Appendix 1

Potential confounders used in estimating propensity score

We included sociodemographic and clinical factors that are considered to be associated with both statin use and risk of the outcomes. For sociodemographic factors, we included age in years, square of age, sex, and health insurance type at cohort entry. We included clinical variables of 20 pre-exposure comorbidities (arrhythmia, asthma, atrial fibrillation, autoimmune disease, chronic lung disease, coronary artery disease, dementia, diabetes mellitus, heart failure, hyperlipidemia, hypertension, kidney disease, liver disease, malignancy, other cerebrovascular diseases, peripheral vascular disease, pneumonia including tuberculosis, psychiatric disorders, stroke or TIA, thromboembolism) and 12 pre-exposure co-medications (acetaminophen, antibacterials, anticoagulants, antidementia, antidepressants, antidiabetics, antiplatelets, antipsychotics, antivirals, anxiolytics, immunosuppressants, NSAIDs). The ascertainment period to define comorbidities was from 3 years prior (–1,080 d) through the start of the exposure ascertainment (–240 d). The ascertainment period to define co-medications was from 2 years prior (–720 d) through –240 d. We defined comorbidity variables from in-hospital ICD-10 diagnostic codes and co-medications from in/out-hospital anatomical therapeutic chemical codes (*Table S1*). When defining malignancy, we additionally used the expanded benefit codes in addition to diagnosis codes to reduce false-positives.

Table S1 Definition of covariates and adverse clinical outcomes

Diagnoses	Codes
Inclusion criteria	
COVID-19 (KCD-7)	B342, B972, Z208, Z290, U18, U181, Z038, Z115, U071, U072
Confirmed (database-specific code)	'Y'
Study endpoints	
All-cause death (database-specific code)	'Y'
Intensive care unit admission (NPC)	AH110, AH190-192, AH194, AH195, AH210, AH29-299, AH390-AH396, AH398, AH399, AH501, AJ001, AJ003-011, AJ020, AJ021, AJ031, AJ043-046, AJ100, AJ102, AJ110, AJ112, AJ120, AJ122, AJ130, AJ132, AJ140, AJ142, AJ143, AJ150, AJ152 AJ160, AJ180, AJ190, AJ200, AJ202, AJ210, AJ212, AJ220, AJ222, AJ230, AJ240, AJ242, AJ250, AJ252, AJ260, AJ280, AJ290, AJ300, AJ302, AJ310, AJ312, AJ320, AJ322, AJ330, AJ332, AJ340, AJ342, AJ350, AJ352, AJ360, AJ380, AJ390, AJ500, AJ510, AJ520, AJ530, AJ540, AJ550, AJ560, AJ580, AJ590
Mechanical ventilation use (NPC)	M0850, M0857, M0858, M0860, M5830, M5850–5858, M5860, MM360, MM400
Cardiovascular adverse outcome	
Myocardial infarction	I21
Ischemic stroke	I63, I64, G463-468
TIA	G45
Comorbidities (ICD-10)	
Arrhythmia	I44, I45, I47
	(or anti-arrhythmias drug uses ATC code 'C01B')
Asthma	J45, J46
Atrial fibrillation	I48
Autoimmune disease	
Rheumatoid arthritis	M05, M06
Systemic connective tissue disorder	M30-M36
Noninfectious enteritis and colitis, ulcerative colitis, Crohn's disease	K50-K52, R652, R653
Idiopathic thrombocytopenic purpura, autoimmune hemolytic anemia	D693, D59
Psoriatic arthritis, juvenile rheumatoid arthritis, Ankylosing spondylitis	M07, M08, M45
Other interstitial pulmonary disease	J84
Transplanted status, rejection	Z97, T86
Glomerular disease	N00-N08
Lupus	L93, M32
Intestinal malabsorption, celiac disease	K90
Multiple sclerosis, myasthenia gravis	G35, G700
Vasculitis	M05
Autoimmune thyroiditis, polyglandular failure, hepatitis	E063, E31, K754
Psoriasis	L40, L41, M07, M09
Sarcoidosis	D86, G532, M633
	(or immunosuppressants drug uses ATC codes 'L04A', 'H02', 'P01BA')
Chronic lung disease	
Bronchiectasis	J47
Chronic obstructive pulmonary disease	J40, J41, J43, J44, E11
Interstitial pulmonary disease	J84
Coronary artery disease	
Coronary artery disease	I20-I25
Atherosclerosis	I70
Dementia	F00, F01, F02, F03, G30, G3100, G3182
Diabetes mellitus	E10-E14
Heart failure	
Heart failure	I110, I50
Valvular heart disease	I34, I35, I36, I37
Hyperlipidemia	E78
Hypertension	I10-I15
	(or Anti-hypertensive drug uses ATC codes 'C09A', 'C09B', 'C09C', 'C09D', 'C07', 'C08', 'C03', 'C01D', 'C02A', 'C02B', 'C02C')
Ischemic stroke or TIA	
Ischemic stroke	I60-I64, G463, G464, G465, G466, G467, G468
TIA	G45
Kidney disease	
Acute kidney failure	N17
Chronic kidney disease (CKD)	N18, N19
Liver disease	
Chronic liver disease	K70-K77
Viral hepatitis	B15-B19
Malignancy	C00-C97
	(and expanded benefit coverage codes 'V027', 'V193', 'V194')
Other cerebrovascular diseases	G46, I65, I66, I67, I68, I69
Peripheral vascular disease	I70-I79
Pneumonia including tuberculosis	
Tuberculosis	A15, A16, A17, A18, A19
Pneumonia	J12, J13, J14, J15, J16, J17, J18
Psychiatric disorders	F04-F99
Thromboembolism	I26, I63, I74, I801, I802, I803, I809, I82
Study drugs (ATC)	
Statin	
Atorvastatin	C10AA05, C10BA05, C10BA08, C10BX03, C10BX06, C10BX08, C10BX11, C10BX12, C10BX15
Cerivastatin	C10AA06
Fluvastatin	C10AA04
Lipid lowering agents	C10AA, C10AA01-08, C10BA, C10BA01-09, C10BX, C10BX01-17, A10BH51, A10BH52
Lovastatin	C10AA02, C10BA01
Pitavastatin	C10AA08
Pravastatin	C10AA03, C10BA03, C10BX02
Rosuvastatin	C10AA07, C10BA06, C10BA07, C10BA09, C10BX05, C10BX07, C10BX09, C10BX10, C10BX13, C10BX14, C10BX16, C10BX17, A10BH52
Simvastatin	C10AA01, C10BA02, C10BA04, C10BX01, C10BX04, A10BH51
Co-medications (ATC)	
Acetaminophen	N02BE01, N02BE05, N02BE51, N02BE71
Antibacterials	J01
Anticoagulants	B01AA, B01AB, B01AE, B01AF, B01AX
Antidementia	N06D
Antidepressants	N06A
Antidiabetics	A10
Antiplatelets	A01AD05, C07FX02, C07FX03, C07FX04, C10BX01, C10BX02, C10BX04, C10BX05, C10BX06, C10BX08, C10BX12, M01BA03, N02AJ02, N02AJ07, N02AJ18, N02BA01, N02BA51, N02BA71, B01AC
Antipsychotics	N05A
Antivirals	J05
Anxiolytics	N05B
Immunosuppressants	L04A (L04AA, L04AB, L04AC, L04AD, L04AX), H02, P01BA
NSAIDs	M01A

ATC, Anatomical Therapeutic Chemical classification code; COVID-19, coronavirus disease 2019; KCD-7, Korean Standard Classification of Diseases 7th Revision; ICD-10, International Classification of Disease 10th Revision; NPC, national procedure codes; TIA, transient cerebral ischemic attack; NSAIDS, nonsteroidal anti-inflammatory drugs.

Table S2 Sensitivity analysis redefining the study population and the exposure ascertainment window

Characteristic	Cumulative incidence, n (%)		IPTW adjusted OR	
	Non–user	User	OR (95% CI)	P value
Redefining study population (all confirmed patients)				
Composite primary endpoint	368 (10.7)	174 (14.7)	0.77 (0.56–1.05)	0.09
All–cause death	135 (3.9)	91 (7.7)	0.81 (0.51–1.28)	0.37
Mechanical ventilation use	66 (1.9)	57 (4.8)	1.18 (0.73–2.06)	0.43
ICU admission	235 (6.8)	99 (8.4)	0.70 (0.48–1.02)	0.07
Cardiovascular adverse disease	31 (0.9)	15 (1.3)	0.80 (0.33–1.96)	0.62
Redefining time window for ascertaining exposure (~360 d)				
Composite primary endpoint	335 (11.2)	175 (15.0)	0.77 (0.57–1.03)	0.08
All-cause death	126 (4.0)	91 (7.8)	0.87 (0.57–1.33)	0.51
Mechanical ventilation use	65 (2.0)	58 (5.0)	1.17 (0.71–1.94)	0.53
ICU admission	230 (7.2)	100 (8.6)	0.67 (0.47–0.97)	0.03
Cardiovascular adverse disease	31 (1.0)	15 (1.3)	0.84 (0.36–1.97)	0.69

IPT, inverse probability of treatment; OR, odds ratio; CI, confidence interval; ICU, intensive care unit.

Table S3 Sensitivity analysis applying alternative statistical methods

Characteristic	IPTW adjusted with trimming		Outcome adjusted		SMRW adjusted		PS matched	
	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value	OR (95% CI)	P value
Main analysis								
Composite primary endpoint	0.77 (0.57–1.03)	0.20	0.82 (0.64–1.06)	0.14	0.64 (0.45–0.93)	0.02	0.74 (0.56–0.98)	0.04
All-cause death	0.87 (0.57–1.33)	0.62	0.84 (0.59–1.21)	0.35	0.56 (0.35–0.89)	0.02	0.67 (0.45–0.98)	0.04
Mechanical ventilation use	1.18 (0.71–1.95)	0.41	1.18 (0.77–1.95)	0.40	1.09 (0.63–1.90)	0.76	1.03 (0.63–1.70)	0.90
ICU admission	0.67 (0.47–0.97)	0.08	0.79 (058–1.09)	0.15	0.67 (0.42–1.06)	0.09	0.77 (0.54–1.10)	0.15
Cardiovascular adverse disease	0.84 (0.36–1.98)	0.62	1.13 (0.36–1.98)	0.77	0.61 (0.16–2.26)	0.46	0.93 (0.36–2.39)	0.88
Redefining study population (All confirmed patients)								
Composite primary endpoint	0.76 (0.56–1.05)	0.10	0.81 (0.65–1.05)	0.12	0.58 (0.40–0.88)	0.01	0.76 (0.57–0.99)	0.05
All-cause death	0.81 (0.51–1.29)	0.37	0.84 (0.59–1.20)	0.34	0.49 (0.29–0.84)	0.01	0.69 (0.48–1.00)	0..05
Mechanical ventilation use	1.21 (0.76–1.92)	0.43	1.23 (0.73–2.06)	0.43	1.11 (0.64–1.92)	0.71	1.03 (0.62–1.69)	0.92
ICU admission	0.70 (0.48–1.02)	0.07	0.79 (0.58–1.08)	0.14	0.70 (0.44–1.11)	0.13	0.78 (0.55–1.11)	0.17
Cardiovascular adverse disease	0.80 (0.33–1.96)	0.62	1.11 (0,50–2.46)	0.80	0.64 (0.18–2.29)	0.49	0.93 (0.36–2.38)	0.88
Redefining time window for ascertaining exposure (~360 d)								
Composite primary endpoint	0.77 (0.57–1.03)	0.08	0.80 (0.62–1.02)	0.08	0.71 (0.48–1.04)	0.08	0.77 (0.59–1.01)	0.06
All-cause death	0.87 (0.56–1.33)	0.51	0.87 (0.61–1.25)	0.46	0.66 (0.40–1.10)	0.11	0.77 (0.53–1.13)	0.18
Mechanical ventilation use	1.17 (0.71–1.94)	0.53	1.12 (0.70–1.77)	0.64	1.13 (0.65–1.99)	0.67	1.02 (0.62–1.67)	0.94
ICU admission	0.67 (0.47–0.97)	0.03	0.75 (0.55–1.02)	0.07	0.73 (0.45–1.17)	0.19	0.76 (0.54–1.07)	0.11
Cardiovascular adverse disease	0.84 (0.36–1.97)	0.69	1.02 (0.47–2.25)	0.95	0.72 (0.22–2.35)	0.58	0.86 (0.34–2.18)	0.76

IPTW, inverse probability of treatment weighting; SMRW, stabilized mortality ratio weighting; PS, propensity score; OR, odds ratio; CI, confidence interval; ICU, intensive care unit.