to demonstrate other underlying effects if present. Although we caution against causal inference regarding drug effects given significant potential for residual confounding in our study, we also note that there is biological plausibility for the potential benefit of biologic medications in treating COVID-19, as evidenced by those with more severe disease having higher levels of cytokines, including IL6 and TNF.[31,32] The use of IL-6 inhibitors is being investigated for COVID-19,

particularly in cases complicated by aberrant inflammatory responses or 'cytokine storm'. This is based on two initial case series of fewer than 20 patients.[33,34] Anti-TNFs have also been suggested as a potential therapy in COVID-19, but this has been based solely on pre-clinical data.[35] Randomized, placebo-controlled trials are needed to clarify potential benefits or harms of biologic therapies in treating COVID-19.

Strengths of our study include the first large analysis of patients with rheumatic diseases and COVID-19. All case data were entered by rheumatology healthcare providers. The C19-GRA physician registry includes cases from 40 countries suggesting that our findings are more generalizable than single-center or regional studies. The registry collects information on specific rheumatic disease diagnoses, which to date have not been captured in large, published case series of COVID-19.[15]

Despite these strengths, there are important limitations to these registry data. The C19-GRA registry is voluntary and does not capture all cases of COVID-19 in patients with rheumatic disease. This approach to data collection places limitations on causal conclusions and temporal relationships and therefore we can only make limited inferences based on our results. There is selection bias due to several factors, including geographic location, hospitalization status and disease severity, with the more severe cases most likely to be captured. Therefore, the data cannot be used to comment on the incidence of COVID-19 in this patient population or its severity. Since the registry's inclusion criteria are restricted to those with rheumatic disease and COVID-19, this precludes the ability to make comparisons with those who do not have rheumatic disease, or those with rheumatic disease who do not have COVID-19. Although physicians may be contacted for follow-up information for unresolved cases, this is a cross-sectional analysis and there is the possibility that some patients may not have progressed to their maximum level of care prior to enrolment. In our dataset, 35% of cases were unresolved or

had an unknown resolution status, although exclusion of these cases in sensitivity analyses did not change our conclusions. Furthermore, while we have collected information on medication use prior to COVID-19 diagnosis, we do not have specific data on the duration of treatment, medication dose, or additional historical treatments.

At the time of this report, the C19-GRA databases remain open for further case reports. With additional cases, we will be able to examine more detailed outcomes associated with specific rheumatic diseases and COVID-19 treatments, as well as the outcomes of COVID-19 in people with rheumatic diseases.

This series of cases demonstrates that the majority of patients with rheumatic diseases captured in our registry recover from COVID-19. In some cases, exposure to specific medication classes is associated with lower odds of hospitalization; however, these findings should be interpreted with caution because of a high risk of bias. Results support the guidance issued by the American College of Rheumatology and the European League Against Rheumatism which suggest continuing rheumatic medications in the absence of COVID-19 infection or SARS-CoV-2 exposure.[36,37]

In this series of people with rheumatic disease and COVID-19, use of DMARDs did not increase the odds of hospitalization. As in the general population, people with rheumatic diseases who are older and/or have comorbidities have a higher odds of COVID-19-related hospitalization. Anti-TNF treatment was associated with reduced odds of hospitalization while prednisone use $\geq$10mg/day was associated with a higher odds of hospitalization. There was no difference in antimalarials, such as hydroxychloroquine, or NSAID use between those who were or were not hospitalized.

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“The views expressed here are those of the authors and participating members of the COVID-19 Global Rheumatology Alliance, and do not necessarily represent the views of the American College of Rheumatology, the European League Against Rheumatism (EULAR), or any other organization."

Contributorship

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Suleman Bhana, Wendy Costello, Rebecca Grainger, Jonathan S. Hausmann, Jean W. Liew, Emily Sirotich, Paul Sufka and Zachary S. Wallace contributed to the acquisition, analysis and interpretation of the data. They drafted, and revised, the manuscript critically for important intellectual content and gave final approval of the version to be published.

Jinoos Yazdany, Pedro M. Machado and Philip C. Robinson directed the work, designed the data collection methods, and contributed to the analysis and interpretation of the data. They drafted, and revised, the manuscript critically for important intellectual content and gave final approval of the version to be published.

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Ethical approval information

The C19-GRA physician registry was determined “not human subjects research” by the UK Health Research Authority and the University of Manchester, as well as under United States Federal Guidelines assessed by the University of California, San Francisco and patient consent was not required.

Data sharing statement

Applications to access the data should be made to the C19-GRA Data and Sharing Committee.

Competing Interests:

MAG reports grants from National Institutes of Health, NIAMS, outside the submitted work; .

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Table 1. Demographic and clinical characteristics of rheumatic disease patients with COVID-19 (N=600)

	N (%)
Region	
Region of the Americas: North	340 (57)
Region of the Americas: South	16 (3)
European Region	218 (36)
African Region	< 5 (<1)
Eastern Mediterranean Region	11 (2)
South-East Asian Region	< 5 (<1)
Western Pacific Region	13 (2)
Female	423 (71)
Age	
18 - 29 years	32 (5)
30 - 49 years	169 (28)
50 - 65 years	229 (38)
> 65 years	170 (28)
Median (IQR)	56 (45 - 67)
Most Common Rheumatic Disease Diagnoses*	

Rheumatoid arthritis	230 (38)
Systemic lupus erythematosus	85 (14)
Psoriatic arthritis	74 (12)
Axial spondyloarthritis or other spondyloarthritis	48 (8)
Vasculitis	44 (7)
Sjogren's syndrome	28 (5)
Other inflammatory arthritis	21 (4)
Inflammatory myopathy	20 (3)
Gout	19 (3)
Systemic sclerosis	16 (3)
Polymyalgia rheumatica	12 (2)
Sarcoidosis	10 (2)
Other	28 (5)
Most Common Comorbidities	
Hypertension	199 (33)
Lung disease#	127 (21)
Diabetes	69 (12)
Cardiovascular disease	63 (11)

Chronic renal insufficiency/End-stage renal disease	40 (7)
Disease Activity (N=575)	
Remission	173 (30)
Minimal or low disease activity	286 (50)
Moderate disease activity	102 (18)
Severe or high disease activity	14 (2)
Smoking Status (N=518)	
Ever	129 (25)
Never	389 (75)
Medication Prior to COVID-19 Diagnosis^	
No DMARD	97 (16)
csDMARD only, including anti-malarial therapy	272 (45)
csDMARD only, excluding anti-malarial therapy	220 (37)
Anti-malarial, with or without other DMARD	130 (22)
Anti-malarial Only	52 (9)
b/tsDMARDs Only	107 (18)
csDMARD + b/tsDMARD Combination Therapy	124 (21)
NSAIDs (N=531)	111 (21)

Prednisone-Equivalent Glucocorticoids (N=592)	
None	403 (68)
1-9 mg/day	125 (21)
≥ 10 mg/day	64 (11)
Hospitalized	277 (46)
Deceased	55 (9)
Reported Days from Onset to Resolution or Death (N=275), median (IQR)	13 (8 - 17)

N (column %) for categorical variables unless otherwise noted.

Percentages may not sum to 100 due to rounding.

NSAID = Nonsteroidal anti-inflammatory drugs, DMARD = disease-modifying anti-rheumatic drug;

*Cases could have more than one disease diagnosis. “Other” rheumatic disease category included (each n<10): undifferentiated connective tissue disease; ocular inflammation; autoinflammatory syndrome; mixed connective tissue disease; antiphospholipid antibody syndrome; calcium pyrophosphate deposition disease; systemic juvenile idiopathic arthritis; juvenile idiopathic arthritis, not systemic; IgG4-related disease.

#Chronic obstructive pulmonary disease, asthma, interstitial lung disease, or other not specified.

^Conventional synthetic DMARD (csDMARD) medications included: antimalarials (hydroxychloroquine, chloroquine), azathioprine, cyclophosphamide, cyclosporine, leflunomide, methotrexate, mycophenolate mofetil/mycophenolic acid, sulfasalazine, tacrolimus; Biologic or targeted synthetic DMARDs (b/tsDMARD) included: abatacept, belimumab, CD-20 inhibitors, IL-

1 inhibitors, IL-6 inhibitors, IL-12/23 inhibitors, IL-17 inhibitors, anti-TNF, and Janus-kinase inhibitors

Table 2. Demographic and Clinical Factors of Rheumatic Disease Patients Diagnosed with COVID-19 by Hospitalization Status

	Not Hospitalized N=323	Hospitalized N=277	*P*-value
Female	238 (74%)	185 (67%)	0.10
Age Group			<0.01
< 30 years	25 (8%)	7 (3%)	
30 - 49 years	113 (35%)	56 (20%)	
50 - 65 years	134 (41%)	95 (34%)	
> 65 years	51 (16%)	119 (43%)	
Median (IQR), years	52 (42 - 60)	62 (51 - 71)	<0.01
Most Common Rheumatic Disease Diagnoses			<0.01
Rheumatoid arthritis	121 (37%)	104 (38%)	
Systemic lupus erythematosus	37 (11%)	48 (17%)	
Psoriatic arthritis	52 (16%)	22 (8%)	

Axial spondyloarthritis or other spondyloarthritis	32 (10%)	16 (6%)	
Vasculitis	15 (5%)	24 (9%)	
Other	66 (20%)	63 (23%)	
Most Common Comorbidities			
Hypertension	75 (23%)	124 (45%)	<0.01
Lung disease#	44 (14%)	83 (30%)	<0.01
Diabetes	21 (7%)	48 (17%)	<0.01
Cardiovascular disease	23 (7%)	40 (14%)	<0.01
Chronic renal insufficiency/End stage renal disease	7 (2%)	33 (12%)	<0.01
Disease Activity (N=575)			0.49
Remission	88 (28)	85 (32)	
Minimal or low disease activity	157 (50)	129 (49)	
Moderate disease activity	60 (19)	42 (16)	
Severe or high disease activity	6 (2)	8 (3)	
Ever smoker (N=518)	61 (21%)	68 (30%)	0.03
Rheumatic Disease Medication Prior to COVID-19 Diagnosis			<0.01

No DMARD	45 (14%)	52 (19%)	
csDMARD only	123 (38%)	149 (54%)	
b/tsDMARDs only	76 (24%)	31 (11%)	
csDMARD + b/tsDMARD combination therapy	79 (24%)	45 (16%)	
Any antimalarial therapy	64 (20%)	66 (24%)	0.23
Antimalarial only	27 (8%)	25 (9%)	0.77
NSAIDs (n=531)	72 (25%)	39 (16%)	0.02
Prednisone-Equivalent Glucocorticoids (N=592)			<0.01
None	241 (75%)	162 (60%)	
1-9 mg/day	58 (18%)	67 (25%)	
$\geq$ 10 mg/day	21 (7%)	43 (16%)	
Reported Days from Onset to Resolution or Death (N=275), median (IQR)	14 (7 - 16)	12 (8 - 17)	0.72

N (column %) for categorical variables unless otherwise noted.

Percentages may not sum to 100 due to rounding.

NSAID = Nonsteroidal anti-inflammatory drugs, DMARD = disease-modifying anti-rheumatic drug;

P-value calculated using chi-square tests for categorical variables and Mann-Whitney U test for continuous variables

*Patients with more than one disease within these five diagnoses were classified as follows: systemic lupus erythematosus > rheumatoid arthritis > psoriatic arthritis > vasculitis > axial/other spondyloarthritis > other. Other rheumatic disease category included (each n<10): undifferentiated connective tissue disease; ocular inflammation; autoinflammatory syndrome; mixed connective tissue disease; antiphospholipid antibody syndrome; calcium pyrophosphate deposition disease; systemic juvenile idiopathic arthritis; juvenile idiopathic arthritis, not systemic; IgG4-related disease.

#Chronic obstructive pulmonary disease, asthma, interstitial lung disease, or other not specified.

^Conventional synthetic DMARD (csDMARD) medications included: antimalarials (hydroxychloroquine, chloroquine), azathioprine, cyclophosphamide, cyclosporine, leflunomide, methotrexate, mycophenolate mofetil/mycophenolic acid, sulfasalazine, tacrolimus; Biologic or targeted synthetic DMARDs (b/tsDMARD) included: abatacept, belimumab, CD-20 inhibitors, IL-1 inhibitors, IL-6 inhibitors, IL-12/23 inhibitors, IL-17 inhibitors, anti-TNF, and Janus-kinase inhibitors

Table 3. Unadjusted and adjusted logistic regression models examining the association between demographic and clinical characteristics and COVID-19 hospitalization status

	No. Hospitalized/ No. Cases, (%)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	*P*-value§
Female	185/423 (44)	0.72 (0.51, 1.02)	0.83 (0.54, 1.28)	0.39

Age > 65 years	119/170 (70)	4.02 (2.74, 5.89)	2.56 (1.62, 4.04)	<0.01
Rheumatic Disease Diagnosis				
Rheumatoid arthritis	104/225 (46)	*Ref*	*Ref*	--
Systemic lupus erythematosus	48/85 (56)	1.51 (0.91, 2.49)	1.80 (0.99, 3.29)	0.06
Psoriatic arthritis	22/74 (30)	0.49 (0.28, 0.86)	0.94 (0.48, 1.83)	0.85
Axial spondyloarthritis or other spondyloarthritis	16/48 (33)	0.58 (0.30, 1.12)	1.11 (0.50, 2.42)	0.80
Vasculitis	24/39 (62)	1.86 (0.93, 3.73)	1.56 (0.66, 3.68)	0.31
Other	63/129 (49)	1.11 (0.72, 1.71)	0.94 (0.55, 1.62)	0.82
Comorbidities (Present vs. Not)				
Hypertension or Cardiovascular Disease	136/218 (62)	2.83 (1.01, 4.00)	1.86 (1.23, 2.81)	<0.01
Lung disease	83/127 (65)	2.71 (1.80, 4.08)	2.48 (1.55, 3.98)	<0.01

Diabetes	48/69 (70)	3.01 (1.76, 5.18)	2.61 (1.39, 4.88)	<0.01
Chronic renal insufficiency/End stage renal disease	33/40 (83)	6.11 (2.66, 14.04)	3.02 (1.21, 7.54)	0.02
Ever smoker (vs Never Smoker)	68/129 (53)	1.41 (1.13, 1.77)	1.18 (0.90, 1.53)	0.23
Rheumatic Disease Medication Prior to COVID-19 Diagnosis				
No DMARD	52/97 (54)	*Ref*	*Ref*	--
csDMARD only	249/272 (55)	1.05 (0.66, 1.67)	1.23 (0.70, 2.17)	0.48
b/tsDMARDs only	31/107 (29)	0.35 (0.20, 0.63)	0.46 (0.22, 0.93)	0.03
csDMARD + b/tsDMARD combination therapy	45/124 (36)	0.49 (0.29, 0.85)	0.74 (0.37, 1.46)	0.38
NSAIDs	39/111 (35)	0.55 (0.35, 0.84)	0.64 (0.39, 1.06)	0.08
Prednisone-Equivalent Glucocorticoids				
None	162/403 (40)	*Ref*	*Ref*	--

1-9 mg/day	67/125 (54)	1.72 (1.15, 2.57)	1.03 (0.64, 1.66)	0.91
≥ 10 mg/day	43/64 (67)	3.05 (1.74, 5.32)	2.05 (1.06, 3.96)	0.03

Adjusted odds ratios from models including all variables shown.

NSAID = Nonsteroidal anti-inflammatory drugs, DMARD = disease-modifying anti-rheumatic drug

§*P*-value for multivariable logistic regression model (see Methods for details)

*Patients with more than one disease within these five diagnoses were classified as follows: systemic lupus erythematosus > rheumatoid arthritis > psoriatic arthritis > vasculitis > axial/other spondyloarthritis > other. Other rheumatic disease category included (each n<10): undifferentiated connective tissue disease; ocular inflammation; autoinflammatory syndrome; mixed connective tissue disease; antiphospholipid antibody syndrome; calcium pyrophosphate deposition disease; systemic juvenile idiopathic arthritis; juvenile idiopathic arthritis, not systemic; IgG4-related disease.

#Chronic obstructive pulmonary disease, asthma, interstitial lung disease, or other not specified.

^Conventional synthetic DMARD (csDMARD) medications included: antimalarials (hydroxychloroquine, chloroquine), azathioprine, cyclophosphamide, cyclosporine, leflunomide, methotrexate, mycophenolate mofetil/mycophenolic acid, sulfasalazine, tacrolimus; Biologic or targeted synthetic DMARDs (b/tsDMARD) included: abatacept, belimumab, CD-20 inhibitors, IL-1 inhibitors, IL-6 inhibitors, IL-12/23 inhibitors, IL-17 inhibitors, anti-TNF, and Janus-kinase inhibitors

Supplementary Table 1. Country origin of cases reported to the registry

Country	Frequency	Percent*
Argentina	n < 5	< 1
Australia	5	1
Austria	n < 5	< 1
Belgium	n < 5	< 1
Bosnia and Herzegovina	n < 5	< 1
Brazil	5	1
Canada	5	1
Chile	8	1
Colombia	n < 5	< 1
Croatia	n < 5	< 1
Cyprus	n < 5	< 1
Czech Republic	n < 5	< 1
Dominican Republic	n < 5	< 1
England	85	14
France	n < 5	< 1
Germany	6	1
Greece	n < 5	< 1
Honduras	n < 5	< 1
India	n < 5	< 1
Iran	7	1
Israel	n < 5	< 1
Italy	6	1
Kuwait	n < 5	< 1
Latvia	n < 5	< 1
Malaysia	5	1
Mexico	n < 5	< 1
Netherlands	8	1
Northern Ireland	n < 5	< 1
Norway	n < 5	< 1
Pakistan	n < 5	< 1
Philippines	n < 5	< 1
Portugal	n < 5	< 1
Republic of Ireland	13	2
Saudi Arabia	n < 5	< 1
Slovenia	n < 5	< 1
South Africa	n < 5	< 1
Spain	59	10

Switzerland	n < 5	< 1
Turkey	15	3
United States of America (USA)	331	55

*Percent may not equal 100 due to rounding

Supplementary Table 2. Demographic and clinical characteristics of rheumatic disease patients with COVID-19 by diagnosis status

	Confirmed Diagnosis† N = 548	Presumptive Diagnosis N = 52
Region		
Region of the Americas: North	321 (59)	19 (37)
Region of the Americas: South	16 (3)	0 (0)
European Region	185 (34)	33 (63)
African Region	n < 5 (<1)	0 (0)
Eastern Mediterranean Region	11 (2)	0 (0)
South-East Asian Region	n < 5 (<1)	0 (0)
Western Pacific Region	13 (2)	0 (0)
Female	386 (70)	37 (71)
Age		
18 - 29 years	30 (5)	n < 5 (<10)
30 - 49 years	146 (27)	23 (44)
50 - 65 years	208 (38)	21 (40)
> 65 years	164 (30)	6 (12)

Median (IQR)	56 (46 – 67.5)	50 (42 – 58.5)
Most Common Rheumatic Disease Diagnoses*		
Rheumatoid arthritis	210 (38)	20 (38)
Systemic lupus erythematosus	80 (15)	5 (10)
Psoriatic arthritis	66 (12)	8 (15)
Axial spondyloarthritis or other spondyloarthritis	41 (7)	7 (13)
Other	156 (28)	12 (23)
Most Common Comorbidities		
Hypertension	187 (34)	12 (23)
Lung disease#	118 (22)	9 (17)
Diabetes	68 (12)	n < 5 (<10)
Cardiovascular disease	59 (11)	4 (8)
Chronic renal insufficiency/End-stage renal disease	40 (7)	n < 5 (<10)
Disease Activity (N=575)		
Remission	160 (31)	13 (25)
Minimal or low disease activity	266 (51)	20 (38)

Moderate disease activity	85 (16)	17 (33)
Severe or high disease activity	12 (2)	n < 5 (<10)
Ever Smoker (N=518)	118 (22)	11 (21)
Medication Prior to COVID-19 Diagnosis^		
No DMARD	92 (17)	5 (10)
csDMARD only, including anti-malarial therapy	253 (46)	19 (37)
csDMARD only, excluding anti-malarial therapy	203 (37)	17 (33)
Anti-malarial, with or without other DMARD	123 (22)	7 (13)
Anti-malarial Only	50 (9)	n < 5 (<10)
b/tsDMARDs Only	95 (17)	12 (23)
csDMARD + b/tsDMARD Combination Therapy	108 (20)	16 (31)
NSAIDs (N=531)	101 (21)	10 (22)
Prednisone-Equivalent Glucocorticoids (N=592)		
None	363 (67)	40 (77)
1-9 mg/day	115 (21)	10 (19)

≥ 10 mg/day	62 (11)	n < 5 (<10)
Hospitalized	273 (50)	n < 5 (<10)
Deceased	54 (10)	n < 5 (<10)
Reported Days from Onset to Resolution or Death (N=275), median (IQR)	12 (7 – 16)	16 (10 – 20)

N (column %) for categorical variables unless otherwise noted.

Percentages may not sum to 100 due to rounding.

NSAID = Nonsteroidal anti-inflammatory drugs, DMARD = disease-modifying anti-rheumatic drug;

†Confirmed diagnosis includes evidence of the patient having: a) a confirmatory COVID test; b) documentation of chest imaging showing bilateral infiltrates in keeping with COVID-19 pneumonia; or c) close contact with a known COVID-19 positive patient.

*Cases could have more than one disease diagnosis. “Other” rheumatic disease category included (each n<10): undifferentiated connective tissue disease; ocular inflammation; autoinflammatory syndrome; mixed connective tissue disease; antiphospholipid antibody syndrome; calcium pyrophosphate deposition disease; systemic juvenile idiopathic arthritis; juvenile idiopathic arthritis, not systemic; IgG4-related disease.

#Chronic obstructive pulmonary disease, asthma, interstitial lung disease, or other not specified.

^Conventional synthetic DMARD (csDMARD) medications included: antimalarials (hydroxychloroquine, chloroquine), azathioprine, cyclophosphamide, cyclosporine, leflunomide, methotrexate, mycophenolate mofetil/mycophenolic acid, sulfasalazine, tacrolimus; Biologic or targeted synthetic DMARDs (b/tsDMARD) included: abatacept, belimumab, CD-20 inhibitors, IL-1 inhibitors, IL-6 inhibitors, IL-12/23 inhibitors, IL-17 inhibitors, anti-TNF, and Janus-kinase inhibitors

Supplementary Table 3. Demographic and clinical characteristics of rheumatic disease patients with COVID-19 by sex

	Male N=177	Female N=423
Region		
Region of the Americas: North	85 (48)	255 (60)
Region of the Americas: South	7 (4)	9 (2)
European Region	77 (44)	140 (33)
African Region	n<5 (<1)	n<5 (<1)
Eastern Mediterranean Region	5 (3)	6 (1)
South-East Asian Region	n<5 (<1)	n<5 (<1)
Western Pacific Region	n<5 (<1)	10 (2)
Age		
18 - 29 years	10 (6)	22 (5)
30 - 49 years	38 (21)	131 (31)
50 - 65 years	56 (32)	173 (41)
> 65 years	73 (41)	97 (23)
Median (IQR)	61 (48 - 71)	54 (43 - 64)

Most Common Rheumatic Disease Diagnoses*		
Rheumatoid arthritis	53 (30)	177 (42)
Systemic lupus erythematosus	7 (4)	78 (18)
Psoriatic arthritis	32 (18)	42 (10)
Axial spondyloarthritis or other spondyloarthritis	19 (11)	20 (5)
Vasculitis	16 (9)	28 (7)
Other	51 (29)	78 (18)
Most Common Comorbidities		
Hypertension	66 (37)	133 (31)
Lung disease#	37 (21)	90 (21)
Diabetes	23 (13)	46 (11)
Cardiovascular disease	34 (19)	29 (7)
Chronic renal Insufficiency/End stage renal disease	19 (11)	21 (5)
Smoking Status (N=518)		
Ever	98 (64)	291 (80)
Never	55 (36)	74 (20)
Medication Prior to COVID-19 Diagnosis^		

No DMARD	37 (21)	60 (14)
csDMARD only, including anti-malarial therapy	72 (41)	200 (47)
csDMARD only, excluding anti-malarial therapy	65 (37)	155 (37)
Anti-malarial, with or without other DMARD	23 (13)	107 (25)
b/tsDMARDs only	39 (22)	68 (16)
csDMARD + b/tsDMARD combination therapy	29 (16)	95 (22)
NSAIDs (N=531)	32 (21)	79 (21)
Prednisone-Equivalent Glucocorticoids (N=592)		
None	127 (73)	276 (66)
1-9 mg	29 (17)	96 (23)
$\geq$ 10 mg	19 (11)	45 (11)
Hospitalized	92 (52)	185 (44)
Deceased	15 (8)	40 (9)
Reported Days from Onset to Resolution / Death (N=275), median (IQR)	12 (7 - 15)	14 (8 - 17)

N (column %) for categorical variables unless otherwise noted.

Percentages may not sum to 100 due to rounding.

NSAID = Nonsteroidal anti-inflammatory drugs, DMARD = disease-modifying anti-rheumatic drug;

*Cases could have more than one disease diagnosis. Other rheumatic disease category included (each n<10): undifferentiated connective tissue disease; ocular inflammation; autoinflammatory syndrome; mixed connective tissue disease; anti-phospholipid antibody syndrome; calcium pyrophosphate deposition disease; systemic juvenile idiopathic arthritis; juvenile idiopathic arthritis, not systemic; IgG4-related disease.

#Chronic obstructive pulmonary disease, asthma, interstitial lung disease, or other not specified.

^Conventional synthetic DMARD (csDMARD) medications included: antimalarials (hydroxychloroquine, chloroquine), azathioprine, cyclophosphamide, cyclosporine, leflunomide, methotrexate, mycophenolate mofetil/mycophenolic acid, sulfasalazine, tacrolimus; Biologic or targeted synthetic DMARDs (b/tsDMARD) included: abatacept, belimumab, CD-20 inhibitors, IL-1 inhibitors, IL-6 inhibitors, IL-12/23 inhibitors, IL-17 inhibitors, anti-TNF, and janus-kinase inhibitors

Supplementary Table 4. Individual counts of b/tsDMARDs in the non-TNF inhibitor b/tsDMARD group

	Biologic or small molecule therapy only (n=107)	Any biologic or small molecule therapy (n=231)
	N (%)	**N (%)**
Anti-TNF	56 (52)	119 (52)
CD-20	10 (9)	27 (12)
IL-1	0 (0)	2 (<1)
IL-12/23	2 (2)	3 (1)
IL-17	15 (14)	16 (7)
IL-6	11 (10)	16 (7)
JAKi	9 (8)	26 (11)
Abatacept	3 (3)	17 (7)
Belimumab	1 (1)	10 (4)

IL – interleukin; JAKi – Janus kinase inhibitor

Supplementary Table 5. Adjusted logistic regression model examining the association between demographic and clinical characteristics and COVID-19 hospitalization status, excluding presumptive cases (N=548)

	OR (95% CI)	*P*-value
Female	0.80 (0.51, 1.25)	0.32
Age > 65 years	2.60 (1.61, 4.19)	<0.01
Rheumatic Disease Diagnosis		
Rheumatoid arthritis	*Ref*	--
Systemic lupus erythematosus	1.93 (1.03, 3.59)	0.04
Psoriatic Arthritis	0.97 (0.49, 1.94)	0.93
Axial spondyloarthritis or other spondyloarthritis	1.32 (0.58, 3.02)	0.51
Vasculitis	1.51 (0.64, 3.58)	0.35
Other	1.05 (0.60, 1.84)	0.87
Comorbidities (present vs. not)		
Hypertension or Cardiovascular Disease	1.86 (1.21, 2.86)	0.01
Lung Disease	2.51 (1.53, 4.13)	<0.01
Diabetes	2.39 (1.26, 4.53)	0.01

Chronic renal Insufficiency/End stage renal disease	2.66 (1.06, 6.66)	0.04
Smoking status, ever (vs never)	1.21 (0.92, 1.60)	0.18
Rheumatic Disease Medication Prior to COVID-19 Diagnosis		
No DMARD	*Ref*	--
csDMARD only	1.32 (0.73, 2.37)	0.36
b/tsDMARDs only	0.46 (0.22, 0.97)	0.04
csDMARD + b/tsDMARD combination therapy	0.84 (0.41, 1.70)	0.63
NSAIDs	0.68 (0.41, 1.14)	0.15
Prednisone-Equivalent Glucocorticoids		
None	*Ref*	--
1-9 mg/day	1.02 (0.62, 1.68)	0.94
$\geq$ 10 mg/day	1.97 (0.99, 3.89)	0.05

Odds ratios adjusted for all variables shown.

NSAID = Nonsteroidal anti-inflammatory drugs, DMARD = disease-modifying anti-rheumatic drug;

*Patients with more than one disease within these five diagnoses were classified as follows: systemic lupus erythematosus > rheumatoid arthritis > psoriatic arthritis > vasculitis > axial/other spondyloarthritis > other. Other rheumatic disease category included (each n<10): undifferentiated connective tissue disease; ocular inflammation; autoinflammatory syndrome;

mixed connective tissue disease; antiphospholipid antibody syndrome; calcium pyrophosphate deposition disease; systemic juvenile idiopathic arthritis; juvenile idiopathic arthritis, not systemic; IgG4-related disease.

#Chronic obstructive pulmonary disease, asthma, interstitial lung disease, or other not specified.

^Conventional synthetic DMARD (csDMARD) medications included: antimalarials (hydroxychloroquine, chloroquine), azathioprine, cyclophosphamide, cyclosporine, leflunomide, methotrexate, mycophenolate mofetil/mycophenolic acid, sulfasalazine, tacrolimus; Biologic or targeted synthetic DMARDs (b/tsDMARD) included: abatacept, belimumab, CD-20 inhibitors, IL-1 inhibitors, IL-6 inhibitors, IL-12/23 inhibitors, IL-17 inhibitors, anti-TNF, and janus-kinase inhibitors

Patients with a “presumptive diagnosis” were excluded, meaning that their physician thought they had symptoms or signs consistent with the disease, but did not have a confirmatory test, chest x-ray, or close contact with a known positive patient.

Supplementary Table 6. Adjusted logistic regression model examining the association between demographic and clinical characteristics and COVID-19 hospitalization status, excluding unresolved cases with reporting < 14 days from symptom onset or diagnosis date, or unknown resolution status (N=386)

	OR (95% CI)	*P*-value
Female	0.83 (0.47, 1.44)	0.51
Age > 65 years	2.82 (1.54, 5.15)	<0.01
Rheumatic Disease Diagnosis		
Rheumatoid Arthritis	*Ref*	--
Systemic Lupus Erythematosus	1.61 (0.71, 3.65)	0.25
Psoriatic Arthritis	0.87 (0.38, 1.99)	0.73
Axial spondyloarthritis or other spondyloarthritis	1.07 (0.40, 2.82)	0.89
Vasculitis	0.82 (0.28, 2.38)	0.72
Other	0.75 (0.37, 1.53)	0.43
Comorbidities (present vs. not)		
Hypertension or Cardiovascular Disease	2.02 (1.16, 3.51)	0.01
Lung Disease	2.33 (1.24, 4.36)	0.01
Diabetes	2.06 (0.90, 4.71)	0.09

Chronic Renal Insufficiency/ESRD	5.32 (1.06, 26.78)	0.04
Smoking status, ever (vs never)	1.32 (0.94, 1.85)	0.11
Rheumatic Disease Medication Prior to COVID-19 Diagnosis		
No DMARD	*Ref*	--
csDMARD only	1.14 (0.56, 2.34)	0.72
b/tsDMARDs only	0.26 (0.10, 0.66)	<0.01
csDMARD + b/tsDMARD combination therapy	0.67 (0.28, 1.61)	0.37
NSAIDs	0.76 (0.41, 1.40)	0.38
Prednisone-Equivalent Glucocorticoids		
None	*Ref*	--
1-9 mg/day	0.69 (0.36, 1.29)	0.24
$\geq$ 10 mg/day	4.31 (1.61, 11.56)	<0.01

Odds ratios adjusted for all variables shown.

NSAID = Nonsteroidal anti-inflammatory drugs, DMARD = disease-modifying anti-rheumatic drug;

*Patients with more than one disease within these five diagnoses were classified as follows: systemic lupus erythematosus > rheumatoid arthritis > psoriatic arthritis > vasculitis > axial/other spondyloarthritis > other. Other rheumatic disease category included (each n<10): undifferentiated connective tissue disease; ocular inflammation; autoinflammatory syndrome; mixed connective tissue disease; antiphospholipid antibody syndrome; calcium pyrophosphate

deposition disease; systemic juvenile idiopathic arthritis; juvenile idiopathic arthritis, not systemic; IgG4-related disease.

#Chronic obstructive pulmonary disease, asthma, interstitial lung disease, or other not specified.

^Conventional synthetic DMARD (csDMARD) medications included: antimalarials (hydroxychloroquine, chloroquine), azathioprine, cyclophosphamide, cyclosporine, leflunomide, methotrexate, mycophenolate mofetil/mycophenolic acid, sulfasalazine, tacrolimus; Biologic or targeted synthetic DMARDs (b/tsDMARD) included: abatacept, belimumab, CD-20 inhibitors, IL-1 inhibitors, IL-6 inhibitors, IL-12/23 inhibitors, IL-17 inhibitors, anti-TNF, and janus-kinase inhibitors

Analysis included only resolved cases, and unresolved cases entered into the registry $\geq$ 14 days from symptom onset (or diagnosis date if symptom onset was not known), as it is unlikely that a patient would be hospitalized more than 2 weeks after onset.

Supplementary Table 7. Complete case adjusted logistic regression model examining the association between demographic and clinical characteristics and COVID-19 hospitalization status (N=458)

	OR (95% CI)	*P*-value
Female	0.90 (0.54, 1.48)	0.68
Age > 65 years	2.44 (1.43, 4.16)	<0.01
Rheumatic Disease Diagnosis		
Rheumatoid Arthritis	*Ref*	--
Systemic Lupus Erythematosus	1.63 (0.83, 3.22)	0.16
Psoriatic Arthritis	0.78 (0.37, 1.65)	0.52
Axial spondyloarthritis or other spondyloarthritis	0.99 (0.42, 2.35)	0.99
Vasculitis	1.38 (0.53, 3.55)	0.51
Other	0.94 (0.50, 1.75)	0.84
Comorbidities (present vs. not)		
Hypertension or Cardiovascular Disease	1.73 (1.08, 2.75)	0.02
Lung Disease	2.28 (1.33, 3.90)	<0.01
Diabetes	3.12 (1.44, 6.79)	<0.01
Chronic Renal Insufficiency/ESRD	3.03 (1.00, 9.13)	0.05

Smoking status, ever (vs never)	1.04 (0.61, 1.74)	0.90
Rheumatic Disease Medication Prior to COVID-19 Diagnosis		
No DMARD	*Ref*	--
csDMARD only	1.02 (0.54, 1.94)	0.95
b/tsDMARDs only	0.41 (0.19, 0.90)	0.03
csDMARD + b/tsDMARD combination therapy	0.58 (0.27, 1.26)	0.17
NSAIDs	0.66 (0.39, 1.12)	0.12
Prednisone-Equivalent Glucocorticoids		
None	*Ref*	--
1-9 mg/day	1.15 (0.66, 2.00)	0.62
$\geq$ 10 mg/day	2.03 (0.99, 4.15)	0.05

Odds ratios adjusted for all variables shown.

NSAID = Nonsteroidal anti-inflammatory drugs, DMARD = disease-modifying anti-rheumatic drug;

*Patients with more than one disease within these five diagnoses were classified as follows: systemic lupus erythematosus > rheumatoid arthritis > psoriatic arthritis > vasculitis > axial/other spondyloarthritis > other. Other rheumatic disease category included (each n<10): undifferentiated connective tissue disease; ocular inflammation; autoinflammatory syndrome; mixed connective tissue disease; antiphospholipid antibody syndrome; calcium pyrophosphate

deposition disease; systemic juvenile idiopathic arthritis; juvenile idiopathic arthritis, not systemic; IgG4-related disease.

#Chronic obstructive pulmonary disease, asthma, interstitial lung disease, or other not specified.

^Conventional synthetic DMARD (csDMARD) medications included: antimalarials (hydroxychloroquine, chloroquine), azathioprine, cyclophosphamide, cyclosporine, leflunomide, methotrexate, mycophenolate mofetil/mycophenolic acid, sulfasalazine, tacrolimus; Biologic or targeted synthetic DMARDs (b/tsDMARD) included: abatacept, belimumab, CD-20 inhibitors, IL-1 inhibitors, IL-6 inhibitors, IL-12/23 inhibitors, IL-17 inhibitors, anti-TNF, and janus-kinase inhibitors

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