

OpenSAFELY: factors associated with COVID-19-related hospital death in the linked electronic health records of 17 million adult NHS patients.

Abstract

Background

To date there have been no large cohort studies with access to the full clinical history of all patients at risk of Covid-19. Establishing factors associated with a rapidly arising novel cause of death requires a new approach to epidemiological research. We therefore set out to deliver a secure analytics platform inside the data centre of major electronic health records vendors, running across the full live linked pseudonymised electronic health records of all NHS patients in England. The following results are preliminary.

Data sources:

Primary care electronic health records managed by the electronic health record vendor TPP, pseudonymously linked to patient-level ECDS A&E presentation data, ICNARC ITU admissions data, CPNS hospital death data, and ONS death data, using the new OpenSAFELY platform.

Population:

17,420,832 adults.

Time period:

1st February 2020 to 16th April 2020.

Primary outcome:

Death in hospital attributed to Covid-19 as recorded by the CPNS system.

Methods:

Cohort study. Cox-regression to generate hazard ratios: crude, age and sex adjusted, and multiply adjusted for clinical co-variables selected prospectively on the basis of clinical interest and prior findings.

Results

Preliminary results are in tables 1 and 2 below. There were 3956 deaths attributed to Covid-19. In summary: death from Covid-19 was strongly associated with being male (hazard ratio 1.98, 95%CI 1.85-2.12); older age and deprivation (both with a strong gradient); diabetes (HR 1.98 95% CI 1.86-2.12); asthma (1.25 (1.14-1.38)); and various other prior medical conditions as per Table 2. Compared to people with ethnicity recorded as white, people of Asian origin were at higher risk of death, with only partial attenuation in hazard ratios from the fully adjusted model (age-sex adjusted HR 2.01 95% CI 1.76-2.30; fully adjusted HR 1.52 95% CI 1.32-1.74)); and similar findings for black people (age-sex adjusted HR 1.89 95% CI 1.30-2.75; fully adjusted HR 1.68 95% CI 1.15-2.45).

Conclusions

We have identified and quantified a range of clinical risk factors for death from Covid-19, in the largest cohort study conducted by any country to date. People from Asian and black groups are at markedly increased risk of death from Covid-19, only partially attributable to

co-morbidity or other risk factors. Deprivation is also a major risk factor, with little of the excess risk explained by co-morbidity or other risk factors. We will update and extend these results regularly; our OpenSAFELY-EMIS platform is adding over 30 million additional current NHS patients' records. The unprecedented statistical power offered by our approach means that associations with less common risk factors can be robustly assessed in more detail, at the earliest possible date, as the pandemic progresses.

Table 1: Numbers of patients with each outcome

		Number (% within stratum) experiencing outcomes		
	N (column %)	Covid-19 ITU admission	Covid-19 Hospital death (CPNS)	Covid-19 death (ONS)
Total	17420832 (100.0)	1098 (0.0)	4009 (0.0)	1152 (0.0)
Age				
18-<40	5974032 (34.3)	88 (0.0)	25 (0.0)	SMALL N
40-<50	2871930 (16.5)	132 (0.0)	66 (0.0)	17 (0.0)
50-<60	3067912 (17.6)	284 (0.0)	243 (0.0)	49 (0.0)
60-<70	2406215 (13.8)	324 (0.0)	488 (0.0)	131 (0.0)
70-<80	1952015 (11.2)	231 (0.0)	1153 (0.1)	354 (0.0)
80+	1148728 (6.6)	39 (0.0)	2034 (0.2)	596 (0.1)
Sex				
Male	8726979 (50.1)	305 (0.0)	1447 (0.0)	425 (0.0)
Female	8693853 (49.9)	793 (0.0)	2562 (0.0)	727 (0.0)
BMI (kg/m2)				
<18.5	314037 (1.8)	7 (0.0)	108 (0.0)	28 (0.0)
18.5-24.9	4811487 (27.6)	105 (0.0)	1023 (0.0)	288 (0.0)
25-29.9	4727168 (27.1)	319 (0.0)	1168 (0.0)	363 (0.0)
30-34.9	2405830 (13.8)	300 (0.0)	827 (0.0)	241 (0.0)
35-39.9	930211 (5.3)	130 (0.0)	334 (0.0)	84 (0.0)
≥40	467093 (2.7)	95 (0.0)	208 (0.0)	47 (0.0)
<i>Missing</i>	3765006 (21.6)	142 (0.0)	341 (0.0)	101 (0.0)
Smoking				
Never	5686215 (32.6)	322 (0.0)	724 (0.0)	220 (0.0)
Former	7225197 (41.5)	663 (0.0)	2778 (0.0)	791 (0.0)
Current	3821922 (21.9)	104 (0.0)	492 (0.0)	134 (0.0)
<i>Missing</i>	687498 (3.9)	9 (0.0)	15 (0.0)	7 (0.0)

Ethnicity				
White	10961052 (62.9)	613 (0.0)	2493 (0.0)	693 (0.0)
Black	170729 (1.0)	18 (0.0)	30 (0.0)	10 (0.0)
Asian	1028813 (5.9)	133 (0.0)	277 (0.0)	111 (0.0)
Mixed	342239 (2.0)	71 (0.0)	115 (0.0)	32 (0.0)
Other	320915 (1.8)	44 (0.0)	47 (0.0)	23 (0.0)
<i>Missing</i>	4597084 (26.4)	219 (0.0)	1047 (0.0)	283 (0.0)
IMD quintile				
1 (most deprived)	3342763 (19.2)	224 (0.0)	927 (0.0)	239 (0.0)
2	3479242 (20.0)	268 (0.0)	854 (0.0)	250 (0.0)
3	3483284 (20.0)	228 (0.0)	792 (0.0)	230 (0.0)
4	3478604 (20.0)	174 (0.0)	722 (0.0)	211 (0.0)
5 (least deprived)	3501396 (20.1)	202 (0.0)	697 (0.0)	216 (0.0)
<i>Missing</i>	135543 (0.8)	SMALL N	17 (0.0)	6 (0.0)
Blood pressure				
Normal	5590903 (32.1)	179 (0.0)	831 (0.0)	253 (0.0)
Elevated	2504371 (14.4)	138 (0.0)	655 (0.0)	186 (0.0)
High Stage 1	5569836 (32.0)	426 (0.0)	1298 (0.0)	365 (0.0)
High Stage 2	3755722 (21.6)	355 (0.0)	1225 (0.0)	348 (0.0)
<i>Missing</i>	0 (0.0)	0 (.)	0 (.)	0 (.)
Comorbidities				
Respiratory disease ex asthma				
Present	715539 (4.1)	96 (0.0)	948 (0.1)	286 (0.0)
Absent	16705293 (95.9)	1002 (0.0)	3061 (0.0)	866 (0.0)
Asthma				
Present	1481350 (8.5)	171 (0.0)	538 (0.0)	172 (0.0)
Absent	15939482 (91.5)	927 (0.0)	3471 (0.0)	980 (0.0)
Chronic heart disease				

Present	1180379 (6.8)	148 (0.0)	1467 (0.1)	439 (0.0)
Absent	16240453 (93.2)	950 (0.0)	2542 (0.0)	713 (0.0)
Diabetes				
Present	1732099 (9.9)	350 (0.0)	1722 (0.1)	494 (0.0)
Absent	15688733 (90.1)	748 (0.0)	2287 (0.0)	658 (0.0)
Cancer ex haem				
Present	82118 (0.5)	7 (0.0)	77 (0.1)	31 (0.0)
Absent	17338714 (99.5)	1091 (0.0)	3932 (0.0)	1121 (0.0)
Canc haem/apl anaem/bone marrow transplant				
Present	67801 (0.4)	17 (0.0)	98 (0.1)	25 (0.0)
Absent	17353031 (99.6)	1081 (0.0)	3911 (0.0)	1127 (0.0)
Liver disease				
Present	114796 (0.7)	SMALL N	81 (0.1)	26 (0.0)
Absent	17306036 (99.3)	1093 (0.0)	3928 (0.0)	1126 (0.0)
Stroke/dementia				
Present	377601 (2.2)	41 (0.0)	702 (0.2)	172 (0.0)
Absent	17043231 (97.8)	1057 (0.0)	3307 (0.0)	980 (0.0)
Other neurology dis				
Present	172934 (1.0)	13 (0.0)	213 (0.1)	59 (0.0)
Absent	17247898 (99.0)	1085 (0.0)	3796 (0.0)	1093 (0.0)
Organ transplant				
Present	20210 (0.1)	10 (0.0)	34 (0.2)	SMALL N
Absent	17400622 (99.9)	1088 (0.0)	3975 (0.0)	1148 (0.0)
Spleen diseases				
Present	28261 (0.2)	SMALL N	19 (0.1)	8 (0.0)
Absent	17392571 (99.8)	1094 (0.0)	3990 (0.0)	1144 (0.0)
Rheumatoid/Lupus/Psoriasis				
Present	886338 (5.1)	87 (0.0)	377 (0.0)	123 (0.0)
Absent	16534494 (94.9)	1011 (0.0)	3632 (0.0)	1029 (0.0)

Table 2: Age and sex adjusted, and fully adjusted hazard ratios from stratified cox regression. *Ethnicity does not feature in the main fully adjusted model due to missing data. Hazard ratios are derived from a separate complete case fully adjusted model.

	CPNS Death HR (95% CI)	
	Age-sex adj	Fully adj
Age		
18-<40	0.05 (0.03-0.08)	0.06 (0.04-0.09)
40-<50	0.28 (0.21-0.36)	0.31 (0.23-0.41)
50-<60	1.00 (ref)	1.00 (ref)
60-<70	2.76 (2.36-3.23)	2.32 (1.99-2.72)
70-<80	8.36 (7.27-9.63)	6.05 (5.25-6.99)
80+	27.06 (23.63-30.98)	17.01 (14.77-19.59)
Sex		
Female	1.00 (ref)	1.00 (ref)
Male	2.31 (2.16-2.47)	1.98 (1.85-2.12)
BMI (kg/m2)		
<40	1.00 (ref)	1.00 (ref)
≥40	3.33 (2.88-3.84)	2.41 (2.08-2.79)
Smoking *		
Non-smoker	1.00 (ref)	1.00 (ref)
Current	0.90 (0.82-0.99)	0.80 (0.72-0.88)
Ethnicity**		
White	1.00 (ref)	1.00 (ref)
Black	1.89 (1.30-2.75)	1.68 (1.15-2.45)
Asian	2.01 (1.76-2.30)	1.52 (1.32-1.74)
Mixed	2.18 (1.79-2.65)	1.78 (1.45-2.17)
Other	1.45 (1.07-1.95)	1.35 (1.00-1.82)

IMD quintile		
1 (most deprived)	1.00 (ref)	1.00 (ref)
2	0.78 (0.70-0.85)	0.83 (0.75-0.91)
3	0.64 (0.58-0.71)	0.72 (0.65-0.79)
4	0.55 (0.50-0.61)	0.64 (0.58-0.71)
5 (least deprived)	0.48 (0.44-0.54)	0.58 (0.53-0.65)
Blood pressure *		
Normal	1.00 (ref)	1.00 (ref)
High	0.73 (0.68-0.77)	0.79 (0.74-0.84)
Co-morbidities		
Respiratory disease ex asthma	2.35 (2.18-2.53)	1.87 (1.72-2.02)
Asthma	1.63 (1.49-1.79)	1.25 (1.14-1.38)
Chronic heart disease	1.86 (1.74-2.00)	1.40 (1.30-1.50)
Diabetes	2.39 (2.24-2.55)	1.98 (1.86-2.12)
Cancer ex haem	1.64 (1.31-2.05)	1.54 (1.23-1.93)
Canc haem/ apl anaem /bone mrrw transpl	2.64 (2.16-3.23)	1.48 (1.20-1.82)
Liver disease	2.33 (1.87-2.91)	1.68 (1.34-2.10)
Stroke/ dementia	2.24 (2.06-2.43)	1.80 (1.65-1.96)
Other neurological	2.65 (2.31-3.05)	2.22 (1.93-2.56)
Organ transplant	7.09 (5.05-9.94)	5.19 (3.68-7.32)
Spleen diseases	2.04 (1.30-3.21)	1.73 (1.10-2.71)
Rheumatoid/Lupus/ Psoriasis	1.40 (1.26-1.56)	1.26 (1.13-1.40)

* Smoking and hypertension: we suspect these surprising findings may be explained by the inclusion of ex-smokers in the non-smoker group; and our coding blood pressure as most

recent reading rather than a diagnosis of hypertension (as the latter combines pathology with health-seeking behaviour); we are now conducting further additional rapid analyses to assess these issues.

** Based on the 73.6% of participants with ethnicity recorded.

