Search Strategy

The literature search in PubMed, China National Knowledge Infrastructure (CNKI), Google Scholar, Scopus, WileyWeb of Science, Cochrane and ScienceDirect online database used the following search terms:
('severe acute respiratory syndrome coronavirus 2' [All Fields] OR 'SARS-CoV-2' [All Fields] OR '2019 new coronavirus' [All Fields] OR '2019 ncov' [All Fields] OR 'coronavirus disease 2019' [All Fields] OR 'COVID-19' [All Fields]) AND ('hepatitis B' [All Fields]), ('severe acute respiratory syndrome coronavirus 2' [All Fields] OR 'SARS-CoV-2' [All Fields] OR '2019 new coronavirus' [All Fields] OR '2019 ncov' [All Fields] OR 'coronavirus disease 2019' [All Fields] OR 'COVID-19' [All Fields]) AND ('HBV' [All Fields]), ('severe acute respiratory syndrome coronavirus 2' [All Fields] OR 'SARS-CoV-2' [All Fields] OR '2019 new coronavirus' [All Fields] OR '2019 ncov' [All Fields] OR 'coronavirus disease 2019' [All Fields] OR 'COVID-19' [All Fields]) AND ('HBsAg') and ('severe acute respiratory syndrome coronavirus 2' [All Fields] OR 'SARS-CoV-2' [All Fields] OR '2019 new coronavirus' [All Fields] OR '2019 ncov' [All Fields] OR 'coronavirus disease 2019' [All Fields] OR 'COVID-19' [All Fields]) AND ('CHB').

Our search strategy for MEDLINE and Embase was:
1 ('severe acute respiratory syndrome coronavirus 2' OR 'SARS-CoV-2' [All Fields]).
2 ('2019 new coronavirus' [All Fields] OR '2019 ncov' [All Fields] OR 'coronavirus disease 2019' [All Fields] OR 'COVID-19' [All Fields]).
3 ('HBV' [All Fields] OR 'HBsAg' [All Fields]).
4 ('hepatitis B' [All Fields] OR 'CHB' [All Fields]).
5 1 and 2.
6 5 and 3.
7 5 and 4.

Table 1 Details of the included studies and related parameters

Ref.	Site	Study design	Sample size (*n*)	No. of patients with HBV, *n* (%)	Major serum biochemical characteristics of co-infected patients	Outcomes		Complications/ comorbidities	Representative drugs used for treatment	Study notes
						Death,*n* (%)	Survival,*n* (%)			
Guan *et al*[53], 2020	China	Multicenter retrospective study	1590	28 (1.8)	NR	1 (3.6)	27 (96.4)	COPD, diabetes, hypertension, cardiovascular disease, cerebrovascular disease	NR	Patients with comorbidities comorbidity yielded poorer clinical outcomes than those without
Zou *et al*[2], 2020	China	Retrospective study	93	93 (100.0)	Most of the patients had different degrees of abnormal liver	7 (7.5)	86 (92.5)	Acute respiratory distress syndrome,	Nucleoside drugs	Abnormal liver function is common in patients with

					function			acute-on-chronic liver failure, acute myocardial injury, acute renal insufficiency, septic shock		CHB and COVID-19
Song *et al*[47], 2020	China	Case series	4	2 (50.0)	Decrease in lymphocytes including total $CD3^+$ T cells, B cells, and natural killer cells	0 (0.0)	2 (100.0)	COPD, hypertension, cardiovascular disease	Oseltamivir, caspofungin, and moxifloxacin	The treatment of SARS-CoV-2 infection in cancer patients is challenged by the immunosuppressive state of these patients under

										chemotherapy or surgery
Qi *et al*[10], 2020	China	Case series	3	1 (33.3)	Liver enzyme system was mildly elevated	1 (100)	0 (0.0)	Bacterial pneumonia, fungal pneumonia, pleural effusion, ascites, melaena, acute on chronic liver failure, acute kidney injury, shock, ARDS	Antiviral and antibiotic treatment	Decompensated cirrhosis may be a risk factor for poor prognosis in COVID-19 patients
Hambali *et al*[11], 2020	Malaysia	Case report	1	1 (100.0)	The liver enzyme system was	0 (0.0)	1 (100.0)	Ascites due to cirrhosis	Spironolactone and	The elevated IL-6 level in a

					elevated and the level of interleukin 6 was very high				tenofovir	COVID-19 patient is not necessarily associated with severe COVID-19
Ali *et al*[12], 2020	Qatar	Case report	1	1 (100.0)	The liver enzyme system was elevated	1 (100)	0 (0.0)	Multiorgan failure, acute liver failure, acute renal failure, and disseminated intravascular coagulation	NR	It is uncommon for SARS-CoV-2 infection with mild respiratory symptoms to result in severe systemic disease and organ failure
Zha *et al*[13], 2020	China	Multicenter retrospective study	31	2 (6.5)	The liver enzyme system was elevated	0 (0.0)	2 (100.0)	Hypertension, diabetes, coronary heart disease	Corticosteroid, lopinavir/ritonavir	The virus clearance was slower in two patients with

										chronic hepatitis B infections
Cai *et al*[14], 2020	China	Retrospective study	298	5 (1.7)	The serum biochemical indexes of the liver were significantly increased	NR	NR	Hypertension, diabetes, coronary heart disease, cancer	Lopinavir/ritonavir and favipiravir	Those having higher IL-6 levels were more likely to progress to severe COVID-19
Naderi *et al*[15], 2022	Iran	Retrospective study	93[1]	13[2](13.8)	The liver enzyme system was significantly elevated	0 (0.0)	13 (100.0)	NR	Hydroxychloroquine, hydroxychloroquine, antibiotic, tenofovir, and entecavir	CHB infection did not predispose COVID-19 patients to more severe outcomes and antiviral agents decreased susceptibility to

										COVID-19 infection
Yip *et al*[16], 2021	Hong Kong SAR, China	Retrospective cohort study	5639	353[3](6.3)	ALT abnormality	8 (2.3)	345 (97.7)	Circulatory system disease, diabetes, malignant tumor, nervous system disease, respiratory disease, kidney disease	Antibiotics, antifungal agents, corticosteroid, and entecavir	Current or past HBV infections were not associated with more liver injury and mortality in COVID-19
Richardson *et al*[17], 2020	United States	Multicenter retrospective study	5700	8 (0.1)	Elevated liver enzymes	NA	NA	Hypertension, obesity, diabetes, coronary artery disease, kidney	Angiotensin-converting enzyme inhibitor and	Abnormal liver function is common in patients with COVID-19 and

								disease	angiotensin II receptor blocker	hepatitis B
Kang *et al*[54], 2021	Korea	Cohort study	7723	267 (3.5)	NR	12 (5.1)	255 (94.9)	Hypertension, diabetes, liver cirrhosis	Adefovir, entecavir, tenofovir	HBV co-infection did not increase the risk of disease severity in COVID-19. Antiviral agents decreased susceptibility to SARS-CoV-2 infection
Li *et al*[18], 2020	China	Case series	7	7 (100.0)	Elevated liver enzyme system and decreased albumin	0 (0.0)	7 (100.0)	None	Lopinavir/ritonavir, atomized inhalation of	No patient developed severe liver-related complications

									interferon α-2b, arbidol	during hospitalization
Chen *et al*[9], 2020	China	Retrospective study	123	15 (12.2)	Elevated total bilirubin and decreased lymphocytes	2 (13.3)	13 (86.7)	Hypertension, cardiovascular disease, diabetes, malignancy, COPD, livercirrhosis	Arbidol and/or lopinavir, antibiotic, corticosteroid	HBV patients would suffer from more severe situation during the disease progress when they were encountered with SARS-CoV-2 infection
Bongiovanni *et al*[19], 2021	Italy	Case report	1	1 (100.0)	Liver enzymes increased	0 (0.0)	1 (100.0)	None	NR	The prognosis of COVID-19 appears to be worse in patients

									with preexisting liver disease
He *et al*[20], 2021	China	Multicenter retrospective study	571	15 (2.6)	Liver enzymes increased	0 (0.0)	15 (100.0)	NR	Entecavir	Patients with preexisting HBV infection may have a lower incidence of admission to the intensive care unit or death
Wen *et al*[21], 2020	China	Retrospective study	110	5 (4.5)	Liver enzymes increased and albumin decreased	NA	NA	Hypertension, cardiovascular disease, diabetes, coronary heart disease	NR	No synergistic effect of HBV and SARS-CoV-2 on hepatocyte injury

Zou *et al*[7], 2021	China	Retrospective study	105	105 (100.0)	Significantly elevated liver enzyme levels	98 (93.3)	7 (6.7)	Diabetes, hypertension, coronary heart disease	Arbidol, lopinavir/ritonavir, interferon, ribavirin, antibiotic, methylprednisolone	Liver injury in patients with SARS-CoV-2 and chronic HBV co-infection was associated with severity and poor prognosis of disease
Wang *et al*[8], 2022	China	Multicenter retrospective study	436	109 (25.0)	The serum levels of inflammatory cytokines and liver enzyme system were significantly elevated	13 (11.93)	96 (88.1)	Disseminated intravascular coagulation	Immunoglobulin, antibiotic, antiviral agents	COVID-19 patients with CHB were more likely to develop into severe illness and die

Chen *et al*[5], 2020	China	Retrospective study	326	20 (6.1)	Lower level of prealbumin	0 (0.0)	20 (100.0)	NR	NR	No evidence was found that SARS-CoV-2/HBV co-infection could aggravate liver injury or extend duration of hospitalization
Zhang *et al*[22], 2020	China	Multicenter retrospective study	23	23 (100.0)	Liver enzymes increased	0 (0.0)	23 (100.0)	Obesity, COPD, hypertension, ARDS, deep venous thrombosis	Antibiotics, herbal medicine, glucocorticoid	Dynamic monitoring of liver function should be performed in patients with COVID-19 who have abnormal liver tests on

									admission
Liu *et al*[48], 2021	China	Retrospective study	220	50 (22.7)	More severe monocytopenia and thrombocytopenia	4 (8)	46 (92.0)	Diabetes, cardiovascular diseases, hypertension cerebral infarction, malignancy	Chloroquine, arbidol, traditional Chinese medicine, oseltamivir, ribavirin	Chronic HBV infection did not predispose COVID-19 patients to more severe outcomes.However, co-infection with SARS-CoV-2 and HBV leads to a higher degree of host dysfunction
Yu *et al*[6], 2021	China	Retrospective study	67	7 (10.4)	Changes in liver function were	0 (0.0)	7 (100.0)	Pulmonary disease,	lopinavir/ritonavir	Effects of SARS-CoV-2 on

				not significant			diabetes, hypertension		the dynamics of chronic HBV infection seemed not apparent
Liu *et al*[23], 2020	China	Retrospective study	71[4]	20(28.2)[4]	Abnormal liver enzyme system	0 (0.0)	20 (100.0)	Diabetes, hypertension, cardiovascular disease, cancer	Methylprednisolone and antiviral agents	Those COVID-19 patients co-infected with chronic HBV could have a risk of hepatitis B reactivation
Lin *et al*[24], 2021	China	Retrospective study	133	17 (12.8)	Liver enzymes increased	NR	NR	None	Arbidol, lopinavir/ritonavir, interferon, antibiotic, methylpred	SARS-CoV-2 and HBV co-infection exacerbates liver function of the patients with COVID-19

									nisolone	
Bekçibaşı and Arslan[25], 2021	Turkey	Retrospective study	156	20 (12.8)	The liver enzyme system was elevated, and creatine kinase levels were significantly elevated	0 (0.0)	20 (100.0)	NR	Antiviral agents	SARS-CoV-2/HBV co-infection did not change the severity and outcome of COVID-19
Colaneri *et al*[26], 2020	Italy	Case report	1	1 (100.0)	Liver enzymes increased	0 (0.0)	1 (100.0)	None	Hemoperfusion[6]	Hemoperfusion may be an alternative treatment for SARS-COV-2 co-infection with HBV

Ma *et al*[50], 2021	China	Retrospective study	109	1 (0.9)	Normal liver enzymes	NA	NA	Hypertension, diabetes, coronary heart disease, COPD, chronic renal disease	Antibiotic, immunoglobulin, glucocorticoid	Liver injury had no negative effect on the prognosis and treatment of COVID-19
Chen *et al*[27], 2020	China	Retrospective study	274	11 (4.0)	Concentrations of liver enzymes, N-terminal pro-brain natriuretic peptide, and D-dimer were markedly higher	5 (45.5)	6 (54.5)	ARDS, type I respiratory failure, sepsis, acute cardiac injury, heart failure, shock, alkalosis, hyperkalaemia, acute kidney injury, hypoxic encephalopathy	Oseltamivir, arbidol, lopinavir/ritonavir, glucocorticoid, immunoglobulin, interferon α inhalation, antibiotic	SARS-CoV-2 infection can cause both pulmonary and systemic inflammation, leading to multi-organ dysfunction in patients at high risk

Ding *et al*[28], 2021	China	Retrospective study	2073	134 (6.5)	Liver enzymes increased	8 (6.0)	126 (94.0)	ARDS, septic shock, cirrhosis	NR	HBV infection in patients did not increase the risk of poor COVID-19-associated outcomes
Rodríguez-Tajes *et al*[29], 2021	Spain	Retrospective study	484	72 (14.9)	Liver enzymes increased	8 (11.1)	64 (88.9)	Hypertension, diabetes, hypercholesterolaemia, cardiovascular disease, chronic renal disease	Tocilizumab, siltuximab, baricitinib, anakinra	The risk of HBV reactivation inpatients with severe COVID-19 and resolved HBV infection undergoing immune modulator treatment was low

Parlar *et al*[51], 2022	Turkey	Multicenter retrospective study	479[5]	43(9.0)[2]	CHB patients with and without COVID-19 infection did not differ in laboratory parameters.	0 (0.0)	43 (100.0)	NR	Nucleos(t)ide analogs	The course of COVID-19 infection was not severe in patients with CHB, probably due to the effective antiviral therapy received by CHB patients
Yang *et al*[30], 2022	China	Cohort study	2899	105 (3.6)	Liver enzymes significantly increased	18 (17.1)	87 (82.9)	Hypertension, diabetes, cardiovascular disease, cancer	Steroid hormones, antibiotics, antiviral medication, antineoplastic drugs	Patients with COVID-19 co-infected with HBV at the HBeAg (+) CHB infection stage have an

										increased risk of poor prognosis
Yigit *et al*[31], 2021	Qatar	Case report	1	1 (100.0)	Liver enzymes increased	1 (100)	0 (0.0)	None	Azithromycin, chloroquine, and oseltamivir	The liver damage occurring in COVID-19 is caused by an impaired innate immune system rather than by direct cell damage caused by SARS-CoV-2
Aldhaleei *et al*[32], 2020	United Arab Emirates	Case report	1	1 (100.0)	Liver enzymes Significantly increased	0 (0.0)	1 (100.0)	Mental disturbances	Lactulose, entecavir, vitamin K, thiamin	Patients with abnormal liver functions tend to have an increased risk of

										COVID-19
Ji *et al*[33], 2020	China	Multicenter retrospective study	140	7 (5.0)	Liver enzymes increased	0 (0.0)	7 (100.0)	Hypertension, diabetes, cardiovascular disease, chronic lung disease	Methylprednisolone, human γ-immune goblins, moxifloxacin	Disease progression was significantly faster in those COVID-19 patients combined with CHB
Kim *et al*[34], 2021	United States	Multicenter, observational cohort study	867	62 (7.2)	Liver enzymes increased	5 (8.1)	57 (91.9)	Diabetes, COPD, hypertension, hyperlipidemia, cardiovascular disease, HIV, asthma, cancer	Remdesivir, steroids, hydroxychloroquine, azithromycin	Chronic liver disease areassociated with severe COVID-19

Wang *et al*[35], 2021	China	Case report	1	1 (100.0)	Abnormal liver enzyme system	0 (0.0)	1 (100.0)	None	Lopinavir, ritonavir, abidor, ribavirin, methylprednisolone	For COVID-19 patients with HBV co-infection, liver function should be closely monitored
Zhong *et al*[36], 2020	China	Case series	2	1 (50.0)	Liver enzymes increased	0 (0.0)	1 (100.0)	Hepatocellular carcinoma, renal failure	Oseltamivir, abidol, moxifloxacin, recombinant human interferon alpha, methylprednisolone,	Reduced immunosuppression combined with low doses of methylprednisolone can benefit solid organ transplant recipients with

									human immunoglobulin	COVID-19 combined with hepatitis B
Fernández-Ruiz *et al*[49], 2020	Spain	Case series	18	2 (11.1)	Decreased white blood cells	1 (50.0)	1 (50.0)	Hypertension, diabetes, coronary artery disease, hypertensive nephropathy, lung cancer	Lopinavir/ritonavir, mycophenolate mofetil, mycophenolic	SARS-CoV-2 and HBV co-infection has a severe course in solid organ transplant recipients
Huang *et al*[37], 2020	China	Case report	1	1 (100.0)	Elevated total bilirubin	1 (100)	0 (0.0)	Decompensated cirrhosis	Lopinavir/ritonavir, piperacillin tazobactam, tacrolimus, mycophenolate	When treating COVID-19, consideration should be given to using as low a dose of immunosuppress

										ants as possible
Patrono *et al*[57], 2020	Italy	Case series	10	2 (20.0)	NR	0 (0.0)	2 (100.0)	Obesity	Hydroxychloroquine, mycophenolatemofetil, tacrolimus	Mortality appears to be higher in liver transplant recipients affected by COVID-19
Qin *et al*[38], 2020	China	Case report	1	1 (100.0)	Abnormal liver enzyme system	0 (0.0)	1 (100.0)	Liver cancer	Tacrolimus, glucocorticoids, antimicrobial agents, caspofungin	Long term follow-up and close monitoring of liver function should be carried out in transplant patients with COVID-19

Liu *et al*[58], 2020	China	Case report	1	1 (100.0)	NR	0 (0.0)	1 (100.0)	Cirrhosis	Umifenovir, lopinavir/ritonavir	Temporary cessation of immunosuppression and low-dose corticosteroid use may be beneficial for COVID-19 transplant recipients
Loinaz *et al*[39], 2020	Spain	Case series	19	4 (21.1)	One patient with severe disease had elevated enzyme system, the rest had no significant abnormalities	1 (25.0)	3 (75.0)	Diabetes, lung disease, hypertension	Everolimus, mycophenolate mofetil, tacrolimus	A broad spectrum of disease severity in liver transplant patients with COVID-19, with

										a favorable outcome in most of them
Adali *et al*[40], 2021	Turkey	Retrospective study	231	77 (33.3)	Abnormal liver enzyme system	6 (7.8)	71 (92.2)	Obesity, COPD, cardiovascular disease, diabetes, hypertension	Hydroxychloroquine, azithromycin	HBV infection was not associated with mortality in patients with COVID-19 and nucleotide analogue treatment for HBV infection might have an antiviral effect on SARS-CoV-2 infection

Oruç *et al*[55], 2022	Turkey	Retrospective study	92	4 (4.3)	NR	0 (0.0)	4 (100.0)	Breast cancer, gastrointestinal system cancers, genitourinary system cancers, lung cancer	NA	Hepatitis B immune status was not associated with the risk of COVID-19 transmission and death
Guardigni *et al*[56], 2021	Italy	Retrospective study	606	12 (2.0)	NR	NA	NA	NR	NR	The preexisting viral liver infection did not have any impact on the clinical and virological evolution of COVID-19

Sagnelli *et al*[41], 2022	Italy	Case report	1	1 (100.0)	Liver enzymes increased	1 (100)	0 (0.0)	NA	Dexamethasone, low-molecular-weight heparin	The primary cause of HBV reactivation may be the corticosteroids and other immunosuppressive drugs given to COVID-19 patients rather than the actual SARS-CoV-2 infection itself
Lens *et al*[59], 2020	Spain	Multicenter retrospective study	1764[5]	9(0.5)[2]	NR	0 (0.0)	9 (100.0)	NR	Sofosbuvir/ velpatasvir, tenofovir	The efficacy of direct-acting antivirals or tenofovir against

										SARS-CoV-2 is unfavorable
Phipps *et al*[42], 2020	United States	Retrospective cohort study	2273	15 (0.7)	The serum levels of liver enzyme system and inflammatory cytokines were elevated	NA	NA	Diabetes, chronic kidney disease, asthma, COPD, pulmonary fibrosis	NR	Severe liver injury is associated with the most severe clinical outcome
Li *et al*[52], 2020	China	Retrospective study	85	2 (2.4)	Normal liver enzymes	0 (0.0)	2 (100.0)	Chronic hepatic diseases	NR	Liver injury may be a complication of COVID-19 infection
Wu *et al*[43], 2021	China	Case report	1	1 (100.0)	Elevated liver enzymes and increased HBV DNA	0 (0.0)	1 (100.0)	None	Recombinant interferon-alpha-2b,	COVID-19 or treatment associated immunosuppress

									lopinavir/ritonavir, methylprednisolone, tenofovir fumarate	ion may trigger hepatitis B virus reactivation
Wu *et al*[44], 2021	China	Multicenter retrospective study	620	70 (11.3)	Elevated liver enzymes	0 (0.0)	70 (100.0)	NR	NR	The original characteristics of COVID-19 cases combined with HBV infection were higher rate of severe tendency and increased susceptibility

Iavarone *et al*[45], 2020	Italy	Multicenter retrospective study	50	5 (10.0)	Elevated liver enzymes	NA	NA	Diabetes, COPD, hypertension, obesity, chronic kidney disease	Hydroxychloroquine, lopinavir/ritonavir	COVID-19 is associated with liver function deterioration and elevated mortality in patients with cirrhosis
Marjot *et al*[60], 2021	United Kingdom	Multicenter retrospective study	745	96 (12.9)	NR	23 (24.0)	73 (76.0)	Obesity, diabetes, hypertension, COPD	Chloroquine/hydroxychloroquine, lopinovir/ritonavir, interferon-alpha	The stage of liver disease is strongly associated with COVID-19 mortality
Huang *et al*[46], 2020	China	Case report	1	1 (100.0)	Elevated liver enzymes	0 (0.0)	1 (100.0)	Hypertension	Entecavir, silibinin	COVID-19 patients with

	meglumine	HBV co-infection can lead to HBV reactivation, and treatment with nucleoside analogs is recommended

[1]93 cases were the sample size of the experimental group and the other healthy control group was 62 cases. 93 cases were all chronic hepatitis B patients.

[2]Patients with hepatitis B virus co-infection with severe acute respiratory syndrome coronavirus 2.

[3]The 353 cases were patients with current co-infection with hepatitis B virus (HBV), and another 359 patients with past infection with HBV were not included.

[4]Sample size afterpropensity score matching.

[5]All were chronic hepatitis B patients.

[6]The authors did not report pharmacological treatment, but instead reported hemoperfusion treatment.

No.: Number; NA: Data not available; NR: Data not reported; COVID-19: Coronavirus disease 2019; SARS-CoV-2: Severe acute respiratory syndrome

coronavirus 2; HBV: Hepatitis B virus; CHB: Chronic hepatitis B; PSM: Propensity score matching; ALT: Alanine aminotransferase; COPD: Chronic obstructive pulmonary disease; ARDS: Acute respiratory distress syndrome; IL: Interleukin; HBeAg:Hepatitis B e antigen.