

Impact of COVID-19 on Patients with COPD

Dongguk University Gyeongju Hospital
Sang Hyuk Kim

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Journal of Asthma and Allergy




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ORIGINAL RESEARCH

Epidemiology, Healthcare Resource Utilization, and Mortality of Asthma and COPD in COVID-19: A Systematic Literature Review and Meta-Analyses

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Table 2 Prevalence of COPD in General Population and COVID-19 Positive Population

Country	General population	COVID-19 Positive Population							
		All Studies				High-Quality Studies			
	COPD Prevalence	N	Prevalence (95% CI)	Difference (95% CI)	P	N	Prevalence (95% CI)	Difference (95% CI)	P
India	4.18	13	3.87 (2.51 to 5.95)	-0.31 (-1.67 to 1.77)	0.74	2	5.11 (2.46 to 10.33)	0.93 (-1.72 to 6.15)	0.59
Saudi Arabia	1.69	2	1.28 (0.77 to 2.10)	-0.41 (-0.92 to 0.41)	0.27				
China	3.92	145	3.01 (2.59 to 3.49)	-0.91 (-1.33 to -0.43)	0.00	20	2.39 (1.53 to 3.70)	-1.53 (-2.39 to -0.22)	0.03
Mexico	3.17	24	2.22 (1.67 to 2.94)	-0.95 (-1.50 to -0.23)	0.01	9	2.75 (1.63 to 4.61)	-0.42 (-1.54 to 1.44)	0.60
Switzerland	7.15	4	6.18 (4.94 to 7.70)	-0.97 (-2.21 to 0.55)	0.20				
Kuwait	2.09	2	0.43 (0.28 to 0.66)	-1.66 (-1.81 to -1.43)	0.00				
Finland	4.63	2	2.61 (1.61 to 4.22)	-2.02 (-3.02 to -0.41)	0.02				
Brazil	4.32	6	2.26 (0.92 to 5.46)	-2.06 (-3.40 to 1.14)	0.15	2	1.16 (0.15 to 8.15)	-3.16 (-4.17 to 3.83)	0.19
Australia	3.81	2	1.67 (0.80 to 3.45)	-2.14 (-3.01 to -0.36)	0.03				
Canada	4.09	3	1.62 (1.02 to 2.56)	-2.47 (-3.07 to -1.53)	0.00	3	1.62 (1.02 to 2.56)	-2.47 (-3.07 to -1.53)	0.00
Korea	3.57	21	3.67 (1.99 to 6.69)	0.10 (-1.58 to 3.12)	0.93	7	2.15 (0.88 to 5.12)	-1.42 (-2.69 to 1.55)	0.26
Russia	4.15	2	4.56 (2.60 to 7.86)	0.41 (-1.55 to 3.71)	0.74				
Sweden	6.76	5	7.48 (3.47 to 15.37)	0.72 (-3.29 to 8.61)	0.79	5	7.48 (3.47 to 15.37)	0.72 (-3.29 to 8.61)	0.79
Denmark	6.01	8	7.09 (4.24 to 11.61)	1.08 (-1.77 to 5.60)	0.53	2	8.48 (7.76 to 9.26)	2.47 (1.75 to 3.25)	0.00
Pakistan	2.48	2	3.62 (2.01 to 6.41)	1.14 (-0.47 to 3.93)	0.20				
France	4.27	14	5.43 (4.00 to 7.34)	1.16 (-0.27 to 3.07)	0.12	7	5.24 (3.17 to 8.54)	0.97 (-1.10 to 4.27)	0.42
Japan	3.49	5	4.91 (4.15 to 5.81)	1.42 (0.66 to 2.32)	0.00	12			
Spain	6.34	37	7.80 (6.28 to 9.66)	1.46 (-0.06 to 3.32)	0.06		6.50 (5.32 to 7.93)	0.16 (-1.02 to 1.59)	
Norway	5.53	2	7.41 (3.75 to 14.12)	1.88 (-1.78 to 8.59)	0.39				
Poland	3.98	2	6.02 (1.33 to 23.31)	2.04 (-2.65 to 19.33)	0.58				
Greece	6	2	9.14 (5.67 to 14.40)	3.14 (-0.33 to 8.40)	0.08	28	10.17 (8.16 to 12.62)		

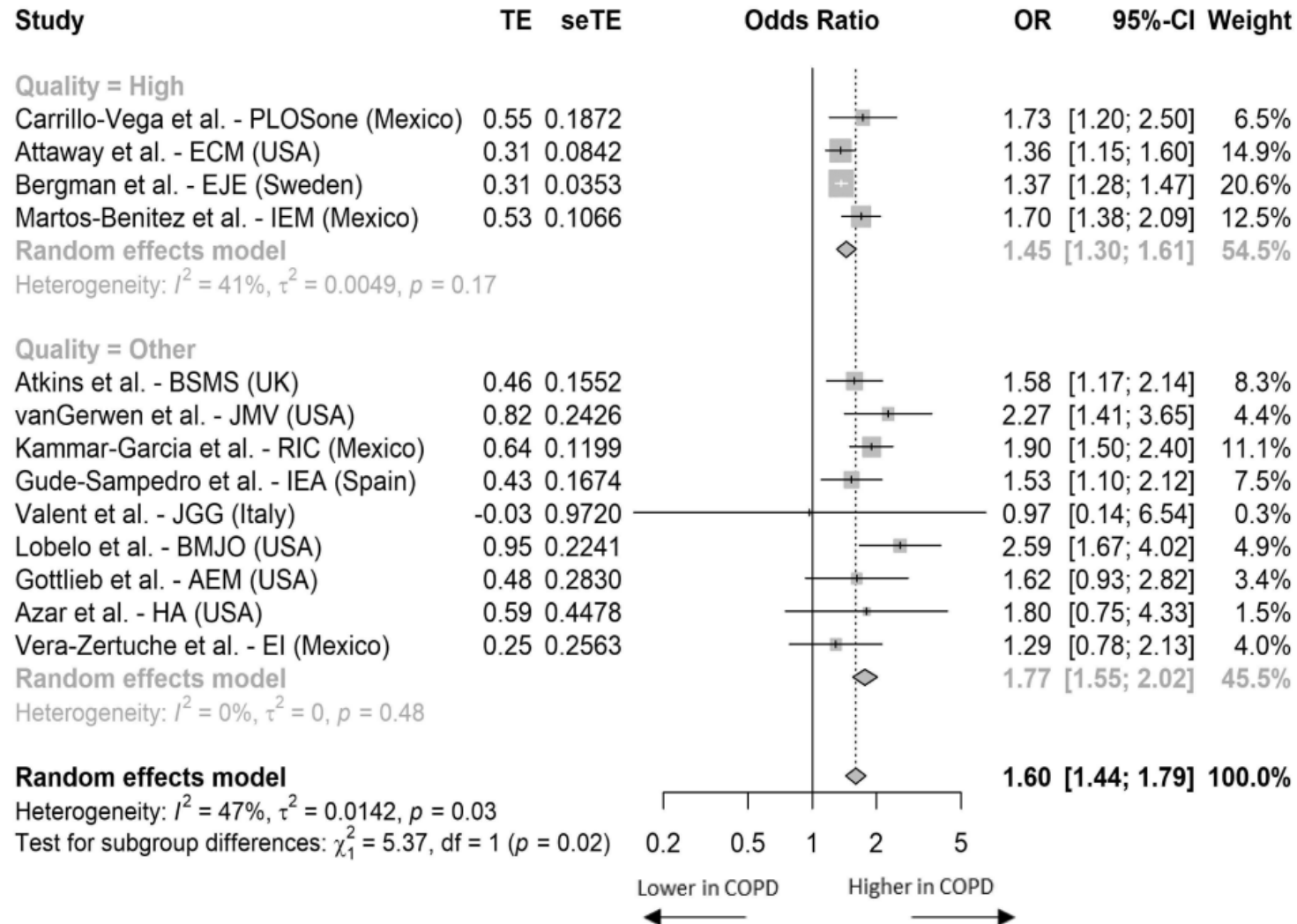
Table 2 (Continued).

Country	General population	COVID-19 Positive Population							
		All Studies				High-Quality Studies			
	COPD Prevalence	N	Prevalence (95% CI)	Difference (95% CI)	P	N	Prevalence (95% CI)	Difference (95% CI)	P
USA	5.16	125	8.40 (7.37 to 9.56)	3.24 (2.21 to 4.40)	0.00	3	6.80 (2.39 to 17.87)	5.01 (3.00 to 7.46)	0.00
Turkey	3.96	29	7.29 (5.69 to 9.29)	3.33 (1.73 to 5.33)	0.00			2.84 (-1.57 to 13.91)	0.31
Iran	2.23	13	5.89 (3.55 to 9.63)	3.66 (1.32 to 7.40)	0.00				
Belgium	6.66	3	10.39 (7.31 to 14.56)	3.73 (0.65 to 7.90)	0.01				
UK	5.32	21	10.10 (7.22 to 13.97)	4.78 (1.90 to 8.65)	0.00	9	9.22 (5.08 to 16.19)	3.90 (-0.24 to 10.87)	0.07
Italy	4.41	49	9.32 (7.61 to 11.36)	4.91 (3.20 to 6.95)	0.00	18	8.14 (6.02 to 10.91)	3.73 (1.61 to 6.50)	0.00
Germany	6.15	7	13.36 (12.82 to 13.91)	7.21 (6.67 to 7.76)	0.00				
Egypt	2.42	4	12.50 (4.17 to 31.95)	10.08 (1.75 to 29.53)	0.00				
Netherlands	5.45	5	15.81 (13.35 to 18.63)	10.36 (7.90 to 13.18)	0.00	2	18.33 (14.99 to 22.21)	12.88 (9.54 to 16.76)	0.00

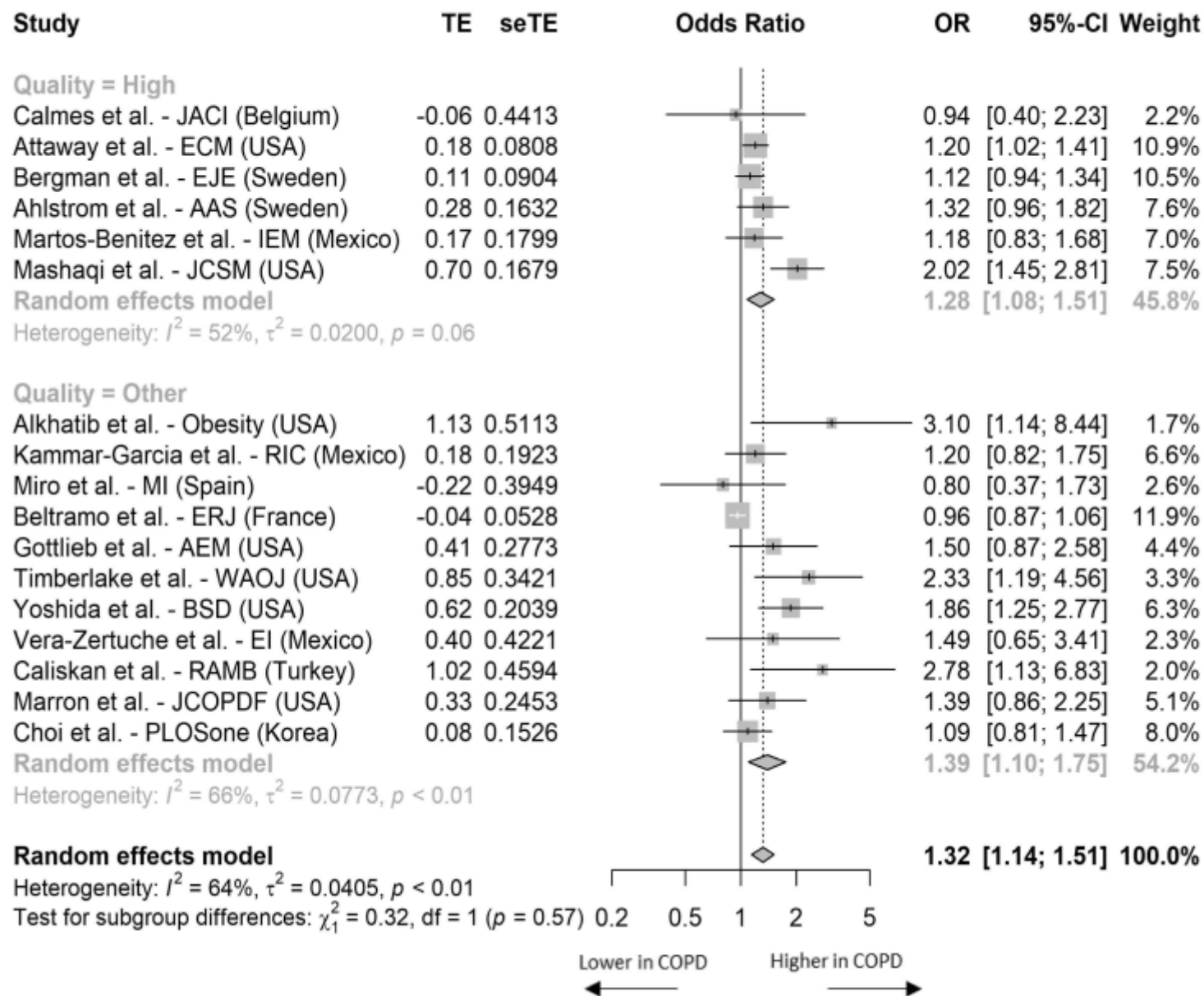
Note: Random effects as I^2 was high (=99.8%) and countries were excluded when the number of studies was < 2.

Abbreviations: CI, confidence interval; N, number of studies.

Hospitalization



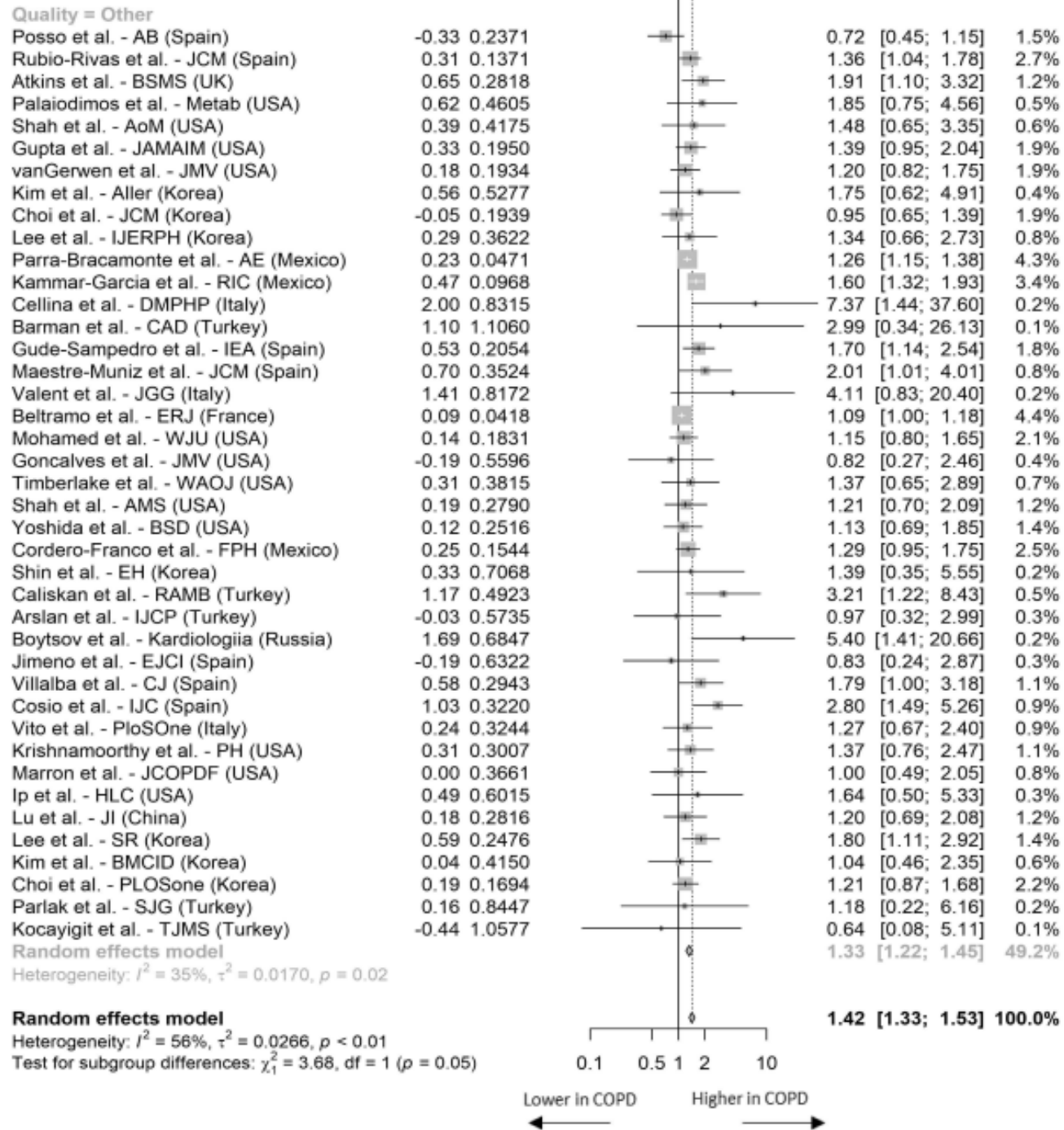
ICU admission



D Mortality

Study	TE	seTE	Odds Ratio	OR	95%-CI	Weight
Quality = High						
Hernandez-Vasquez et al. - JPMPH (Mexico)	0.48	0.0738		1.62	[1.40; 1.87]	3.9%
Carrillo-Vega et al. - PLOSone (Mexico)	0.52	0.1629		1.68	[1.22; 2.31]	2.3%
Calmes et al. - JACI (Belgium)	0.47	0.3615		1.60	[0.79; 3.25]	0.8%
Attaway et al. - ECM (USA)	0.08	0.1432		1.08	[0.82; 1.43]	2.6%
Maddaloni et al. - CD (Italy)	1.53	0.4904		4.63	[1.77; 12.11]	0.5%
Harrison et al. - PLoS (USA)	0.22	0.0716		1.24	[1.08; 1.43]	3.9%
Chen et al. - CID (China)	0.54	0.3914		1.72	[0.80; 3.70]	0.7%
Perez-Guzman et al. - IDSA (UK)	-0.25	0.4266		0.78	[0.34; 1.80]	0.6%
Corradini et al. - IEM (Italy)	0.16	0.1643		1.17	[0.85; 1.61]	2.3%
Ahlstrom et al. - AAS (Sweden)	0.55	0.2574		1.74	[1.05; 2.88]	1.3%
Tessitore et al. - OH (Switzerland)	0.69	0.3879		2.00	[0.94; 4.28]	0.7%
Girardin et al. - CRD (USA)	0.24	0.1116		1.27	[1.02; 1.58]	3.2%
Schwartz et al. - PlosOne (Canada)	0.33	0.1019		1.39	[1.14; 1.70]	3.3%
Fisman et al. - OFID (Canada)	1.18	0.5321		3.26	[1.15; 9.25]	0.4%
Padilla-Raygoza et al. - BPJ (Mexico)	0.42	0.0370		1.52	[1.41; 1.63]	4.4%
Padilla et al. - Raygoza et al. - BPJ (Mexico)	0.65	0.0937		1.92	[1.60; 2.31]	3.5%
Martos-Benitez et al. - IEM (Mexico)	0.41	0.1111		1.50	[1.21; 1.86]	3.2%
Guan et al. - JACIP (China)	0.01	0.1179		1.01	[0.80; 1.27]	3.1%
Oh et al. - BMCPM (Korea)	0.44	0.1863		1.56	[1.08; 2.25]	2.0%
Myint et al. - TADS (Italy, UK)	0.41	0.2586		1.50	[0.90; 2.49]	1.3%
Purroy et al. - PlosOne (Spain)	0.59	0.3022		1.81	[1.00; 3.27]	1.0%
Alam et al. - PMR (International)	0.66	0.1983		1.93	[1.31; 2.85]	1.9%
Polverino et al. - FCM (Italy)	0.66	0.1983		1.93	[1.31; 2.85]	1.9%
Mashaqi et al. - JCSM (USA)	0.81	0.1808		2.25	[1.58; 3.21]	2.1%
Random effects model				1.51	[1.37; 1.65]	50.8%
Heterogeneity: $I^2 = 59\%$, $\tau^2 = 0.0223$, $p < 0.01$						

D Mortality





Risk factors for SARS-CoV-2 among patients in the Oxford Royal College of General Practitioners Research and Surveillance Centre primary care network: a cross-sectional study



Simon de Lusignan, Jienchi Dorward, Ana Correa, Nicholas Jones, Oluwafunmi Akinyemi, Gayatri Amirthalingam, Nick Andrews, Rachel Byford, Gavin Dabrera, Alex Elliot, Joanna Ellis, Filipa Ferreira, Jamie Lopez Bernal, Cecilia Okusi, Mary Ramsay, Julian Sherlock, Gillian Smith, John Williams, Gary Howsam, Maria Zambon, Mark Joy, F D Richard Hobbs

	Adjusted odds ratio (95% CI)	p value
Age (years)	..	<0.0001
0–17	1 (ref)	..
18–39	2.83 (1.69–4.74)	..
40–64	5.36 (3.28–8.76)	..
65–74	4.41 (2.52–7.69)	..
≥75	5.23 (3.00–9.09)	..
Sex	..	<0.0001
Female	1 (ref)	..
Male	1.55 (1.27–1.89)	..
Ethnicity	..	<0.0001
White	1 (ref)	..
Asian	1.46 (0.94–2.29)	..
Black	4.75 (2.65–8.51)	..
Mixed, other	1.71 (0.97–3.01)	..
Socioeconomic deprivation level*	..	<0.0001
5 (least deprived)	1 (ref)	..
4	1.51 (1.13–2.03)	..
3	2.35 (1.78–3.11)	..
1 and 2 (most deprived)	2.03 (1.51–2.71)	..

Household size	..	0.4900
1	1 (ref)	..
2–4	0.97 (0.77–1.23)	..
5–8	0.86 (0.57–1.31)	..
≥9	1.29 (0.80–2.07)	..
Settlement or population density	..	<0.0001
Rural	1 (ref)	..
Urban	4.59 (3.57–5.90)	..
Smoking status	..	0.0010
Non-smoker	1 (ref)	..
Active smoker	0.49 (0.34–0.71)	..
Ex-smoker	0.87 (0.69–1.10)	..
BMI†	..	0.0090
Normal weight	1 (ref)	..
Overweight	1.26 (0.99–1.61)	..
Obese	1.41 (1.04–1.91)	..
Severely obese	1.28 (0.78–2.10)	..

(Table 3 continues in next column)

	Adjusted odds ratio (95% CI)	p value
(Continued from previous column)		
Hypertension	..	0.3100
No	1 (ref)	..
Yes	0.89 (0.69–1.14)	..
Chronic kidney disease	..	<0.0001
No	1 (ref)	..
Yes	1.91 (1.31–2.78)	..
Diabetes	..	0.8300
No	1 (ref)	..
Yes	1.03 (0.78–1.36)	..
Chronic heart disease	..	0.1800
No	1 (ref)	..
Yes	1.21 (0.92–1.60)	..
Chronic respiratory disease	..	0.8200
No	1 (ref)	..
Yes	1.04 (0.72–1.50)	..
Malignancy or immunocompromised	..	0.9800
No	1 (ref)	..
Yes	1.01 (0.78–1.31)	..

Current conclusion

COPD patients do not seem to be at greatly increased risk of infection with COVID-19

COPD patients seem to more likely to experience severe COVID-19 when infected against COVID-19

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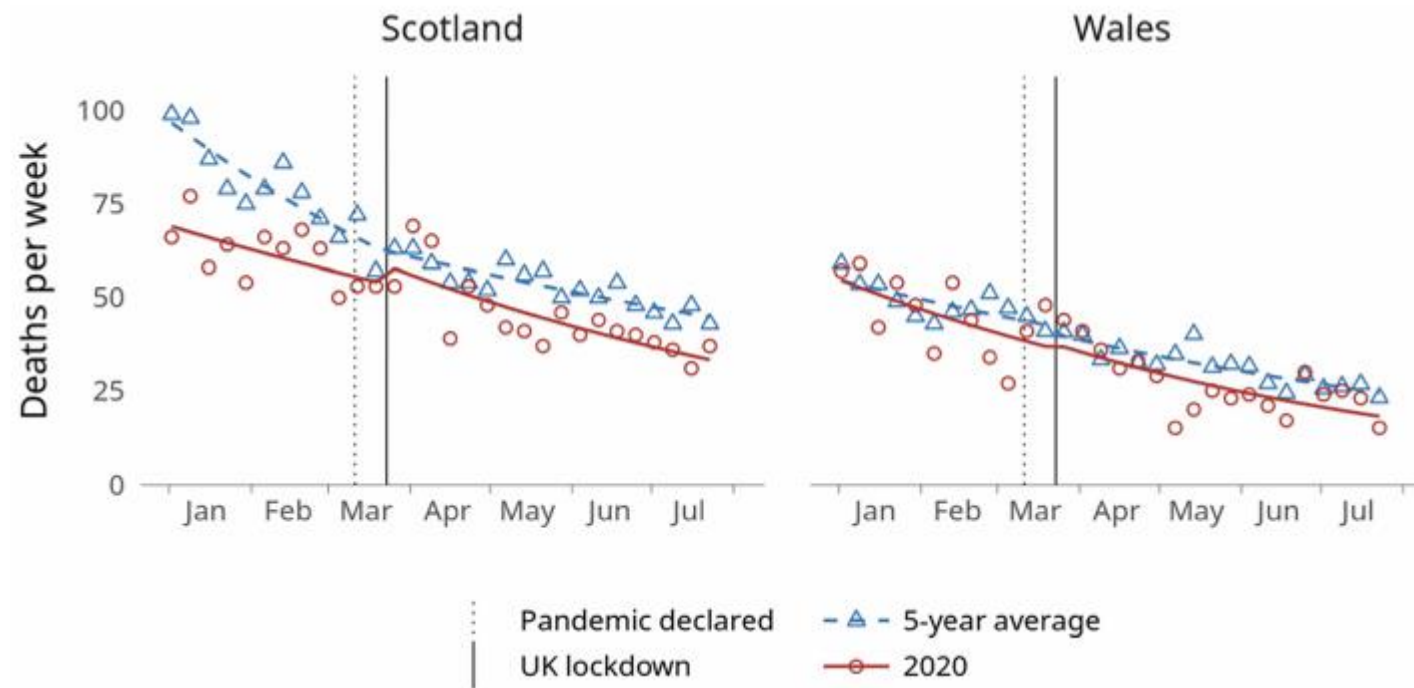
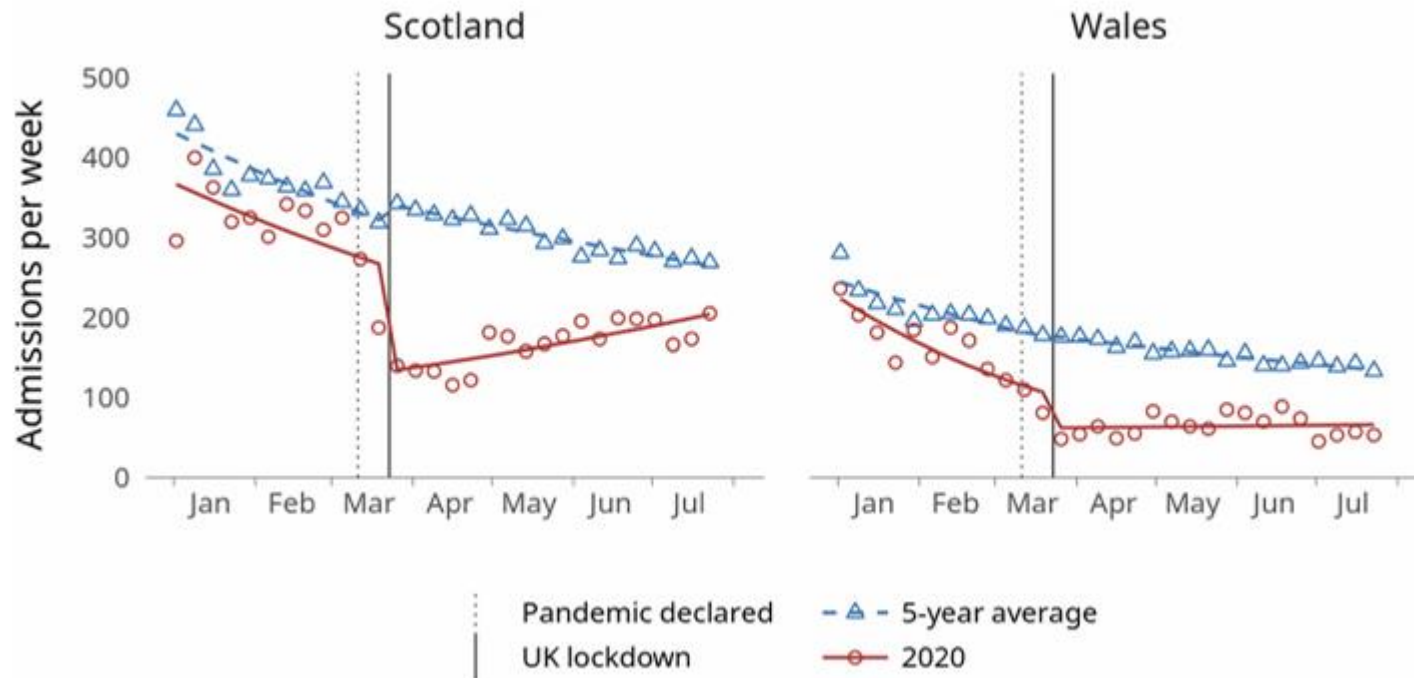
RESEARCH ARTICLE

Open Access

Impact of COVID-19 lockdown on the incidence and mortality of acute exacerbations of chronic obstructive pulmonary disease: national interrupted time series analyses for Scotland and Wales



Mohammad A. Alsallakh^{1,2*†} , Shanya Sivakumaran^{1†} , Sharon Kennedy³, Eleftheria Vasileiou^{2,4} , Ronan A. Lyons¹ ,
Chris Robertson^{3,5} , Aziz Sheikh^{2,4} , Gwyneth A. Davies^{1,2}  and on behalf of the EAVE II Collaborators



Decrease in hospital admissions for respiratory diseases during the COVID-19 pandemic: a nationwide claims study


Kyungmin Huh,¹ Young-Eun Kim,² Wonjun Ji,³ Dong Wook Kim,² Eun-Joo Lee,²
Jong-Hun Kim,⁴ Ji-Man Kang,⁵ Jaehun Jung ^{6,7}

Table 1 Cumulative incidence of hospital admission from February through July in 2020 versus 2016–2019

Disease	Cumulative incidence, February–July (per 1 000 000)		Rate ratio (95% CI)	P value
	Mean (2016–2019)	Observed (2020)		
Pneumonia	3965.29	1872.59	0.47 (0.45 to 0.50)	<0.001
Patients with COPD	28 304.95	15 182.24	0.54 (0.53 to 0.55)	<0.001
Patients with asthma	3196.58	1200.35	0.38 (0.35 to 0.40)	<0.001
Influenza	1366.09	299.33	0.22 (0.19 to 0.25)	<0.001
Patients with COPD	1355.74	363.06	0.27 (0.24 to 0.30)	<0.001
Patients with asthma	554.65	79.56	0.14 (0.11 to 0.18)	<0.001
COPD	435.11	251.70	0.58 (0.49 to 0.68)	<0.001
Asthma	353.16	168.13	0.48 (0.39 to 0.57)	<0.001
Diabetic ketoacidosis/hyperosmolar hyperglycaemic state	54.94	55.25	1.02 (0.69 to 1.51)	>0.999
Intracranial haemorrhage	329.17	305.69	0.93 (0.79 to 1.09)	0.361
Myocardial infarct	286.37	280.00	0.98 (0.82 to 1.15)	0.801
Cancer	1914.28	1922.59	1.00 (0.94 to 1.07)	0.910

Exacerbation and COVID-19

To date, MERS-CoV, SARS-CoV, and SARS-CoV-2 infection **have not been reported** in COPD exacerbation

COPD **exacerbation was decreased** during pandemic period, particularly due to protective measurements

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FOLLOW-UP OF COPD PATIENTS WHO DEVELOPED COVID-19

Several organizations have developed guidelines to address the evaluation and management of patients recovering from COVID-19^(1519,1617-1620) but none of these have specific recommendations for patients with underlying COPD. Assessment protocols generally include a comprehensive physical, cognitive, and psychological assessment and there is no reason why these should not also apply to patients with COPD; however, high quality data on the outcomes of these evaluation and management strategies are still lacking.

COVID-19 and risk of exacerbation in COPD

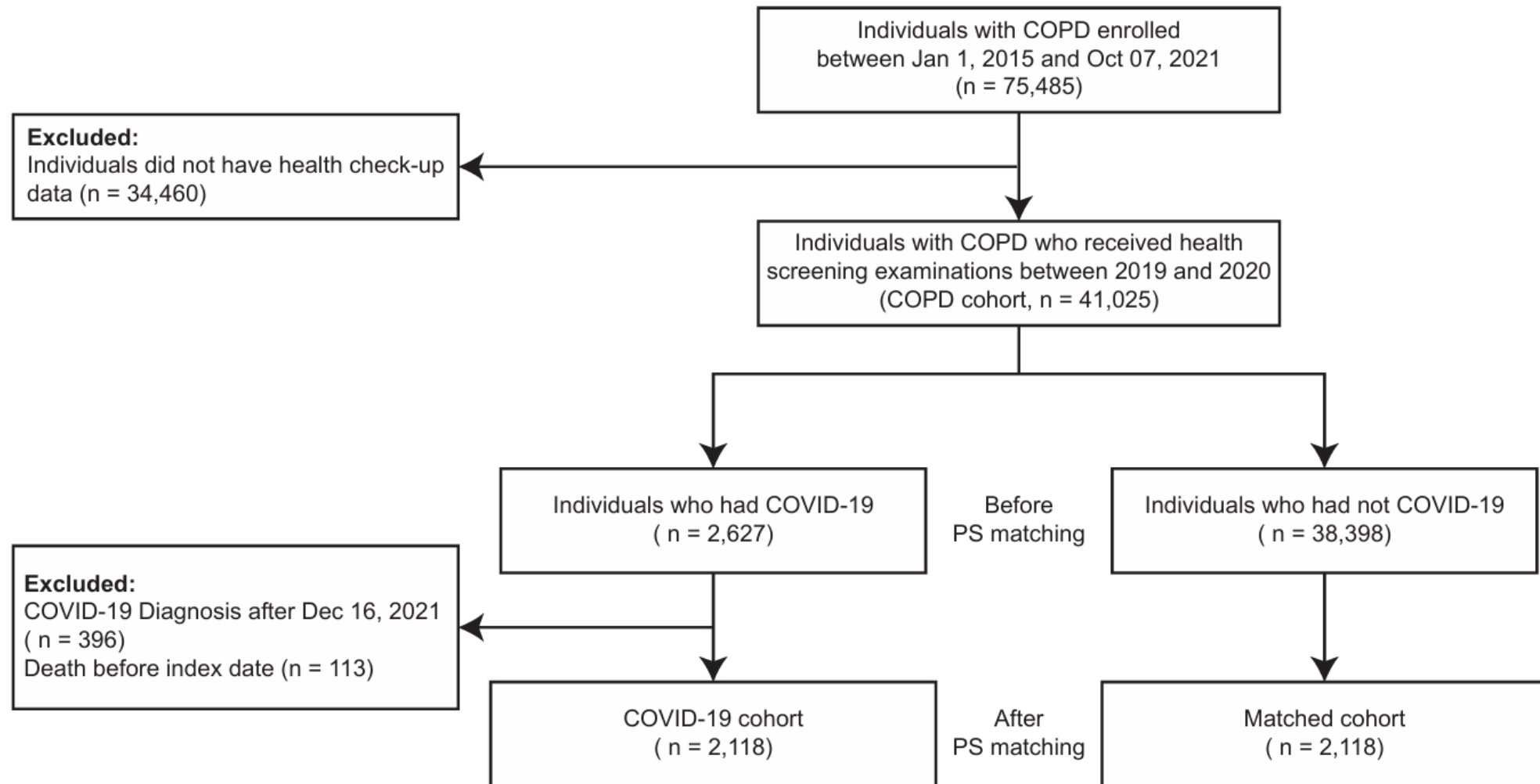


Table 1: Baseline characteristics of the study population

	Matched cohort (n = 2,118)	COVID-19 cohort (n = 2,118)	SMD
Age, years, mean (SD)	68.3 (11.4)	68.7 (11.5)	0.03
Age, years			0.05
20 - 49	153 (7.2)	145 (6.8)	
50 - 59	200 (9.4)	218 (10.3)	
60 - 69	701 (33.1)	661 (31.2)	
70 - 79	746 (35.2)	760 (35.9)	
≥ 80	318 (15.0)	334 (15.8)	
Sex, male	1,441 (68.0)	1,416 (66.9)	0.03
BMI, kg/m ² , mean (SD)	24.4 (3.69)	24.5 (3.54)	0.02
Low (< 18.5 kg/m ²)	103 (4.9)	82 (3.9)	0.07
Normal (18.5–22.9 kg/m ²)	619 (29.2)	625 (29.5)	
Overweight (23.0–24.9 kg/m ²)	510 (24.1)	489 (23.1)	
Obese (25.0–29.9 kg/m ²)	742 (35.0)	789 (37.3)	
Highly obese (≥ 30 kg/m ²)	144 (6.8)	133 (6.3)	
Regular physical activity			< 0.01
No	1,546 (73.0)	1,542 (72.8)	
Yes	572 (27.0)	576 (27.2)	
Smoking status			0.01
Never smoker	1,068 (50.4)	1,082 (51.1)	
Ever smoker	1,050 (49.6)	1,036 (48.9)	
Alcohol drinking status			0.03
None	1,462 (69.0)	1,487 (70.2)	
1 - 2 times	386 (18.2)	367 (17.3)	
3 - 4 times	152 (7.2)	156 (7.4)	
Nearly every day	118 (5.6)	108 (5.1)	
Income			0.02

Table 1: Baseline characteristics of the study population

	Matched cohort (n = 2,118)	COVID-19 cohort (n = 2,118)	SMD
Low	516 (24.4)	527 (24.9)	
Middle	891 (42.1)	899 (42.4)	
High	711 (33.6)	692 (32.7)	
Residential area			0.02
Metropolitan cities	1,526 (72.0)	1,525 (72.0)	
Mid-size and small cities	432 (20.4)	423 (20.0)	
Rural areas	160 (7.6)	170 (8.0)	
A history of severe exacerbations	257 (12.1)	258 (12.2)	< 0.01
Comorbidities			
Hypertension	903 (42.6)	925 (43.7)	0.02
Diabetes mellitus	518 (24.5)	537 (25.4)	0.02
Chronic kidney disease	55 (2.6)	68 (3.2)	0.04
Asthma	805 (38.0)	869 (41.0)	0.06
Dyslipidemia	366 (17.3)	377 (17.8)	0.01

Abbreviations: COVID-19 = coronavirus disease 2019, SMD = standard mean difference, interval, SD = standard deviation, BMI = body mass index.

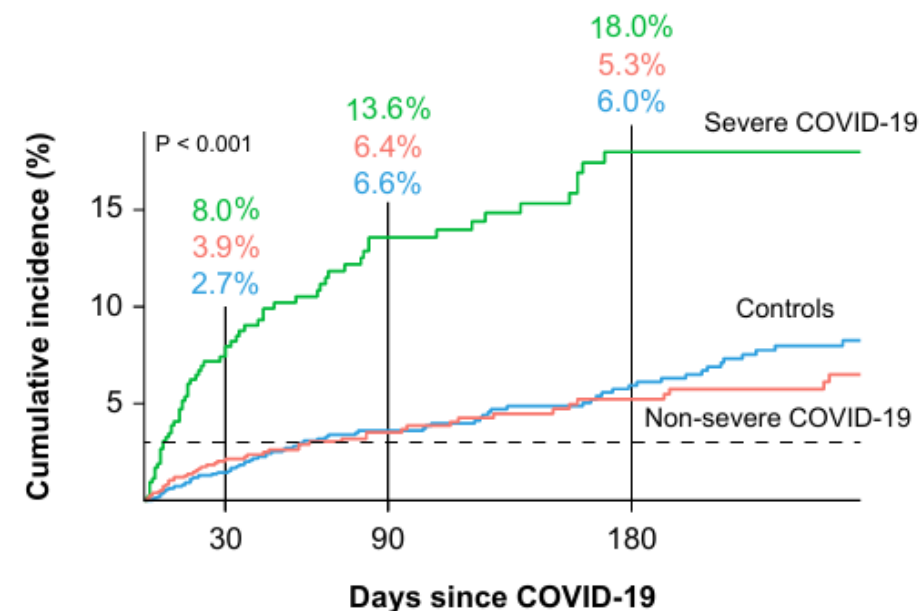
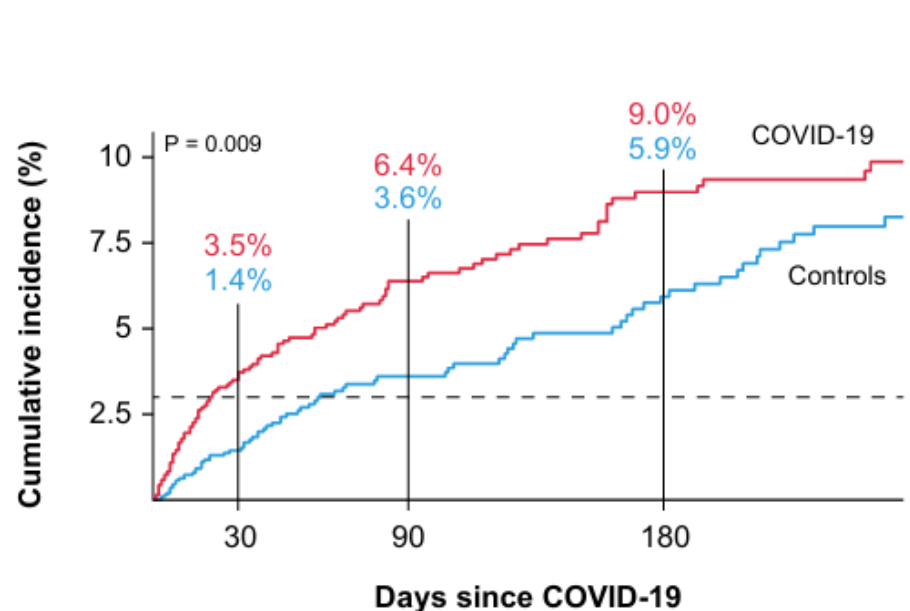
Table 2: Risk of exacerbation after COVID-19 recovery in individuals with COPD

Outcome	Exposure	N	Number of exacerbations	Exacerbation rate (per 10,000 population)	Unadjusted HR (95% CI)	Adjusted HR (95% CI)
Overall exacerbation	Matched controls	2,118	82	1328.75	Reference	Reference
	COVID-19 cohort					
	Total	2,118	118	1926.48	1.46 (1.10–1.93)	1.45 (1.09–1.92)
	Non-severe cases	1,579	51	1164.56	0.87 (0.61–1.24)	0.92 (0.65–1.31)
	Severe cases	539	67	3837.76	2.97 (2.15–4.11)	2.57 (1.85–3.57)
Non-severe exacerbation	Matched controls	2,118	60	972.25	Reference	Reference
	COVID-19 cohort					
	Total	2,118	81	1322.42	1.36 (0.98–1.91)	1.34 (0.96–1.88)
	Non-severe cases	1,579	43	981.88	1.00 (0.68–1.48)	1.01 (0.68–1.49)
	Severe cases	539	38	2176.64	2.31 (1.54–3.47)	2.15 (1.42–3.26)
Severe exacerbation	Matched controls	2,118	22	356.49	Reference	Reference
	COVID-19 cohort					
	Total	2,118	37	604.07	1.70 (1.01–2.89)	1.72 (1.01–2.92)
	Non-severe cases	1,579	8	182.68	0.51 (0.23–1.15)	0.62 (0.27–1.40)
	Severe cases	539	29	1661.12	4.77 (2.74–8.30)	3.38 (1.92–5.96)

Abbreviations: COVID-19 = coronavirus disease 2019, COPD = chronic obstructive pulmonary disease, HR = hazard ratio, CI = confidence interval.

COVID-19 and risk of exacerbation in COPD

A. Total



No. at Risk

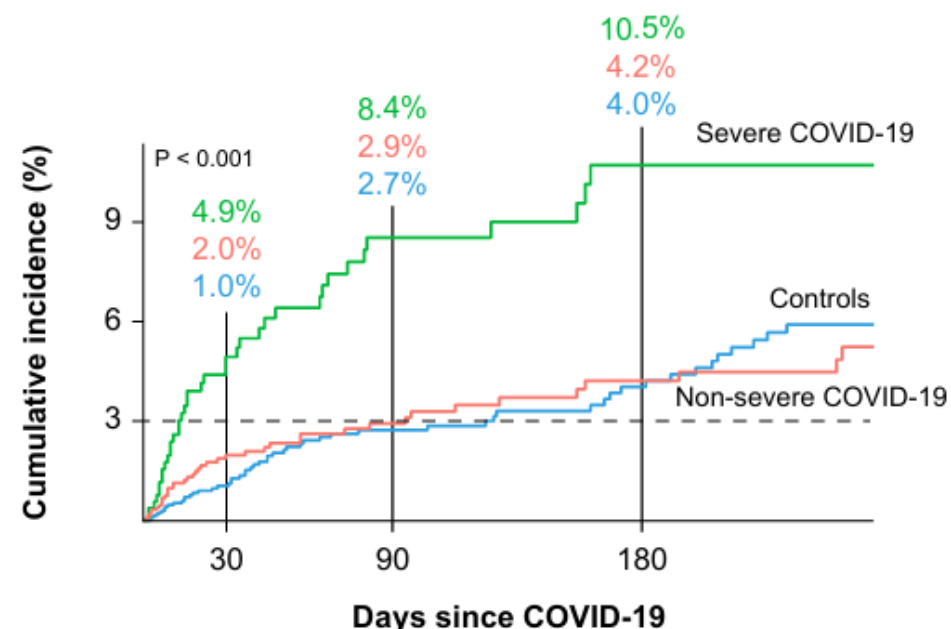
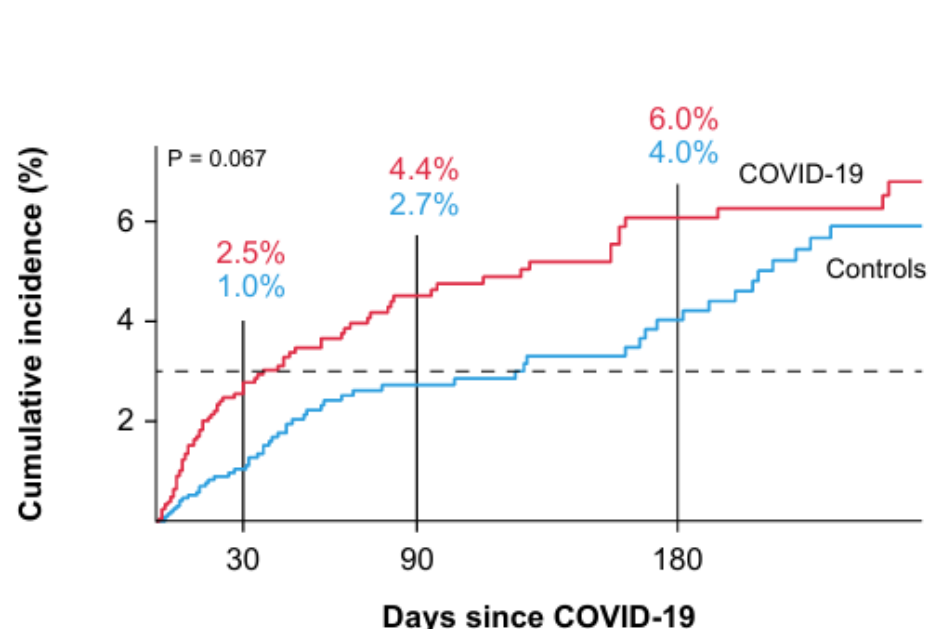
	2118	1057	778	559	483
Not infected	2118	1057	778	559	483
Infected	2118	1032	757	553	481

No. at Risk

	2118	1057	778	559	483
Not infected	2118	1057	778	559	483
Infected, severe	539	296	228	164	134
Infected, not severe	1579	736	529	389	347

COVID-19 and risk of exacerbation in COPD

B. Non-severe exacerbation



No. at Risk

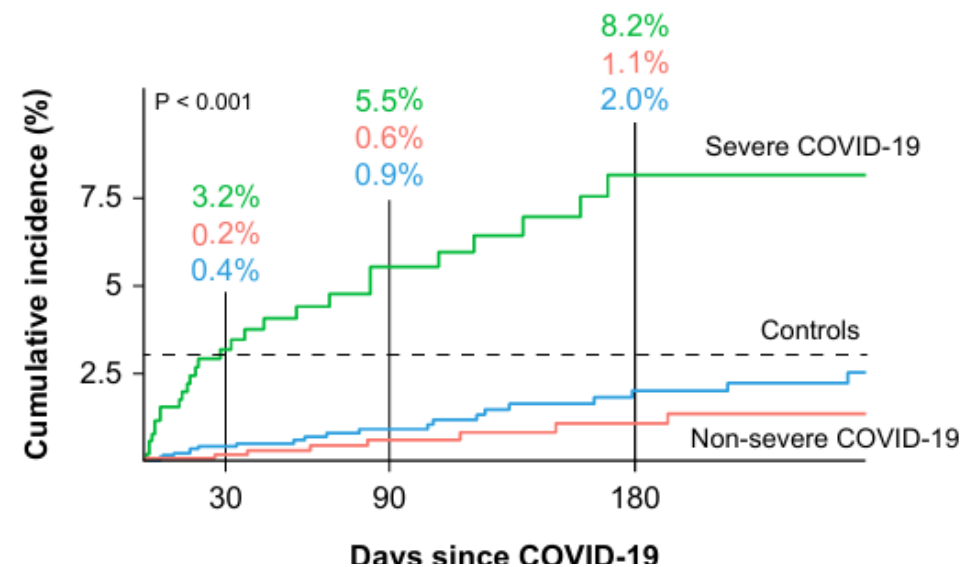
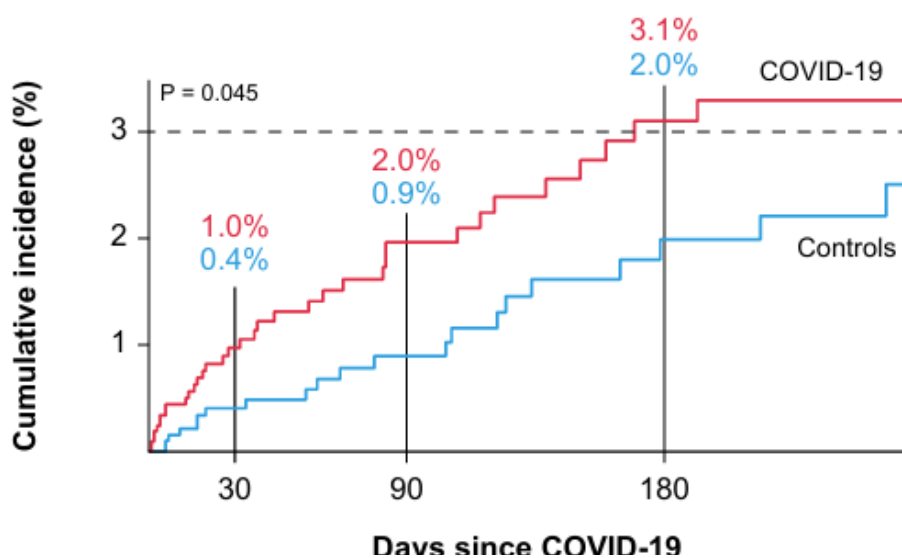
Not infected	2118	1057	778	559	483
Infected	2118	1032	757	553	481

No. at Risk

Not infected	2118	1057	778	559	483
Infected, severe	539	296	228	164	134
Infected, not severe	1579	736	529	389	347

COVID-19 and risk of exacerbation in COPD

C. Severe exacerbation



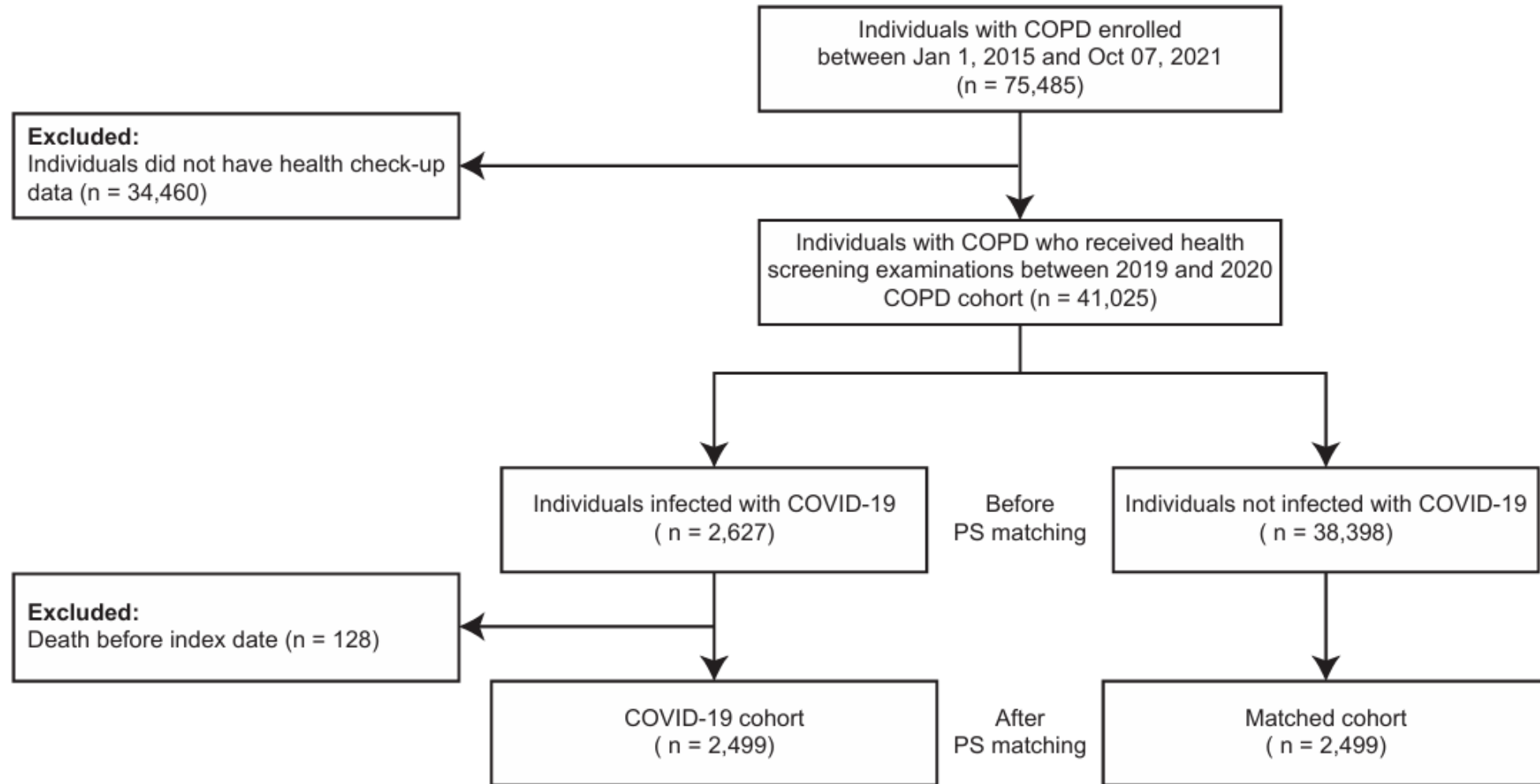
No. at Risk

Not infected	2118	1057	778	559	483
Infected	2118	1032	757	553	481

No. at Risk

Not infected	2118	1057	778	559	483
Infected, severe	539	296	228	164	134
Infected, not severe	1579	736	529	389	347

COVID-19 and mortality risk in COPD



COVID-19 and mortality risk in COPD

Table 2. Long-term mortality risk in the COVID-19 cohort versus matched controls

	N	Number of deaths	Mortality rate (per 10,000 population)	Unadjusted HR (95% CI)	Adjusted HR (95% CI)
Matched controls	2,499	67	270.831	Ref.	Ref.
COVID-19 cohort					
Overall	2,499	120	491.822	1.81 (1.35–2.45)	1.81 (1.34–2.44)
Non-severe	1,879	38	207.410	0.76 (0.51–1.13)	0.85 (0.57–1.28)
Severe	620	82	1349.146	5.05 (3.65–6.97)	3.73 (2.68–5.20)

Data are shown as number or ratio (95% CI), as appropriate.

Abbreviations: COVID-19 = coronavirus disease 2019, HR = hazard ratio, CI = confidence interval.

COVID-19 and mortality risk in COPD

Table 3. Long-term mortality risk between the COVID-19 cohort and matched controls according to time interval following recovery date from COVID-19.

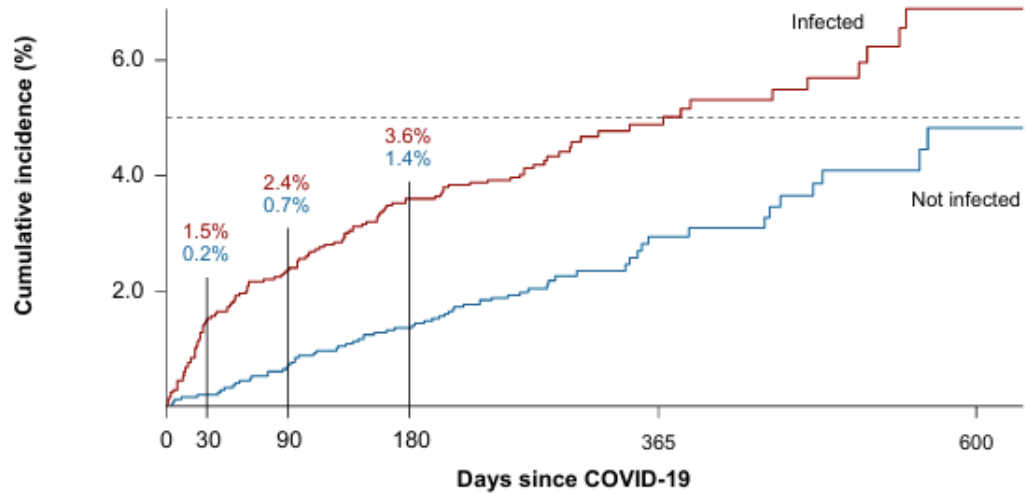
	Adjusted HR (95% CI)			
	< 30 days	30–90 days	90–180 days	≥180 days
Matched controls	Ref.	Ref.	Ref.	Ref.
COVID-19 cohort				
Overall	7.49 (2.95–19.06)	1.55 (0.77–3.10)	2.07 (1.13–3.80)	0.93 (0.57–1.53)
Non-severe	1.73 (0.53–5.69)	0.72 (0.29–1.81)	1.47 (0.72–2.99)	0.50 (0.24–1.01)
Severe	20.25 (7.79–52.64)	3.68 (1.69–8.02)	3.33 (1.64–6.76)	1.64 (0.93–2.89)

Data are shown as number or ratio (95% CI), as appropriate.

Abbreviations: COVID-19 = coronavirus disease 2019, HR = hazard ratio, CI = confidence interval.

COVID-19 and mortality risk in COPD

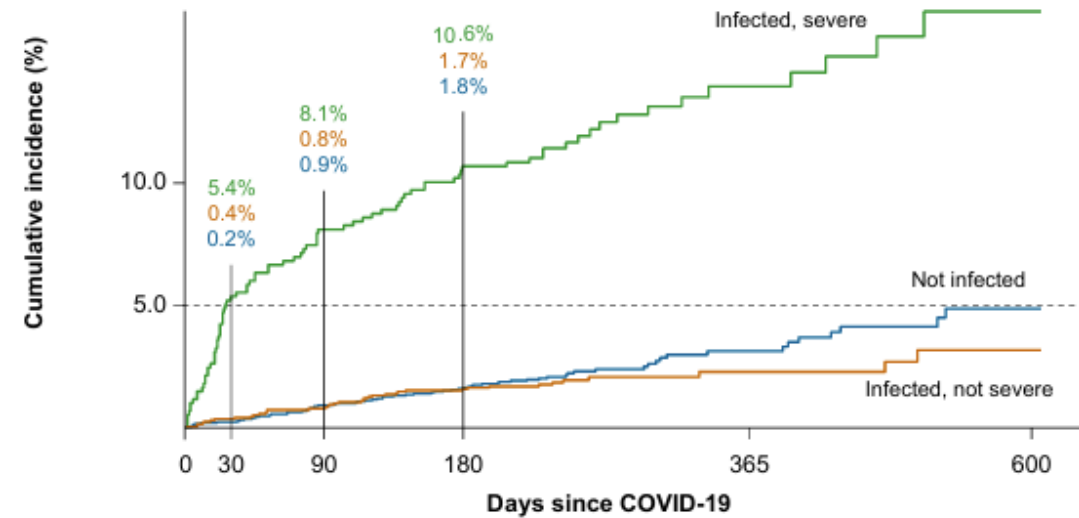
A



No. at Risk

Not infected	2499	2461	595	159
Infected	2499	2408	593	165

B



No. at Risk

Not infected	2499	2461	595	159
Infected, severe	620	557	183	49
Infected, not severe	1879	1851	410	116

Vaccination, COVID-19, and risk of exacerbation in COPD

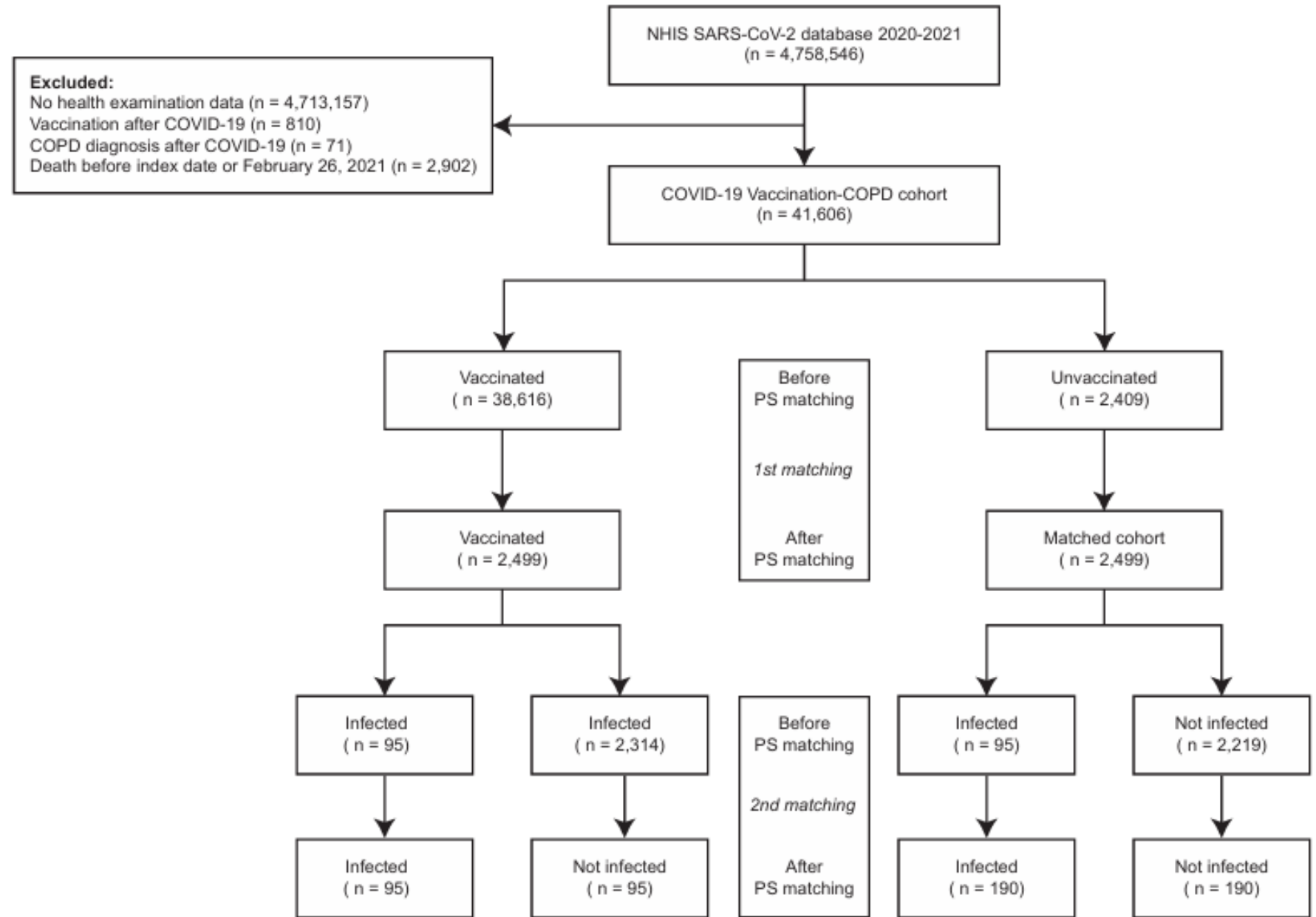


Table 1: Baseline characteristics of the study population

	Vaccinated, COVID-19 negative (n = 95)	Vaccinated, COVID-19 positive (n = 95)	Unvaccinated, COVID-19 negative (n = 190)	Unvaccinated, COVID-19 positive (n = 190)	SMD
Age, years					0.379
20–49	4 (4.2)	3 (3.2)	18 (9.5)	23 (12.1)	
50–59	5 (5.3)	7 (7.4)	20 (10.5)	14 (7.4)	
60–69	30 (31.6)	29 (30.5)	46 (24.2)	55 (28.9)	
70–79	44 (48.4)	42 (44.2)	62 (32.6)	55 (28.9)	
≥ 80	10 (10.5)	14 (14.7)	44 (23.2)	43 (22.6)	
Sex, male	56 (58.9)	63 (66.3)	116 (61.1)	113 (59.5)	0.082
BMI					0.330
Low (< 18.5 kg/m ²)	10 (10.5)	3 (3.2)	17 (8.9)	12 (6.3)	
Normal (18.5–22.9 kg/m ²)	37 (38.9)	32 (33.7)	64 (33.7)	63 (33.2)	
Overweight (23.0–24.9 kg/m ²)	25 (26.3)	26 (27.4)	35 (18.4)	34 (17.9)	
Obese (25.0–29.9 kg/m ²)	19 (20.0)	27 (28.4)	55 (28.9)	70 (36.8)	
Highly obese (≥ 30 kg/m ²)	4 (4.2)	7 (7.4)	19 (10.0)	11 (5.8)	
Smoking status					0.152
Never smoker	47 (49.5)	49 (51.6)	115 (60.5)	108 (56.8)	
Former smoker	38 (40.0)	34 (35.8)	60 (31.6)	61 (32.1)	
Current smoker	10 (10.5)	12 (12.6)	15 (7.9)	21 (11.1)	
Alcohol consumption					0.273
None	69 (72.6)	65 (68.4)	157 (82.6)	159 (83.7)	
1 - 2 times	12 (12.6)	18 (18.9)	15 (7.9)	19 (10.0)	
3 - 4 times	6 (6.3)	6 (6.3)	11 (5.8)	7 (3.7)	
Almost every day	8 (8.4)	6 (6.3)	7 (3.7)	5 (2.6)	
Economic status					0.090
Low	27 (28.4)	22 (23.2)	55 (28.9)	55 (28.9)	
Middle	42 (44.2)	43 (45.3)	83 (43.7)	82 (43.2)	
High	31 (32.6)	25 (26.3)	52 (27.4)	53 (27.9)	
Residential area					0.233

	Vaccinated, COVID-19 negative (n = 95)	Vaccinated, COVID-19 positive (n = 95)	Unvaccinated, COVID-19 negative (n = 190)	Unvaccinated, COVID-19 positive (n = 190)	SMD
Metropolitan cities	78 (82.1)	72 (75.8)	123 (64.7)	130 (68.4)	
Mid-size and small cities	11 (11.6)	16 (16.8)	42 (22.1)	40 (21.1)	
Rural areas	6 (6.3)	7 (7.4)	25 (13.2)	20 (10.5)	
Regular physical activity	22 (23.2)	23 (24.2)	34 (17.9)	38 (20.0)	0.090
One or more Severe exacerbations in the previous year	22 (23.2)	17 (17.9)	47 (24.7)	49 (25.8)	0.102
Comorbidities					
Hypertension	49 (51.6)	47 (49.5)	76 (40.0)	86 (45.3)	0.131
Diabetes mellitus	22 (23.2)	25 (26.3)	39 (20.5)	46 (24.2)	0.073
Dyslipidemia	19 (20.0)	17 (17.9)	20 (10.5)	23 (12.1)	0.160
Chronic kidney disease	4 (4.2)	5 (5.3)	15 (7.9)	10 (5.3)	0.078
Asthma	30 (31.6)	37 (38.9)	68 (35.8)	70 (36.8)	0.081

Data are shown in mean (SD) or number (%), as appropriate.

Abbreviations: COVID-19 = coronavirus disease 2019, SMD = standard mean difference, interval, SD = standard deviation, BMI = body mass index.

Vaccination, COVID-19, and risk of exacerbation in COPD

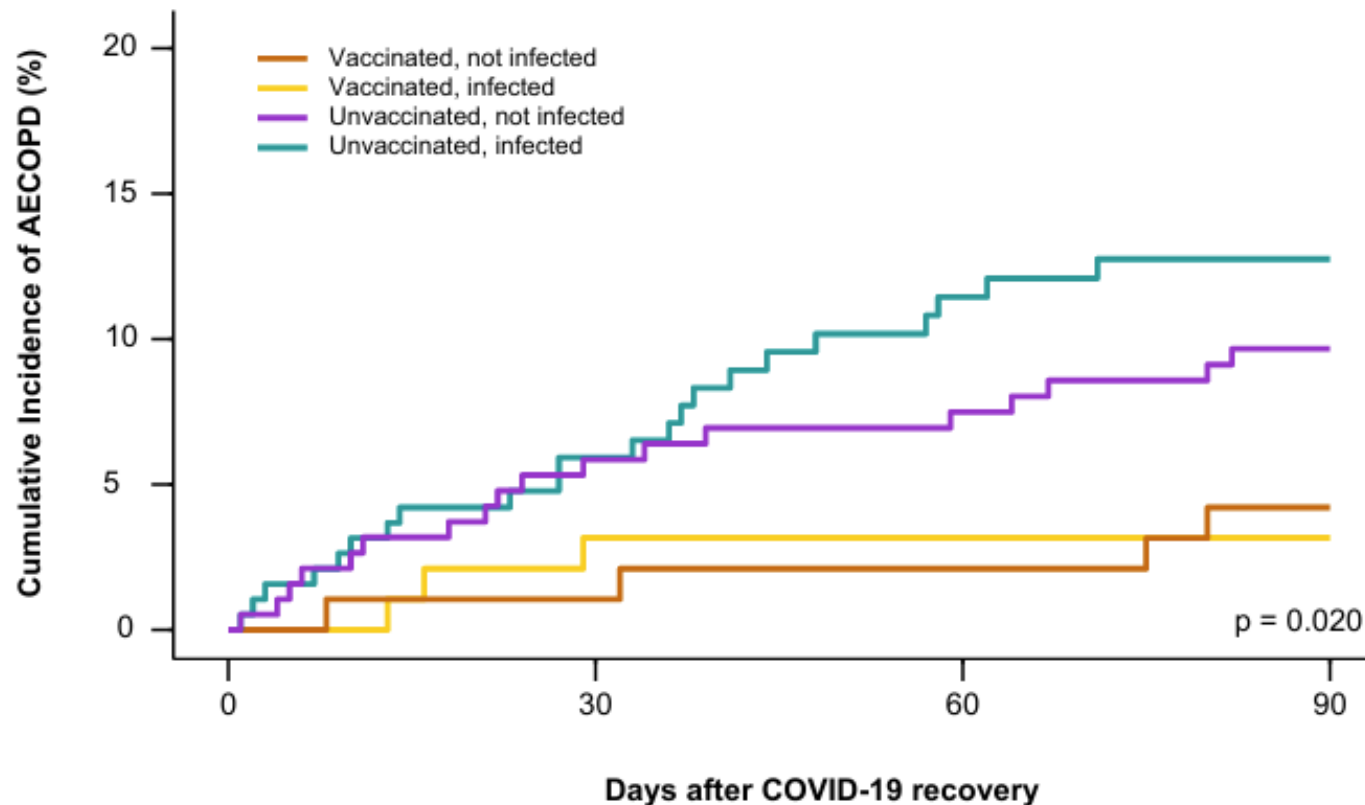
Table 2: Risk of COPD exacerbation based on COVID-19 vaccination and infection status

COVID-19 Vaccination	COVID-19 infection	N	Number of exacerbation	Exacerbations (per 10,000 population)	Unadjusted HR (95% CI)	Adjusted HR (95% CI)
Yes	No	95	4	1741	Ref.	Ref.
Yes	Yes	95	3	1334	0.76 (0.17–3.40)	0.68 (0.15–3.07)
No	No	190	18	4203	2.38 (1.10–9.24)	2.24 (0.75–9.68)
No	Yes	190	22	5850	3.18 (0.81–7.04)	3.26 (1.10–6.70)

Data are shown in number or ratio (95% CI), as appropriate.

Abbreviations: COPD = chronic obstructive pulmonary disease, COVID-19 = coronavirus disease 2019, HR = hazard ratio, CI = confidence interval.

Vaccination, COVID-19, and risk of exacerbation in COPD



No. at Risk

Vaccinated, not infected	95	94	93	91
Vaccinated, infected	95	91	91	89
Unvaccinated, not infected	190	175	170	166
Unvaccinated, infected	190	159	140	127

Summary

Risk of COVID-19 infection

Risk of progression to severe COVID-19

Exacerbation and COVID-19

After COVID-19 recovery

Mortality risk

Exacerbation risk

Vaccination and exacerbation