

Risk of mortality in COVID-19 patients: a meta- and network analysis

Rasoul Kowsar^{1*}, Amir Mohammad Rahimi², Magdalena Sroka³, Alireza Mansouri⁴, Khaled Sadeghi¹, Elham Bonakdar¹, Sayed Farshad Kateb⁵, Amir Hossein Mahdavi¹

¹ Department of Animal Sciences, College of Agriculture, Isfahan University of Technology, Isfahan, 84156–83111, Iran.

² Department of Developmental Biology, Göttingen Center for Molecular Biosciences (GZMB), Georg-August-University, Göttingen, 37073, Germany.

³ University Medical Center Göttingen, Georg-August-University, Göttingen, 37075, Germany.

⁴ Global Agromedicine Research Center (GAMRC), Obihiro University of Agriculture and Veterinary Medicine, Obihiro, Hokkaido, Japan.

⁵ Yektadam Persian Co. Isfahan, Iran.

***Corresponding author:** Rasoul Kowsar, Rasoul_kowsarzar@yahoo.com. Isfahan University of Technology, Iran. Tel: +989177525210, PC: 8415683111.

Supplementary Table 1. Characteristics of included studies in the meta-analysis.

Author	Country	Patients (N)	Male	Severity	Study type	Study length (days)	Survivors	Any Treatment
Yang et al. [4]	China	52	67.0	Severe	Observational	33	Both	No
Zhou et al. [12]	China	191	62.0	All	Observational	33	Both	Yes
Shi et al. [13]	China	81	42.0	All	Observational	50	Both	No
Yang et al. [14]	China	149	54.4	Mild	Observational	29	Survivors	Yes
Qian et al. [15]	China	91	41	All	Observational	27	Survivors	No
Xu et al. [16]	China	62	56.5	All	Observational	16	Both	Yes
Deng et al. [17]	China	33	49.0	All	Observational	43	Both	Yes
Guan et al. [18]	China	1099	58.1	All	Observational	49	Survivors	Yes
Wang et al. [19]	China	138	54.3	Severe	Observational	33	Both	Yes
Chang et al. [20]	China	13	77.0	Mild	Observational	19	Survivors	No
Wan et al. [21]	China	135	53.3	Mild	Observational	16	Survivors	Yes
Young et al. [22]	Singapore	18	50.0	All	Observational	33	Survivors	Yes
Wu et al. [23]	China	201		All	Observational	32	Survivors	Yes
Chan et al. [24]	China	7	50.0	All	Observational	14	Survivors	No
Hill et al. [25]	Scotland	1	100	Mild	Observational	7	Both	Yes
Jin et al. [26]	China	651	50.8	All	Observational	12	Both	Yes
Wang et al [27]	China	339	49.0	All	Observational	36	Both	No
Kim et al. [28]	Korea	1	100	Mild	Observational	13	Both	No
Lim et al. [29]	Korea	1	50.6	Mild	Observational	17	Survivors	Yes
Holshue et al. [30]	USA	1	100	Mild	Observational	15	Survivors	Yes
Wang et al. [31]	China	125	56.8	All	Observational	29	Both	Yes
Chen et al. [32]	China	274	62.0	All	Observational	46	Both	Yes
Zheng et al. [33]	China	161	49.7	All	Observational	21	Both	No
Zhao et al. [34]	China	77	44.2	Mild	Observational	17	Both	No
Liu et al. [35]	China	625	52.6	All	Observational	39	Both	Yes
Li et al. [36]	China	17	53.0	All	Observational	19	Survivors	No
Zhang et al. [37]	China	110	68.7	All	Observational	52	Both	Yes
Xu [38]	China	10		Severe	Observational	41	Both	Yes
Zhang et al. [39]	China	82	65.9	Severe	Observational	30	Non-survivors	Yes
Miao et al. [40]	China	163	67.3	All	Observational	32	Survivors	Yes
Luo et al. [41]	China	403	47.9	All	Observational	26	Both	Yes
Shi et al. [42]	China	101	59.4	Severe	Observational	45	Non-survivors	Yes
Yao et al. [43]	China	55	67.0	Severe	Observational	23	Non-survivors	Yes
Huang et al. [44].	China	36	69.4	Severe	Observational	24	Non-survivors	Yes
Liu et al. [45]	China	51	63.7	Mild	Observational	22	Survivors	Yes
Wang et al. [46]	China	110	43.6	All	Observational	40	Both	No
Liao et al. [47]	China	46	52.2	All	Observational	29	Survivors	Yes
Liu et al. [48]	China	64	36.0	All	Observational	39	Survivors	Yes
Qiu et al. [49]	China	104	47.1	All	Observational	21	Survivors	Yes
Liao et al. [50]	China	539	63.3	all	Observational	59	Both	Yes

Yan et al. [51]	China	120	45.0	All	Observational	38	Survivors	Yes
Tan et al. [52]	China	2	50.0	Mild	Observational	40	Survivors	Yes
Zhang et al. [53]	China	67	61.2	All	Observational	65	Both	Yes
Jiang et al. [54]	China	55	49.0	All	Observational	24	Both	Yes
Qi et al. [55]	China	21	52.4	All	Observational	84	Both	Yes
Huang et al. [56]	China	223	46.5	Mild	Observational	67	Both	No
Pan et al. [57]	China	21	29.0	Mild	Observational	25	Both	No
Xu et al. [58]	China	51	50.0	Mild	Observational	26	Both	No
Lillie et al. [59].	UK	2	50.0	Mild	Observational	14	Both	Yes
Ghinai et al. [60]	USA	2	50.0	Mild	Observational	26	Survivors	No
Wolfel et al. [61]	Germany	9		All	Observational	28	Both	No
Ge et al. [62]	China	7	57.0	All	Observational	8	Both	No
Xie et al. [63]	China	79	55.7	All	Observational	12	Survivors	Yes
Zhou et al. [64]	China	17	64.7	All	Observational	16	Survivors	Yes
Duan et al. [65]	China	10	60.0	Severe	Observational	28	Survivors	Yes
Zhu et al. [66]	China	50	52.0	All	Observational	37	Both	Yes
Sun et al. [67]	China	83	71.1	All	Observational	35	Survivors	No
Liu et al. [68]	China	80	42.5	All	Observational	26	Both	Yes
Fan et al. [69]	China	55	54.5	All	Observational	55	Survivors	Yes
Wang et al. [70]	China	4	75.0	All	Observational	15	Survivors	Yes
The COVID-19 Investigation Team [71]	USA	12	67.0	All	Observational	33	Both	No
Hu et al. [72]	China	24	33.3	Mild	Observational	21	Survivors	Yes
Shen et al. [73]	China	5	60.0	Severe	Observational	65	Both	Yes
Auld et al. [74]	USA	217	45.2	Severe	Observational	42	Non-survivors	Yes
Tang et al. [75]	China	183	63.4	Severe	Observational	34	Both	No
Onder et al. [76]	Italy	1625	28.3	All	Observational		Non-survivors	NA
Liu et al. [77]	China	73	54.3	All	Observational	13	Both	Yes
McMichael et al. [78]	USA	167	32.9	All	Observational	20	Both	No
Zhou et al. [79]	Japan	26		Mild	Observational	40	Survivors	No
Shen et al. [80]	China	119	47.0	Mild	Observational	59	Both	No
Lin et al. [81]	China	95	47.4	All	Observational	29	Both	Yes
Gudbjartsson et al. [82]	Iceland	190	60.6	All	Observational	19	Both	No
Li et al. [83]	China	86	46.5	All	Randomized	77	Survivors	Yes
Arons et al. [84]	USA	48		All	Observational	21	Both	No
COVID-19 Surveillance Group [85]	Italy	3200	70.6	Severe	Observational	19	Non-survivors	No
Kang et al. [86]	China	37	48.6	All	Observational	26	Both	No
Xu et al. [87]	China	48	27.1	Severe	Observational	25	Non-survivors	Yes
Chen et al [88].	China	240	46.6	All	Randomized	21	Both	Yes
Bi et al. [89]	China	420	47.6	All	Observational	87	Both	Yes
Lei et al. [90]	China	308	17.4	All	Observational	26	Both	Yes
Tian et al. [91]	China	262	48.5	All	Observational	21	Survivors	No
Xu et al. [92]	China	50	58.0	All	Observational	51	Both	No
Han et al. [93]	China	206	44.2	All	Observational	16	Survivors	No
Grasselli et al. [94]	Italy	4	75.0	Severe	Observational	36	Both	Yes

Spinato et al. [95]	UK	202	48.0	All	Observational	51	Both	Yes
Chow et al. [96]	USA	48	22.9	All	Observational	14	Both	No
Chen et al. [97]	China	11	36.4	Mild	Observational	36	Survivors	Yes
Department of Epidemiology [98]	Chile	922	49.0	All	Observational	22	Both	No
Li et al. [99]	China	25	40.0	Severe	Observational	30	Non-survivors	No
Kluytmans et al. [100]	Netherlands	86	17.4	All	Observational		Survivors	No
ICARNAC [101]	UK	165	59.3	All	Observational	27	Both	Yes
Zhao et al. [102]	China	173	49.0	All	Observational	29	Both	No
Petrilli et al. [103]	USA	1941	39.0	Mild	Observational	32	Both	Yes
Guo et al. [104]	China	159	62.3	All	Observational	68	Both	Yes
Tabata et al [105]	Japan	104	54.0	All	Observational	15	Survivors	Yes
Liu et al. [106]	China	100	60.0	All	Observational	99	Both	Yes
Tao et al. [107]	China	167		Mild	Observational	60	Survivors	No

Supplementary Table 2. Pearson and Spearman analysis (Bonferroni correction) of the blood indices and complications in Covid-19 patients

	Liver dys.		Res. fail		Heart fail		Sep. shock		ACI		AKI		Sec. infection	
	Pe	Sp	Pe	Sp	Pe	Sp	Pe	Sp	Pe	Sp	Pe	Sp	Pe	Sp
PLT	-0.19	0.70	-0.75	0.99	-0.83	0.47	-0.76	0.13	-0.85	0.23	-0.61	-0.14	-0.42	0.40
LYM	0.01	-0.11	-0.41	-0.41	-0.64	-0.18	-0.42	-0.56	-0.42	-0.51	-0.28	-0.03	-0.39	-0.43
WBC	0.29	0.68	0.52	0.99	0.77	0.47	0.64	0.13	0.57	0.23	0.46	-0.13	0.39	0.41
NEU	0.20	0.62	0.55	0.99	0.71	0.38	0.50	0.37	0.60	0.07	0.64	-0.23	0.76	0.40
HBG	-0.13	0.66	-0.37	0.99	-0.44	0.73	-0.32	0.37	-0.37	0.24	-0.34	-0.13	-0.30	0.40
Albumin	-0.08	-0.21	-0.11	0.33	-0.26	0.05	-0.17	0.13	-0.25	-0.01	-0.17	-0.35	-0.55	-0.43
ALT	-0.33	0.69	-0.02	0.99	0.23	0.71	0.29	0.36	0.07	0.23	0.18	-0.14	0.08	0.36
AST	0.32	0.66	0.37	0.99	0.56	0.72	0.26	0.36	0.18	0.23	0.48	-0.14	0.64	0.40
TB	0.15	0.65	0.56	0.99	0.73	0.72	0.61	0.36	0.47	0.23	0.64	-0.14	0.57	0.40
BUN	0.10	0.74	0.68	0.99	0.89	0.68	0.55	0.86	0.61	0.87	0.61	0.50	0.63	0.76
Cr	-0.10	0.70	0.51	0.99	0.62	0.59	0.75	0.27	0.70	0.23	0.65	-0.13	0.33	0.41
CK	0.15	0.67	0.44	0.99	0.63	0.68	0.63	0.85	0.67	0.87	0.39	0.51	0.40	0.71
CRP	-0.02	0.70	0.40	0.99	0.48	0.59	0.51	0.20	0.59	0.23	0.52	-0.14	0.52	0.40
GGT	0.14	0.80	0.91	0.81	0.88	0.01	0.67	0.76	0.75	0.02	0.77	0.89	0.60	0.01
IL6	-0.17	0.80	0.29	0.96	0.47	0.01	0.53	0.90	0.49	0.85	0.36	0.36	0.20	0.76
PCT	-0.14	0.54	-0.15	0.78	-0.10	0.13	-0.07	0.34	-0.13	0.31	-0.08	-0.07	-0.14	-0.10
D-dimer	-0.21	0.57	-0.15	0.80	-0.09	0.27	-0.08	0.13	-0.15	-0.06	-0.16	-0.43	-0.13	-0.15

Pe: Pearson correlation, Sp: Spearman correlation; dys: dysfunction; Res: respiratory; fail: failure; Sep: septic; ACI: acute cardiac injury; AKI: acute kidney injury; TB: total bilirubin; CK: Creatine Kinase; Sec: secondary; Cr: creatinine; Bold values denote statistical significance at the $P < 0.05$.

Supplementary Table 3. Pearson and Spearman analysis (Bonferroni correction) of the pre-existing conditions and complications in Covid-19 patients

	Liver dys.		Res. fail		Heart fail		Sep. shock		ACI		AKI		Sec. infection	
	Pe	Sp	Pe	Sp	Pe	Sp	Pe	Sp	Pe	Sp	Pe	Sp	Pe	Sp
Age	0.14	0.04	0.69	0.77	0.80	0.72	0.66	0.70	0.66	0.75	0.63	0.53	0.50	0.67
Male	0.16	-0.13	0.43	-0.04	0.45	0.21	0.49	-0.14	0.61	0.25	0.43	0.17	0.49	0.06
Smoking	0.40	0.27	0.24	0.29	0.32	0.29	0.34	0.25	0.28	0.24	0.17	0.23	0.20	0.27
Comorb.	0.09	0.33	0.64	0.74	0.78	0.82	0.62	0.73	0.69	0.66	0.56	0.69	0.39	0.83
Hyperten.	0.18	-0.01	0.21	0.63	0.51	0.66	0.23	0.70	0.25	0.61	0.26	0.54	0.36	0.70
Diabetes	-0.30	0.24	0.39	0.69	0.48	0.81	0.49	0.77	0.52	0.66	0.45	0.54	0.33	0.70
Cardiovas.	0.41	0.33	0.46	0.66	0.79	0.71	0.28	0.69	0.23	0.70	0.33	0.68	0.57	0.88
COPD	-0.24	0.52	0.38	0.67	0.57	0.70	0.41	0.36	0.49	0.78	0.41	0.57	0.35	0.69
Cancer	-0.25	0.51	0.15	0.49	0.19	0.54	-0.07	0.36	0.05	0.26	0.20	-0.01	0.27	0.39
Liver D.	-0.25	0.20	-0.03	0.23	0.32	0.19	0.47	0.33	0.24	0.31	0.25	0.56	0.09	0.21
Cerebrov.	-0.16	0.14	0.58	0.59	0.75	0.88	0.73	0.70	0.67	0.72	0.55	0.84	0.33	0.77
Renal D.	0.04	0.25	0.34	0.64	0.43	0.72	-0.01	0.56	0.16	0.72	0.39	0.70	0.59	0.38
Other	-0.08	0.56	0.34	0.52	0.19	0.20	0.40	0.20	0.52	0.45	0.28	0.40	-0.09	0.46

Pe: Pearson correlation, Sp: Spearman correlation; dys: dysfunction; Res: respiratory; fail: failure; Sep: septic; ACI: acute cardiac injury; AKI: acute kidney injury; Sec: secondary; Comorb: comorbidities; D: disease; Hyperten: hypertension; Cardiovas: cardiovascular disease; Cerebrov: cerebrovascular disease. Bold values denote statistical significance at the $P < 0.05$.

Supplementary Table 4. Multicollinearity is measured using Variance Inflation Factors (VIF) withinblood indices associated with complications

Multicollinearity is measured using Variance Inflation Factors (VIF) withinblood indices associated with complications																	
Secondary infection																	
Statistic	PLT	LYM	WBC	NEU	HBG	Albumin	ALT	AST	TB	BUN	Creatinine	CK	CRP	GGT	IL6	PCT	D-Dimer
R ²	0.99	0.84	0.98	0.96	0.86	0.88	0.92	0.94	0.99	0.95	0.98	0.98	0.94	0.99	0.97	0.92	0.75
Tolerance	0.01	0.16	0.02	0.04	0.14	0.12	0.08	0.06	0.01	0.05	0.02	0.02	0.06	0.01	0.03	0.08	0.25
VIF	152.85	6.19	49.05	23.72	7.25	8.41	12.44	17.49	71.32	21.06	45.28	49.08	16.10	74.69	39.99	13.26	4.05
Acute kidney injury																	
Statistic	PLT	LYM	WBC	NEU	HBG	Albumin	ALT	AST	TB	BUN	Creatinine	CK	CRP	GGT	IL6	PCT	D-Dimer
R ²	0.99	0.84	0.98	0.95	0.85	0.88	0.90	0.91	0.99	0.96	0.97	0.98	0.94	0.99	0.97	0.93	0.75
Tolerance	0.01	0.16	0.02	0.05	0.15	0.12	0.10	0.09	0.01	0.04	0.03	0.02	0.06	0.01	0.03	0.07	0.25
VIF	150.93	6.19	41.87	20.87	6.81	8.55	10.08	11.37	68.52	26.27	39.70	48.53	18.02	86.10	36.95	13.48	3.97
Acute cardiac injury																	
Statistic	PLT	LYM	WBC	NEU	HBG	Albumin	ALT	AST	TB	BUN	Creatinine	CK	CRP	GGT	IL6	PCT	D-Dimer
R ²	1.00	0.84	0.98	0.98	0.96	0.91	0.91	0.90	0.99	0.96	0.98	0.99	0.97	0.99	0.98	0.96	0.87
Tolerance	0.00	0.16	0.02	0.02	0.04	0.09	0.09	0.10	0.01	0.04	0.02	0.01	0.03	0.01	0.02	0.04	0.13
VIF	290.63	6.13	42.59	42.14	22.49	11.57	11.41	10.50	70.61	24.10	47.80	72.18	34.48	73.12	52.73	22.39	7.83
Septic shock																	
Statistic	PLT	LYM	WBC	NEU	HBG	Albumin	ALT	AST	TB	BUN	Creatinine	CK	CRP	GGT	IL6	PCT	D-Dimer
R ²	1.00	0.99	0.99	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00	1.00	0.99	1.00	1.00	1.00	1.00
Tolerance	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
VIF	20271.19	70.58	85.44	11544.65	3167.00	3634.56	125.67	314.27	1919.01	809.94	4216.83	3449.87	179.02	2288.25	1087.42	3032.20	874.99
Heart failure																	
Statistic	PLT	LYM	WBC	NEU	HBG	Albumin	ALT	AST	TB	BUN	Creatinine	CK	CRP	GGT	IL6	PCT	D-Dimer
R ²	0.99	0.91	0.99	0.96	0.86	0.97	0.95	0.91	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.93	0.75
Tolerance	0.01	0.09	0.01	0.04	0.14	0.03	0.05	0.09	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.07	0.25
VIF	184.19	11.06	79.61	26.94	6.99	30.16	21.72	11.24	103.74	112.89	100.21	90.45	81.06	103.94	67.49	13.70	4.08
Respiratory failure																	
Statistic	PLT	LYM	WBC	NEU	HBG	Albumin	ALT	AST	TB	BUN	Creatinine	CK	CRP	GGT	IL6	PCT	D-Dimer
R ²	1.00	0.88	0.98	0.95	0.91	0.95	0.90	0.97	0.99	0.99	0.99	0.99	0.98	1.00	0.98	0.92	0.78
Tolerance	0.00	0.12	0.02	0.05	0.09	0.05	0.10	0.03	0.01	0.01	0.01	0.01	0.02	0.00	0.02	0.08	0.22
VIF	213.17	8.06	43.45	21.00	11.06	20.66	10.36	31.81	68.49	145.84	69.36	69.87	52.05	234.49	42.11	13.07	4.48
Liver dysfunction																	
Statistic	PLT	LYM	WBC	NEU	HBG	Albumin	ALT	AST	TB	BUN	Creatinine	CK	CRP	GGT	IL6	PCT	D-Dimer
R ²	0.99	0.84	0.98	0.96	0.87	0.91	0.90	0.92	0.99	0.97	0.98	0.98	0.94	0.99	0.97	0.93	0.75
Tolerance	0.01	0.16	0.02	0.04	0.13	0.09	0.10	0.08	0.01	0.03	0.02	0.02	0.06	0.01	0.03	0.07	0.25
VIF	151.16	6.13	43.50	26.87	7.70	10.76	10.44	13.17	69.07	29.90	45.16	49.04	16.06	73.95	36.73	14.32	3.98

Variance inflation factor measures how much the behavior (variance) of an independent variable is influenced, or inflated, by its interaction/correlation with the other independent variables. Variance inflation factors allow a quick measure of how much a variable is contributing to the standard error in the regression. If the VIF is equal to

1 there is no multicollinearity among factors, but if the VIF is greater than 1, the predictors may be moderately correlated, but not enough to be overly concerned about. A VIF between 5 and 10 indicates high correlation that may be problematic. And if the VIF goes above 10, you can assume that the regression coefficients are poorly estimated due to multicollinearity.

Supplementary Table 5. Multicollinearity is measured using Variance Inflation Factors (VIF) within pre-existing health conditions associated with complications

Multicollinearity is measured using Variance Inflation Factors (VIF) within pre-existing health conditions associated with complications													
Liver dysfunction													
Statistic	Age	Male	Smoking	Any Comorbidity	Hypertension	Diabetes	Cardiovascular D.	COPD	Cancer	Liver D.	Cerebrovascular D.	Renal D.	Other
R ²	0.75	0.56	0.88	0.82	0.72	0.87	0.84	0.93	0.63	0.40	0.93	0.95	0.55
Tolerance	0.25	0.44	0.12	0.18	0.28	0.13	0.16	0.07	0.37	0.60	0.07	0.05	0.45
VIF	3.92	2.29	8.33	5.57	3.58	7.88	6.44	14.49	2.72	1.66	14.35	19.01	2.23
Respiratory failure													
Statistic	Age	Male	Smoking	Any Comorbidity	Hypertension	Diabetes	Cardiovascular D.	COPD	Cancer	Liver D.	Cerebrovascular D.	Renal D.	Other
R ²	0.75	0.54	0.78	0.86	0.75	0.82	0.83	0.93	0.60	0.46	0.94	0.92	0.56
Tolerance	0.25	0.46	0.22	0.14	0.25	0.18	0.17	0.07	0.40	0.54	0.06	0.08	0.44
VIF	3.94	2.17	4.63	6.91	3.98	5.50	5.90	14.60	2.49	1.86	16.88	12.16	2.26
Heart failure													
Statistic	Age	Male	Smoking	Any Comorbidity	Hypertension	Diabetes	Cardiovascular D.	COPD	Cancer	Liver D.	Cerebrovascular D.	Renal D.	Other
R ²	0.88	0.72	0.77	0.91	0.78	0.86	0.95	0.91	0.63	0.52	0.93	0.92	0.67
Tolerance	0.12	0.28	0.23	0.09	0.22	0.14	0.05	0.09	0.37	0.48	0.07	0.08	0.33
VIF	8.62	3.58	4.28	11.29	4.59	7.40	20.95	10.59	2.73	2.09	14.05	11.80	3.03
Septic shock													
Statistic	Age	Male	Smoking	Any Comorbidity	Hypertension	Diabetes	Cardiovascular D.	COPD	Cancer	Liver D.	Cerebrovascular D.	Renal D.	Other
R ²	0.87	0.79	0.82	0.92	0.84	0.89	0.86	0.92	0.61	0.61	0.94	0.97	0.59
Tolerance	0.13	0.21	0.18	0.08	0.16	0.11	0.14	0.08	0.39	0.39	0.06	0.03	0.41
VIF	8.00	4.79	5.53	11.78	6.45	9.22	7.40	12.14	2.55	2.58	17.63	29.10	2.43
Acute cardiac injury													
Statistic	Age	Male	Smoking	Any Comorbidity	Hypertension	Diabetes	Cardiovascular D.	COPD	Cancer	Liver D.	Cerebrovascular D.	Renal D.	Other
R ²	0.77	0.72	0.76	0.88	0.75	0.84	0.83	0.92	0.63	0.36	0.93	0.93	0.58
Tolerance	0.23	0.28	0.24	0.12	0.25	0.16	0.17	0.08	0.37	0.64	0.07	0.07	0.42
VIF	4.31	3.55	4.24	8.43	3.93	6.32	5.98	11.84	2.67	1.55	15.11	15.10	2.38
Acute kidney injury													
Statistic	Age	Male	Smoking	Any Comorbidity	Hypertension	Diabetes	Cardiovascular D.	COPD	Cancer	Liver D.	Cerebrovascular D.	Renal D.	Other
R ²	0.74	0.54	0.78	0.80	0.71	0.82	0.84	0.92	0.60	0.36	0.93	0.92	0.55
Tolerance	0.26	0.46	0.22	0.20	0.29	0.18	0.16	0.08	0.40	0.64	0.07	0.08	0.45
VIF	3.81	2.17	4.60	4.89	3.45	5.63	6.35	12.26	2.50	1.57	15.16	12.62	2.24
Secondary infection													
Statistic	Age	Male	Smoking	Any Comorbidity	Hypertension	Diabetes	Cardiovascular D.	COPD	Cancer	Liver D.	Cerebrovascular D.	Renal D.	Other
R ²	0.73	0.72	0.82	0.79	0.71	0.82	0.83	0.93	0.59	0.35	0.93	0.95	0.77
Tolerance	0.27	0.28	0.18	0.21	0.29	0.18	0.17	0.07	0.41	0.65	0.07	0.05	0.23
VIF	3.75	3.63	5.55	4.84	3.45	5.45	5.80	13.90	2.46	1.55	14.92	20.03	4.36

Variance inflation factor measures how much the behavior (variance) of an independent variable is influenced, or inflated, by its interaction/correlation with the other independent variables. Variance inflation factors allow a quick measure of how much a variable is contributing to the standard error in the regression. If the VIF is equal to

1 there is no multicollinearity among factors, but if the VIF is greater than 1, the predictors may be moderately correlated, but not enough to be overly concerned about. A VIF between 5 and 10 indicates high correlation that may be problematic. And if the VIF goes above 10, you can assume that the regression coefficients are poorly estimated due to multicollinearity. D: disease, COPD: Chronic obstructive pulmonary.

Supplementary Table 6. Risk of bias according to the QUIPS tool (+: High risk of bias, +/-: moderate risk of bias, -: low risk of bias, NA: not applicable).

Study	Participation	Attrition	Prognostic Factor	Outcome	Statistical Analysis and Reporting	Study Confounding	Risk of bias: + = high, +/- = moderate, - = low
Yang et al. [4]	Moderate	Low	Low	Low	High	High	+/-
Zhou et al. [12]	Low	Moderate	Low	Low	Low	Low	-
Shi et al. [13]	Moderate	Low	Moderate	moderate	Moderate	Moderate	+/-
Yang et al. [14]	Low	Low	Low	High	High	High	+/-
Qian et al. [15]	Moderate	Low	Low	Moderate	Moderate	High	+/-
Xu et al. [16]	High	High	Low	Low	High	Moderate	+
Deng et al. [17]	High	Low	Moderate	Low	Moderate	Moderate	+/-
Guan et al. [18]	Low	Low	Low	Low	High	High	+/-
Wang et al. [19]	Moderate	Low	Low	Low	Moderate	Moderate	+/-
Chang et al. [20]	High	Low	Low	Low	High	High	+/-
Wan et al. [21]	Moderate	Low	Low	Low	Moderate	Moderate	+/-
Young et al. [22]	High	Low	Low	Low	High	High	+/-
Wu et al. [23]	Moderate	Low	Low	Low	Low	Low	-
Chan et al. [24]	NA	Low	Low	Low	NA	NA	-
Hill et al. [25]	High	Low	Moderate	Low	NA	NA	+/-
Jin et al. [26]	Low	Low	Low	Low	Low	Low	-
Wang et al [27]	Low	Low	Low	Low	Low	Low	-
Kim et al. [28]	NA	Low	High	Low	NA	NA	+/-
Lim et al. [29]	High	Low	High	Low	NA	NA	+/-
Holshue et al. [30]	NA	Low	Low	Low	NA	NA	-
Wang et al. [31]	Moderate	Low	Low	Low	Moderate	Moderate	+/-
Chen et al. [32]	Low	Low	Low	Low	Low	Moderate	-
Zheng et al. [33]	Low	High	Low	Moderate	High	High	+/-
Zhao et al. [34]	Moderate	Low	Low	Low	Low	Low	-
Liu et al. [35]	Low	Low	Low	Moderate	Low	Low	-
Li et al. [36]	High	Low	Low	Moderate	High	High	+/-
Zhang et al. [37]	Moderate	Low	Low	Low	Low	Low	-
Xu [38]	High	High	Low	Low	NA	NA	+/-
Zhang et al. [39]	Moderate	Low	Low	Low	Moderate	Moderate	+/-
Miao et al. [40]	Low	High	Low	Moderate	Moderate	High	+/-
Luo et al. [41]	Low	Moderate	Low	Low	Moderate	High	+/-
Shi et al. [42]	Moderate	Moderate	Low	Low	Low	High	+/-
Yao et al. [43]	Moderate	Low	Low	Low	Moderate	High	+/-
Huang et al. [44].	Moderate	Low	Low	Low	High	High	+/-
Liu et al. [45]	High	High	Low	Low	Moderate	High	+/-
Wang et al. [46]	Moderate	High	Moderate	Low	Low	Moderate	+/-
Liao et al. [47]	High	High	Low	Low	Low	Moderate	+/-
Liu et al. [48]	Moderate	Moderate	Low	Low	Low	Low	-
Qiu et al. [49]	Moderate	Low	Low	Low	Moderate	Moderate	+/-
Liao et al. [50]	High	Low	Low	Low	Moderate	Moderate	+/-

Yan et al. [51]	Moderate	High	Low	Low	Low	Low	-
Tan et al. [52]	High	Moderate	Moderate	Moderate	High	High	+
Zhang et al. [53]	Moderate	Low	Low	Low	High	High	+/-
Jiang et al. [54]	High	Low	Low	Low	Moderate	High	+/-
Qi et al. [55]	High	Low	Low	Low	High	High	+/-
Huang et al. [56]	Low	High	Low	High	High	High	+/-
Pan et al. [57]	High	Low	Low	Moderate	Moderate	High	+/-
Xu et al. [58]	High	Low	Low	Low	High	High	+/-
Lillie et al. [59].	NA	Low	Moderate	High	NA	NA	+/-
Ghinai et al. [60]	NA	Low	Moderate	Moderate	NA	NA	+/-
Wolfel et al. [61]	High	NA	Low	Low	Low	Low	-
Ge et al. [62]	NA	Low	Moderate	High	NA	NA	+/-
Xie et al. [63]	Moderate	High	Low	Low	Low	High	+/-
Zhou et al. [64]	High	High	Low	High	Low	High	+
Duan et al. [65]	Moderate	Low	Low	Low	High	High	+/-
Zhu et al. [66]	Low	Moderate	Low	Low	High	High	+/-
Sun et al. [67]	High	Moderate	Low	Low	Low	Low	-
Liu et al. [68]	High	Low	Low	Low	Moderate	High	+/-
Fan et al. [69]	High	Low	Low	Low	High	High	+/-
Wang et al. [70]	NA	Low	Low	Low	NA	NA	-
The COVID-19 Investigation Team [71]	<u>NA</u>	<u>Low</u>	<u>Low</u>	Moderate	NA	NA	-
Hu et al. [72]	High	Low	Moderate	Low	High	High	+/-
Shen et al. [73]	High	Low	Low	Low	NA	NA	-
Auld et al. [74]	Low	High	Moderate	Low	Moderate	High	+/-
Tang et al. [75]	Moderate	Moderate	Low	Low	Moderate	High	+/-
Onder et al. [76]	Low	High	Moderate	Moderate	NA	NA	+/-
Liu et al. [77]	High	Low	Moderate	Low	High	High	+/-
McMichael et al. [78]	Moderate	Moderate	Moderate	Low	NA	NA	+/-
Zhou et al. [79]	High	NA	NA	Low	NA	NA	+/-
Shen et al. [80]	High	High	Low	Moderate	High	High	+
Lin et al. [81]	Moderate	Low	Low	Low	High	High	+/-
Gudbjartsson et al. [82]	Low	Low	Low	Low	Low	Low	-
Li et al. [83]	Moderate	Low	Low	Low	High	High	+/-
Arons et al. [84]	Moderate	Low	Moderate	Low	High	High	+/-
COVID-19 Surveillance Group [85]	Low	NA	Low	Low	NA	NA	-
Kang et al. [86]	Low	High	Moderate	Moderate	High	High	+
Xu et al. [87]	High	High	Low	Moderate	High	High	+/-
Chen et al. [88].	Low	Low	Low	Low	Moderate	High	+/-
Bi et al. [89]	Moderate	Low	Low	Low	Low	Low	-
Lei et al. [90]	Moderate	Moderate	Low	Low	Moderate	High	+/-
Tian et al. [91]	Low	Low	Moderate	Low	High	High	+/-
Xu et al. [92]	High	Low	Low	Low	High	High	+/-

Han et al. [93]	Moderate	Low	Low	Low	High	High	+/-
Grasselli et al. [94]	Low	Low	Moderate	Low	Moderate	Moderate	+/-
Spinato et al. [95]	Moderate	Low	High	Moderate	High	High	+/-
Chow et al. [96]	Moderate	High	High	Low	NA	NA	+/-
Chen et al. [97]	NA	High	Low	Low	High	High	+/-
Department of Epidemiology [98]	<u>Low</u>	<u>High</u>	<u>Low</u>	Low	High	High	+/-
Li et al. [99]	High	NA	Low	Low	High	High	+/-
Kluytmans et al. [100]	Moderate	Low	Low	Low	NA	NA	-
ICARNAC [101]	Low	Low	Low	Low	NA	NA	-
Zhao et al. [102]	Moderate	Low	Low	Low	Low	High	+/-
Petrilli et al. [103]	Low	Low	Low	Low	Low	Low	-
Guo et al. [104]	Moderate	Low	Moderate	Low	High	High	+/-
Tabata et al [105]	Moderate	Low	Low	Low	High	High	+/-
Liu et al. [106]	Low	Moderate	Moderate	Low	Low	Low	+/-
Tao et al. [107]	High	High	Low	High	High	High	+
Overall: High risk	30/97	20/97	4/97	6/97	35/97	50/97	6/97
Overall: moderate risk	34/97	11/97	19/97	15/97	21/97	13/97	68/97
Overall: Low risk	24/97	62/97	73/97	76/97	22/97	15/97	23/97

In the case of participation, the study was judged to have a low risk of bias if the diagnosis of mortality for COVID-19 patients was explicitly specified, with adequate participation in the study by individuals. In the case of study attrition, a good explanation of patient health follow-up indicated a low risk of bias, a moderate risk of bias indicated an incomplete or short follow-up, and a high risk of bias indicated a lack of description. In terms of the outcome, a clear description of the outcomes was needed to achieve low risk of bias. Among SARS-Cov-2 patients, if outcomes were specifically and separately reported, a low risk of bias was achieved. If multipurpose factors related to COVID-19 infection were assessed, a sufficient prognostic factor with a low risk of bias on an individual study basis. In the case of statistical analysis and confounding factors, the rater attributed a low risk of bias to the study provided enough information available to explain the statistical methods used. The use of suitable statistical method, the establishment of a multivariate analysis indicates, and considerations of major confounding factors (e.g. age, gender, treatment etc.) suggested a low risk of bias.