

# ICNARC report on COVID-19 in critical care: England, Wales and Northern Ireland 8 April 2022

This report presents analyses of data on patients critically ill with confirmed COVID-19, admitted up to 23:59 on 31 March 2022 (reported to ICNARC by 23:59 on 7 April 2022), from critical care units participating in the Case Mix Programme (the national clinical audit covering all NHS adult, general intensive care and combined intensive care/high dependency units in England, Wales and Northern Ireland, plus some additional specialist and non-NHS critical care units) and increasing numbers of surge/other areas providing critical care.

Data are reported separately for patients critically ill with confirmed COVID-19 either at or after the admission to critical care:

- admitted from 1 May 2021 to date; and
- admitted from 1 September 2020 to 30 April 2021.

For additional reporting on patients admitted up to 31 August 2020, please see the report dated 5 July 2021 available from <https://www.icnarc.org/Our-Audit/Audits/Cmp/Reports>.

Please note that adult critical care units in Scotland, paediatric intensive care units and neonatal intensive care units do not participate in the Case Mix Programme.

## Reporting process

Critical care units/areas participating in the Case Mix Programme are asked to:

- log a case with ICNARC by submitting a record, with minimal data, as soon as they have an admission with confirmed COVID-19;
- resubmit data, including first 24-hour physiology, as soon as possible after the end of the first 24 hours in critical care;
- resubmit data for the whole critical care stay, including critical care outcome and organ support, when the patient leaves critical care; and
- submit final data when the patient leaves acute hospital.

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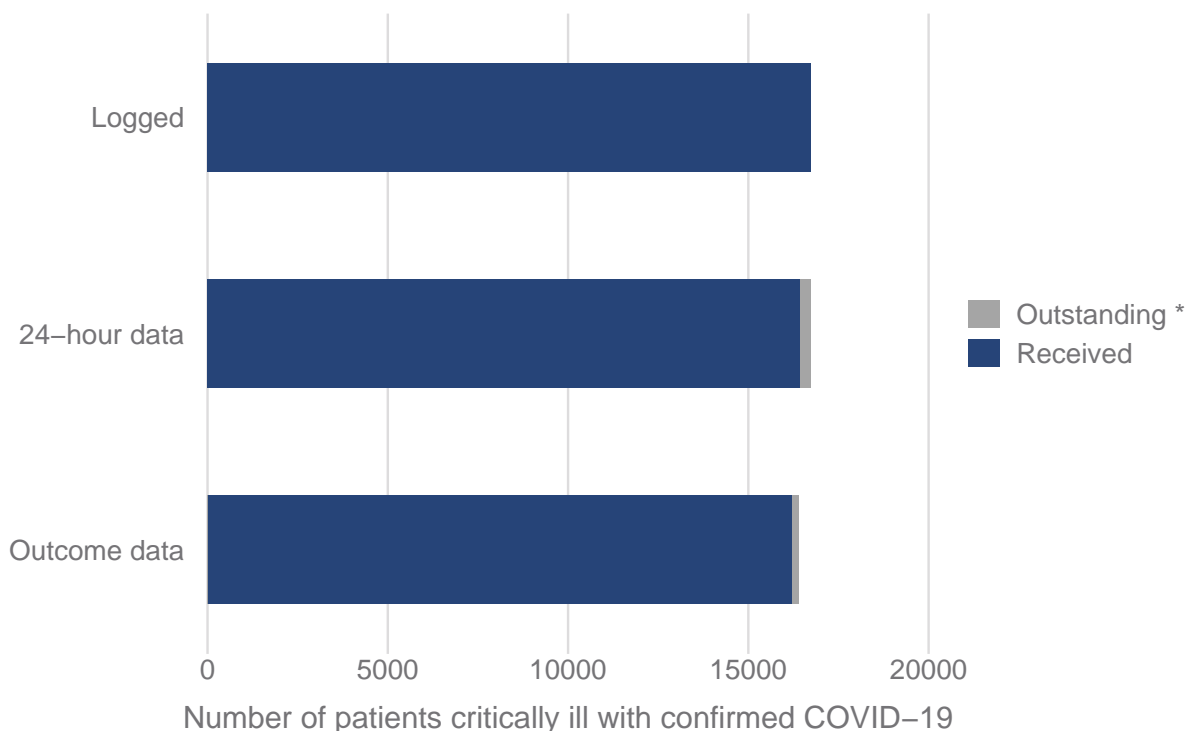
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\* Please see individual notes for Figures/Tables.

## Admissions to critical care – COVID-19

ICNARC have logged data for 19,199 admissions of 16,727 patients critically ill with confirmed COVID-19, either at or after admission to critical care, admitted from 1 May 2021 to date in England, Wales and Northern Ireland. Of these, data covering the first 24 hours of critical care have been submitted to ICNARC for 16,422 patients (Figure 1). Of the 16,727 total patients, 16,198 have outcomes reported and 529 patients were last reported as still receiving critical care. These patients are compared with a cohort of 25,847 patients with confirmed COVID-19 admitted from 1 September 2020 to 30 April 2021.



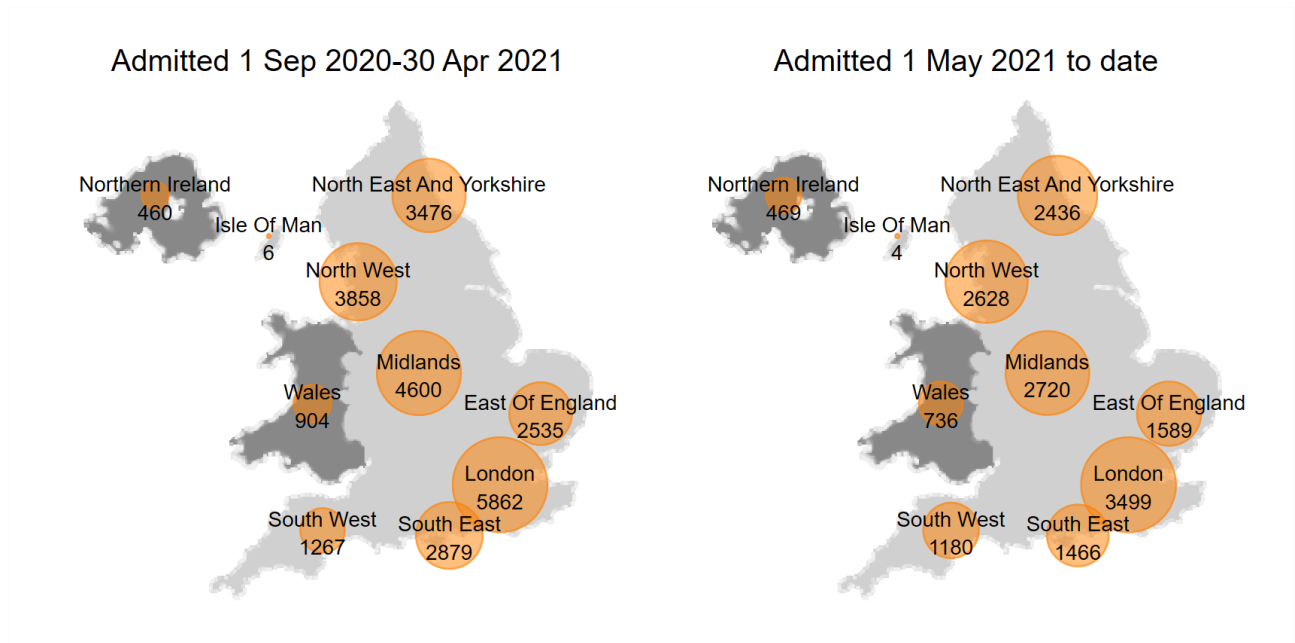
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### Figure 1. Numbers of patients with data included in this report and outstanding \*

Numbers of critically ill patients with confirmed COVID-19 admitted from 1 May 2021 to date with data included in this report and outstanding \*.

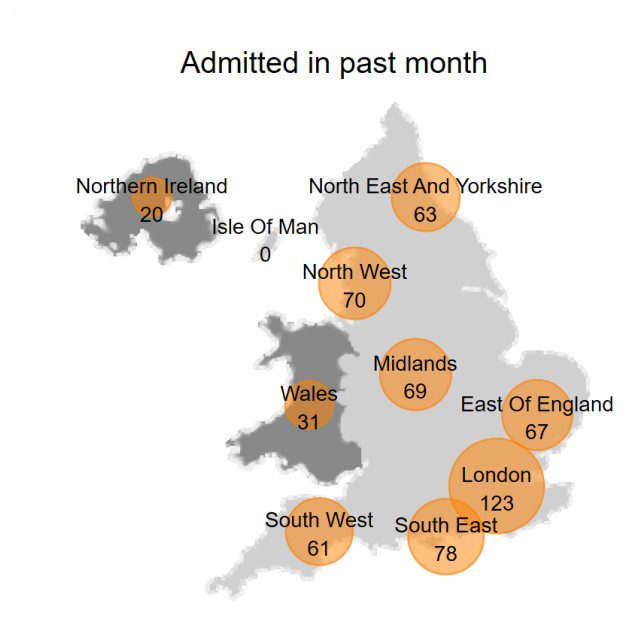
\* Please note that 24-hour data are considered outstanding when a case was logged at least 48 hours previously and outcome data are considered outstanding when 24-hour data have been received and at least 10 days have elapsed since the admission to critical care.

The geographical distribution of patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to date by NHS region is shown in Figure 2 and compared with those admitted from 1 September 2020 to 30 April 2021. Of the patients included in this month's report, 582 patients were admitted to critical care within the last month (1 March 2022 to 31 March 2022). The geographical spread of these patients is shown in Figure 3.



**Figure 2. Geographical distribution**

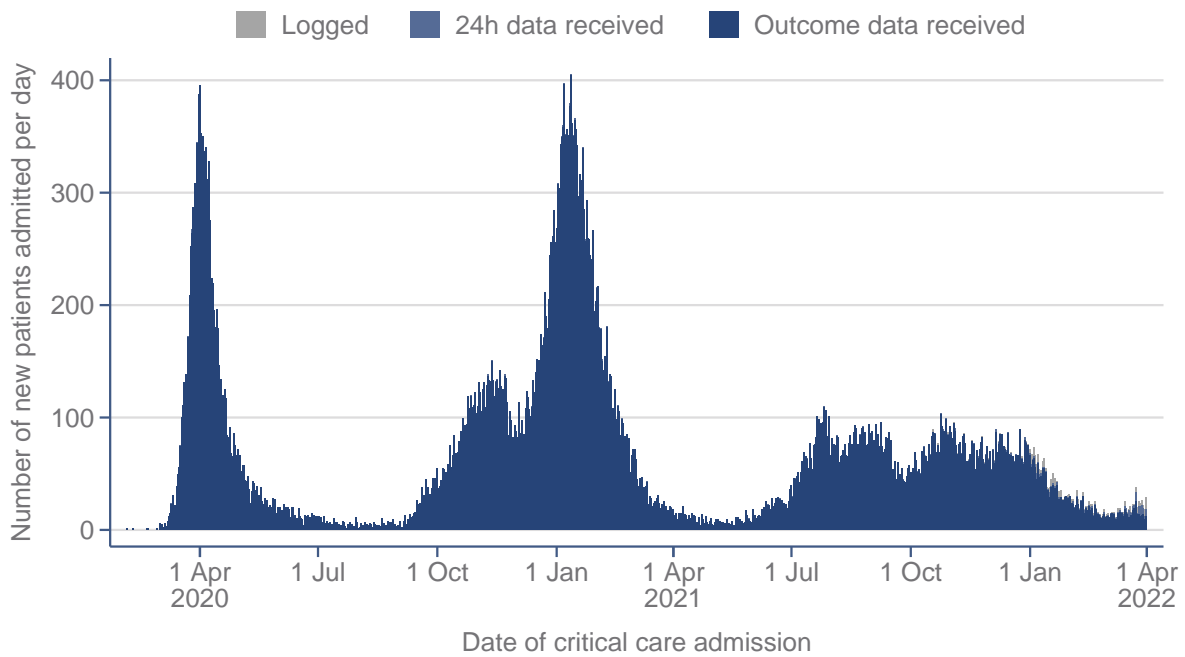
Geographical distribution of patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to date compared with those admitted from 1 September 2020 to 30 April 2021 by NHS region.



**Figure 3. Geographical distribution – last month**

Geographical distribution of patients critically ill with confirmed COVID-19 admitted during the last month by NHS region.

The numbers of new patients, cumulative numbers of patients and numbers of patients in critical care by date are shown in Figures 4-13. Please note that these figures are affected by a variable lag time for submission of data.

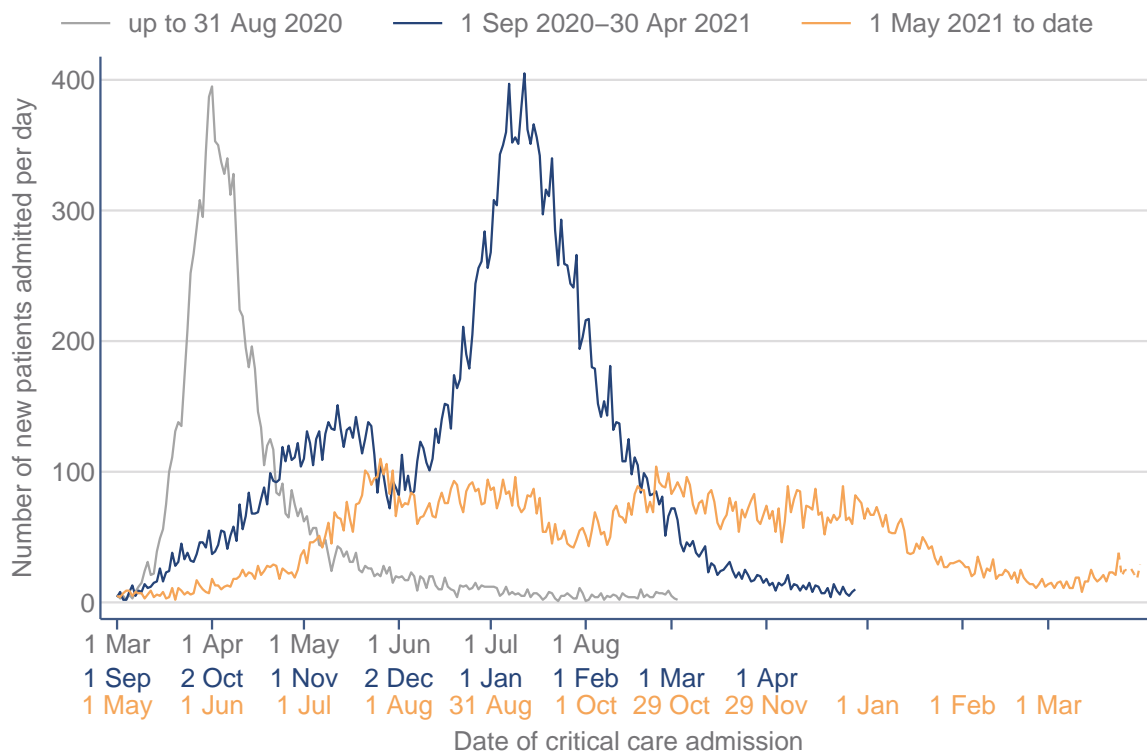


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#### **Figure 4. Number of new patients by date of admission to critical care**

Number of new patients critically ill with confirmed COVID-19 by date of admissions to critical care over the entire epidemic.



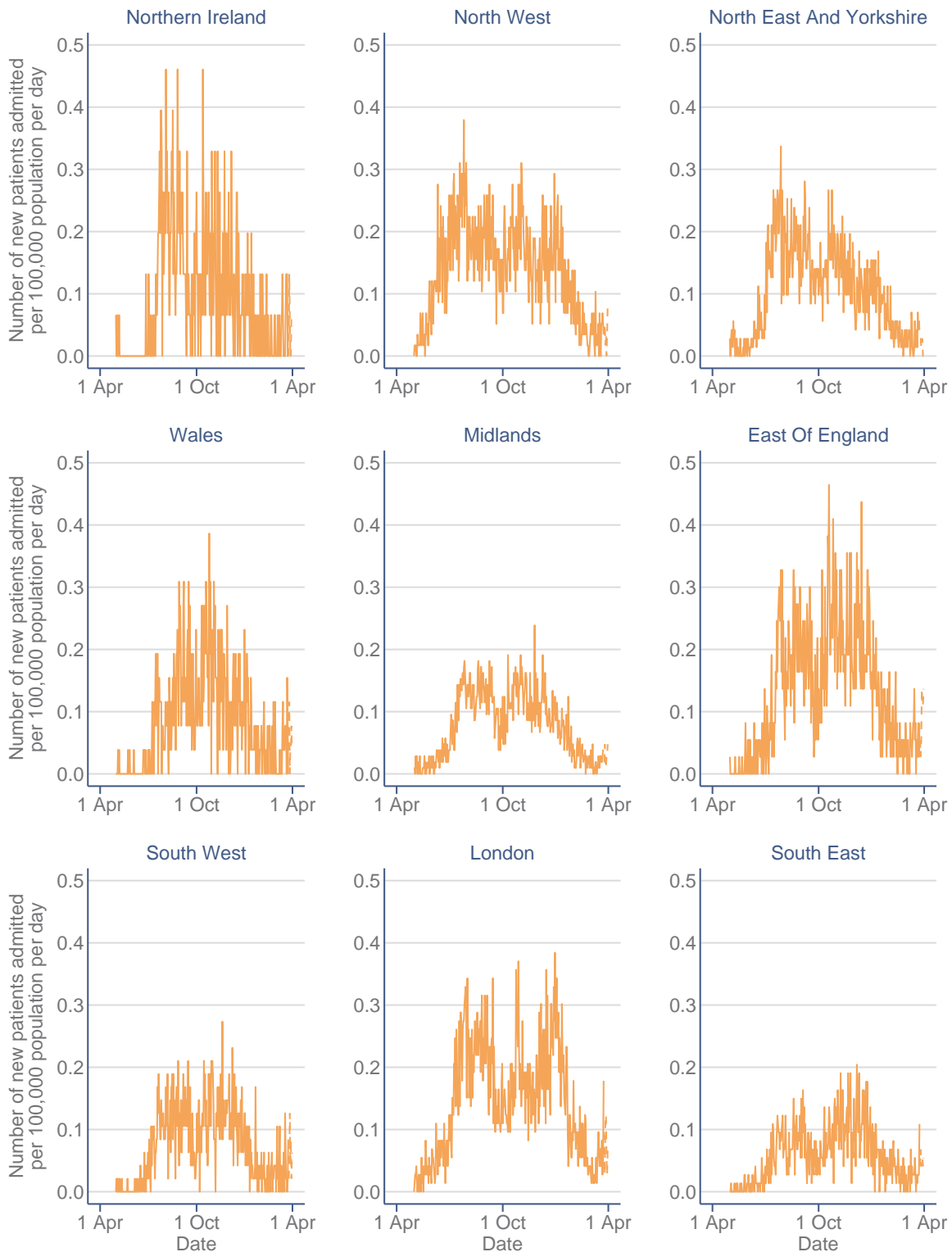


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### Figure 5. Number of new patients admitted by time period \*

Comparison of the number of new patients critically ill with confirmed COVID-19 by date of admission to critical care from 1 May 2021 to date compared with 1 September 2020 to 30 April 2021 and 1 March 2020 to 31 August 2020.

\* Dashed line indicates lag in data submission.

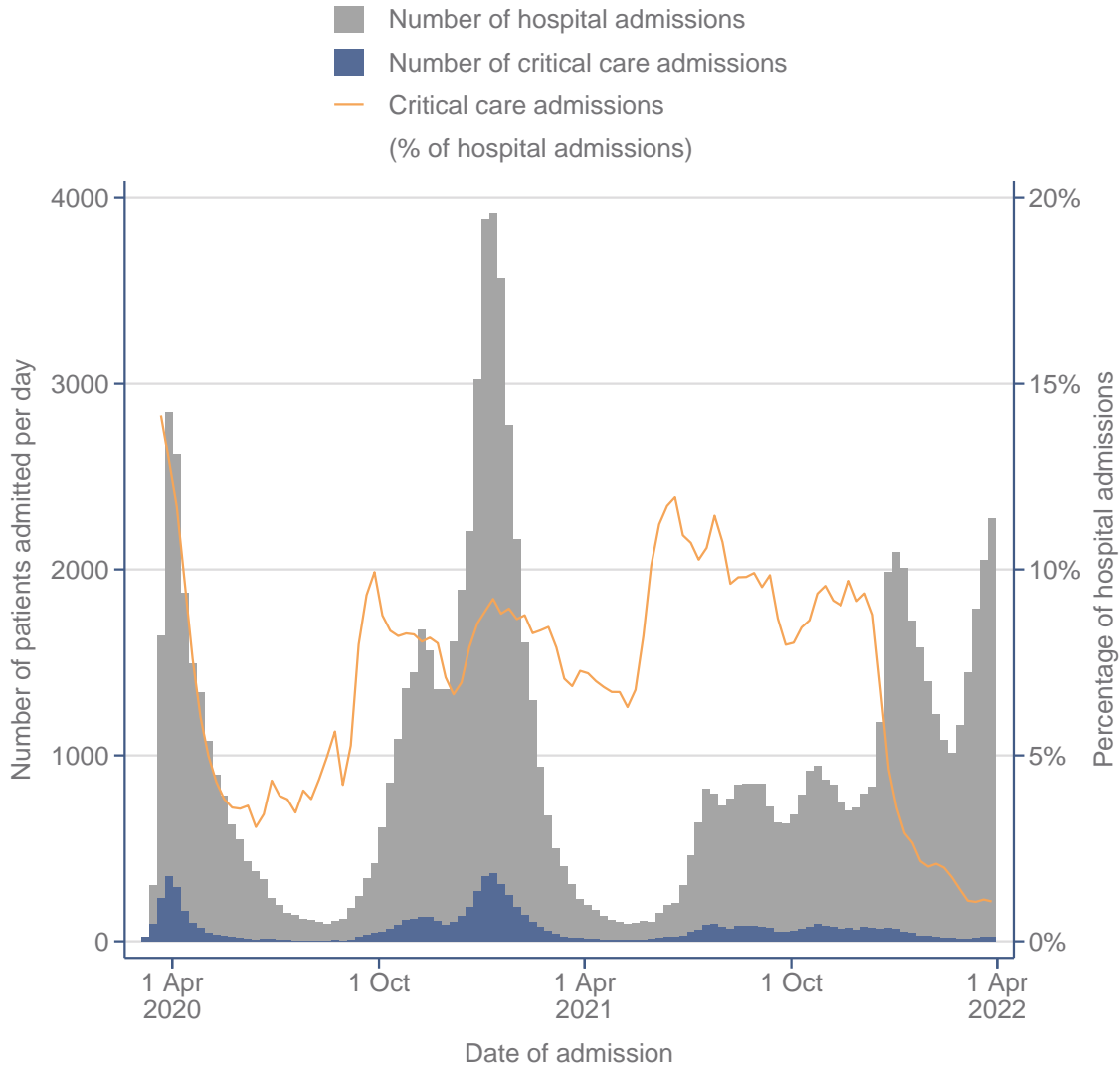


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**Figure 6. Number of new patients admitted from 1 May 2021 to date by region \***

Number of new patients critically ill with confirmed COVID-19 by date of admission to critical care from 1 May 2021 to date by region.

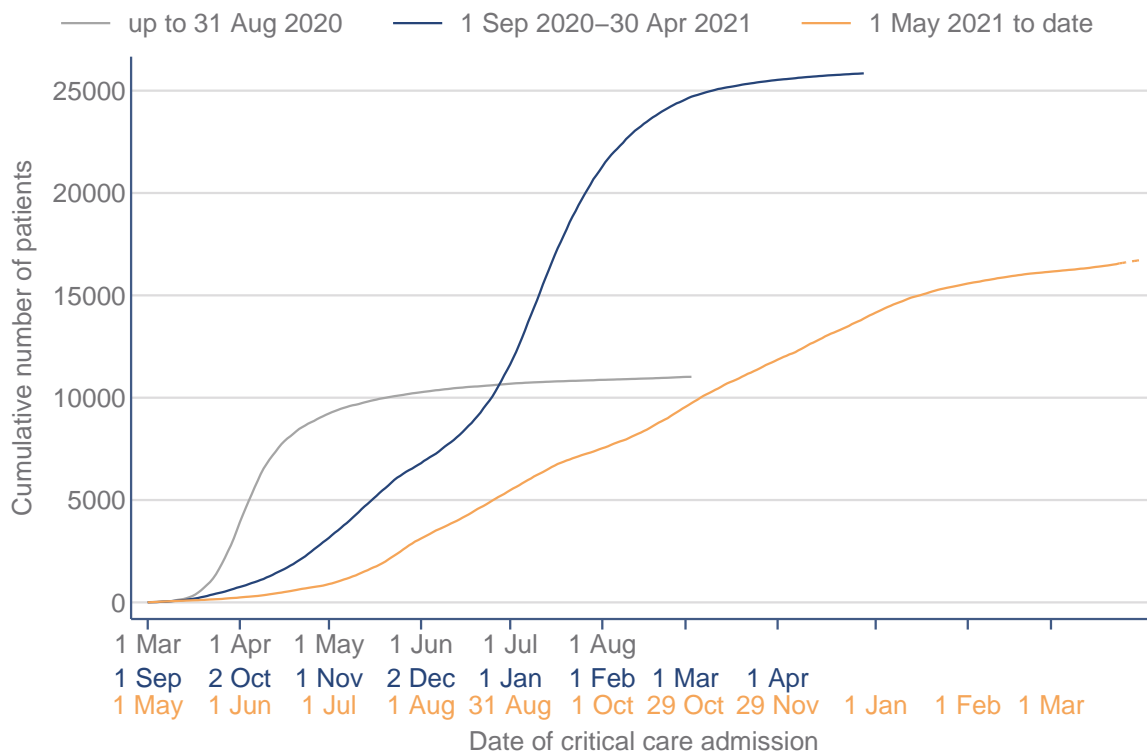
\* Dashed line indicates lag in data submission.



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**Figure 7. Number of new patients admitted to critical care compared with hospital admissions**

Comparison of the number of new patients critically ill with confirmed COVID-19 by date of admission to critical care versus the total number of hospital admissions (source: <https://coronavirus.data.gov.uk/details/healthcare>).

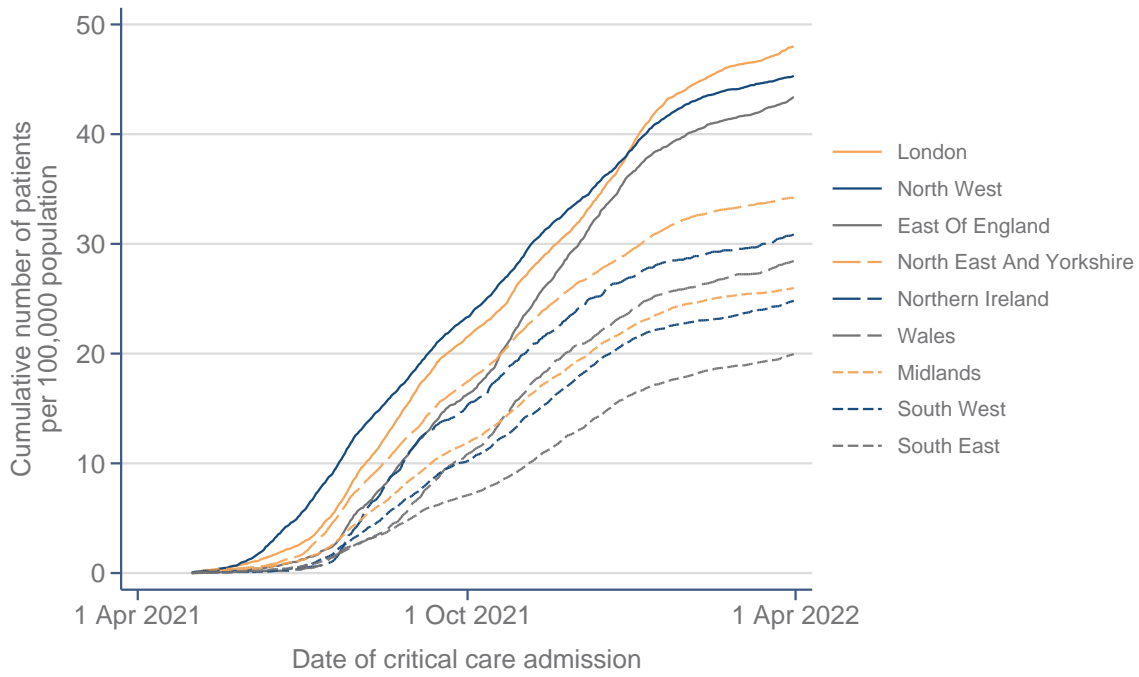


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**Figure 8. Cumulative number of patients by time period \***

Comparison of the cumulative number of patients critically ill with confirmed COVID-19 by date of admission to critical care from 1 May 2021 to date compared with 1 September 2020 to 30 April 2021 and 1 March 2020 to 31 August 2020.

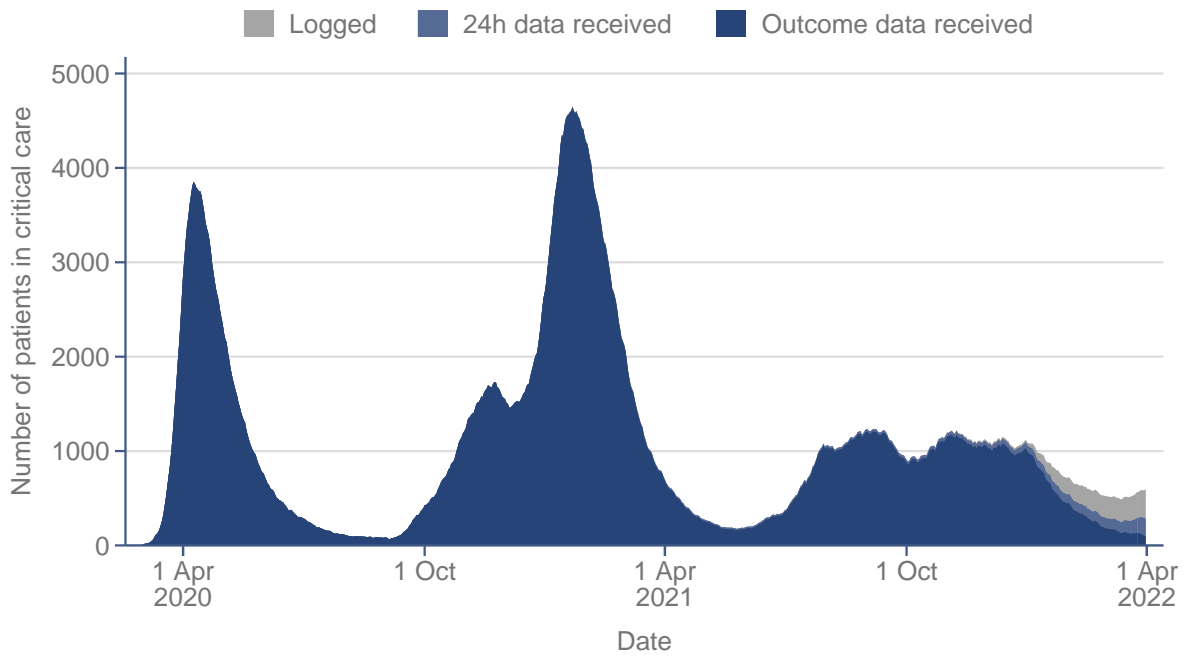
\* Dashed line indicates lag in data submission.



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### Figure 9. Cumulative number of patients per 100,000 adult population by region

Cumulative number of patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to date per 100,000 adult population by region.

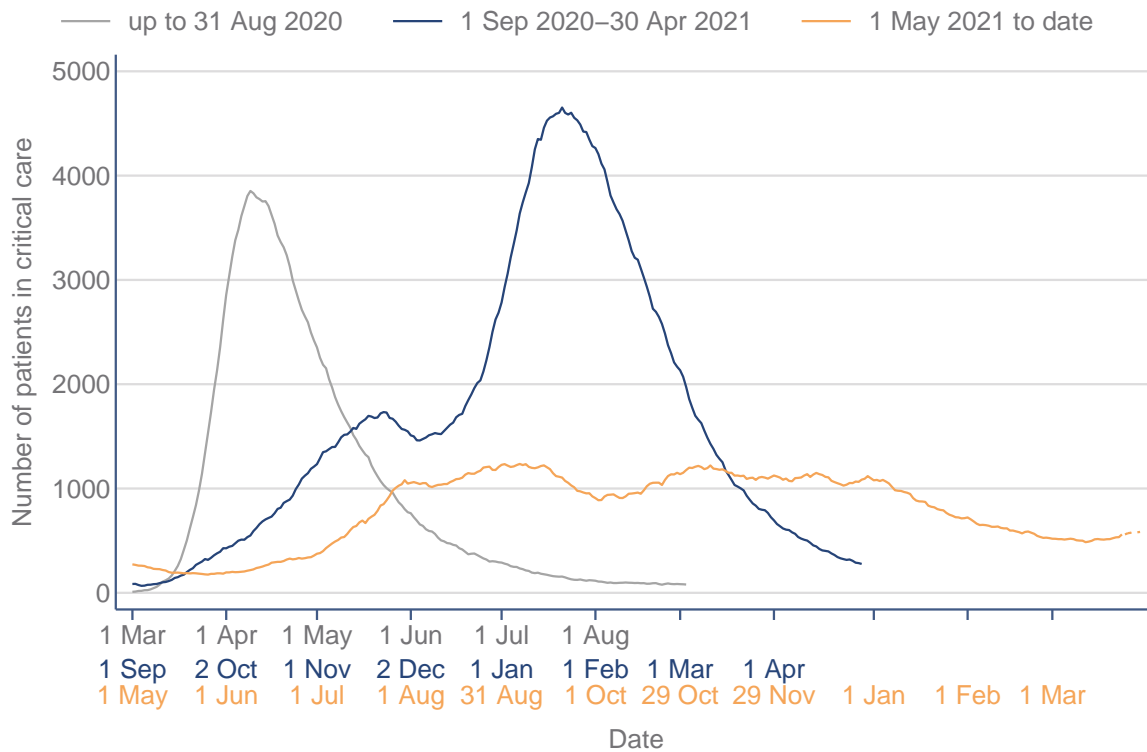


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### Figure 10. Number of patients in critical care \*

Number of patients with confirmed COVID-19 in critical care \* by date over the entire epidemic.

\* Please note patients whose outcome data have not been received are assumed to remain in critical care as of 31 March 2022.

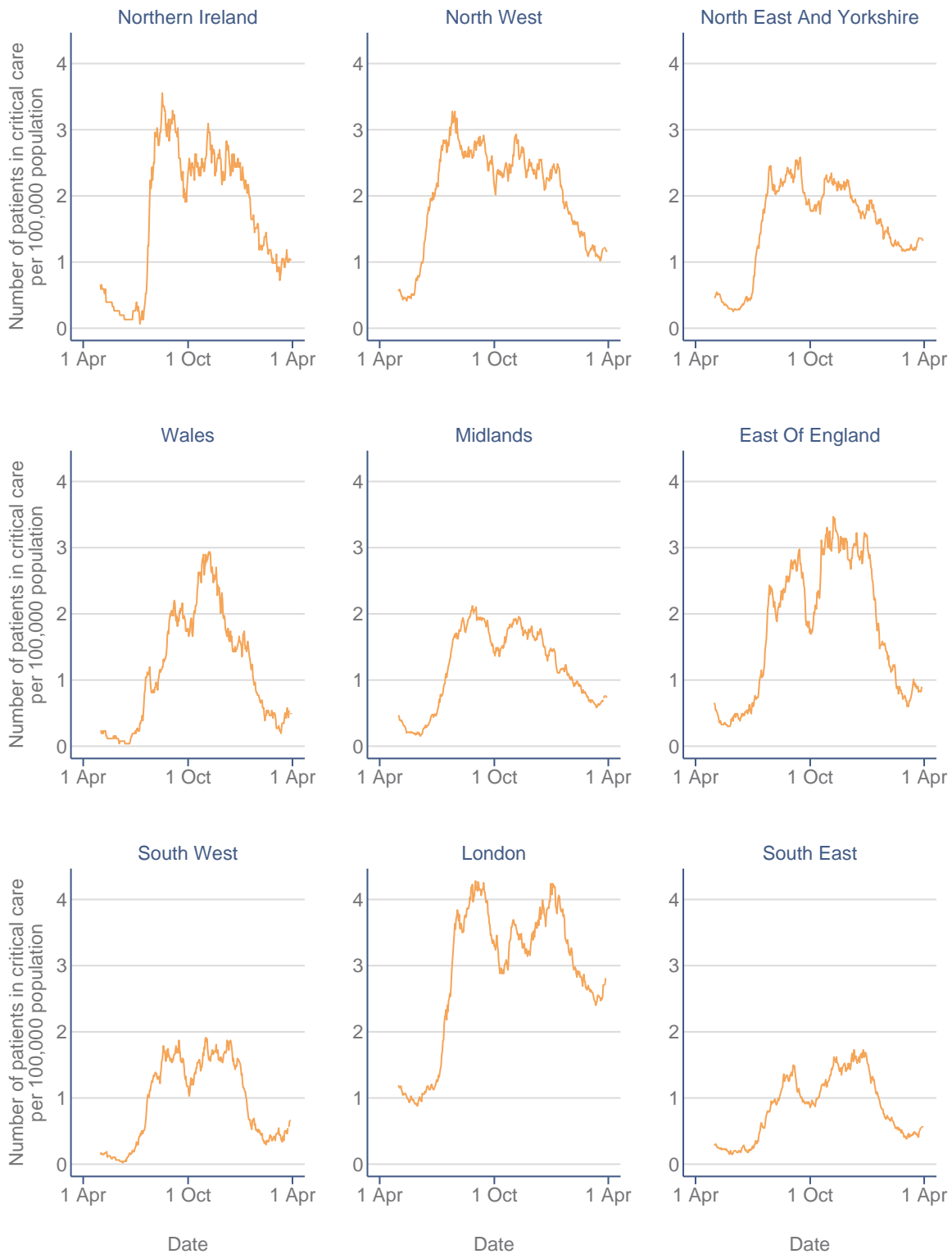


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**Figure 11. Number of patients in critical care \* by time period**

Number of patients with confirmed COVID-19 in critical care \* by date from 1 May 2021 to date compared with 1 September 2020 to 30 April 2021 and 1 March 2020 to 31 August 2020.

\* Please note patients whose outcome data have not been received are assumed to remain in critical care as of 31 March 2022. Dashed line indicates lag in data submission.



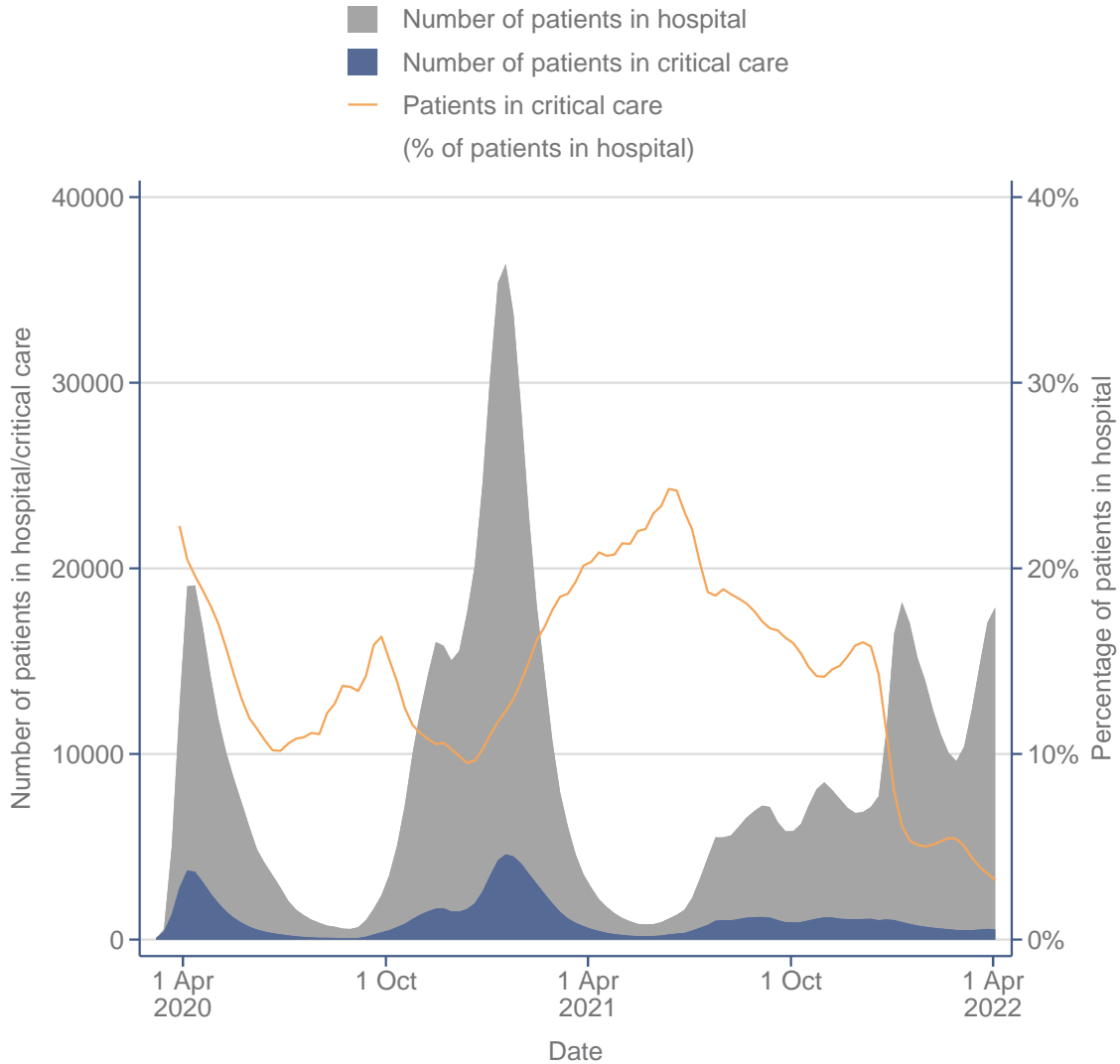
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**Figure 12. Number of patients in critical care \* from 1 May 2021 to date by region**

Number of patients with confirmed COVID-19 in critical care \* by date from 1 May 2021 to date by region.

\* Please note patients whose outcome data have not been received are assumed to remain in critical care as of 31 March 2022. Dashed line indicates lag in data submission.





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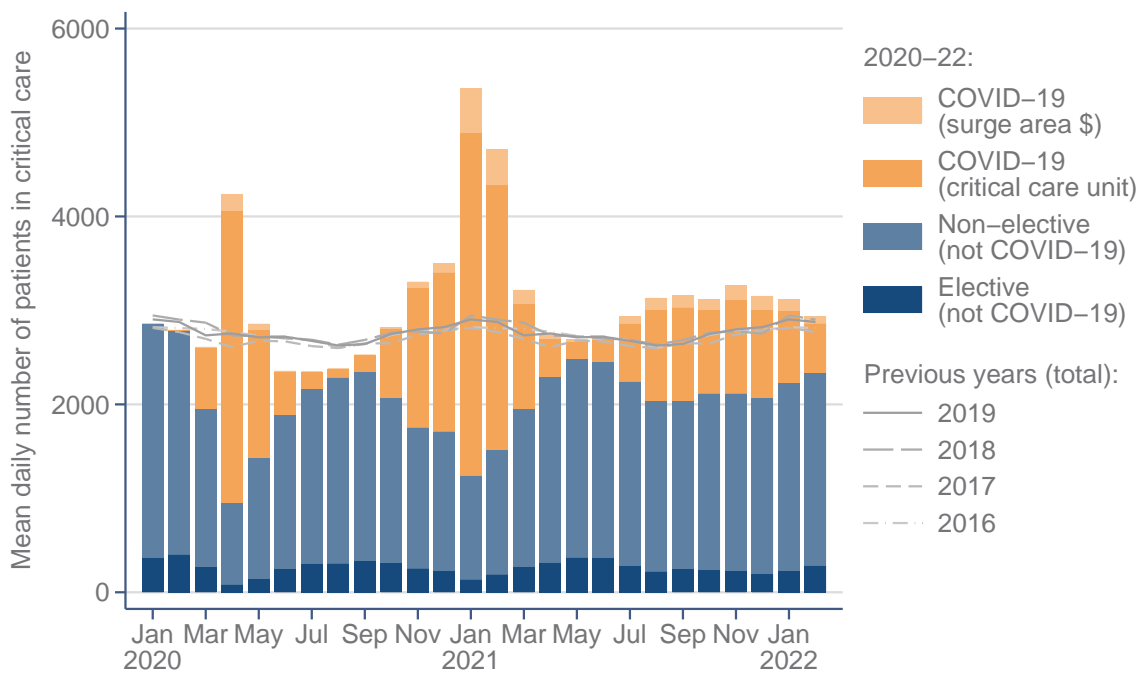
**Figure 13. Number of patients in critical care compared with number in hospital**

Comparison of the number of patients with confirmed COVID-19 in critical care by date \* versus the total number in hospital (source: <https://coronavirus.data.gov.uk/details/healthcare>).

\* Please note patients whose outcome data have not been received are assumed to remain in critical care as of 31 March 2022.

## Admissions to critical care – COVID-19 and non-COVID-19

Figure 14 shows the average daily number of patients in critical care for each month over the past five years. For 2020-22, this is broken down into the numbers of: elective admissions (not COVID-19) – those admitted directly following elective or scheduled surgery or for a planned medical procedure; non-elective admissions (not COVID-19); confirmed COVID-19 admitted to a critical care unit; and confirmed COVID-19 managed in a surge area outside of an established critical care unit.



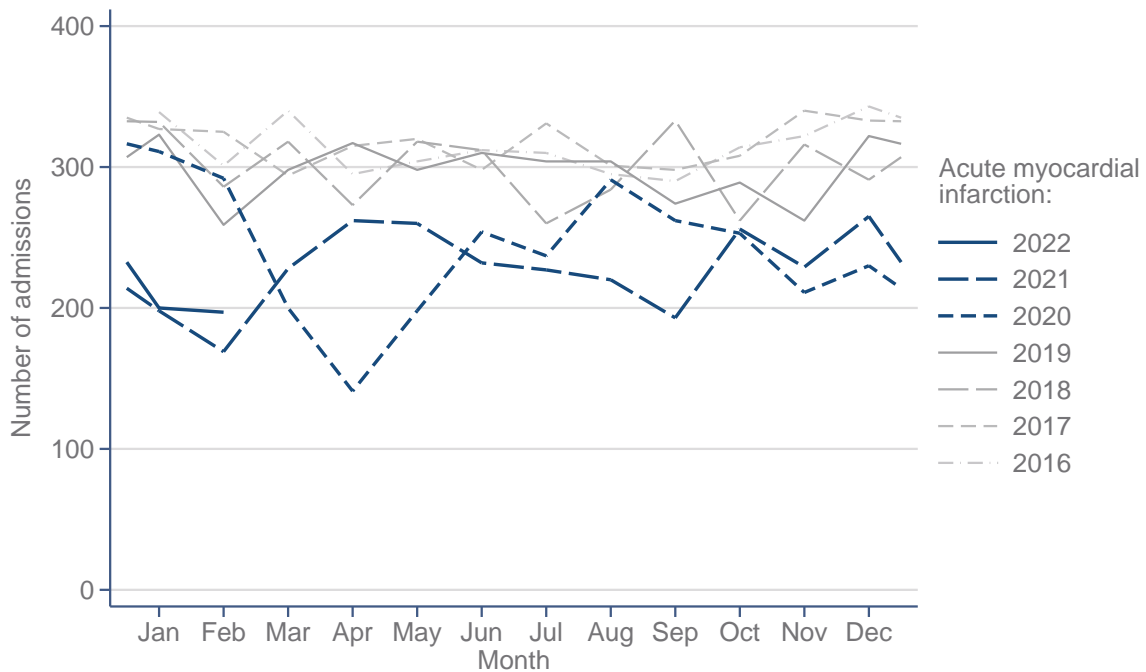
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**Figure 14. Average daily number of patients in critical care by month, 2016-2021 \***

\* Please note that data for patients without COVID-19 are submitted by participating critical care units either monthly or quarterly. Values have been adjusted for coverage.

\$ Not all surge patients are identifiable from critical care unit data and not all surge areas are covered.

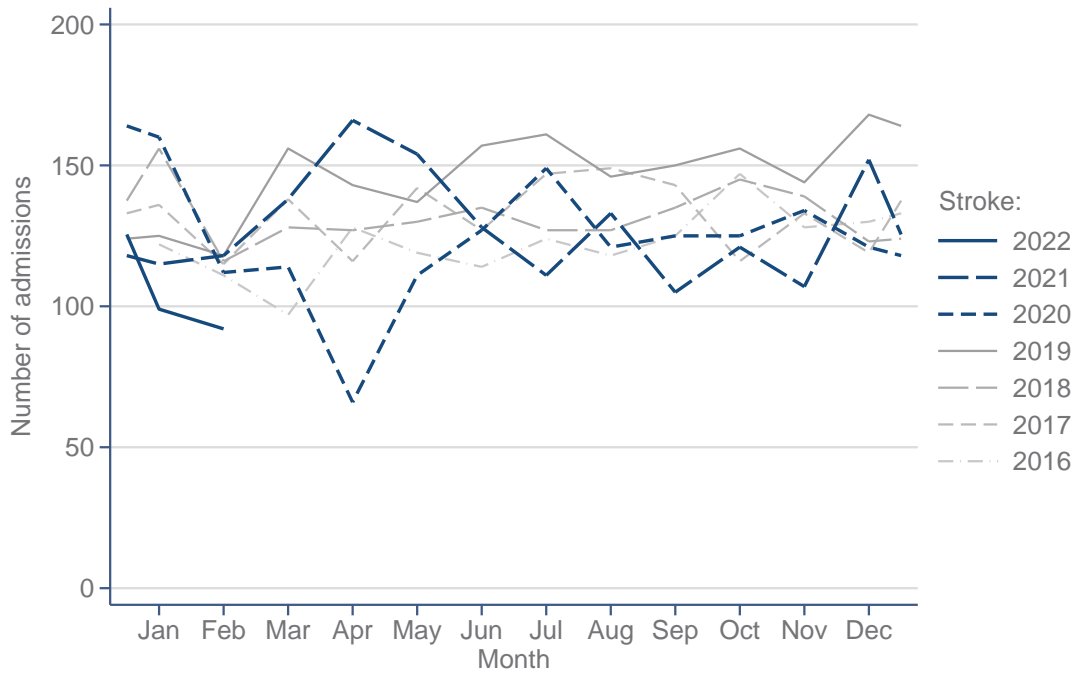
The numbers of admissions with acute myocardial infarction, stroke, trauma and self-harm (with drugs or other substances) recorded as primary or secondary reason for admission to critical care (with or without recording of COVID-19 as the other reason for admission) are shown in Figures 15 to 18.



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**Figure 15. Number of admissions with acute myocardial infarction by month, 2016-2021 \***

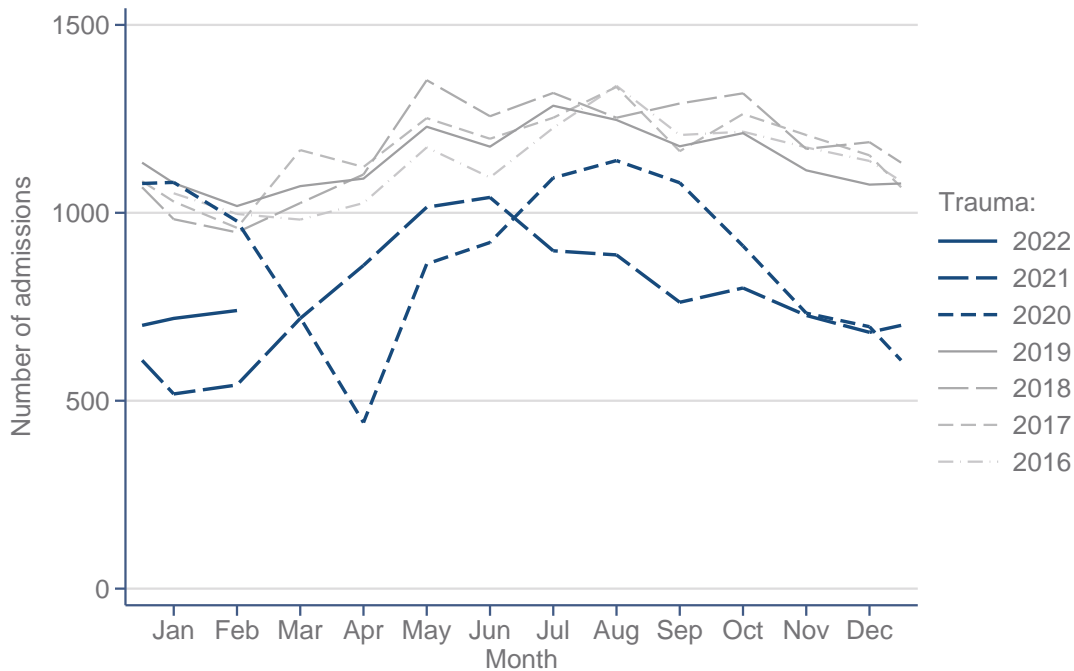
\* Please note that data for patients without COVID-19 are submitted by participating critical care units either monthly or quarterly. Values have been adjusted for coverage.



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**Figure 16. Number of admissions with stroke by month, 2016-2021 \***

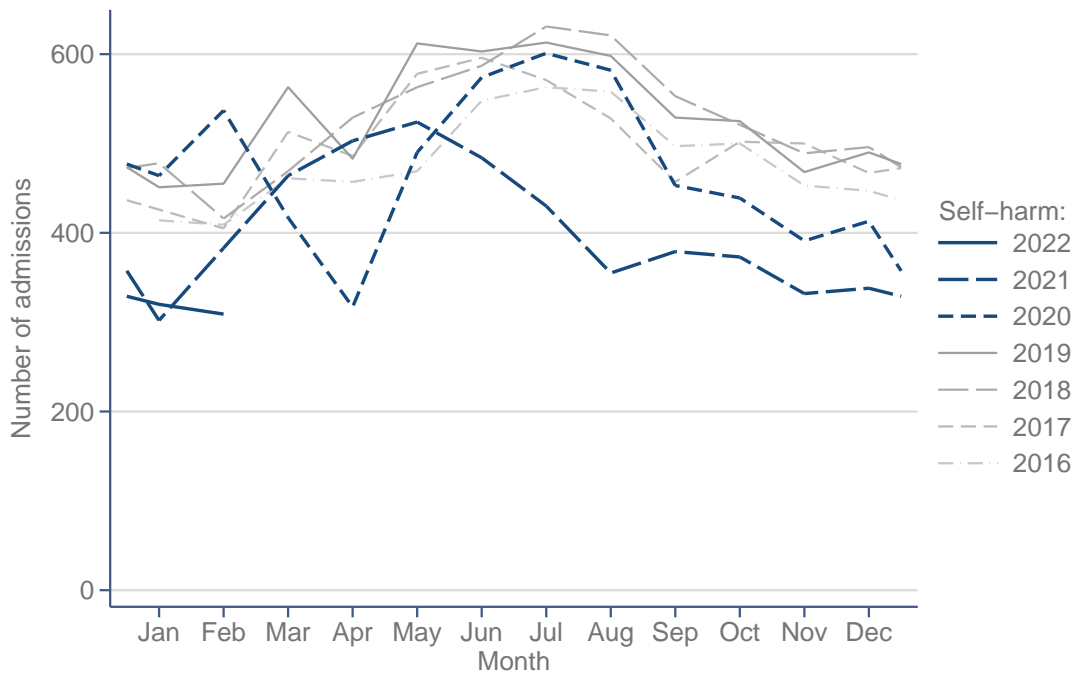
\* Please note that data for patients without COVID-19 are submitted by participating critical care units either monthly or quarterly. Values have been adjusted for coverage.



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**Figure 17. Number of admissions with trauma by month, 2016-2021 \***

\* Please note that data for patients without COVID-19 are submitted by participating critical care units either monthly or quarterly. Values have been adjusted for coverage.



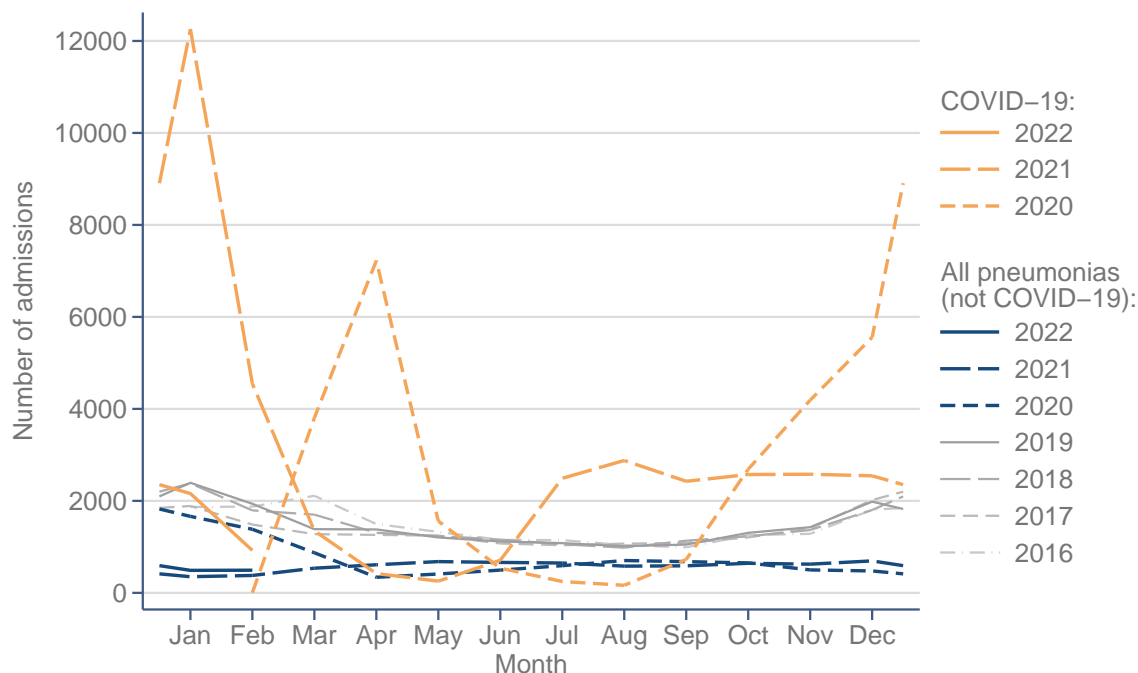
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**Figure 18. Number of admissions with self-harm (drugs or other substances) by month, 2016-2021 \***

\* Please note that data for patients without COVID-19 are submitted by participating critical care units either monthly or quarterly. Values have been adjusted for coverage.

## Admissions to critical care – pneumonia (not COVID-19)

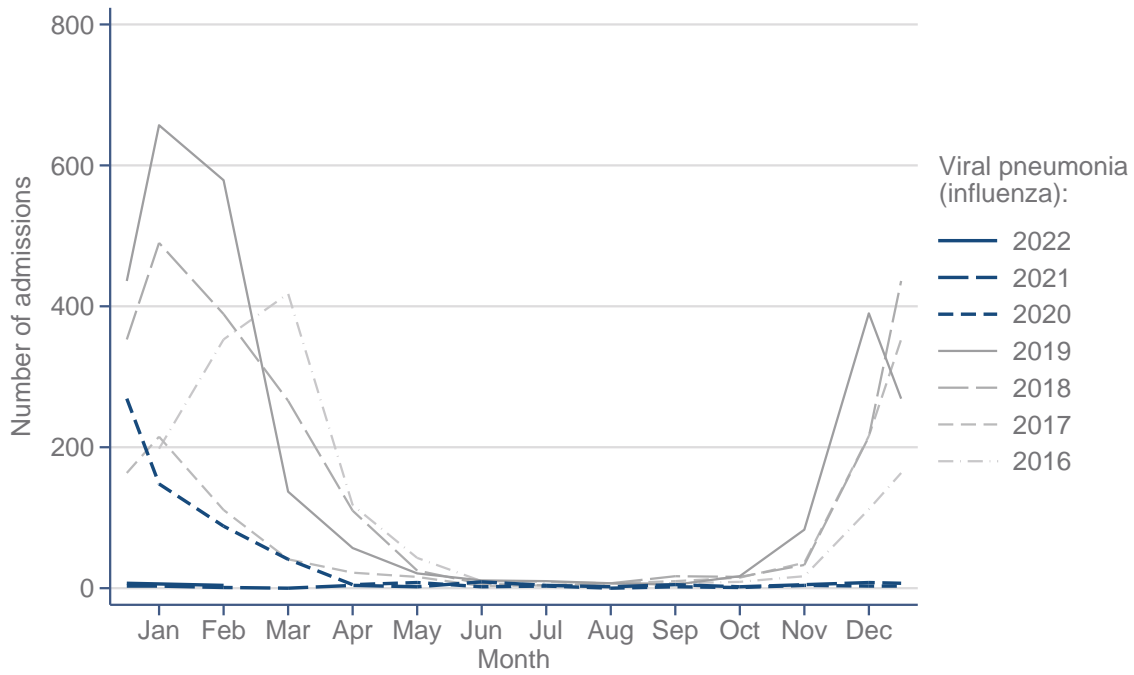
Figure 19 shows the total numbers of admissions to critical care over the past five years by month of admission reported as due to pneumonia (not COVID-19), compared with the numbers with confirmed COVID-19. Figure 20 shows the number of these pneumonia admissions that were specifically coded as due to influenza. Note that not all admissions due to influenza will be coded as viral pneumonia (influenza) as if the organism has not yet been identified, then these will likely be coded under pneumonia (no organism isolated).



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**Figure 19. Number of admissions with pneumonia (not COVID-19) by month, 2016-2021 \*, compared with confirmed COVID-19 during 2020**

\* Please note that data for patients without COVID-19 are submitted by participating critical care units either monthly or quarterly. Values have been adjusted for coverage.



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**Figure 20. Number of admissions with viral pneumonia (influenza) by month, 2016-2021 \***

\* Please note that data for patients without COVID-19 are submitted by participating critical care units either monthly or quarterly. Values have been adjusted for coverage.

## Patient characteristics

Characteristics of patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to date are summarised in Tables 1-3 and compared with those admitted from 1 September 2020 to 30 April 2021.

**Table 1. Patient characteristics: demographics**

Demographics	Patients with confirmed COVID-19	
	Admitted 1 May 2021 to date (N=16,727)	Admitted 1 Sep 2020-30 Apr 2021 (N=25,847)
Age at admission (years) [N=16486]		
Mean (SD)	54.6 (15.8)	59.2 (13.3)
Median (IQR)	56 (43, 67)	60 (51, 69)
Sex, n (%) [N=16486]		
Female	6316 (38.3)	8847 (34.2)
Male	10170 (61.7)	16988 (65.8)
Ethnicity, n (%) [N=15473]		
White	11598 (75.0)	17653 (71.8)
Mixed	245 (1.6)	365 (1.5)
Asian	1565 (10.1)	3969 (16.1)
Black	1180 (7.6)	1320 (5.4)
Other	885 (5.7)	1289 (5.2)
Index of Multiple Deprivation (IMD) quintile *, n (%) [N=16182]		
1 (least deprived)	1826 (11.3)	3136 (12.3)
2	2403 (14.8)	3906 (15.3)
3	2953 (18.2)	4789 (18.7)
4	3925 (24.3)	6204 (24.3)
5 (most deprived)	5075 (31.4)	7545 (29.5)
Urban/rural classification *, n (%) [N=15894]		
Major conurbation	6804 (42.8)	11352 (44.9)
Minor conurbation	703 (4.4)	948 (3.8)
City and town	6462 (40.7)	10158 (40.2)
Rural	1905 (12.0)	2803 (11.1)

\* Please see Definitions on page 95.



**Table 2. Patient characteristics: medical history**

Medical history	Patients with confirmed COVID-19	
	Admitted 1 May 2021 to date (N=16,727)	Admitted 1 Sep 2020-30 Apr 2021 (N=25,847)
Dependency prior to admission to acute hospital, n (%) [N=16054]		
Able to live without assistance in daily activities	14209 (88.5)	22430 (87.8)
Some assistance with daily activities	1768 (11.0)	3044 (11.9)
Total assistance with all daily activities	77 (0.5)	72 (0.3)
Very severe comorbidities *, n (%) [N=16163]		
Cardiovascular	103 (0.6)	168 (0.7)
Respiratory	221 (1.4)	245 (1.0)
Renal	291 (1.8)	419 (1.6)
Liver	165 (1.0)	169 (0.7)
Metastatic disease	121 (0.7)	172 (0.7)
Haematological malignancy	504 (3.1)	437 (1.7)
Immunocompromised	925 (5.7)	915 (3.6)
Body mass index *, n (%) [N=15531]		
<18.5	210 (1.4)	181 (0.7)
18.5-<25	3236 (20.8)	4700 (19.5)
25-<30	4734 (30.5)	7486 (31.0)
30-<40	5429 (35.0)	8932 (37.0)
≥40	1922 (12.4)	2841 (11.8)
CPR within previous 24h, n (%) [N=16326]		
In the community	180 (1.1)	161 (0.6)
In hospital	177 (1.1)	268 (1.0)
Prior hospital length of stay [N=16460]		
Mean (SD)	2.7 (8.2)	3.2 (6.8)
Median (IQR)	1 (0, 3)	1 (0, 4)
Currently or recently pregnant, n (% of females aged 16-49) [N=2621]		
Currently pregnant	356 (13.6)	169 (7.4)
Recently pregnant (within 6 weeks)	300 (11.4)	150 (6.6)
Not known to be pregnant	1965 (75.0)	1971 (86.1)
COVID-19 reported as primary, rather than secondary, reason for admission to critical care †, n (%) [N=16492]	14103 (85.5)	24445 (94.6)

\* Please see Definitions on page 95.

† For patients with COVID-19 reported as secondary reason for admission, COVID-19 may or may not have contributed to the reason for admission.

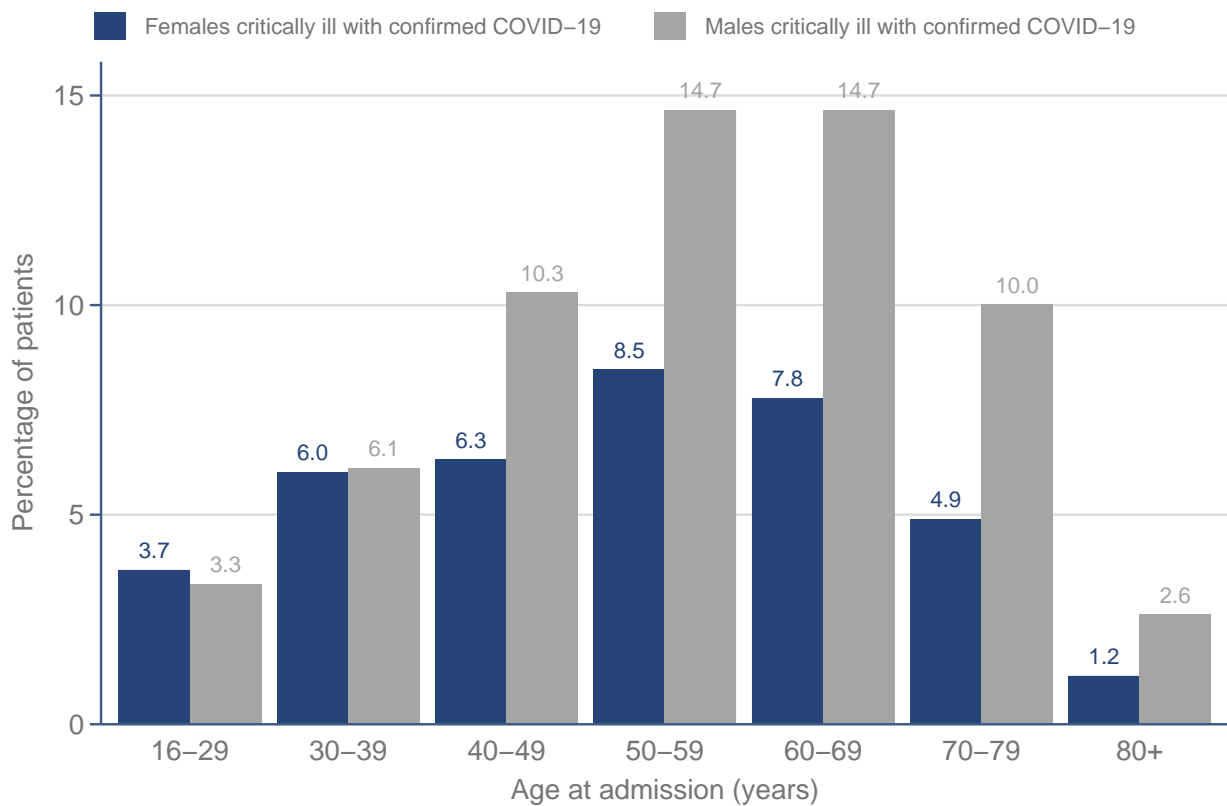
**Table 3. Patient characteristics: indicators of acute severity**

Indicators of acute severity	Patients with confirmed COVID-19 and 24h data received	
	Admitted 1 May 2021 to date (N=16,422)	Admitted 1 Sep 2020-30 Apr 2021 (N=25,847)
Invasively ventilated within first 24h *, n (%) [N=15978]	3828 (24.0)	7871 (30.7)
APACHE II Score [N=16236]		
Mean (SD)	14.1 (5.7)	14.4 (5.2)
Median (IQR)	13 (10, 17)	14 (11, 17)
PaO <sub>2</sub> /FiO <sub>2</sub> ratio † (kPa), median (IQR) [N=15016]	14.0 (10.1, 20.8)	13.0 (9.6, 18.2)
PaO <sub>2</sub> /FiO <sub>2</sub> ratio †, n (%) [N=15016]		
< 13.3 kPa (< 100 mmHg)	6885 (45.9)	12453 (51.9)
13.3-26.6 kPa (100-200 mmHg)	5781 (38.5)	9211 (38.4)
≥ 26.7 kPa (≥ 200 mmHg)	2350 (15.6)	2349 (9.8)
FiO <sub>2</sub> †, median (IQR) [N=15016]	0.60 (0.40, 0.75)	0.60 (0.45, 0.80)

\* Please see Definitions on page 95. Indicators of acute severity are based on data from the first 24 hours of critical care.

† Derived from the arterial blood gas with the lowest PaO<sub>2</sub> during the first 24 hours of critical care.

The distribution of age and sex for patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to date is presented in Figure 21.

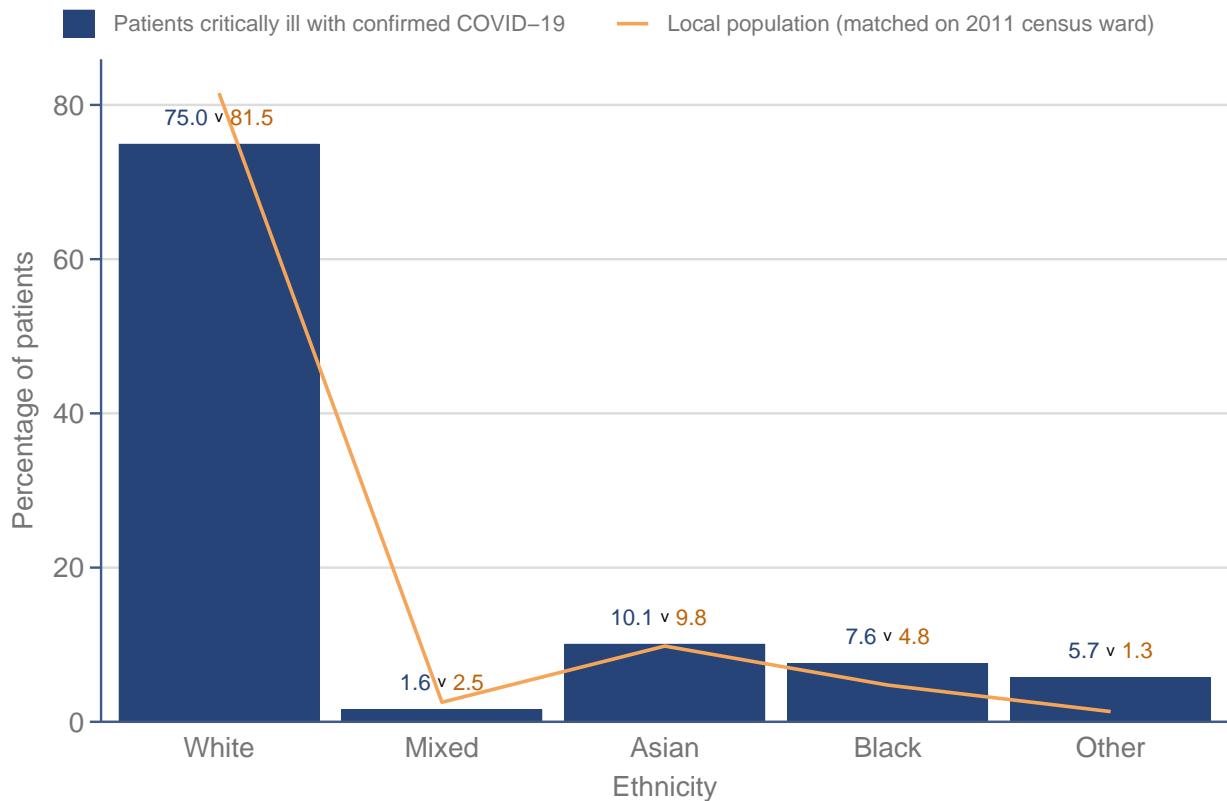


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### Figure 21. Age and sex distribution

Age and sex distribution of patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to date.

The distribution of ethnicity for patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to date, compared with a local population matched on 2011 census ward for residence of patients critically ill with COVID-19, is presented in Figure 22.

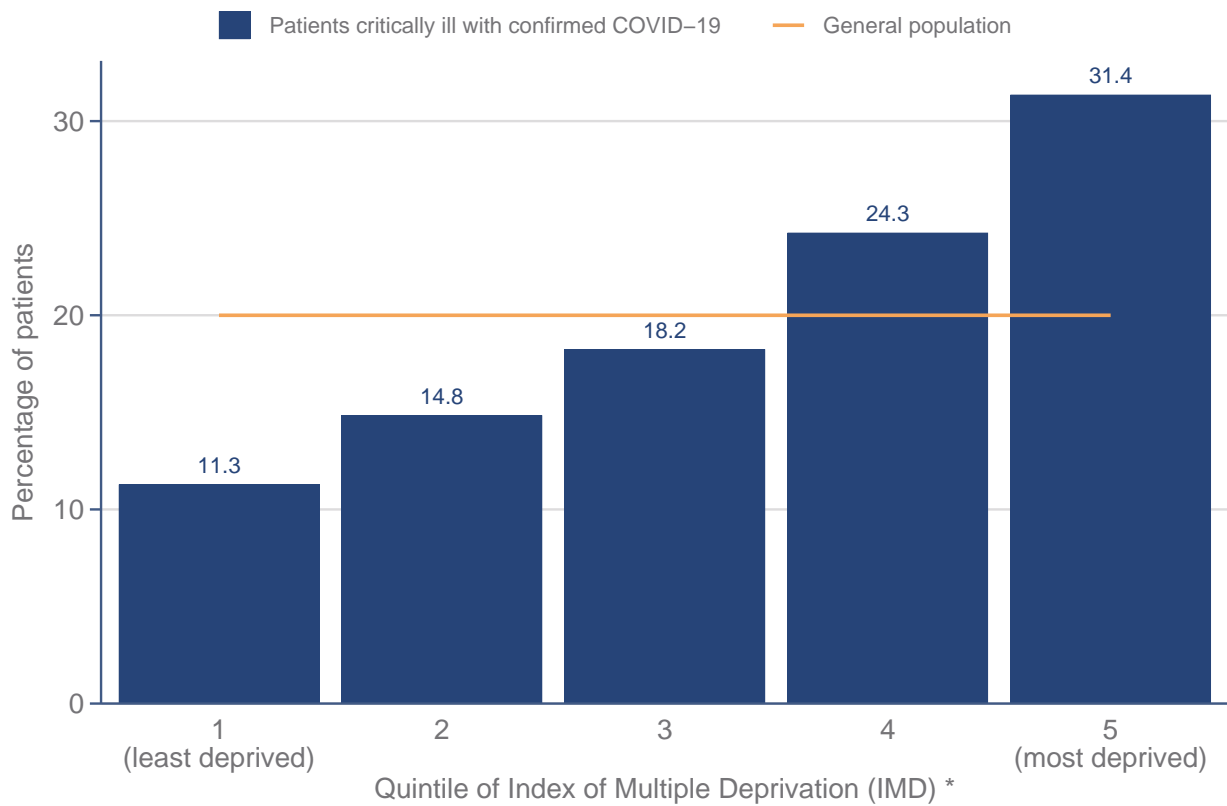


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### Figure 22. Ethnicity distribution compared with the local population

Ethnicity distribution of patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to date compared with the local population (linked to 2011 census ward).

The distribution of Index of Multiple Deprivation (IMD) for patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to date, compared with the general population, is presented in Figure 23.



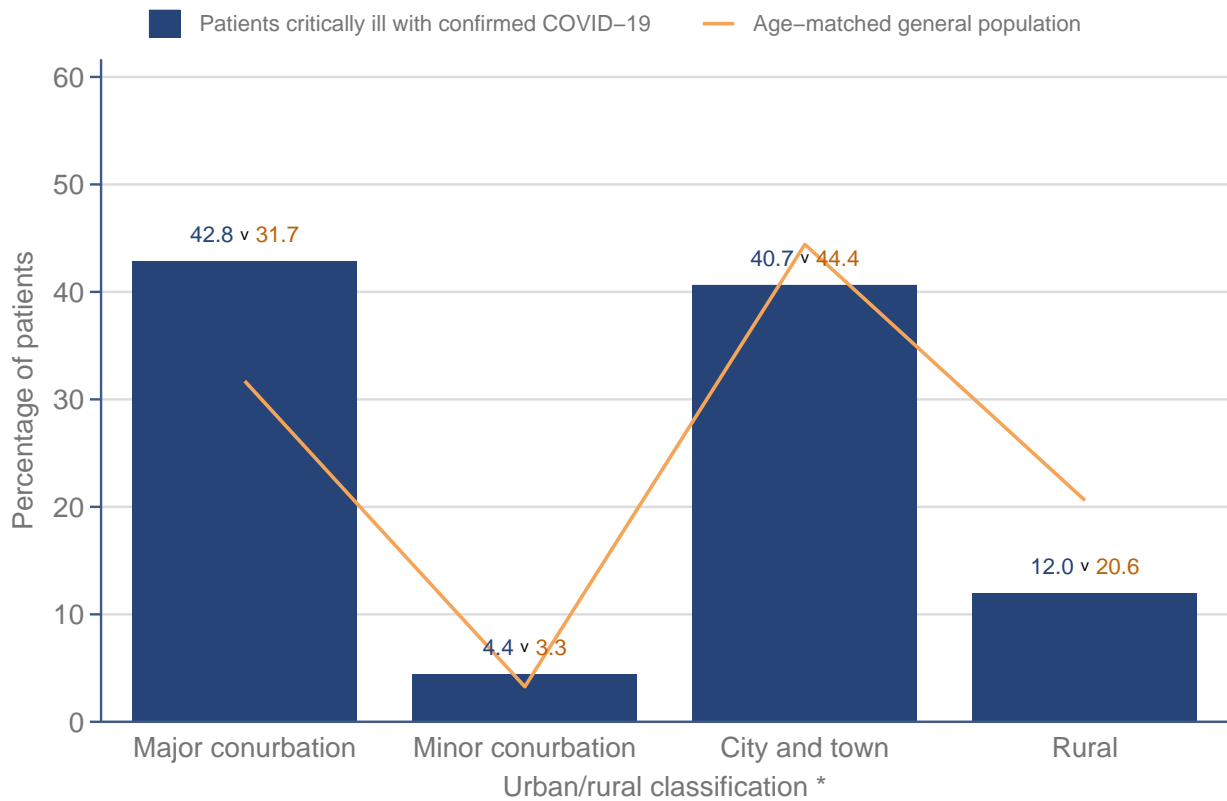
© ICNARC 2022

**Figure 23. Index of Multiple Deprivation \* distribution compared with the general population**

Index of Multiple Deprivation (IMD) \* distribution of patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to date compared with the general population.

\* Please see Definitions on page 95.

The distribution of the percentage of patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to date by the urban/rural classification of their usual residence, compared with the age-matched general population (Office for National Statistics 2020), is presented in Figure 24.



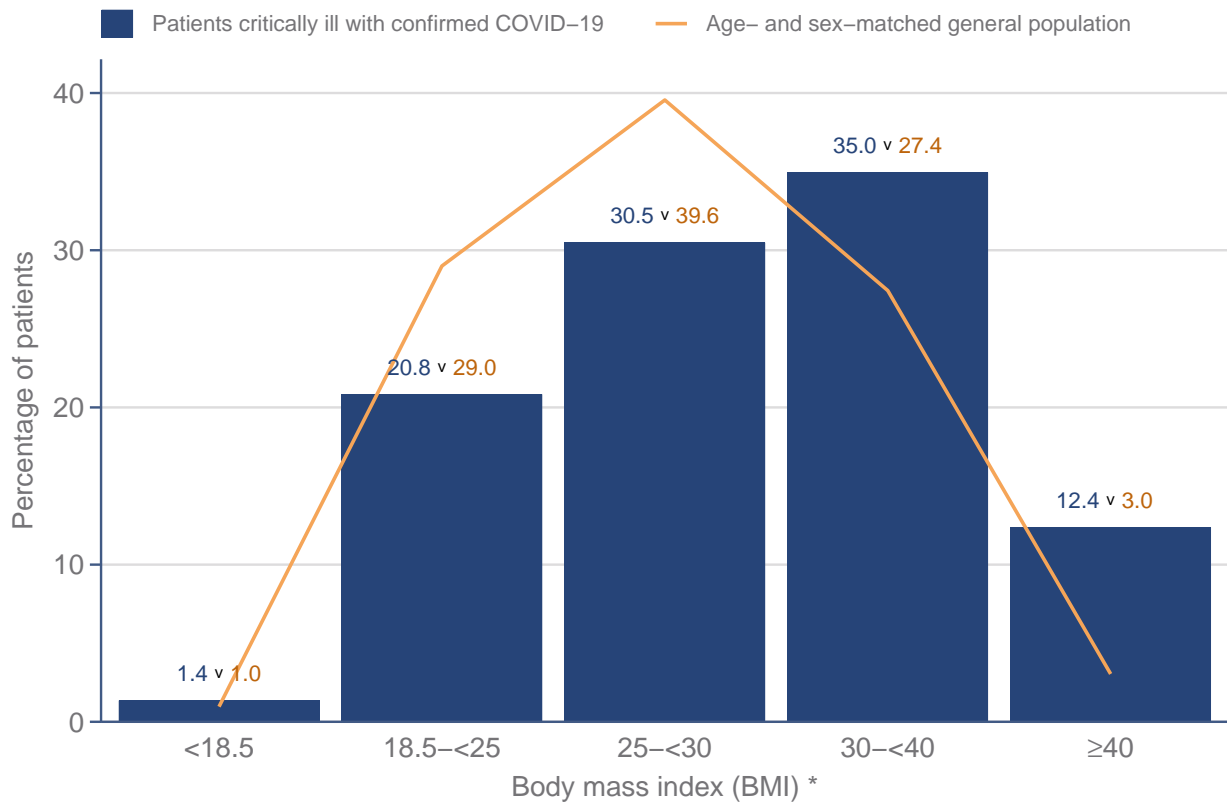
© ICNARC 2022

**Figure 24. Urban/rural \* distribution compared with the age-matched general population**

Urban/rural \* distribution of patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to date compared with the age-matched general population.

\* Please see Definitions on page 95.

The distribution of body mass index (BMI) for patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to date, compared with an age- and sex-matched population (from the Health Survey for England 2018), is presented in Figure 25.



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**Figure 25. Body mass index \* distribution compared with the age- and sex-matched general population**

Body mass index (BMI) \* distribution of patients critically ill with confirmed COVID-19 admitted from 1 May 2021 compared with the age- and sex-matched general population (Health Survey for England 2018).

\* Please see Definitions on page 95.

## Patient characteristics – invasively ventilated first 24 hours

Characteristics of patients critically ill with confirmed COVID-19 and receiving invasive ventilation during the first 24 hours in critical care admitted from 1 May 2021 to date are summarised in Tables 4-6 and compared with those admitted from 1 September 2020 to 30 April 2021.

**Table 4. Patient characteristics: demographics (invasively ventilated first 24 hours)**

Patients with confirmed COVID-19 invasively ventilated first 24 hours *		
Demographics	Admitted 1 May 2021 to date (N=3828)	Admitted 1 Sep 2020-30 Apr 2021 (N=7871)
Age at admission (years) [N=3825]		
Mean (SD)	53.9 (15.5)	58.6 (12.9)
Median (IQR)	56 (44, 66)	60 (51, 68)
Sex, n (%) [N=3824]		
Female	1501 (39.3)	2734 (34.8)
Male	2323 (60.7)	5133 (65.2)
Ethnicity, n (%) [N=3590]		
White	2665 (74.2)	4983 (67.2)
Mixed	61 (1.7)	127 (1.7)
Asian	386 (10.8)	1357 (18.3)
Black	298 (8.3)	494 (6.7)
Other	180 (5.0)	458 (6.2)
Index of Multiple Deprivation (IMD) quintile *, n (%) [N=3755]		
1 (least deprived)	404 (10.8)	899 (11.5)
2	532 (14.2)	1117 (14.3)
3	666 (17.7)	1431 (18.4)
4	928 (24.7)	1968 (25.3)
5 (most deprived)	1225 (32.6)	2371 (30.5)
Urban/rural classification *, n (%) [N=3503]		
Major conurbation	1599 (45.6)	3985 (52.7)
Minor conurbation	96 (2.7)	196 (2.6)
City and town	1424 (40.7)	2669 (35.3)
Rural	382 (10.9)	705 (9.3)

\* Please see Definitions on page 95.



**Table 5. Patient characteristics: medical history (invasively ventilated first 24 hours)**

Medical history	Patients with confirmed COVID-19 invasively ventilated first 24 hours *	
	Admitted 1 May 2021 to date (N=3828)	Admitted 1 Sep 2020-30 Apr 2021 (N=7871)
Dependency prior to admission to acute hospital, n (%) [N=3808]		
Able to live without assistance in daily activities	3300 (86.7)	6884 (88.3)
Some assistance with daily activities	488 (12.8)	895 (11.5)
Total assistance with all daily activities	20 (0.5)	21 (0.3)
Very severe comorbidities *, n (%) [N=3793]		
Cardiovascular	29 (0.8)	61 (0.8)
Respiratory	35 (0.9)	58 (0.7)
Renal	60 (1.6)	103 (1.3)
Liver	67 (1.8)	78 (1.0)
Metastatic disease	27 (0.7)	29 (0.4)
Haematological malignancy	81 (2.1)	114 (1.5)
Immunocompromised	216 (5.7)	268 (3.4)
Body mass index *, n (%) [N=3693]		
<18.5	66 (1.8)	66 (0.9)
18.5-<25	840 (22.7)	1550 (20.6)
25-<30	1132 (30.7)	2327 (31.0)
30-<40	1163 (31.5)	2688 (35.8)
≥40	492 (13.3)	885 (11.8)
CPR within previous 24h, n (%) [N=3820]		
In the community	145 (3.8)	128 (1.6)
In hospital	124 (3.2)	204 (2.6)
Prior hospital length of stay [N=3826]		
Mean (SD)	2.9 (8.5)	3.7 (6.7)
Median (IQR)	1 (0, 3)	2 (0, 5)
Currently or recently pregnant, n (% of females aged 16-49) [N=652]		
Currently pregnant	49 (7.5)	35 (4.7)
Recently pregnant (within 6 weeks)	94 (14.4)	64 (8.5)
Not known to be pregnant	509 (78.1)	651 (86.8)
COVID-19 reported as primary, rather than secondary, reason for admission to critical care †, n (%) [N=3828]	2883 (75.3)	7209 (91.6)

\* Please see Definitions on page 95.

† For patients with COVID-19 reported as secondary reason for admission, COVID-19 may or may not have contributed to the reason for admission.

**Table 6. Patient characteristics: indicators of acute severity (invasively ventilated first 24 hours)**

Indicators of acute severity	Patients with confirmed COVID-19 invasively ventilated first 24 hours *	
	Admitted 1 May 2021 to date (N=3828)	Admitted 1 Sep 2020-30 Apr 2021 (N=7871)
APACHE II Score [N=3828]		
Mean (SD)	16.1 (6.1)	16.2 (5.5)
Median (IQR)	15 (12, 20)	16 (13, 19)
PaO <sub>2</sub> /FiO <sub>2</sub> ratio † (kPa), median (IQR) [N=3789]	14.0 (8.8, 23.8)	12.6 (8.6, 19.0)
PaO <sub>2</sub> /FiO <sub>2</sub> ratio †, n (%) [N=3789]		
< 13.3 kPa (< 100 mmHg)	1799 (47.5)	4191 (53.4)
13.3-26.6 kPa (100-200 mmHg)	1212 (32.0)	2779 (35.4)
≥ 26.7 kPa (≥ 200 mmHg)	778 (20.5)	878 (11.2)
FiO <sub>2</sub> †, median (IQR) [N=3789]	0.60 (0.35, 0.90)	0.65 (0.45, 0.90)

\* Please see Definitions on page 95. Indicators of acute severity are based on data from the first 24 hours of critical care.

† Derived from the arterial blood gas with the lowest PaO<sub>2</sub> during the first 24 hours of critical care.

## Patient characteristics – advanced respiratory support

Characteristics of patients critically ill with confirmed COVID-19 that received advanced respiratory support at any time during their critical care stay admitted from 1 May 2021 to date are summarised in Tables 7-9 and compared with those admitted 1 September 2020 to 30 April 2021.

**Table 7. Patient characteristics: demographics (any advanced respiratory support)**

Patients with confirmed COVID-19 and any advanced respiratory support *		
Demographics	Admitted 1 May 2021 to date (N=7574)	Admitted 1 Sep 2020-30 Apr 2021 (N=14,282)
Age at admission (years) [N=7569]		
Mean (SD)	54.6 (14.7)	59.2 (12.3)
Median (IQR)	56 (45, 66)	61 (52, 68)
Sex, n (%) [N=7569]		
Female	2758 (36.4)	4647 (32.6)
Male	4811 (63.6)	9624 (67.4)
Ethnicity, n (%) [N=7142]		
White	5269 (73.8)	9336 (68.8)
Mixed	116 (1.6)	214 (1.6)
Asian	808 (11.3)	2484 (18.3)
Black	562 (7.9)	786 (5.8)
Other	387 (5.4)	758 (5.6)
Index of Multiple Deprivation (IMD) quintile *, n (%) [N=7415]		
1 (least deprived)	822 (11.1)	1662 (11.8)
2	1045 (14.1)	2073 (14.7)
3	1308 (17.6)	2634 (18.6)
4	1814 (24.5)	3484 (24.7)
5 (most deprived)	2426 (32.7)	4277 (30.3)
Urban/rural classification *, n (%) [N=7162]		
Major conurbation	3075 (42.9)	6664 (48.1)
Minor conurbation	276 (3.9)	430 (3.1)
City and town	3005 (42.0)	5260 (38.0)
Rural	795 (11.1)	1491 (10.8)

\* Please see Definitions on page 95.

**Table 8. Patient characteristics: medical history (any advanced respiratory support)**

Patients with confirmed COVID-19 and any advanced respiratory support *		
Medical history	Admitted 1 May 2021 to date (N=7574)	Admitted 1 Sep 2020-30 Apr 2021 (N=14,282)
Dependency prior to admission to acute hospital, n (%) [N=7436]		
Able to live without assistance in daily activities	6656 (89.5)	12680 (89.7)
Some assistance with daily activities	758 (10.2)	1418 (10.0)
Total assistance with all daily activities	22 (0.3)	34 (0.2)
Very severe comorbidities *, n (%) [N=7469]		
Cardiovascular	43 (0.6)	84 (0.6)
Respiratory	76 (1.0)	102 (0.7)
Renal	126 (1.7)	198 (1.4)
Liver	106 (1.4)	112 (0.8)
Metastatic disease	50 (0.7)	57 (0.4)
Haematological malignancy	220 (2.9)	244 (1.7)
Immunocompromised	456 (6.1)	513 (3.6)
Body mass index *, n (%) [N=7185]		
<18.5	96 (1.3)	89 (0.7)
18.5-<25	1471 (20.5)	2613 (19.3)
25-<30	2198 (30.6)	4235 (31.3)
30-<40	2496 (34.7)	5060 (37.4)
≥40	924 (12.9)	1529 (11.3)
CPR within previous 24h, n (%) [N=7554]		
In the community	161 (2.1)	143 (1.0)
In hospital	152 (2.0)	240 (1.7)
Prior hospital length of stay [N=7569]		
Mean (SD)	2.8 (8.1)	3.4 (6.5)
Median (IQR)	1 (0, 3)	1 (0, 4)
Currently or recently pregnant, n (% of females aged 16-49) [N=1136]		
Currently pregnant	147 (12.9)	79 (6.8)
Recently pregnant (within 6 weeks)	142 (12.5)	77 (6.6)
Not known to be pregnant	847 (74.6)	1009 (86.6)
COVID-19 reported as primary, rather than secondary, reason for admission to critical care †, n (%) [N=7574]	6397 (84.5)	13466 (94.3)

\* Please see Definitions on page 95.

† For patients with COVID-19 reported as secondary reason for admission, COVID-19 may or may not have contributed to the reason for admission.

**Table 9. Patient characteristics: indicators of acute severity (any advanced respiratory support)**

Patients with confirmed COVID-19 and any advanced respiratory support *		
Indicators of acute severity	Admitted 1 May 2021 to date (N=7574)	Admitted 1 Sep 2020-30 Apr 2021 (N=14,282)
APACHE II Score [N=7504]		
Mean (SD)	15.2 (5.7)	15.4 (5.2)
Median (IQR)	14 (11, 18)	15 (12, 18)
PaO <sub>2</sub> /FiO <sub>2</sub> ratio † (kPa), median (IQR) [N=7285]	12.5 (9.1, 18.9)	12.0 (8.9, 16.8)
PaO <sub>2</sub> /FiO <sub>2</sub> ratio †, n (%) [N=7285]		
< 13.3 kPa (< 100 mmHg)	3943 (54.1)	8132 (58.7)
13.3-26.6 kPa (100-200 mmHg)	2374 (32.6)	4606 (33.2)
≥ 26.7 kPa (≥ 200 mmHg)	968 (13.3)	1123 (8.1)
FiO <sub>2</sub> †, median (IQR) [N=7285]	0.60 (0.45, 0.80)	0.65 (0.50, 0.85)

\* Please see Definitions on page 95. Indicators of acute severity are based on data from the first 24 hours of critical care.

† Derived from the arterial blood gas with the lowest PaO<sub>2</sub> during the first 24 hours of critical care.

## Patient characteristics – basic respiratory support only

Characteristics of patients critically ill with confirmed COVID-19 that received basic respiratory support only during their critical care stay admitted from 1 May 2021 to date are summarised in Tables 10-12 and compared with those admitted 1 September 2020 to 30 April 2021.

**Table 10. Patient characteristics: demographics (basic respiratory support only)**

Patients with confirmed COVID-19 and basic respiratory support only *		
Demographics	Admitted 1 May 2021 to date (N=7708)	Admitted 1 Sep 2020-30 Apr 2021 (N=10,882)
Age at admission (years) [N=7707]		
Mean (SD)	54.6 (16.3)	59.2 (14.3)
Median (IQR)	56 (42, 68)	60 (50, 70)
Sex, n (%) [N=7708]		
Female	3052 (39.6)	3925 (36.1)
Male	4656 (60.4)	6957 (63.9)
Ethnicity, n (%) [N=7240]		
White	5487 (75.8)	7860 (75.7)
Mixed	117 (1.6)	143 (1.4)
Asian	658 (9.1)	1408 (13.6)
Black	533 (7.4)	488 (4.7)
Other	445 (6.1)	486 (4.7)
Index of Multiple Deprivation (IMD) quintile *, n (%) [N=7590]		
1 (least deprived)	856 (11.3)	1390 (12.9)
2	1166 (15.4)	1721 (16.0)
3	1423 (18.7)	2022 (18.8)
4	1821 (24.0)	2542 (23.6)
5 (most deprived)	2324 (30.6)	3099 (28.8)
Urban/rural classification *, n (%) [N=7564]		
Major conurbation	3164 (41.8)	4349 (40.5)
Minor conurbation	395 (5.2)	498 (4.6)
City and town	3029 (40.0)	4664 (43.4)
Rural	969 (12.8)	1230 (11.4)

\* Please see Definitions on page 95.

**Table 11. Patient characteristics: medical history (basic respiratory support only)**

Patients with confirmed COVID-19 and basic respiratory support only *		
Medical history	Admitted 1 May 2021 to date (N=7708)	Admitted 1 Sep 2020-30 Apr 2021 (N=10,882)
Dependency prior to admission to acute hospital, n (%) [N=7574]		
Able to live without assistance in daily activities	6661 (87.9)	9264 (85.8)
Some assistance with daily activities	866 (11.4)	1495 (13.9)
Total assistance with all daily activities	47 (0.6)	35 (0.3)
Very severe comorbidities *, n (%) [N=7621]		
Cardiovascular	55 (0.7)	78 (0.7)
Respiratory	137 (1.8)	142 (1.3)
Renal	125 (1.6)	185 (1.7)
Liver	40 (0.5)	49 (0.5)
Metastatic disease	50 (0.7)	105 (1.0)
Haematological malignancy	247 (3.2)	180 (1.7)
Immunocompromised	394 (5.2)	376 (3.5)
Body mass index *, n (%) [N=7351]		
<18.5	73 (1.0)	76 (0.8)
18.5-<25	1377 (18.7)	1869 (18.7)
25-<30	2239 (30.5)	3066 (30.6)
30-<40	2723 (37.0)	3736 (37.3)
≥40	939 (12.8)	1274 (12.7)
CPR within previous 24h, n (%) [N=7685]		
In the community	12 (0.2)	12 (0.1)
In hospital	12 (0.2)	21 (0.2)
Prior hospital length of stay [N=7701]		
Mean (SD)	2.4 (5.9)	2.8 (7.0)
Median (IQR)	1 (0, 3)	1 (0, 3)
Currently or recently pregnant, n (% of females aged 16-49) [N=1266]		
Currently pregnant	184 (14.5)	81 (7.8)
Recently pregnant (within 6 weeks)	132 (10.4)	62 (6.0)
Not known to be pregnant	950 (75.0)	892 (86.2)
COVID-19 reported as primary, rather than secondary, reason for admission to critical care †, n (%) [N=7708]	7133 (92.5)	10547 (96.9)

\* Please see Definitions on page 95.

† For patients with COVID-19 reported as secondary reason for admission, COVID-19 may or may not have contributed to the reason for admission.

**Table 12. Patient characteristics: indicators of acute severity (basic respiratory support only)**

Patients with confirmed COVID-19 and basic respiratory support only *		
Indicators of acute severity	Admitted 1 May 2021 to date (N=7708)	Admitted 1 Sep 2020-30 Apr 2021 (N=10,882)
APACHE II Score [N=7657]		
Mean (SD)	13.1 (5.3)	13.3 (5.0)
Median (IQR)	12 (10, 16)	13 (10, 16)
<hr/>		
PaO <sub>2</sub> /FiO <sub>2</sub> ratio † (kPa), median (IQR) [N=6895]	14.6 (11.0, 20.3)	14.0 (10.8, 18.9)
<hr/>		
PaO <sub>2</sub> /FiO <sub>2</sub> ratio †, n (%) [N=6895]		
< 13.3 kPa (< 100 mmHg)	2847 (41.3)	4274 (44.3)
13.3-26.6 kPa (100-200 mmHg)	3235 (46.9)	4511 (46.8)
≥ 26.7 kPa (≥ 200 mmHg)	813 (11.8)	852 (8.8)
<hr/>		
FiO <sub>2</sub> †, median (IQR) [N=6895]	0.55 (0.40, 0.70)	0.60 (0.45, 0.70)

\* Please see Definitions on page 95. Indicators of acute severity are based on data from the first 24 hours of critical care.

† Derived from the arterial blood gas with the lowest PaO<sub>2</sub> during the first 24 hours of critical care.



## Patient characteristics – renal support

Characteristics of patients critically ill with confirmed COVID-19 that received renal support at any time during their critical care stay admitted from 1 May 2021 to date are summarised in Tables 13-15 and compared with those admitted 1 September 2020 to 30 April 2021 2020.

**Table 13. Patient characteristics: demographics (any renal support)**

Demographics	Patients with confirmed COVID-19 and any renal support *	
	Admitted 1 May 2021 to date (N=2273)	Admitted 1 Sep 2020-30 Apr 2021 (N=4309)
Age at admission (years) [N=2270]		
Mean (SD)	56.7 (13.5)	60.3 (11.5)
Median (IQR)	58 (48, 67)	61 (53, 69)
Sex, n (%) [N=2272]		
Female	761 (33.5)	1152 (26.7)
Male	1511 (66.5)	3155 (73.3)
Ethnicity, n (%) [N=2157]		
White	1475 (68.4)	2645 (64.7)
Mixed	38 (1.8)	70 (1.7)
Asian	270 (12.5)	813 (19.9)
Black	244 (11.3)	333 (8.1)
Other	130 (6.0)	228 (5.6)
Index of Multiple Deprivation (IMD) quintile *, n (%) [N=2235]		
1 (least deprived)	258 (11.5)	465 (10.9)
2	312 (14.0)	647 (15.2)
3	392 (17.5)	774 (18.1)
4	571 (25.5)	1135 (26.6)
5 (most deprived)	702 (31.4)	1247 (29.2)
Urban/rural classification *, n (%) [N=2194]		
Major conurbation	996 (45.4)	2184 (52.1)
Minor conurbation	55 (2.5)	95 (2.3)
City and town	905 (41.2)	1494 (35.6)
Rural	233 (10.6)	419 (10.0)

\* Please see Definitions on page 95.

**Table 14. Patient characteristics: medical history (any renal support)**

Medical history	Patients with confirmed COVID-19 and any renal support *	
	Admitted 1 May 2021 to date (N=2273)	Admitted 1 Sep 2020-30 Apr 2021 (N=4309)
Dependency prior to admission to acute hospital, n (%) [N=2229]		
Able to live without assistance in daily activities	1904 (85.4)	3700 (86.6)
Some assistance with daily activities	320 (14.4)	564 (13.2)
Total assistance with all daily activities	5 (0.2)	7 (0.2)
Very severe comorbidities *, n (%) [N=2242]		
Cardiovascular	21 (0.9)	43 (1.0)
Respiratory	19 (0.8)	33 (0.8)
Renal	240 (10.7)	349 (8.2)
Liver	56 (2.5)	44 (1.0)
Metastatic disease	9 (0.4)	25 (0.6)
Haematological malignancy	60 (2.7)	86 (2.0)
Immunocompromised	184 (8.2)	196 (4.6)
Body mass index *, n (%) [N=2154]		
<18.5	22 (1.0)	22 (0.5)
18.5-<25	463 (21.5)	811 (19.9)
25-<30	672 (31.2)	1348 (33.0)
30-<40	724 (33.6)	1485 (36.4)
≥40	273 (12.7)	417 (10.2)
CPR within previous 24h, n (%) [N=2270]		
In the community	27 (1.2)	28 (0.7)
In hospital	49 (2.2)	81 (1.9)
Prior hospital length of stay [N=2273]		
Mean (SD)	3.0 (6.7)	3.9 (7.2)
Median (IQR)	1 (0, 4)	2 (0, 5)
Currently or recently pregnant, n (% of females aged 16-49) [N=256]		
Currently pregnant	16 (6.3)	8 (3.3)
Recently pregnant (within 6 weeks)	20 (7.8)	8 (3.3)
Not known to be pregnant	220 (85.9)	229 (93.5)
COVID-19 reported as primary, rather than secondary, reason for admission to critical care †, n (%) [N=2273]	1907 (83.9)	4043 (93.8)

\* Please see Definitions on page 95.

† For patients with COVID-19 reported as secondary reason for admission, COVID-19 may or may not have contributed to the reason for admission.

**Table 15. Patient characteristics: indicators of acute severity (any renal support)**

Indicators of acute severity	Patients with confirmed COVID-19 and any renal support *	
	Admitted 1 May 2021 to date (N=2273)	Admitted 1 Sep 2020-30 Apr 2021 (N=4309)
Invasively ventilated within first 24h *, n (%) [N=2198]	890 (40.5)	2143 (49.9)
APACHE II Score [N=2249]		
Mean (SD)	18.3 (6.4)	17.7 (5.9)
Median (IQR)	18 (14, 22)	17 (14, 21)
PaO <sub>2</sub> /FiO <sub>2</sub> ratio † (kPa), median (IQR) [N=2152]	12.6 (9.1, 19.0)	12.1 (8.9, 17.3)
PaO <sub>2</sub> /FiO <sub>2</sub> ratio †, n (%) [N=2152]		
< 13.3 kPa (< 100 mmHg)	1162 (54.0)	2376 (57.2)
13.3-26.6 kPa (100-200 mmHg)	692 (32.2)	1408 (33.9)
≥ 26.7 kPa (≥ 200 mmHg)	298 (13.8)	371 (8.9)
FiO <sub>2</sub> †, median (IQR) [N=2152]	0.60 (0.45, 0.80)	0.65 (0.50, 0.80)

\* Please see Definitions on page 95. Indicators of acute severity are based on data from the first 24 hours of critical care.

† Derived from the arterial blood gas with the lowest PaO<sub>2</sub> during the first 24 hours of critical care.

## Vaccination status

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To ascertain COVID-19 vaccination status, ICNARC data for patients admitted to critical care units in England were linked with data from COVID-19 test results and from the National Immunisation Management System (NIMS) on the QResearch Trusted Research Environment. COVID-19 test results and NIMS data were only available for England.

Patients were included in the analysis if they were aged 18 years or over, resident in England, and were successfully linked to a positive COVID-19 test between 28 days before and up to 2 days after admission to the critical care unit.

Of 14,859 patients admitted to critical care units in England between 1 May 2021 and 28 February 2022 when the data were locked for linkage, 297 (2.0%) were missing NHS number and unable to be linked, 99 (0.7%) were aged under 18 years and 168 (1.1%) were not resident in England. Of the remaining 14,295 patients, 12,596 (88.1%) were successfully linked to a positive COVID-19 test between 28 days before and up to 2 days after admission to the critical care unit.

Based on knowledge that it takes 2-3 weeks following each vaccination to reach maximum effectiveness, vaccination status was defined (prior to analysis) as:

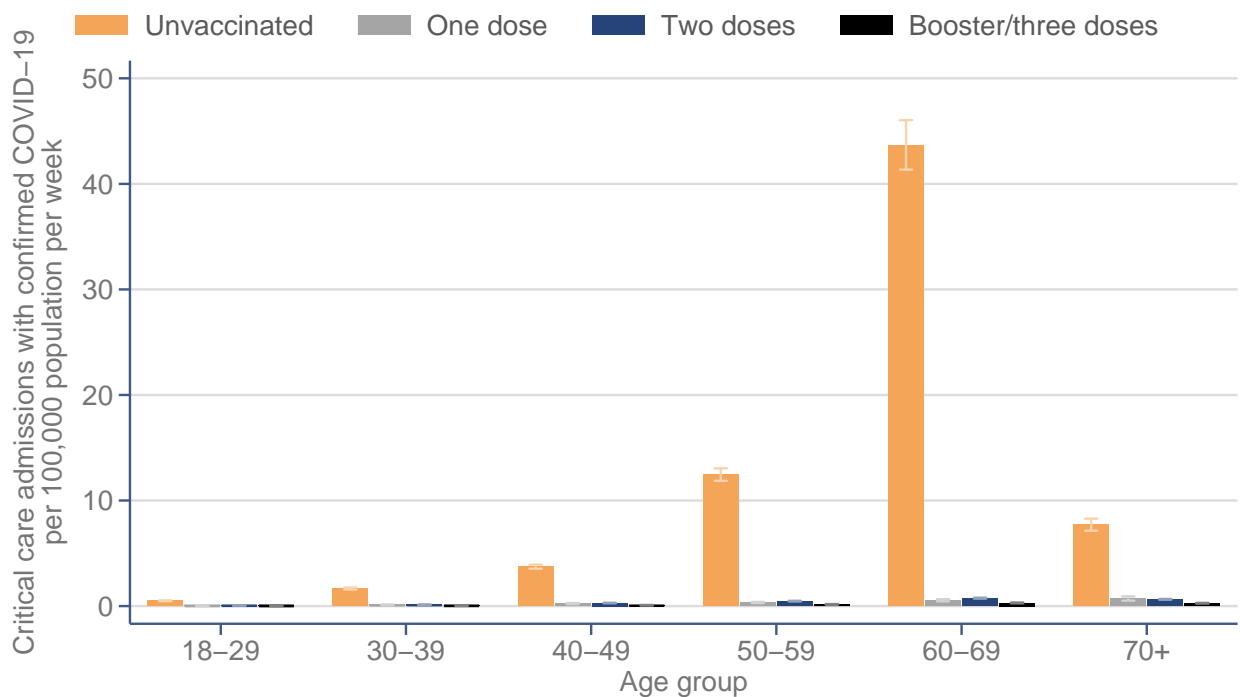
- **Unvaccinated** Either no linked vaccination record in NIMS or first dose of vaccine received within 14 days prior to the positive COVID-19 test
- **One dose** First dose of vaccine received at least 14 days prior to the positive COVID-19 test (includes patients that received a second dose within 14 days prior to the positive COVID-19 test)
- **Two doses** Second dose of vaccine received at least 14 days prior to the positive COVID-19 test (includes patients that received a third or booster dose within 14 days prior to the positive COVID-19 test)
- **Booster or three doses** Booster or third dose of vaccine received at least 14 days prior to the positive COVID-19 test (includes booster doses for adults that have received two doses and third doses for people with a weakened immune system)

Of 7202 patients classified as unvaccinated, 125 (1.7%) had received a first dose of vaccine within 14 days prior to the positive COVID-19 test.

As the numbers of people in the population at each vaccination status differ both between age groups and over time, rates of admission to critical care with confirmed COVID-19 were calculated per 100,000 population per week, allowing the denominators to change over time. Denominators for vaccinated patients were based on the numbers vaccinated from NIMS over the time period 17 April 2021 to 14 February 2022 (14 days prior to the date range of the analyses). Denominators for unvaccinated patients were based on the Office for National Statistics (ONS) population estimates for 2020 minus the numbers vaccinated.

The rates of admission by vaccination status, as defined above, and age are shown in Figure 26.

The SARS-CoV-2 test data and NIMS data are collated, maintained and quality assured by NHS Digital. NHS Digital bear no responsibility for the analysis or interpretation of the data. We acknowledge the contribution of EMIS Health and the Universities of Nottingham and Oxford for expertise in establishing, developing and supporting the QResearch database. This research is part of the Data and Connectivity National Core Study, led by Health Data Research UK in partnership with the Office For National Statistics and funded by UK Research and Innovation (grant ref. MC\_PC\_20029).



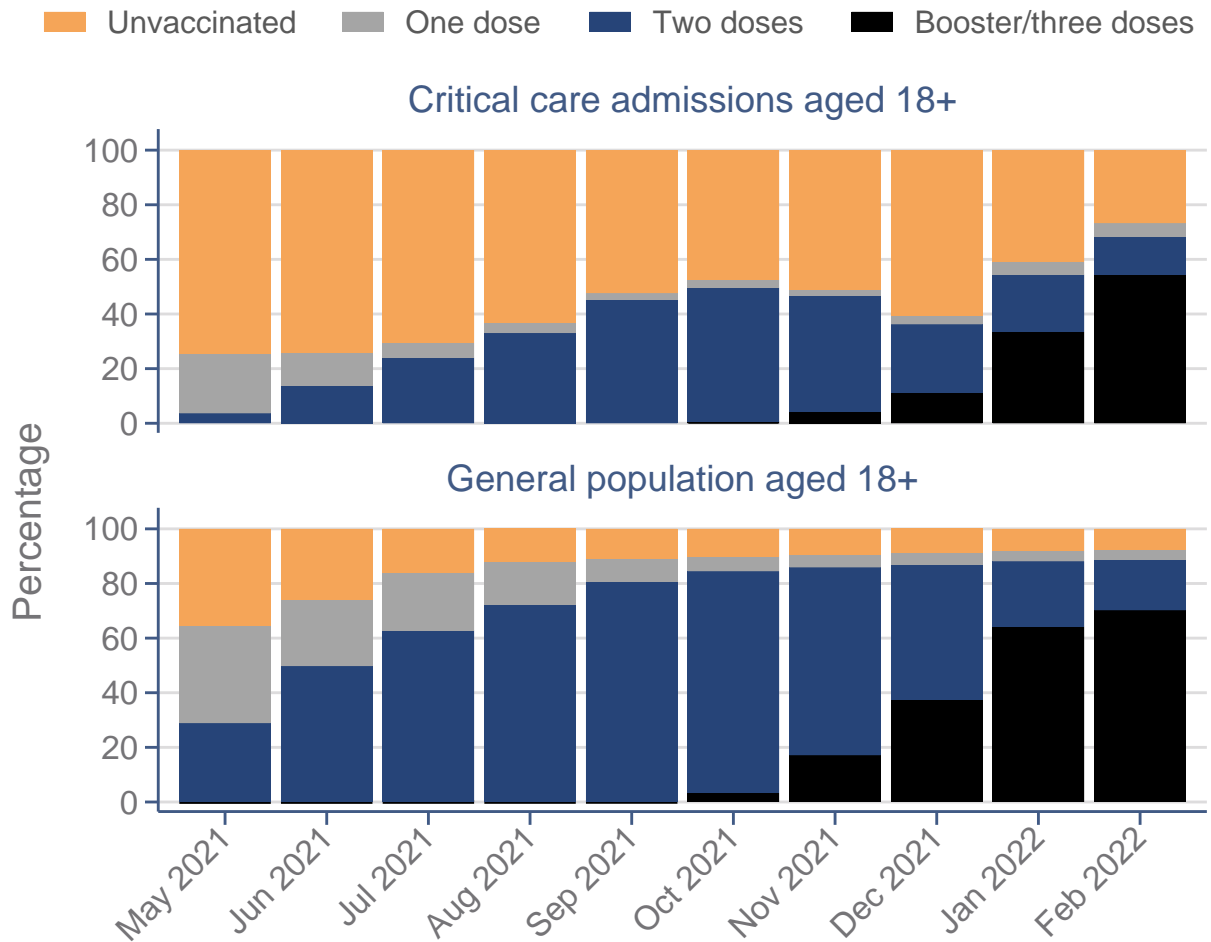
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**Figure 26. Rate of admission to critical care with confirmed COVID-19 by vaccination status for patients admitted 1 May 2021 to 31 January 2022**

Rate of admission to critical care with confirmed COVID-19 per 100,000 population per week (with 95% confidence interval) by vaccination status, assessed at 14 days prior to the positive COVID-19 test, and age group.

The percentage of patients admitted to critical care with confirmed COVID-19 that were unvaccinated decreased from 74% in May 2021 to 27% in February 2022, compared with a reduction from 35% to 7% among the general population (Figure 27). Percentages that were unvaccinated varied by region as well as over time (Figure 28).

The characteristics of patients critically ill with confirmed COVID-19 by vaccination status are shown in Table 16.



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**Figure 27. Percentage of admissions to critical care with confirmed COVID-19 by vaccination status for patients admitted 1 May 2021 to 31 January 2022 compared with the general population**

Percentage of admissions to critical care with confirmed COVID-19 by vaccination status, assessed at 14 days prior to the positive COVID-19 test, and month of admission compared with the percentage of the general population aged 18 years or older by vaccination status.



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**Figure 28. Percentage of admissions to critical care with confirmed COVID-19 that were unvaccinated by region for patients admitted 1 May 2021 to 31 January 2022**

Percentage of admissions to critical care with confirmed COVID-19 that were unvaccinated, assessed at 14 days prior to the positive COVID-19 test, by region and month of admission. Data for May 2021 and February 2022 not shown for regions with five or fewer patients either vaccinated or unvaccinated.

**Table 16. Characteristics of patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to 31 January 2022 by vaccination status**

Characteristics	Vaccination status †			
	Unvaccinated (N=7202)	One dose (N=526)	Two doses (N=4201)	Booster/three doses (N=665)
Age at admission (years), median (IQR)	50 (39, 61)	53 (44, 63)	63 (53, 71)	68 (59, 76)
Sex, n (%)				
Female	2921 (40.6)	210 (39.9)	1465 (34.9)	234 (35.2)
Male	4281 (59.4)	316 (60.1)	2736 (65.1)	431 (64.8)
Ethnicity, n (%)				
White	4405 (66.2)	345 (68.7)	3377 (84.5)	530 (85.8)
Mixed	144 (2.2)	12 (2.4)	30 (0.8)	8 (1.3)
Asian	792 (11.9)	91 (18.1)	322 (8.1)	45 (7.3)
Black	787 (11.8)	30 (6.0)	151 (3.8)	12 (1.9)
Other	522 (7.8)	24 (4.8)	117 (2.9)	23 (3.7)
IMD quintile *, n (%)				
1 (least deprived)	567 (8.0)	53 (10.2)	615 (14.8)	141 (21.5)
2	835 (11.7)	61 (11.7)	733 (17.6)	143 (21.8)
3	1227 (17.2)	81 (15.5)	765 (18.4)	131 (19.9)
4	1855 (26.0)	128 (24.5)	938 (22.5)	125 (19.0)
5 (most deprived)	2642 (37.1)	199 (38.1)	1113 (26.7)	117 (17.8)
Any dependency, n (%)	477 (7.1)	66 (13.4)	646 (16.7)	134 (22.0)
Any severe comorbidity *, n (%)	295 (4.2)	66 (12.9)	817 (19.8)	233 (35.8)
Immunocompromised *, n (%)	169 (2.4)	36 (7.0)	580 (14.0)	180 (27.7)
Body mass index *, median (IQR)	30.1 (26.2, 35.6)	30.1 (25.9, 35.4)	29.7 (25.7, 35.3)	27.0 (23.9, 31.0)
Currently or recently pregnant, n (% of females aged 18-49)				
Currently pregnant	294 (19.7)	9 (9.4)	N≤5	N≤5
Recently pregnant (within 6 wks)	226 (15.1)	N≤5	N≤5	N≤5
Not known to be pregnant	976 (65.2)			
COVID-19 reported as primary, rather than secondary, reason for admission to critical care §, n (%)	6763 (94.0)	449 (85.5)	3643 (86.9)	406 (61.7)
Invasively ventilated first 24h *, n (%)	1523 (21.4)	110 (21.3)	880 (21.2)	180 (28.0)
PaO <sub>2</sub> /FiO <sub>2</sub> ratio ‡ (kPa), median (IQR)	13.3 (10.0, 18.4)	14.2 (10.4, 20.1)	13.8 (9.9, 20.3)	19.3 (12.2, 33.2)
FiO <sub>2</sub> ‡, median (IQR)	0.60 (0.45, 0.75)	0.60 (0.40, 0.75)	0.60 (0.40, 0.75)	0.40 (0.28, 0.60)

\* Please see Definitions on page 95. Indicators of acute severity are based on data from the first 24 hours of critical care. N≤5 indicates that results have been suppressed due to five or fewer patients in a category.

† Vaccination status assessed at 14 days prior to the positive COVID-19 test.

‡ Derived from the arterial blood gas with the lowest PaO<sub>2</sub> during the first 24 hours of critical care.

§ For patients with COVID-19 reported as secondary reason for admission, COVID-19 may or may not have contributed to the reason for admission.

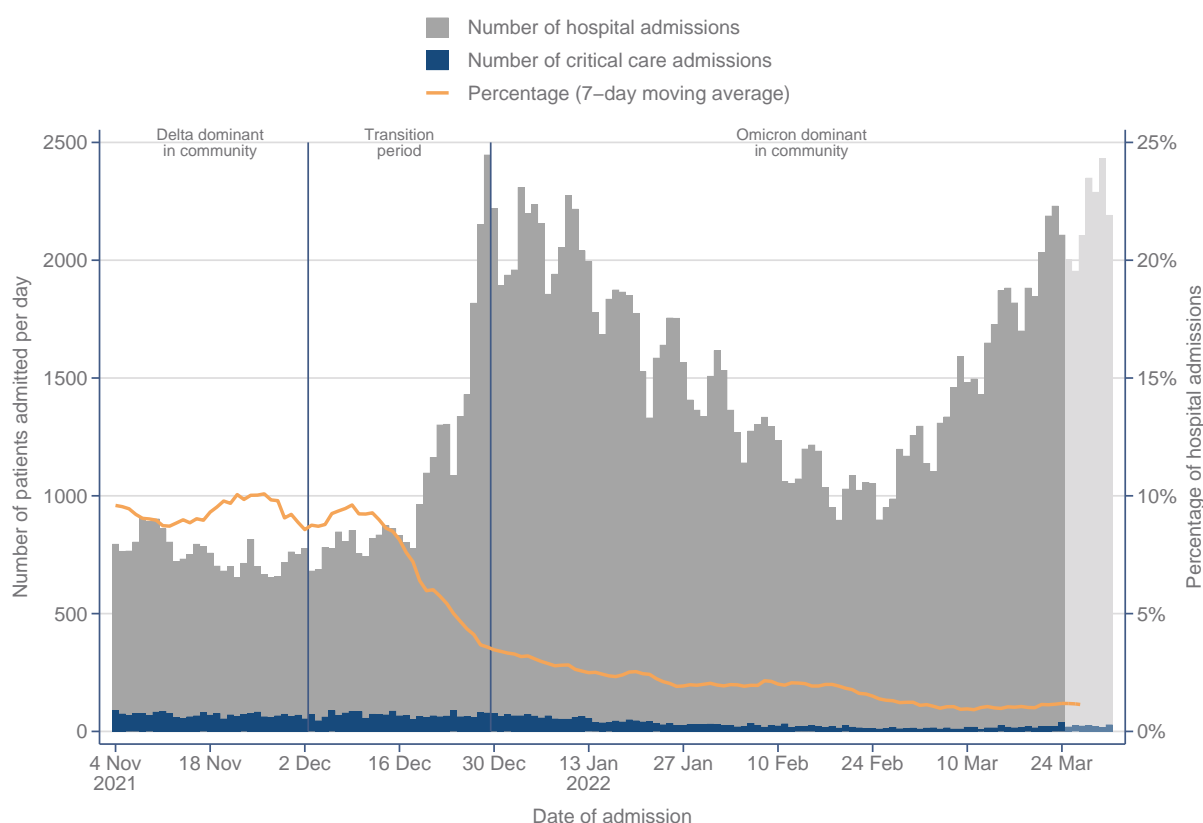


## Potential impact of Omicron variant

For characteristics of patients admitted to critical care since Omicron became dominant in the community, please see Figures 40-45 (monthly trends) and 50-55 (weekly trends).

The number of patients admitted to critical care with confirmed COVID-19 as a percentage of the reported hospital admissions over the time periods when Delta and Omicron were dominant in the community is shown in Figure 29.

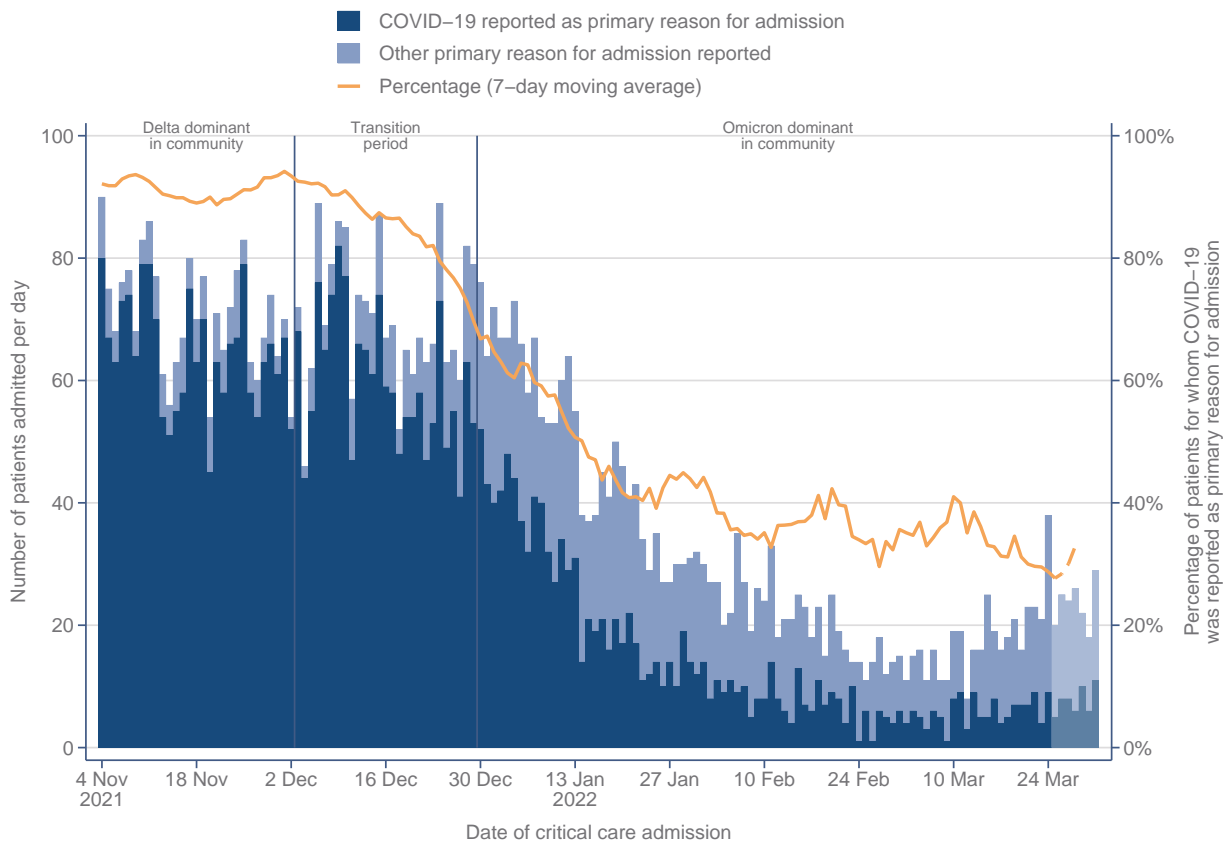
The proportion of patients admitted to critical care with confirmed COVID-19 that had COVID-19 reported as the primary, rather than secondary, reason for admission to critical care over the time periods when Delta and Omicron were dominant in the community is shown in Figure 30. For comparison, the equivalent proportion over the entire pandemic is shown in Figure 31.



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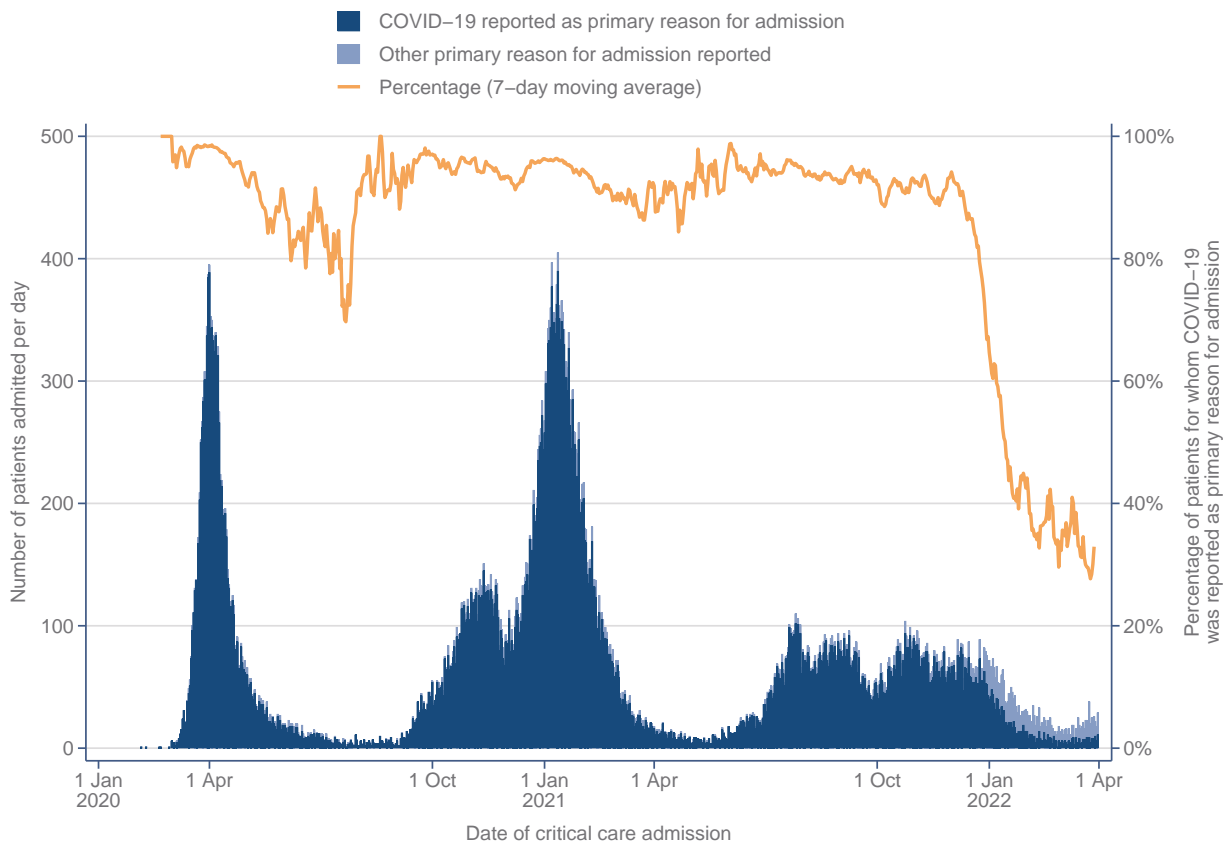
**Figure 29. Admissions to critical care with confirmed COVID-19 as a percentage of hospital admissions, 4 November 2021 to date**

Comparison of the number of new patients critically ill with confirmed COVID-19 by date of admission to critical care versus the total number of hospital admissions (source: <https://coronavirus.data.gov.uk/details/healthcare>) for periods when Delta and Omicron were dominant in the community.



**Figure 30. Number and percentage of admissions to critical care with confirmed COVID-19 that had COVID-19 reported as primary versus secondary reason for admission, 4 November 2021 to date**

Number and percentage of admissions to critical care with confirmed COVID-19 that had COVID-19 reported as the primary versus secondary reason for admission to critical care for periods when Delta and Omicron were dominant in the community. For patients with COVID-19 reported as secondary reason for admission, COVID-19 may or may not have contributed to the reason for admission.

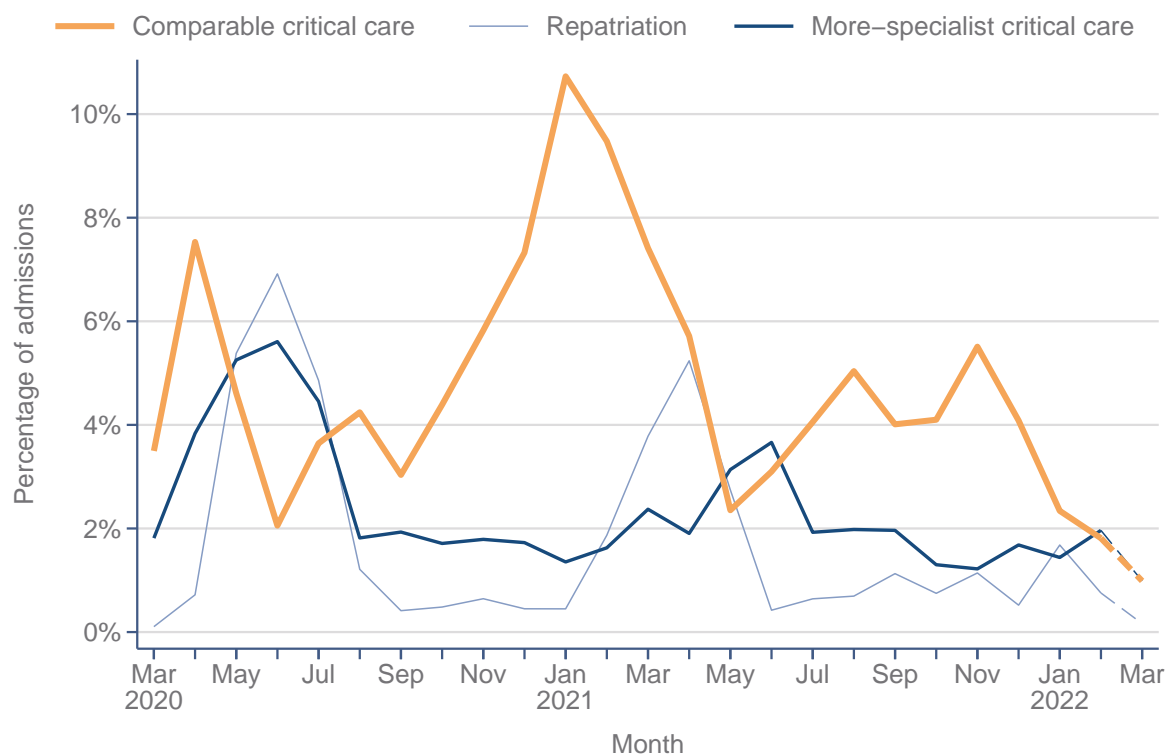


**Figure 31. Number and percentage of admissions to critical care with confirmed COVID-19 that had COVID-19 reported as primary versus secondary reason for admission**

Number and percentage of admissions to critical care with confirmed COVID-19 that had COVID-19 reported as the primary versus secondary reason for admission to critical care. For patients with COVID-19 reported as secondary reason for admission, COVID-19 may or may not have contributed to the reason for admission.

## Inter-hospital critical care transfers

From 1 May 2021 to date, there have been 1257 inter-hospital critical care transfers of 1064 patients with confirmed COVID-19, of which 766 transfers of 713 patients were classified as being for comparable critical care. The percentage of transfers by month is shown in Figure 32.



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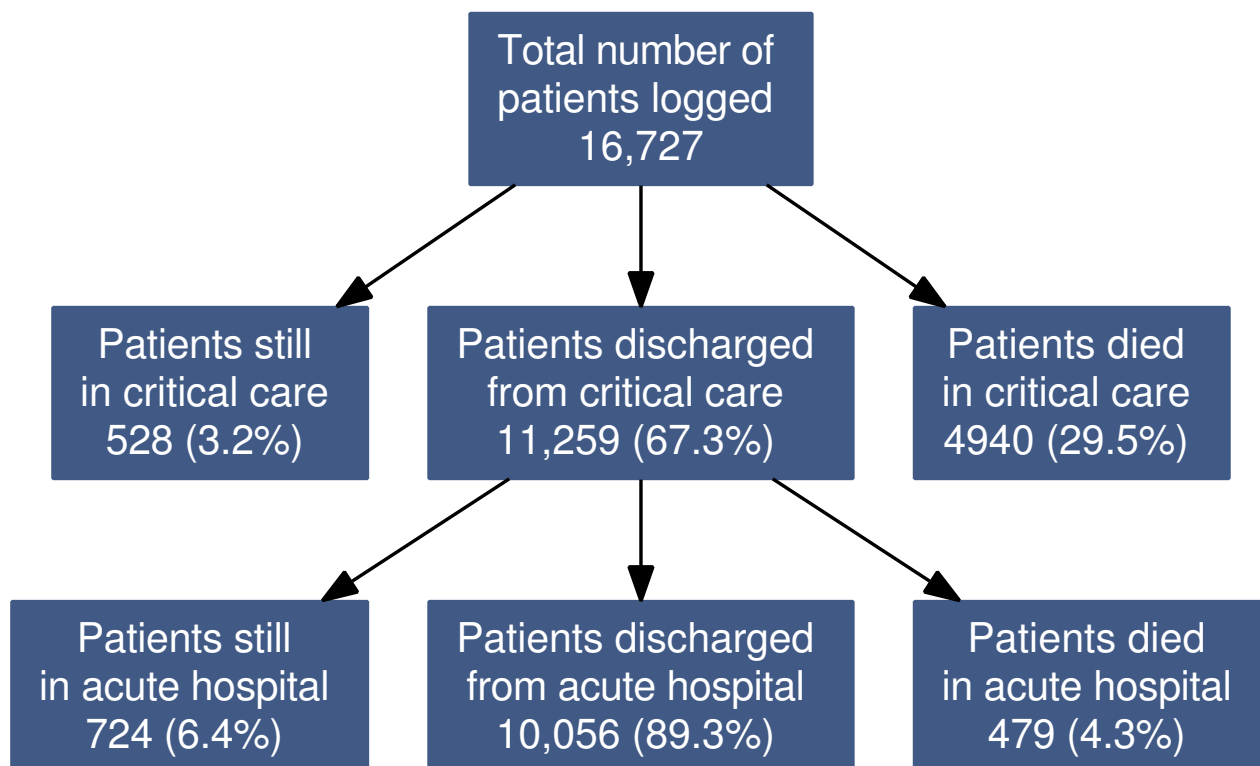
### Figure 32. Inter-hospital critical care transfers

Percentage of critical care admissions with confirmed COVID-19 that were transfers between critical care units in different hospitals by month of admission and reason for transfer \*.

\* Please see Definitions on page 95. Dashed line indicates incomplete month.

## Outcomes, duration of critical care and organ support

Critical care outcomes have been received for 16,198 (of 16,727) patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to date. Of these, 4,940 have died and 11,258 have been discharged from critical care (Figures 33). The remaining 529 were last reported to still be receiving critical care.



**Figure 33. Critical care and acute hospital outcomes**

Critical care and acute hospital outcomes for patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to date.

Critical care outcome, duration of critical care and organ support for patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to date for whom outcomes have been received are summarised in Table 17 and compared with those admitted from 1 September 2020 to 30 April 2021.

**Table 17. Critical care outcome, duration of critical care and organ support**

Critical care outcome	Patients with confirmed COVID-19 and outcome received	
	Admitted 1 May 2021 to date (N=16,727)	Admitted 1 Sep 2020-30 Apr 2021 (N=25,847)
Outcome at end of critical care, n (%)		
Discharged	11259 (67.3)	15917 (61.6)
Died	4940 (29.5)	9895 (38.3)
Last reported still in critical care	528 (3.2)	35 (0.1)
<b>Duration of critical care</b>	<b>(N=15,920)</b>	<b>(N=25,777)</b>
Duration of critical care (days) †, median (IQR)		
Survivors	6 (3, 12)	7 (4, 16)
Non-survivors	11 (5, 19)	12 (6, 19)
<b>Organ support (Critical Care Minimum Dataset) *</b>	<b>(N=16,177)</b>	<b>(N=25,792)</b>
Receipt of organ support, at any point, n (%)		
Advanced respiratory support	7574 (47.0)	14282 (55.5)
Basic respiratory support only	7708 (47.8)	10882 (42.3)
No respiratory support	837 (5.2)	568 (2.2)
Advanced cardiovascular support	3148 (19.5)	6035 (23.5)
Basic cardiovascular support only	12041 (74.7)	18476 (71.8)
No cardiovascular support	930 (5.8)	1221 (4.7)
Renal support	2273 (14.1)	4309 (16.7)
Liver support	176 (1.1)	231 (0.9)
Neurological support	1060 (6.6)	1791 (7.0)
Duration of organ support (calendar days), median (IQR)		
Advanced respiratory support	11 (5, 21)	13 (6, 24)
Total (advanced + basic) respiratory support	8 (4, 16)	9 (5, 19)
Advanced cardiovascular support	3 (1, 5)	3 (1, 5)
Total (advanced + basic) cardiovascular support	8 (4, 15)	9 (5, 19)
Renal support	6 (3, 12)	6 (3, 13)

Please note that the results for patients admitted from 1 May 2021 are biased towards patients with shorter lengths of stay in critical care prior to discharge or death, i.e. those who died or recovered quickly.

\* Please see Definitions on page 95.

† Duration of critical care is the total over all critical care admissions for the the same patient and excludes any time spent outside critical care areas (e.g. prior to any readmissions).

## Outcomes, duration of critical care and organ support – invasively ventilated first 24 hours

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Critical care outcome, duration of critical care and organ support for patients critically ill with confirmed COVID-19 for whom outcomes have been received and who received invasive ventilation during the first 24 hours in critical care admitted from 1 May 2021 to date are summarised in Table 18 and compared with those admitted from 1 September 2020 to 30 April 2021.

**Table 18. Critical care outcome, duration of critical care and organ support (invasively ventilated first 24 hours)**

Patients with confirmed COVID-19 invasively ventilated first 24 hours *		
Critical care outcome	Admitted 1 May 2021 to date (N=3828)	Admitted 1 Sep 2020-30 Apr 2021 (N=7871)
Outcome at end of critical care, n (%)		
Discharged	2175 (56.8)	3969 (50.4)
Died	1554 (40.6)	3885 (49.4)
Last reported still in critical care	99 (2.6)	17 (0.2)
<b>Duration of critical care</b>	<b>(N=3719)</b>	<b>(N=7849)</b>
Duration of critical care (days) †, median (IQR)		
Survivors	12 (7, 27)	17 (8, 36)
Non-survivors	10 (3, 18)	12 (6, 19)
<b>Organ support (Critical Care Minimum Dataset) *</b>	<b>(N=3722)</b>	<b>(N=7849)</b>
Receipt of organ support, at any point, n (%)		
Advanced cardiovascular support	1412 (37.9)	3191 (40.7)
Basic cardiovascular support only	2299 (61.8)	4651 (59.3)
No cardiovascular support	11 (0.3)	7 (0.1)
Renal support	890 (23.9)	2143 (27.3)
Liver support	90 (2.4)	140 (1.8)
Neurological support	576 (15.5)	1074 (13.7)
Duration of organ support (calendar days), median (IQR)		
Advanced respiratory support	10 (4, 19)	13 (6, 24)
Total (advanced + basic) respiratory support	11 (5, 21)	14 (8, 26)
Advanced cardiovascular support	3 (1, 5)	3 (2, 5)
Total (advanced + basic) cardiovascular support	12 (6, 21)	14 (8, 26)
Renal support	7 (3, 14)	7 (3, 14)

Please note that the results for patients admitted from 1 May 2021 are biased towards patients with shorter lengths of stay in critical care prior to discharge or death, i.e. those who died or recovered quickly.

\* Please see Definitions on page 95.

† Duration of critical care is the total over all critical care admissions for the the same patient and excludes any time spent outside critical care areas (e.g. prior to any readmissions).



## Outcomes, duration of critical care and organ support – advanced respiratory support

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Critical care outcome, duration of critical care and organ support for patients critically ill with confirmed COVID-19 for whom outcomes have been received and who received advanced respiratory support at any time during their critical care stay admitted from 1 May 2021 to date are summarised in Table 19 and compared with those admitted 1 September 2020 to 30 April 2021.

**Table 19. Critical care outcome, duration of critical care and organ support (any advanced respiratory support)**

Patients with confirmed COVID-19 and any advanced respiratory support *		
Critical care outcome	Admitted 1 May 2021 to date (N=8090 †)	Admitted 1 Sep 2020-30 Apr 2021 (N=14,282)
Outcome at end of critical care, n (%)		
Discharged	3769 (46.6)	6333 (44.3)
Died	3805 (47.0)	7949 (55.7)
Last reported still in critical care ‡	516 (6.4)	0 (0.0)
<b>Duration of critical care</b>	<b>(N=7410)</b>	<b>(N=14,272)</b>
Duration of critical care (days) †, median (IQR)		
Survivors	15 (8, 35)	20 (10, 40)
Non-survivors	13 (7, 21)	14 (8, 21)
<b>Organ support (Critical Care Minimum Dataset) *</b>	<b>(N=7574)</b>	<b>(N=14,282)</b>
Receipt of organ support, at any point, n (%)		
Advanced cardiovascular support	2947 (38.9)	5784 (40.5)
Basic cardiovascular support only	4601 (60.7)	8479 (59.4)
No cardiovascular support	26 (0.3)	19 (0.1)
Renal support	1916 (25.3)	3889 (27.2)
Liver support	147 (1.9)	216 (1.5)
Neurological support	970 (12.8)	1713 (12.0)
Duration of organ support (calendar days), median (IQR)		
Advanced respiratory support	11 (5, 21)	13 (6, 24)
Total (advanced + basic) respiratory support	14 (7, 26)	16 (9, 28)
Advanced cardiovascular support	3 (1, 5)	3 (1, 5)
Total (advanced + basic) cardiovascular support	14 (8, 25)	16 (9, 28)
Renal support	7 (3, 14)	7 (3, 14)

\* Please see Definitions on page 95.

† Duration of critical care is the total over all critical care admissions for the the same patient and excludes any time spent outside critical care areas (e.g. prior to any readmissions).

‡ Numbers of patients still receiving critical care estimated based on observed, incomplete organ support data received.

## Outcomes, duration of critical care and organ support – basic respiratory support only

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Critical care outcome, duration of critical care and organ support for patients critically ill with confirmed COVID-19 for whom outcomes have been received and who received basic respiratory support only during their critical care stay admitted from 1 May 2021 to date are summarised in Table 20 and compared with those admitted 1 September 2020 to 30 April 2021.

**Table 20. Critical care outcome, duration of critical care and organ support (basic respiratory support only)**

Patients with confirmed COVID-19 and basic respiratory support only *		
Critical care outcome	Admitted 1 May 2021 to date (N=7800 †)	Admitted 1 Sep 2020-30 Apr 2021 (N=10,882)
Outcome at end of critical care, n (%)		
Discharged	6620 (84.9)	8977 (82.5)
Died	1088 (13.9)	1905 (17.5)
Last reported still in critical care ‡	92 (1.2)	0 (0.0)
<b>Duration of critical care</b>	<b>(N=7601)</b>	<b>(N=10,869)</b>
Duration of critical care (days) †, median (IQR)		
Survivors	5 (3, 8)	5 (3, 8)
Non-survivors	5 (2, 10)	5 (2, 9)
<b>Organ support (Critical Care Minimum Dataset) *</b>	<b>(N=7708)</b>	<b>(N=10,882)</b>
Receipt of organ support, at any point, n (%)		
Advanced cardiovascular support	149 (1.9)	214 (2.0)
Basic cardiovascular support only	6796 (88.2)	9531 (87.6)
No cardiovascular support	763 (9.9)	1137 (10.4)
Renal support	271 (3.5)	339 (3.1)
Liver support	18 (0.2)	11 (0.1)
Neurological support	68 (0.9)	70 (0.6)
Duration of organ support (calendar days), median (IQR)		
Total (advanced + basic) respiratory support	5 (3, 8)	5 (3, 8)
Advanced cardiovascular support	2 (1, 3)	2 (1, 3)
Total (advanced + basic) cardiovascular support	5 (4, 8)	5 (3, 8)
Renal support	4 (2, 6)	4 (2, 7)

\* Please see Definitions on page 95.

† Duration of critical care is the total over all critical care admissions for the the same patient and excludes any time spent outside critical care areas (e.g. prior to any readmissions).

‡ Numbers of patients still receiving critical care estimated based on observed, incomplete organ support data received.

## Outcomes, duration of critical care and organ support – renal support

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Critical care outcome, duration of critical care and organ support for patients critically ill with confirmed COVID-19 for whom outcomes have been received and who received renal support at any time during their critical care stay admitted from 1 May 2021 to date are summarised in Table 21 and compared with those admitted 1 September 2020 to 30 April 2021.

**Table 21. Critical care outcome, duration of critical care and organ support (any renal support)**

Critical care outcome	Patients with confirmed COVID-19 and any renal support *	
	Admitted 1 May 2021 to date (N=2401 †)	Admitted 1 Sep 2020-30 Apr 2021 (N=4309)
Outcome at end of critical care, n (%)		
Discharged	902 (37.6)	1354 (31.4)
Died	1371 (57.1)	2955 (68.6)
Last reported still in critical care ‡	128 (5.3)	0 (0.0)
<b>Duration of critical care</b>	<b>(N=2207)</b>	<b>(N=4302)</b>
Duration of critical care (days) †, median (IQR)		
Survivors	21 (8, 45)	33 (12, 54)
Non-survivors	14 (8, 23)	15 (9, 23.5)
<b>Organ support (Critical Care Minimum Dataset) *</b>	<b>(N=2273)</b>	<b>(N=4309)</b>
Receipt of organ support, at any point, n (%)		
Advanced respiratory support	1916 (84.3)	3889 (90.3)
Basic respiratory support only	271 (11.9)	339 (7.9)
No respiratory support	86 (3.8)	81 (1.9)
Advanced cardiovascular support	1210 (53.2)	2382 (55.3)
Basic cardiovascular support only	1039 (45.7)	1898 (44.0)
No cardiovascular support	24 (1.1)	29 (0.7)
Liver support	87 (3.8)	133 (3.1)
Neurological support	258 (11.4)	542 (12.6)
Duration of organ support (calendar days), median (IQR)		
Advanced respiratory support	15 (8, 29)	17 (9, 30)
Total (advanced + basic) respiratory support	17 (9, 31)	18 (10, 32)
Advanced cardiovascular support	4 (2, 6)	3 (2, 6)
Total (advanced + basic) cardiovascular support	17 (8, 30)	18 (10, 32)
Renal support	6 (3, 12)	6 (3, 13)

\* Please see Definitions on page 95.

† Duration of critical care is the total over all critical care admissions for the the same patient and excludes any time spent outside critical care areas (e.g. prior to any readmissions).

‡ Numbers of patients still receiving critical care estimated based on observed, incomplete organ support data received.

## Critical care outcome by patient characteristics

Critical care outcome for patients critically ill with confirmed COVID-19 for whom outcomes have been received admitted from 1 May 2021 to 1 March 2022 (to allow for almost complete outcomes) are summarised in Table 22.

**Table 22. Critical care outcome by patient characteristics, admitted up to 1 March 2022**

Patient subgroup	Patients with confirmed COVID-19 and outcome received (N=15,788)	
	Discharged alive from critical care n (%)	Died in critical care n (%)
Age at admission to critical care		
16-49	4795 (84.4)	884 (15.6)
50-69	4609 (63.9)	2601 (36.1)
70+	1503 (52.5)	1361 (47.5)
Sex		
Female	4479 (73.9)	1582 (26.1)
Male	6456 (66.4)	3266 (33.6)
BMI		
<25	2167 (67.6)	1039 (32.4)
25-<30	3133 (68.8)	1423 (31.2)
≥30	5075 (70.8)	2095 (29.2)
Assistance required with daily activities		
No	9728 (71.0)	3974 (29.0)
Yes	992 (57.2)	742 (42.8)
Any very severe comorbidities *		
No	9856 (71.5)	3928 (28.5)
Yes	901 (51.6)	844 (48.4)
Any respiratory support *		
Basic only	6482 (85.9)	1060 (14.1)
Advanced	3684 (49.6)	3749 (50.4)
Any renal support *		
	879 (39.4)	1353 (60.6)

\* Please see Definitions on page 95.

## Critical care outcome by patient characteristics – invasively ventilated first 24 hours

Critical care outcome for patients critically ill with confirmed COVID-19 for whom outcomes have been received and who received invasive ventilation during the first 24 hours in critical care admitted from 1 May 2021 to 1 March 2022 (to allow for almost complete outcomes) are summarised in Table 23.

**Table 23. Critical care outcome by patient characteristics, admitted up to 1 March 2022 (invasively ventilated first 24 hours)**

Patients with confirmed COVID-19 invasively ventilated first 24 hours * (N=3626)		
Patient subgroup	Discharged alive from critical care n (%)	Died in critical care n (%)
Age at admission to critical care		
16-49	988 (75.2)	325 (24.8)
50-69	883 (51.2)	840 (48.8)
70+	228 (39.7)	347 (60.3)
Sex		
Female	903 (63.2)	526 (36.8)
Male	1206 (55.0)	987 (45.0)
BMI		
<25	468 (56.0)	368 (44.0)
25-<30	606 (56.9)	459 (43.1)
≥30	982 (61.3)	619 (38.7)
Assistance required with daily activities		
No	1867 (59.6)	1265 (40.4)
Yes	242 (50.5)	237 (49.5)
Any very severe comorbidities *		
No	1946 (60.6)	1265 (39.4)
Yes	157 (40.5)	231 (59.5)
Any renal support *		
	332 (37.9)	545 (62.1)

\* Please see Definitions on page 95.



## Critical care outcome by patient characteristics – advanced respiratory support

Critical care outcome for patients critically ill with confirmed COVID-19 for whom outcomes have been received and who received advanced respiratory support at any time during their critical care stay admitted from 1 May 2021 to 1 March 2022 (to allow for almost complete outcomes) are summarised in Table 24.

**Table 24. Critical care outcome by patient characteristics, admitted up to 1 March 2022 (any advanced respiratory support)**

Patients with confirmed COVID-19 and any advanced respiratory support * (N=7433)		
Patient subgroup	Discharged alive from critical care n (%)	Died in critical care n (%)
Age at admission to critical care		
16-49	1717 (68.3)	797 (31.7)
50-69	1582 (42.1)	2176 (57.9)
70+	367 (32.2)	774 (67.8)
Sex		
Female	1516 (55.9)	1196 (44.1)
Male	2164 (45.9)	2553 (54.1)
BMI		
<25	747 (49.4)	765 (50.6)
25-<30	1024 (47.5)	1131 (52.5)
≥30	1738 (51.4)	1646 (48.6)
Assistance required with daily activities		
No	3307 (50.6)	3232 (49.4)
Yes	325 (42.7)	436 (57.3)
Any very severe comorbidities *		
No	3351 (51.7)	3135 (48.3)
Yes	294 (34.6)	556 (65.4)
Any renal support *	634 (33.4)	1264 (66.6)

\* Please see Definitions on page 95.

## Critical care outcome by patient characteristics – basic respiratory support

Critical care outcome for patients critically ill with confirmed COVID-19 for whom outcomes have been received and who received advanced respiratory support only during their critical care stay admitted from 1 May 2021 to 1 March 2022 (to allow for almost complete outcomes) are summarised in Table 25.

**Table 25. Critical care outcome by patient characteristics, admitted up to 1 March 2022 (basic respiratory support only)**

Patients with confirmed COVID-19 and basic respiratory support only * (N=7542)		
Patient subgroup	Discharged alive from critical care n (%)	Died in critical care n (%)
Age at admission to critical care		
16-49	2754 (97.1)	83 (2.9)
50-69	2760 (87.2)	404 (12.8)
70+	957 (62.5)	573 (37.5)
Sex		
Female	2613 (87.6)	369 (12.4)
Male	3869 (84.8)	691 (15.2)
BMI		
<25	1125 (81.2)	261 (18.8)
25-<30	1917 (87.0)	286 (13.0)
≥30	3163 (87.7)	442 (12.3)
Assistance required with daily activities		
No	5822 (89.0)	722 (11.0)
Yes	573 (65.9)	296 (34.1)
Any very severe comorbidities *		
No	5898 (88.4)	771 (11.6)
Yes	515 (64.9)	279 (35.1)
Any renal support *	172 (67.5)	83 (32.5)

\* Please see Definitions on page 95.

## Critical care outcome by patient characteristics – renal support

Critical care outcome for patients critically ill with confirmed COVID-19 for whom outcomes have been received and who received renal support at any time during their critical care stay admitted from 1 May 2021 to 1 March 2022 (to allow for almost complete outcomes) are summarised in Table 26.

**Table 26. Critical care outcome by patient characteristics, admitted up to 1 March 2022 (any renal support)**

Patients with confirmed COVID-19 and any renal support * (N=2232)		
Patient subgroup	Discharged alive from critical care n (%)	Died in critical care n (%)
Age at admission to critical care		
16-49	336 (53.2)	296 (46.8)
50-69	424 (34.4)	808 (65.6)
70+	117 (32.1)	247 (67.9)
Sex		
Female	331 (44.1)	419 (55.9)
Male	547 (36.9)	934 (63.1)
BMI		
<25	197 (42.0)	272 (58.0)
25-<30	239 (36.2)	422 (63.8)
≥30	391 (39.7)	595 (60.3)
Assistance required with daily activities		
No	732 (39.0)	1145 (61.0)
Yes	131 (42.0)	181 (58.0)
Any very severe comorbidities *		
No	665 (38.4)	1065 (61.6)
Yes	203 (42.9)	270 (57.1)
Any respiratory support *		
Basic only	172 (67.5)	83 (32.5)
Advanced	634 (33.4)	1264 (66.6)

\* Please see Definitions on page 95.

## Duration of critical care by patient characteristics

Duration of critical care for patients critically ill with confirmed COVID-19 for whom outcomes have been received admitted from 1 May 2021 to 1 March 2022 (to allow for almost complete outcomes) is summarised in Table 27.

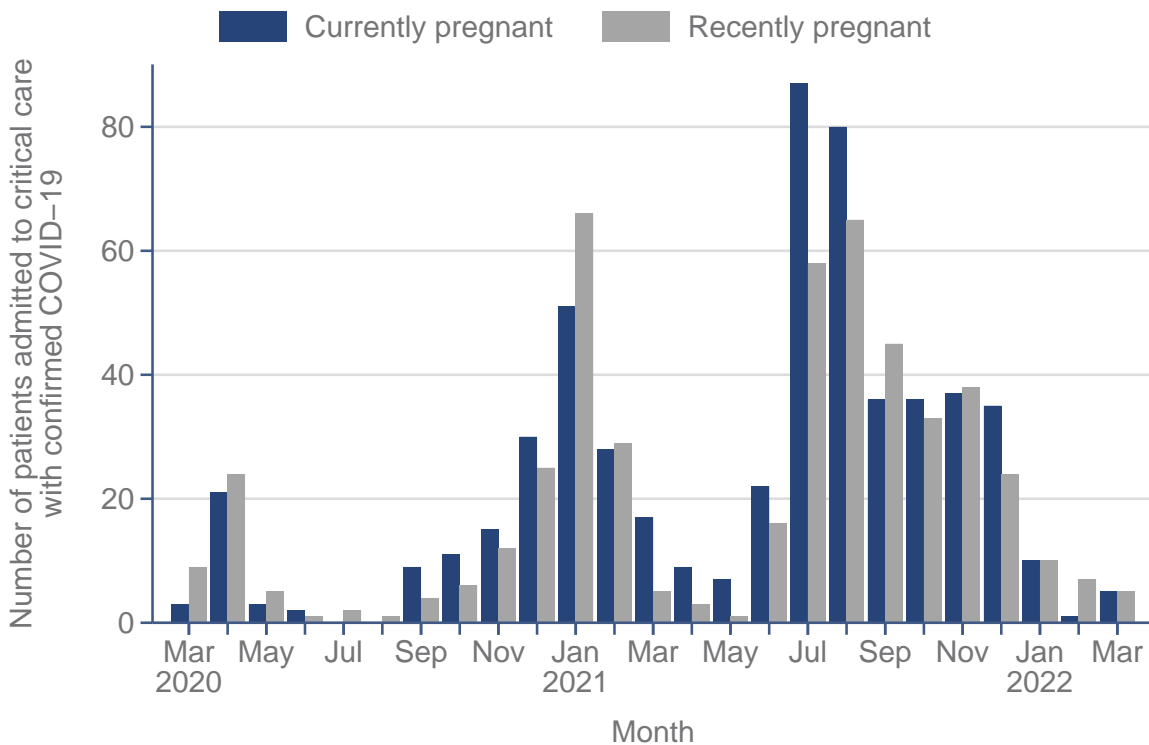
**Table 27. Duration of critical care by patient characteristics, admitted up to 1 March 2022**

Patient subgroup	Patients with confirmed COVID-19 and outcome received (N=15,520)	
	Discharged alive from critical care median (IQR)	Died in critical care median (IQR)
Age at admission to critical care		
16-49	6 (3, 12)	13 (6, 22)
50-69	7 (4, 14)	12 (6, 19)
70+	6 (3, 10)	8 (3, 15)
Sex		
Female	6 (3, 11)	11 (5, 19)
Male	6 (3, 13)	11 (5, 19)
BMI		
<25	5 (3, 11)	9 (3, 17)
25-<30	6 (3, 12)	12 (6, 19)
≥30	7 (4, 13)	12 (6, 19)
Assistance required with daily activities		
No	6 (3, 13)	12 (6, 20)
Yes	6 (3, 12)	7 (2, 13)
Any very severe comorbidities *		
No	6 (3, 12)	12 (6, 19)
Yes	6 (3, 14)	8 (3, 14)
Any respiratory support *		
Basic only	5 (3, 8)	5 (2, 10)
Advanced	16 (8, 36)	13 (7, 21)
Any renal support *		
	22 (8, 46)	15 (8, 23)

\* Please see Definitions on page 95.

## Pregnancy

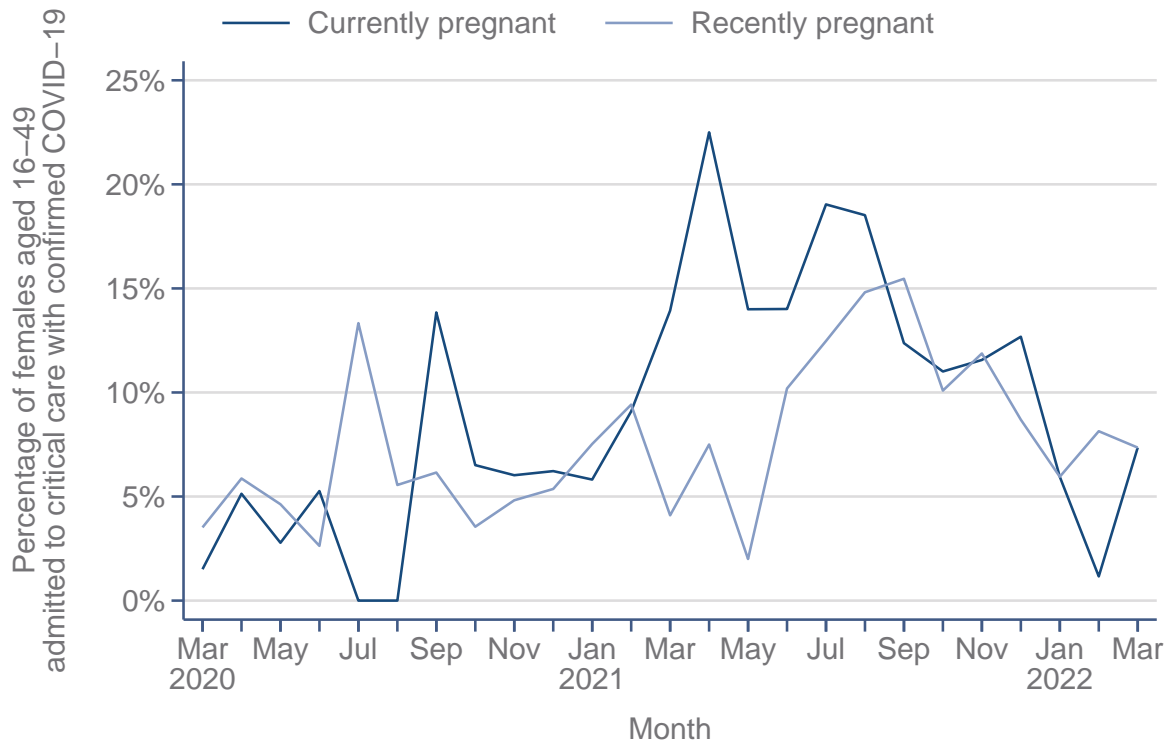
The numbers of critically ill women with confirmed COVID-19 reported to be currently and recently pregnant on admission to critical care are shown in Figure 34 and, as a percentage of women aged 16-49 years, in Figure 35. The percentage of all critically ill patients with confirmed COVID-19 that were currently or recently pregnant women by region and time period are shown in Figure 36. Characteristics and critical care outcome of women aged 16-49 years by pregnancy status are reported in Table 28 for women admitted from 1 May 2021 to date and compared with women admitted from 1 September 2020 to 30 April 2021 in Table 29.



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### Figure 34. Numbers currently and recently pregnant

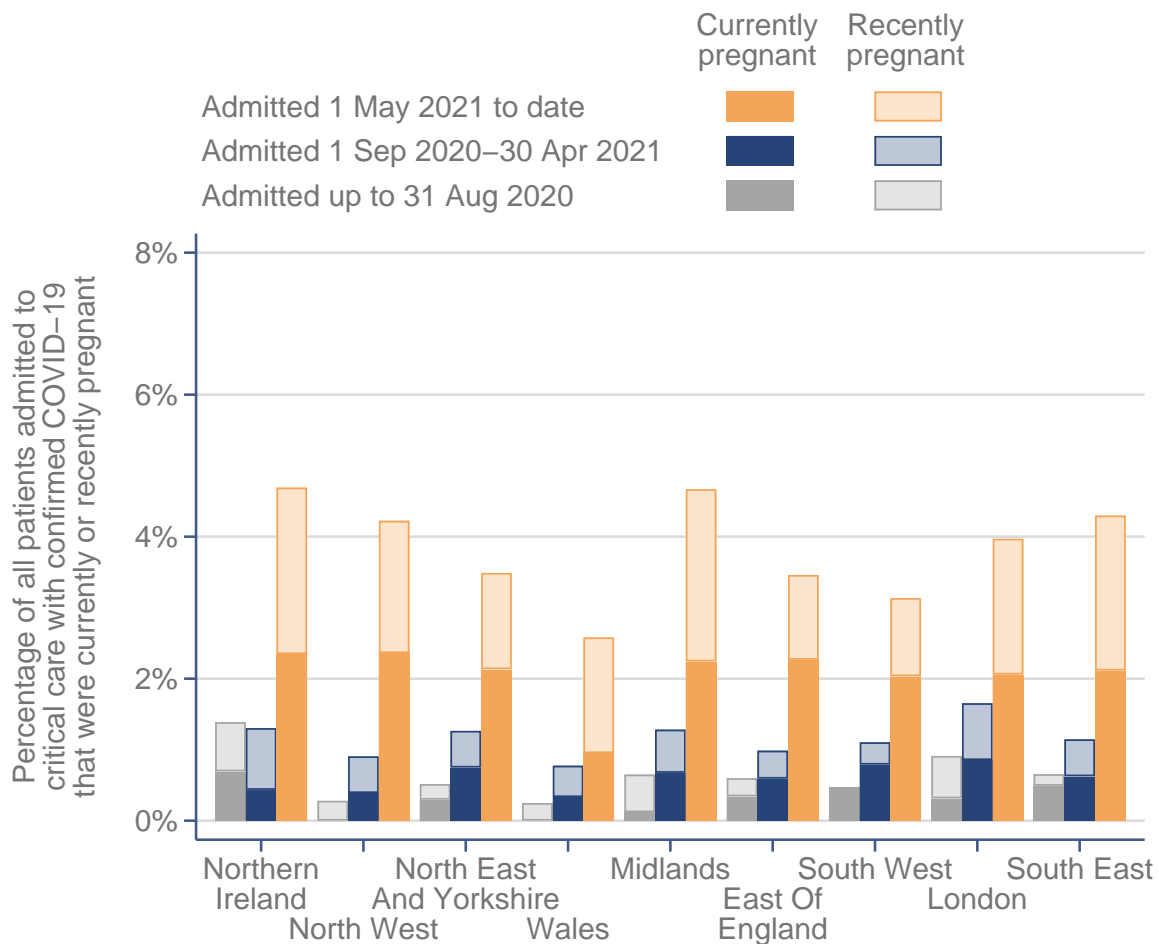
Monthly trend in the number of women reported to be currently or recently pregnant on admission to critical care.



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**Figure 35. Percentages currently and recently pregnant**

Monthly trend in the percentage of women aged 16-49 years reported to be currently or recently pregnant on admission to critical care.



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**Figure 36. Percentages currently and recently pregnant by region**

Percentage of all critically ill patients with confirmed COVID-19 that were reported to be currently or recently pregnant on admission to critical care by region and time period.

**Table 28. Characteristics of females aged 16-49 admitted from 1 May 2021 to date by pregnancy status**

Characteristics	Women with confirmed COVID-19 aged 16-49 years		
	Currently pregnant (N=356)	Recently pregnant (N=300)	Not known to be pregnant (N=1965)
Age at admission (years)			
Mean (SD)	32.2 (5.7)	31.1 (5.6)	37.8 (8.7)
Median (IQR)	32 (28, 36)	31 (27, 35)	40 (32, 45)
Ethnicity, n (%)			
White	198 (57.6)	178 (62.2)	1312 (69.7)
Mixed	12 (3.5)	11 (3.8)	60 (3.2)
Asian	81 (23.5)	55 (19.2)	242 (12.9)
Black	34 (9.9)	25 (8.7)	163 (8.7)
Other	19 (5.5)	17 (5.9)	106 (5.6)
IMD quintile *, n (%)			
1 (least deprived)	39 (11.4)	26 (9.0)	145 (7.5)
2	36 (10.6)	36 (12.4)	211 (10.9)
3	59 (17.3)	47 (16.2)	324 (16.8)
4	85 (24.9)	74 (25.5)	517 (26.8)
5 (most deprived)	122 (35.8)	107 (36.9)	734 (38.0)
First pregnancy, n (%)	N/A	106 (38.5)	N/A
Invasively ventilated within first 24h *, n (%)	49 (14.0)	94 (32.1)	509 (26.6)
APACHE II Score			
Mean (SD)	11.4 (3.8)	10.5 (3.9)	12.1 (5.1)
Median (IQR)	11 (9, 14)	10 (8, 13)	11 (9, 14)
PaO <sub>2</sub> /FiO <sub>2</sub> ratio † (kPa), median (IQR)	16.4 (12.5, 23.3)	20.0 (14.5, 29.3)	14.8 (10.4, 23.1)
PaO <sub>2</sub> /FiO <sub>2</sub> ratio †, n (%)			
< 13.3 kPa (< 100 mmHg)	102 (31.2)	102 (31.2)	102 (31.2)
13.3-26.6 kPa (100-200 mmHg)	60 (21.6)	60 (21.6)	60 (21.6)
≥ 26.7 kPa (≥ 200 mmHg)	765 (42.8)	765 (42.8)	765 (42.8)
FiO <sub>2</sub> †, median (IQR)	0.50 (0.40, 0.70)	0.41 (0.30, 0.60)	0.55 (0.39, 0.75)
Outcome at end of critical care, n (%)			
Discharged	344 (96.6)	283 (94.3)	1618 (82.3)
Died	9 (2.5)	14 (4.7)	320 (16.3)
Last reported still in critical care	3 (0.8)	3 (1.0)	27 (1.4)

\* Please see Definitions on page 95. Indicators of acute severity are based on data from the first 24 hours of critical care. N/A denotes not available.

† Derived from the arterial blood gas with the lowest PaO<sub>2</sub> during the first 24 hours of critical care.



**Table 29. Characteristics of females aged 16-49 admitted from 1 September 2020 to 30 April 2021 by pregnancy status**

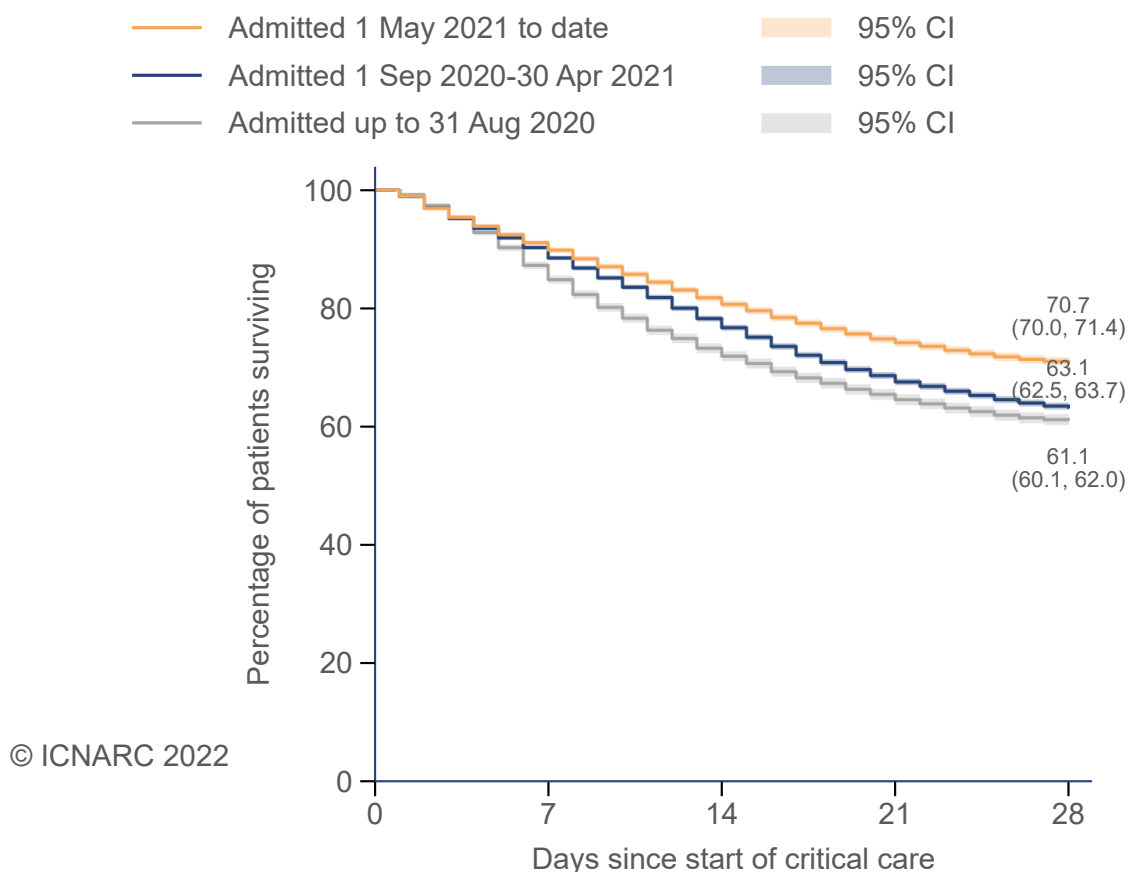
Characteristics	Women with confirmed COVID-19 aged 16-49 years		
	Currently pregnant (N=169)	Recently pregnant (N=150)	Not known to be pregnant (N=1971)
Age at admission (years)			
Mean (SD)	32.4 (5.6)	32.8 (5.6)	40.1 (7.7)
Median (IQR)	32 (29, 37)	33 (29, 37)	42 (35, 47)
Ethnicity, n (%)			
White	66 (40.2)	76 (52.4)	1260 (66.5)
Mixed	5 (3.0)	10 (6.9)	37 (2.0)
Asian	58 (35.4)	37 (25.5)	358 (18.9)
Black	20 (12.2)	14 (9.7)	130 (6.9)
Other	15 (9.1)	8 (5.5)	109 (5.8)
IMD quintile *, n (%)			
1 (least deprived)	12 (7.3)	15 (10.3)	170 (8.7)
2	13 (7.9)	18 (12.4)	212 (10.9)
3	29 (17.7)	28 (19.3)	335 (17.2)
4	54 (32.9)	29 (20.0)	521 (26.7)
5 (most deprived)	56 (34.1)	55 (37.9)	711 (36.5)
First pregnancy, n (%)	N/A	63 (42.0)	N/A
Invasively ventilated within first 24h *, n (%)	35 (20.7)	64 (42.7)	651 (33.2)
APACHE II Score			
Mean (SD)	11.5 (4.2)	11.1 (4.1)	12.2 (4.9)
Median (IQR)	12 (9, 14)	11 (8, 14)	12 (9, 15)
PaO <sub>2</sub> /FiO <sub>2</sub> ratio † (kPa), median (IQR)	16.9 (11.6, 26.0)	19.3 (12.6, 32.3)	13.7 (9.6, 20.0)
PaO <sub>2</sub> /FiO <sub>2</sub> ratio †, n (%)			
< 13.3 kPa (< 100 mmHg)	51 (32.5)	51 (32.5)	51 (32.5)
13.3-26.6 kPa (100-200 mmHg)	38 (26.8)	38 (26.8)	38 (26.8)
≥ 26.7 kPa (≥ 200 mmHg)	886 (48.0)	886 (48.0)	886 (48.0)
FiO <sub>2</sub> †, median (IQR)	0.50 (0.35, 0.70)	0.40 (0.30, 0.65)	0.60 (0.40, 0.80)
Outcome at end of critical care, n (%)			
Discharged	163 (96.4)	148 (98.7)	1593 (80.8)
Died	6 (3.6)	2 (1.3)	378 (19.2)
Last reported still in critical care	0 (0.0)	0 (0.0)	0 (0.0)

\* Please see Definitions on page 95. Indicators of acute severity are based on data from the first 24 hours of critical care. N/A denotes not available.

† Derived from the arterial blood gas with the lowest PaO<sub>2</sub> during the first 24 hours of critical care.

## 28-day in-hospital outcome - overall

A Kaplan-Meier plot of in-hospital survival to 28 days following admission to critical care for patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to date is shown in Figure 37 and compared with those admitted from 1 September 2020 to 30 April 2021 and up to 31 August 2020.



### Admitted 1 May 2021 to date

At risk	16422	14661	13012	11824	11169
Died (in hospital)	0	1672	3153	4190	4745
Censored	0	89	257	408	508

### Admitted 1 Sep 2020-30 Apr 2021

At risk	25847	22863	19803	17440	16264
Died (in hospital)	0	2976	6004	8357	9527
Censored	0	8	40	50	56

### Admitted up to 31 Aug 2020

At risk	11021	9349	7931	7126	6728
Died (in hospital)	0	1672	3090	3895	4292
Censored	0	0	0	0	1

### Figure 37. In-hospital survival to 28 days following admission to critical care

Kaplan-Meier survival analysis for patients critically ill with confirmed COVID-19. Patients last reported to be still receiving critical care censored on the most recent date of data submission by the treating unit. Patients discharged from acute hospital within 28 days assumed to survive to 28 days. Please note that these survival curves are not adjusted for differences in patient characteristics (see Tables 1-3).

## Comparison of adjusted 28-day in-hospital mortality between time periods

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Figure 38 shows hazard ratios comparing 28-day in-hospital mortality for patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to 30 November 2021 compared with those admitted from 1 September 2020 to 30 April 2021 across patient subgroups. Hazard ratios are calculated from Cox proportional hazards models adjusted for all the subgroup variables shown and for physiology measured during the first 24 hours of critical care. Dashed vertical line shows the overall adjusted hazard ratio between the time periods.



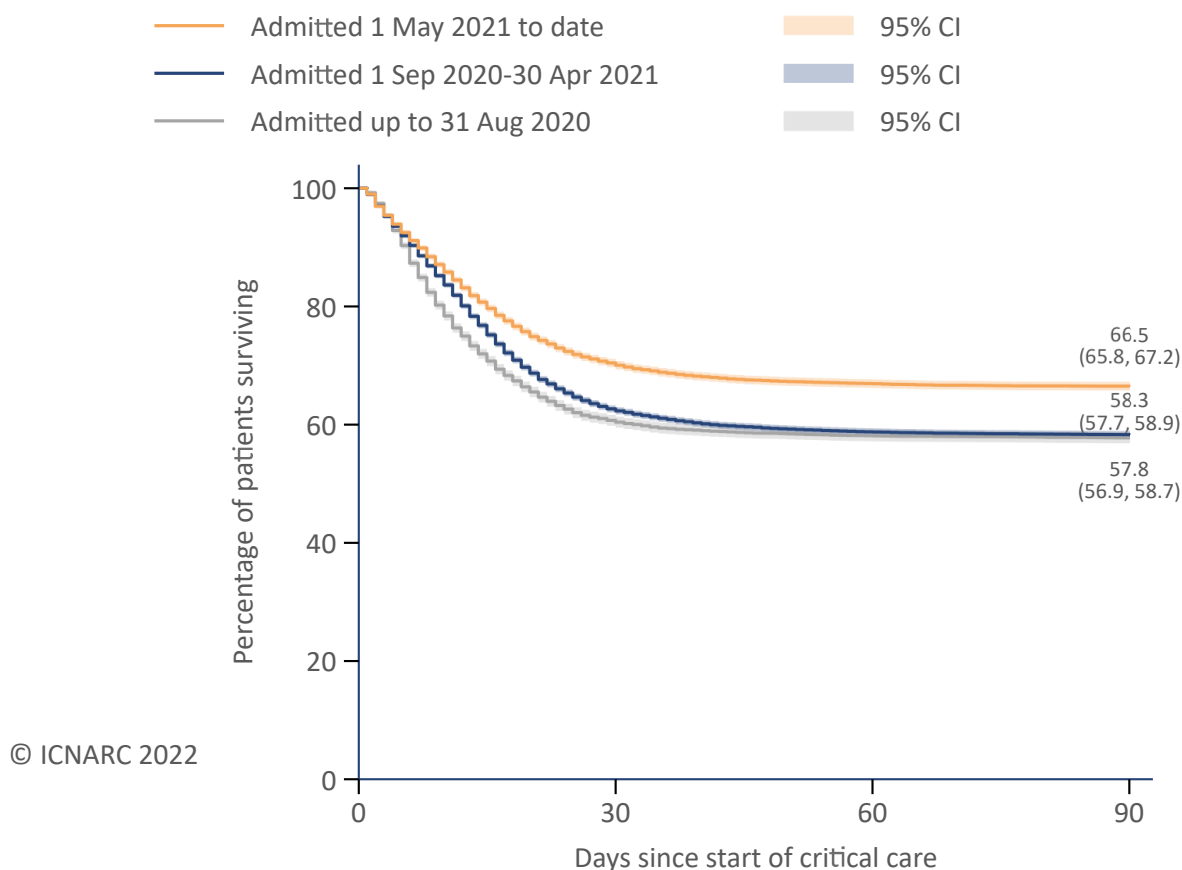
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**Figure 38. Hazard ratios comparing patients admitted May 2021 to November 2021 versus September 2020 to April 2021 by patient subgroup \***

Hazard ratios from Cox proportional hazards models adjusted for all subgroup variables plus the following physiological measurements from the first 24 hours of critical care: highest heart rate; highest respiratory rate; highest blood lactate concentration; highest serum creatinine; highest serum urea; lowest platelet count; and neutrophil count associated with the lowest white blood cell count.

## 90-day in-hospital outcome

A Kaplan-Meier plot of in-hospital survival to 90 days following admission to critical care for patients critically ill with confirmed COVID-19 admitted from 1 May 2021 to date is shown in Figure 39 and compared with those admitted from 1 September 2020 to 30 April 2021 and up to 31 August 2020.



### Admitted 1 May 2021 to date

At risk	16422	11023	10112	9365
Died (in hospital)	0	4853	5338	5402
Censored	0	546	972	1655

### Admitted 1 Sep 2020-30 Apr 2021

At risk	25847	16068	15108	14976
Died (in hospital)	0	9719	10636	10752
Censored	0	60	103	119

### Admitted up to 31 Aug 2020

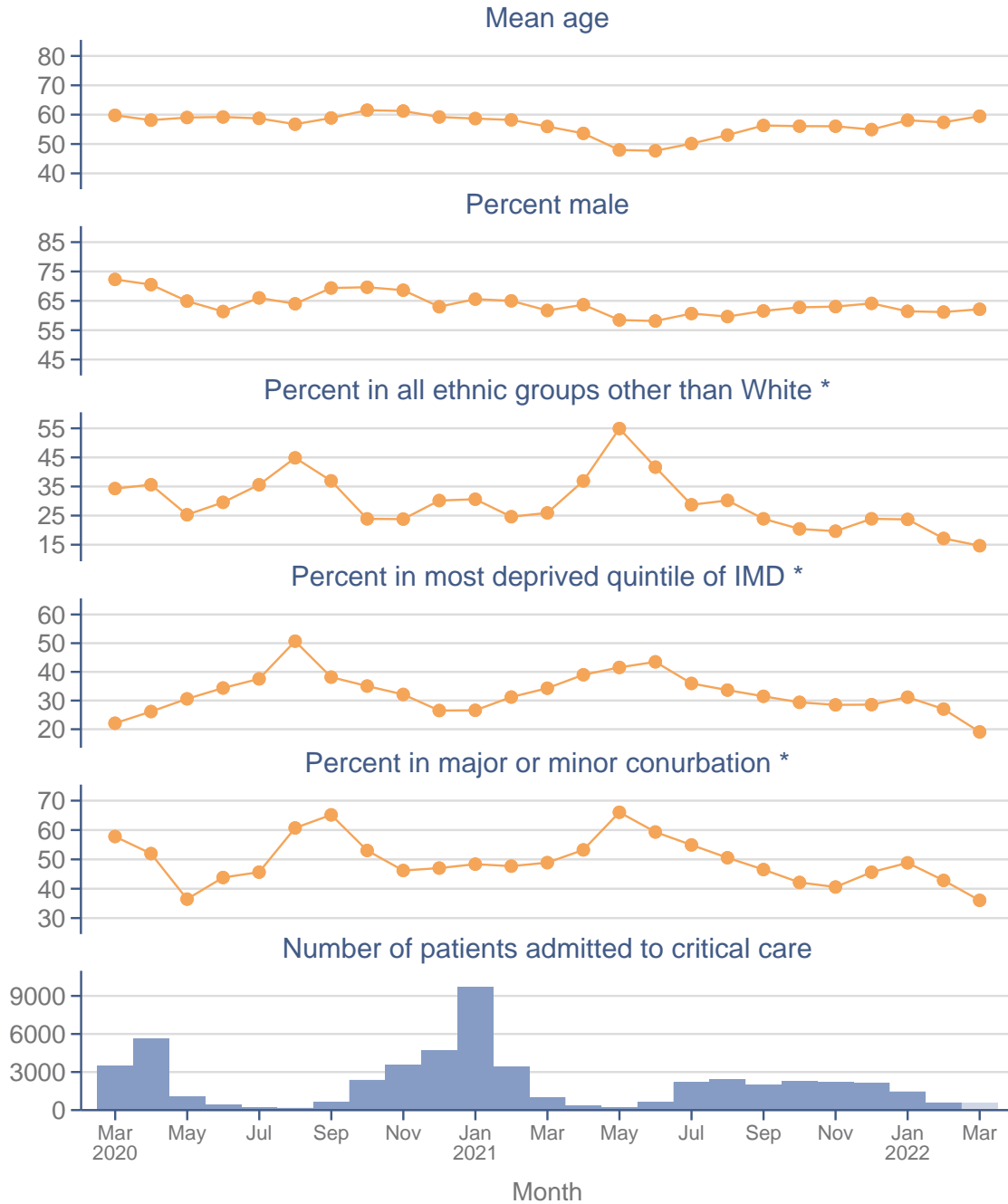
At risk	11021	6660	6389	6349
Died (in hospital)	0	4360	4614	4650
Censored	0	1	18	22

### Figure 39. In-hospital survival to 90 days following admission to critical care

Kaplan-Meier survival analysis for patients critically ill with confirmed COVID-19. Patients last reported to be still receiving critical care censored on the most recent date of data submission by the treating unit. Patients discharged from acute hospital within 90 days assumed to survive to 90 days. Please note that these survival curves are not adjusted for differences in patient characteristics (see Tables 1-3).

# Monthly trends – COVID-19

Monthly trends in characteristics for patients critically ill with confirmed COVID-19 are shown for key summary statistics in Figures 40-42 and as full distributions in Figures 43-45.

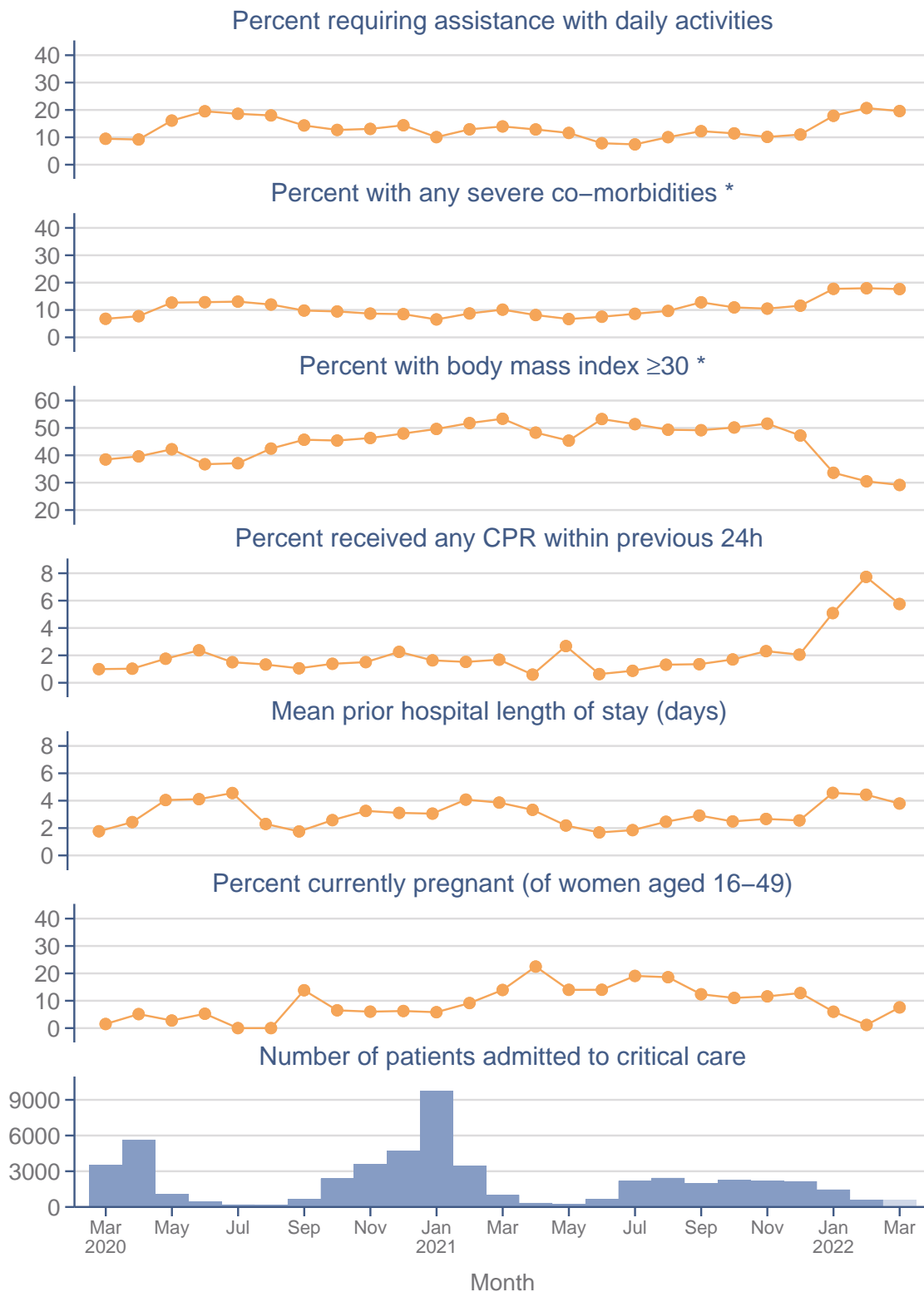


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## Figure 40. Monthly trend in patient characteristics (demographics)

Monthly trend in patient characteristics (demographics) for patients critically ill with confirmed COVID-19.

\* Please see Definitions on page 95. Dashed line and shading indicates incomplete month.

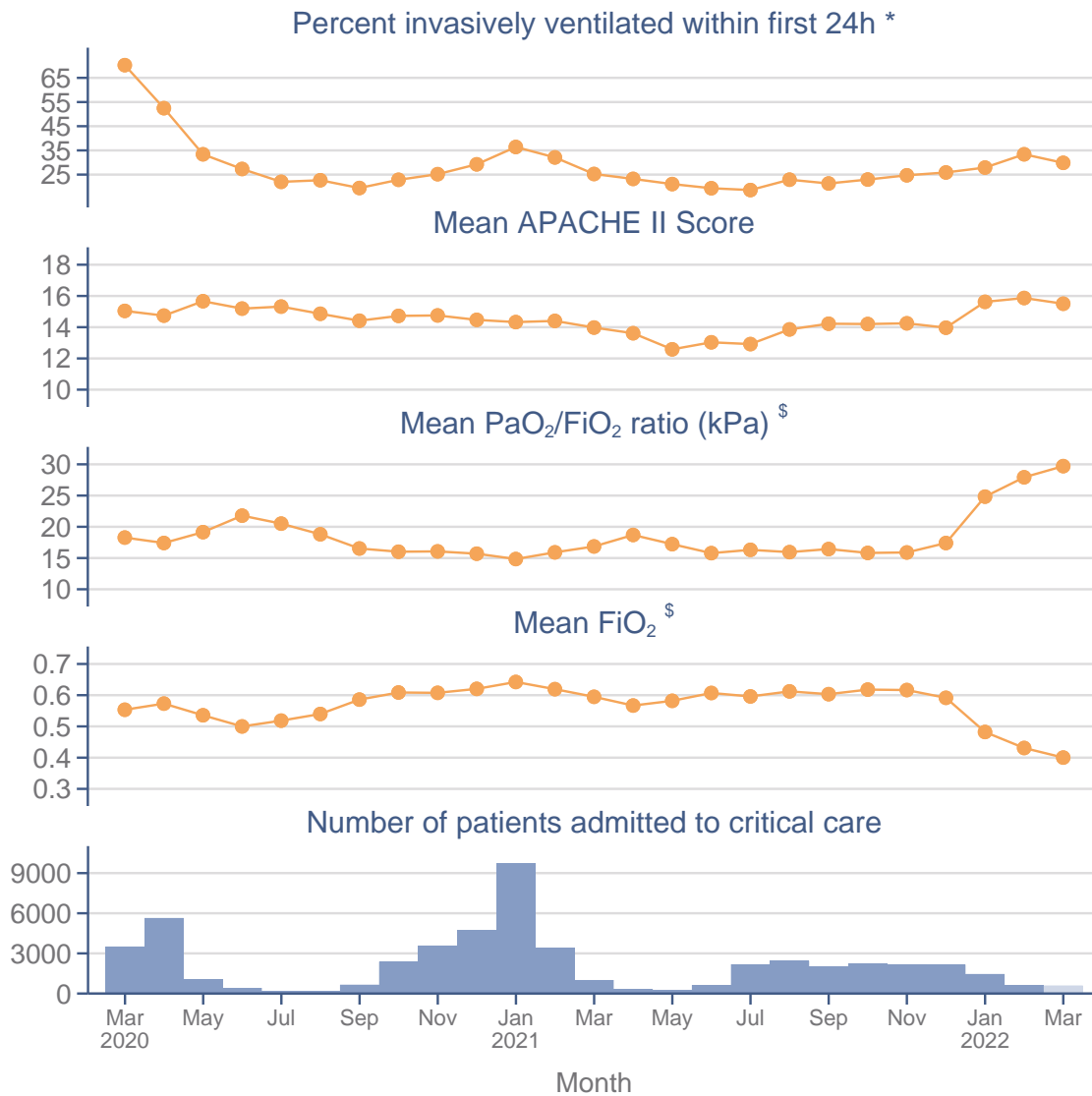


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**Figure 41. Monthly trend in patient characteristics (medical history)**

Monthly trend in patient characteristics (medical history) for patients critically ill with confirmed COVID-19.

\* Please see Definitions on page 95. Dashed line and shading indicates incomplete month.



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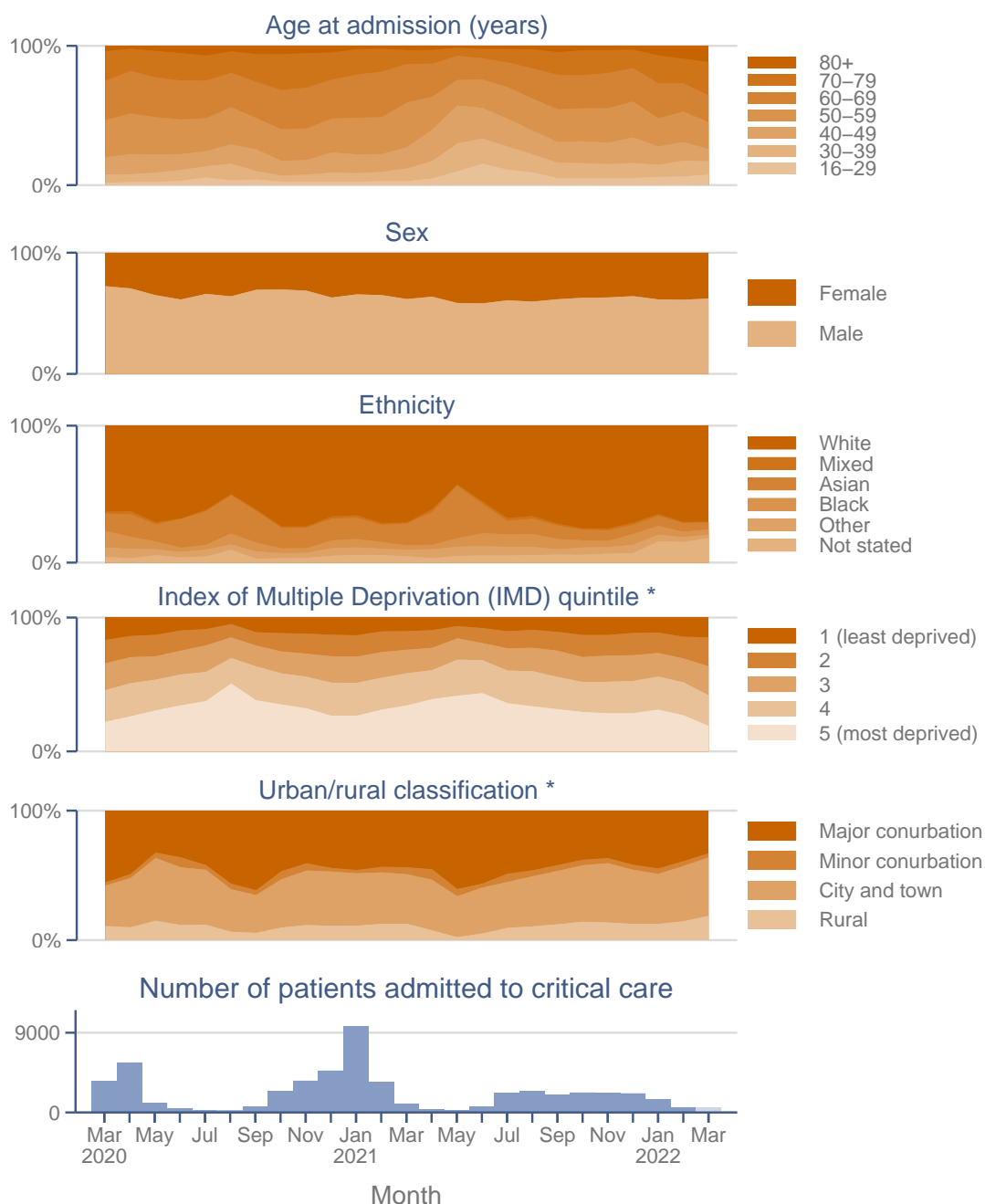
**Figure 42. Monthly trend in patient characteristics (indicators of acute severity)**

Monthly trend in patient characteristics (indicators of acute severity) for patients critically ill with confirmed COVID-19.

\* Please see Definitions on page 95. Dashed line and shading indicates incomplete month.

§ Derived from the arterial blood gas with the lowest PaO<sub>2</sub> during the first 24 hours of critical care.



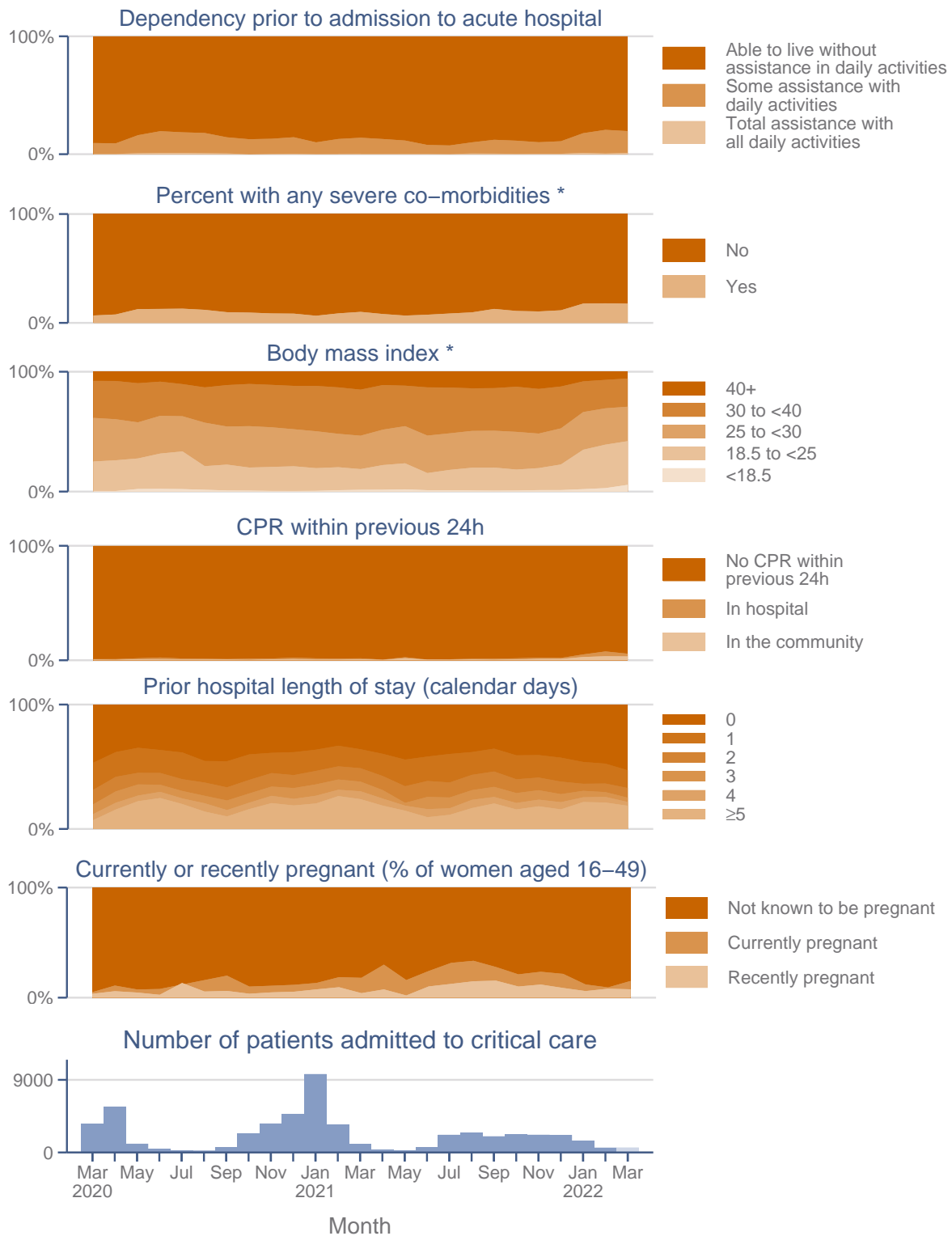


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**Figure 43. Monthly trend in patient characteristics (demographics) – distributions**

Monthly trend in the distribution of patient characteristics (demographics) for patients critically ill with confirmed COVID-19.

\* Please see Definitions on page 95. Shading indicates incomplete month.

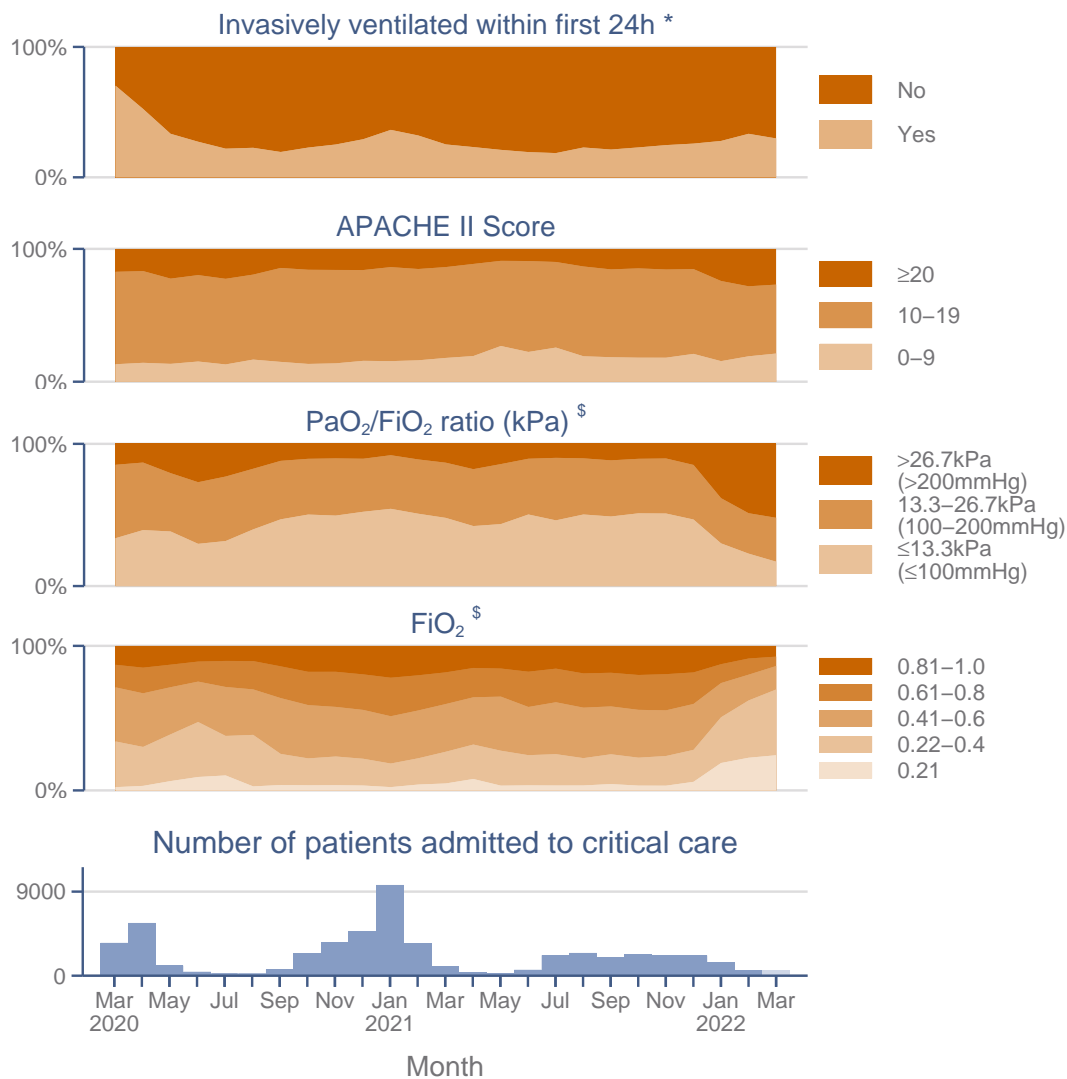


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**Figure 44. Monthly trend in patient characteristics (medical history) – distributions**

Monthly trend in the distribution of patient characteristics (medical history) for patients critically ill with confirmed COVID-19.

\* Please see Definitions on page 95. Shading indicates incomplete month.



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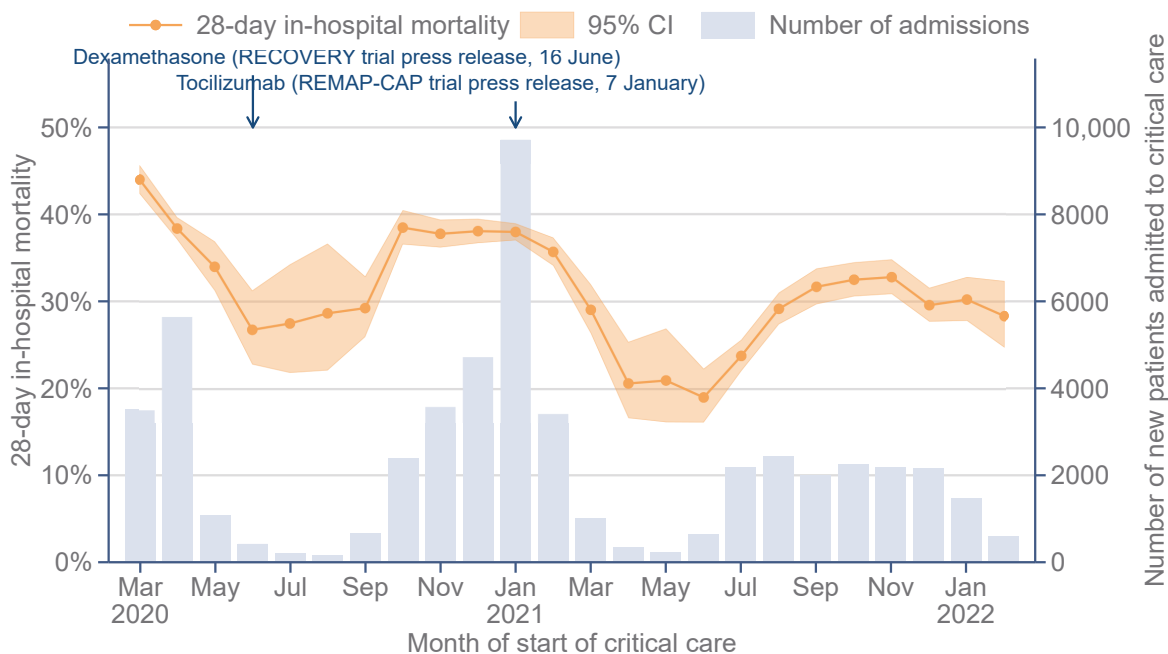
**Figure 45. Monthly trend in patient characteristics (indicators of acute severity) – distributions**

Monthly trend in the distribution of patient characteristics (indicators of acute severity) for patients critically ill with confirmed COVID-19.

\* Please see Definitions on page 95. Shading indicates incomplete month.

§ Derived from the arterial blood gas with the lowest PaO<sub>2</sub> during the first 24 hours of critical care.

Figure 46 shows the monthly number of new patients critically ill with confirmed COVID-19 from March 2020 until the last complete month and the corresponding 28-day in-hospital mortality, indicating the months in which information became available identifying steroids (Dexamethasone) and IL-6 inhibitors (Tocilizumab) as effective treatments for critically ill patients. Figures 47-49 show monthly variation in patient characteristics relating to ventilation and timing of critical care compared with the change in mortality.

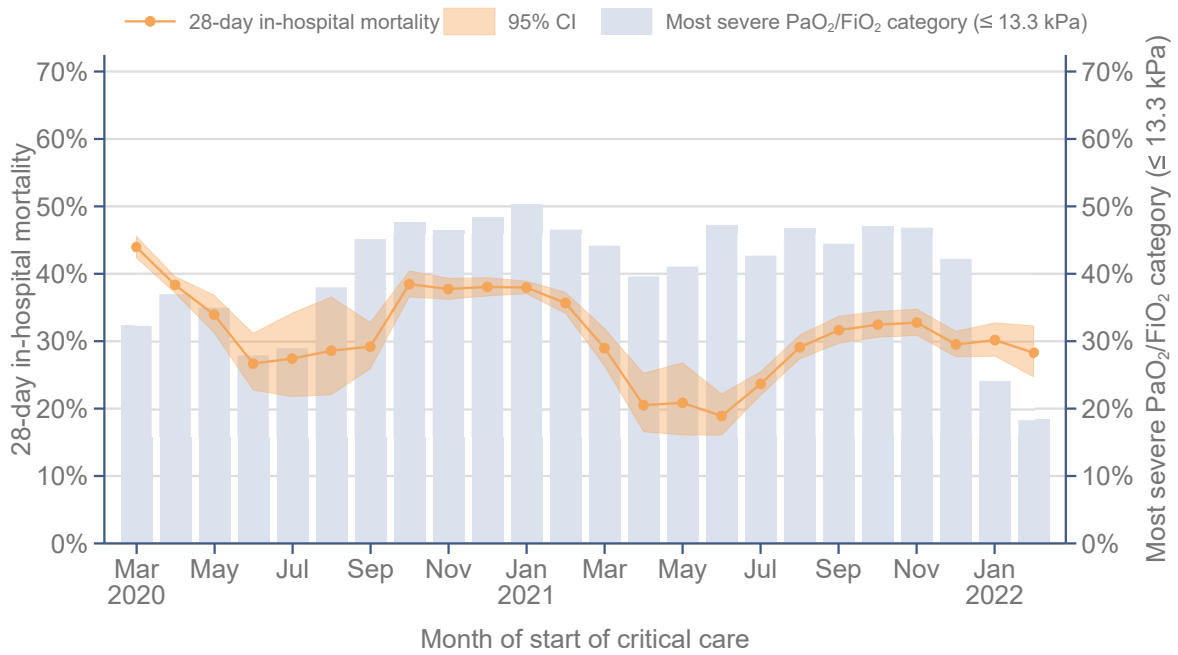


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### Figure 46. Number of admissions and 28-day in-hospital mortality by month

Number of new admissions and 28-day in-hospital mortality for patients critically ill with confirmed COVID-19 by month of admission to critical care.

Estimates of 28-day in-hospital mortality based on Kaplan-Meier survival analysis. Patients last reported to be still receiving critical care censored on the most recent date of data submission by the treating unit. Patients discharged from acute hospital within 28 days assumed to survive to 28 days. Please note that these estimates are not adjusted for changes in patient characteristics (see Tables 1-3).

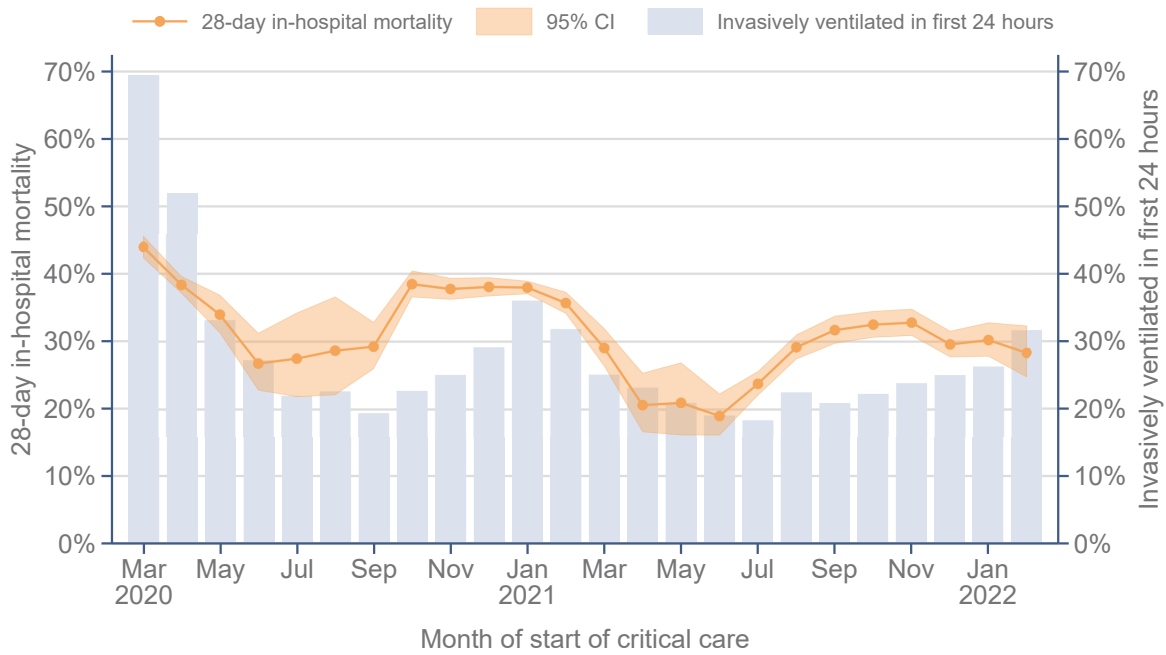


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### Figure 47. PaO<sub>2</sub>/FiO<sub>2</sub> and 28-day in-hospital mortality by month

Percentage of patients in most severe PaO<sub>2</sub>/FiO<sub>2</sub> category (≤ 13.3 kPa) and 28-day in-hospital mortality for patients critically ill with confirmed COVID-19 by month of admission to critical care.

Estimates of 28-day in-hospital mortality based on Kaplan-Meier survival analysis. Patients last reported to be still receiving critical care censored on the most recent date of data submission by the treating unit. Patients discharged from acute hospital within 28 days assumed to survive to 28 days. Please note that these estimates are not adjusted for changes in patient characteristics (see Tables 1-3).

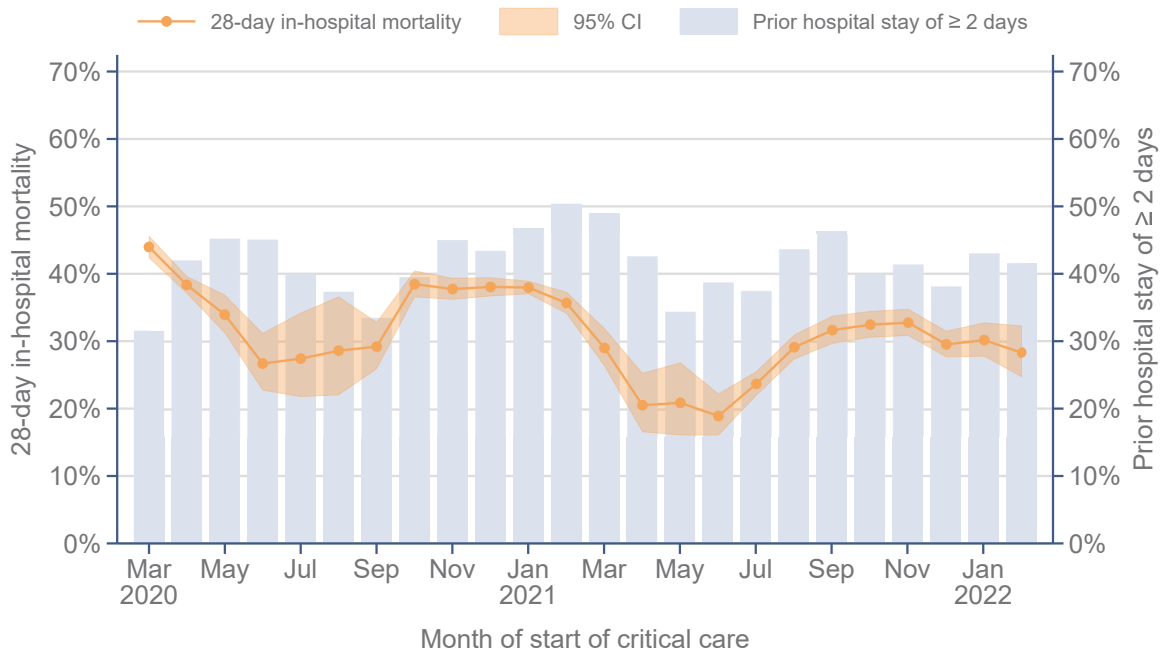


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### Figure 48. Invasive ventilation first 24 hours and 28-day in-hospital mortality by month

Percentage of patients receiving invasive ventilation during the first 24 hours in critical care and 28-day in-hospital mortality for patients critically ill with confirmed COVID-19 by month of admission to critical care.

Estimates of 28-day in-hospital mortality based on Kaplan-Meier survival analysis. Patients last reported to be still receiving critical care censored on the most recent date of data submission by the treating unit. Patients discharged from acute hospital within 28 days assumed to survive to 28 days. Please note that these estimates are not adjusted for changes in patient characteristics (see Tables 1-3).



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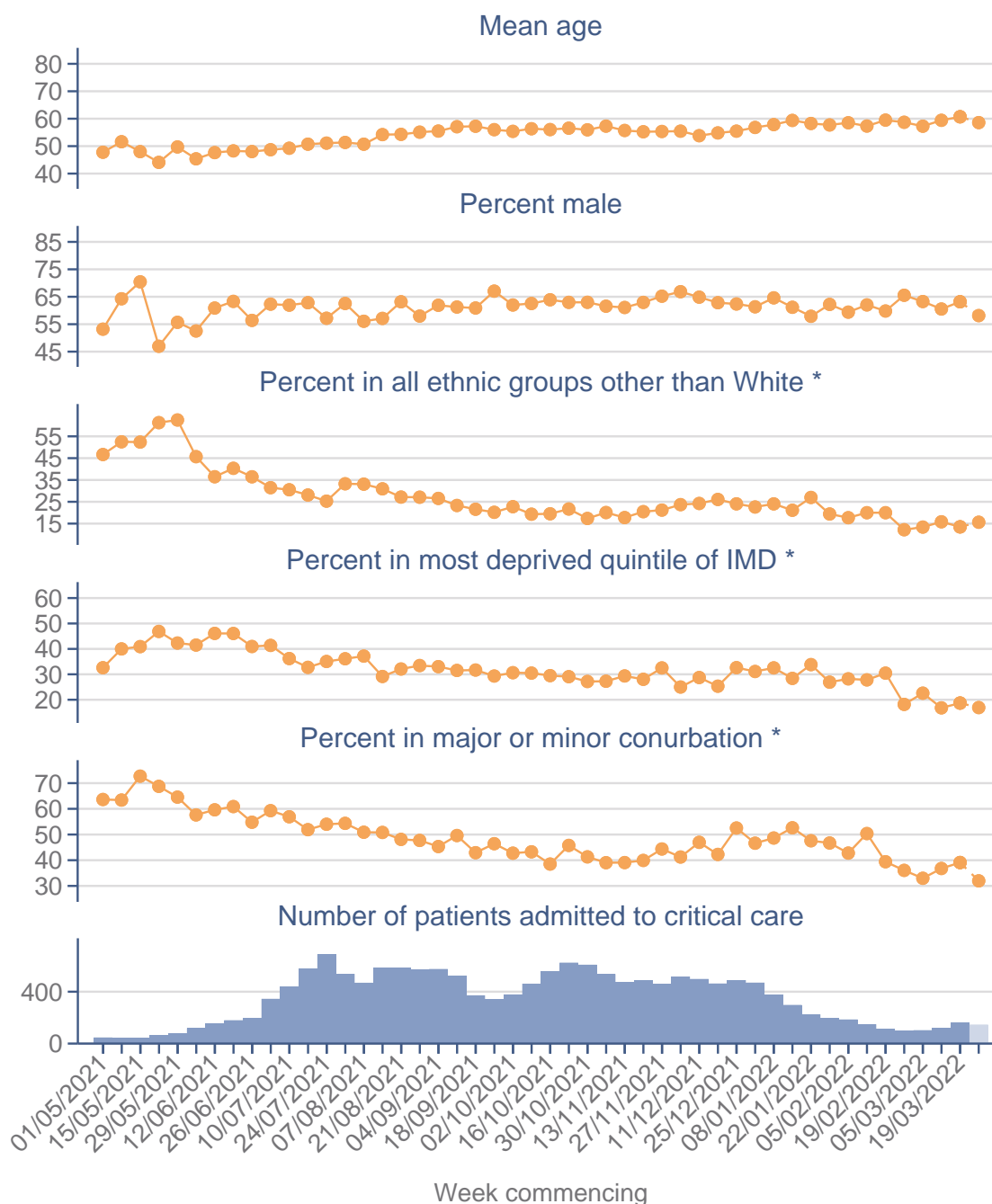
**Figure 49. Prior hospital length of stay and 28-day in-hospital mortality by month**

Percentage of patients with a hospital stay of 2 or more days before admission to critical care and 28-day in-hospital mortality for patients critically ill with confirmed COVID-19 by month of admission to critical care.

Estimates of 28-day in-hospital mortality based on Kaplan-Meier survival analysis. Patients last reported to be still receiving critical care censored on the most recent date of data submission by the treating unit. Patients discharged from acute hospital within 28 days assumed to survive to 28 days. Please note that these estimates are not adjusted for changes in patient characteristics (see Tables 1-3).

## Weekly trends in recent admissions – COVID-19

Weekly trends in characteristics for patients critically ill with confirmed COVID-19 from 1 May 2021 onwards are shown for key summary statistics in Figures 50-52 and as full distributions in Figures 53-55.



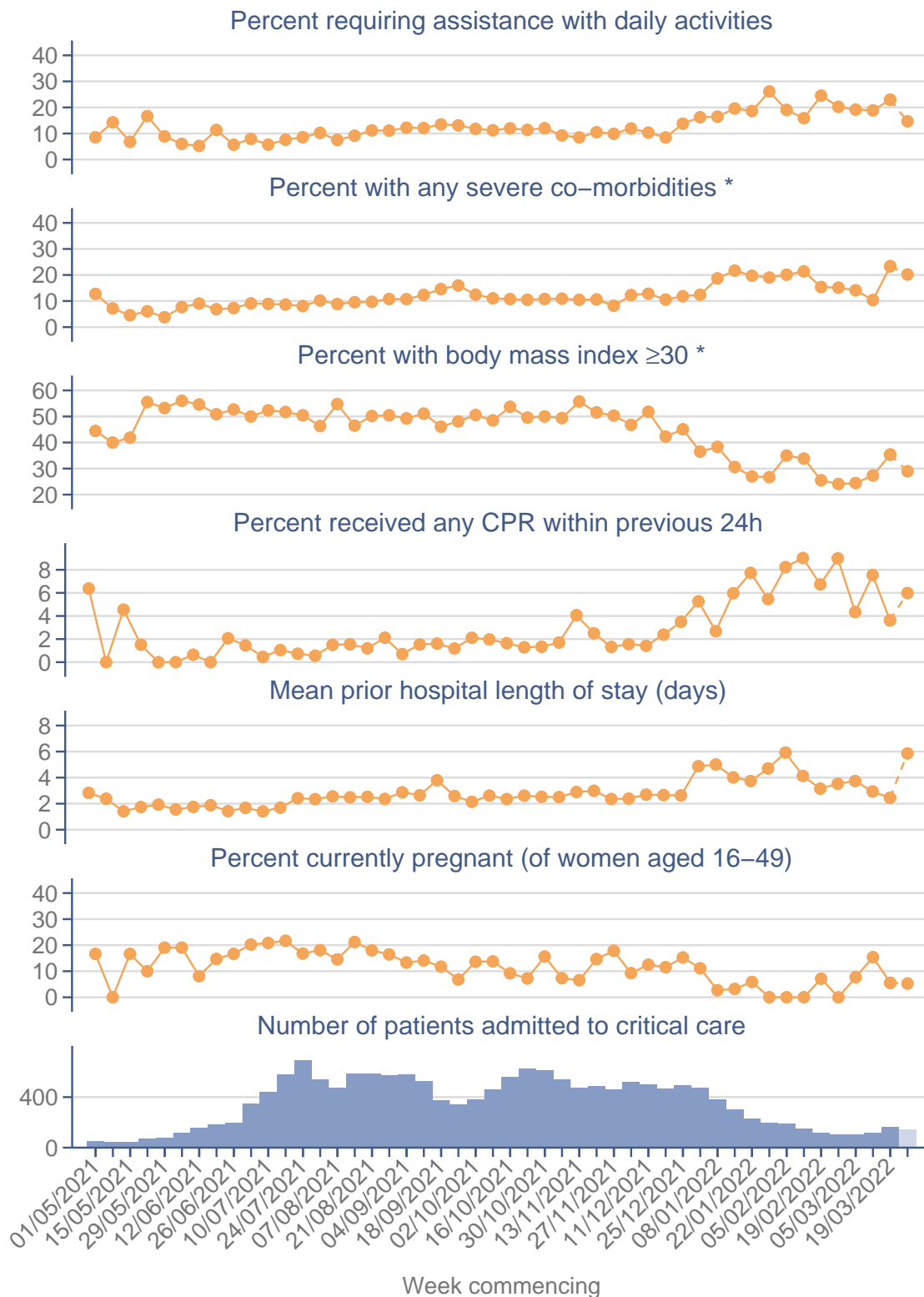
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### Figure 50. Weekly trend in patient characteristics (demographics)

Weekly trend in patient characteristics (demographics) for patients critically ill with confirmed COVID-19.

\* Please see Definitions on page 95. Dashed line and shading indicates incomplete week.



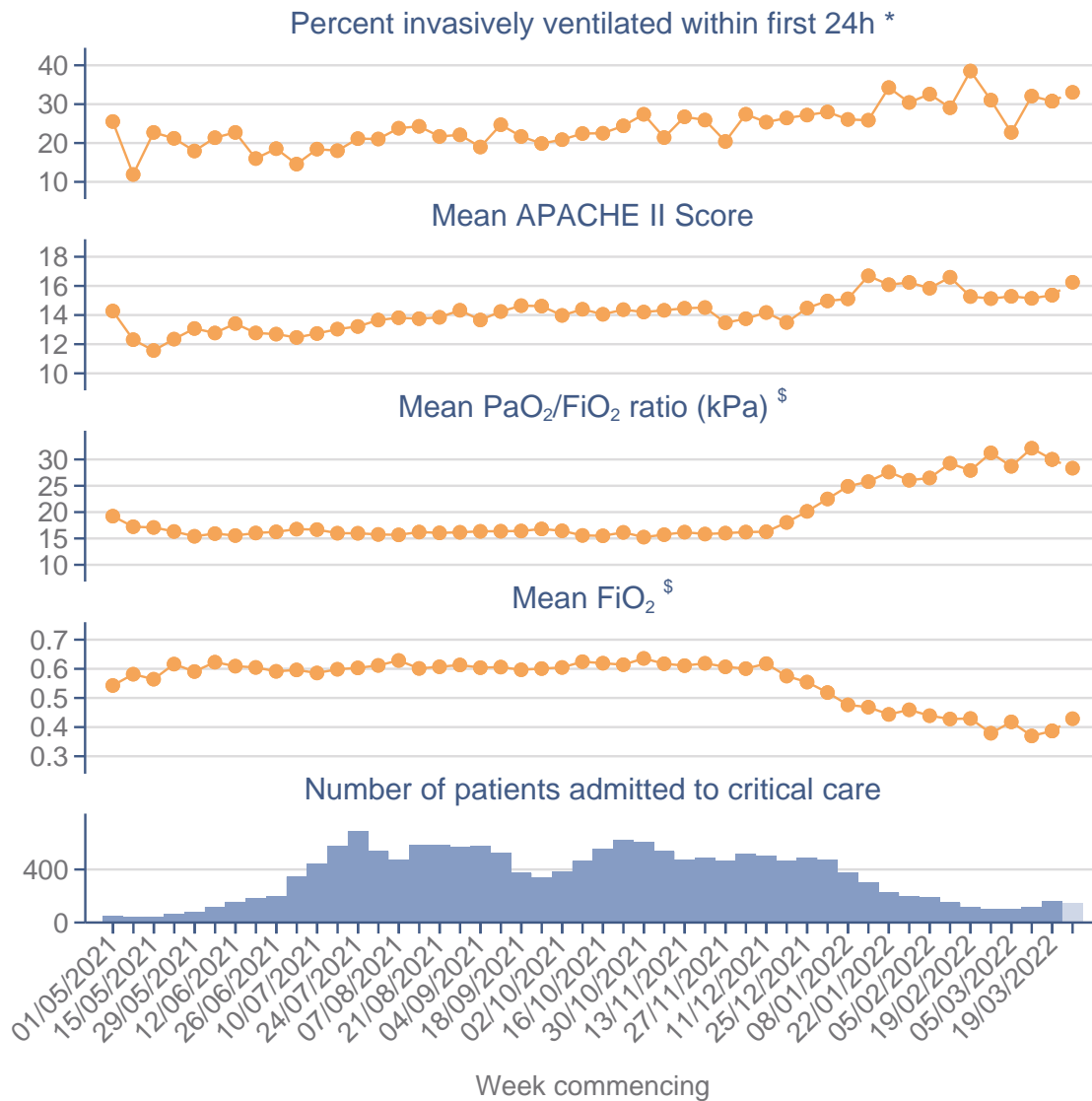


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**Figure 51. Weekly trend in patient characteristics (medical history)**

Weekly trend in patient characteristics (medical history) for patients critically ill with confirmed COVID-19.

\* Please see Definitions on page 95. Dashed line and shading indicates incomplete week.



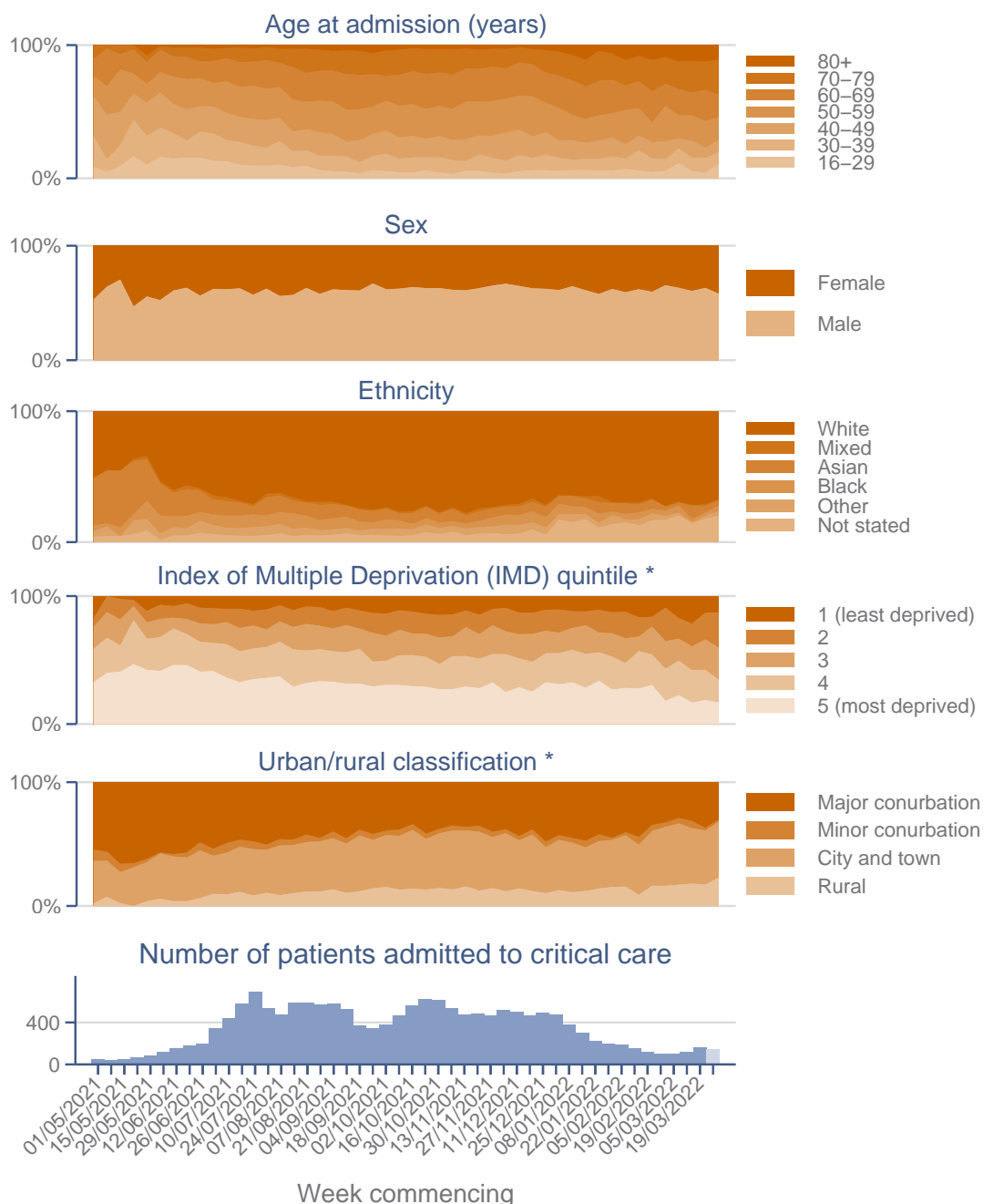
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**Figure 52. Weekly trend in patient characteristics (indicators of acute severity)**

Weekly trend in patient characteristics (indicators of acute severity) for patients critically ill with confirmed COVID-19.

\* Please see Definitions on page 95. Dashed line and shading indicates incomplete week.

§ Derived from the arterial blood gas with the lowest PaO<sub>2</sub> during the first 24 hours of critical care.

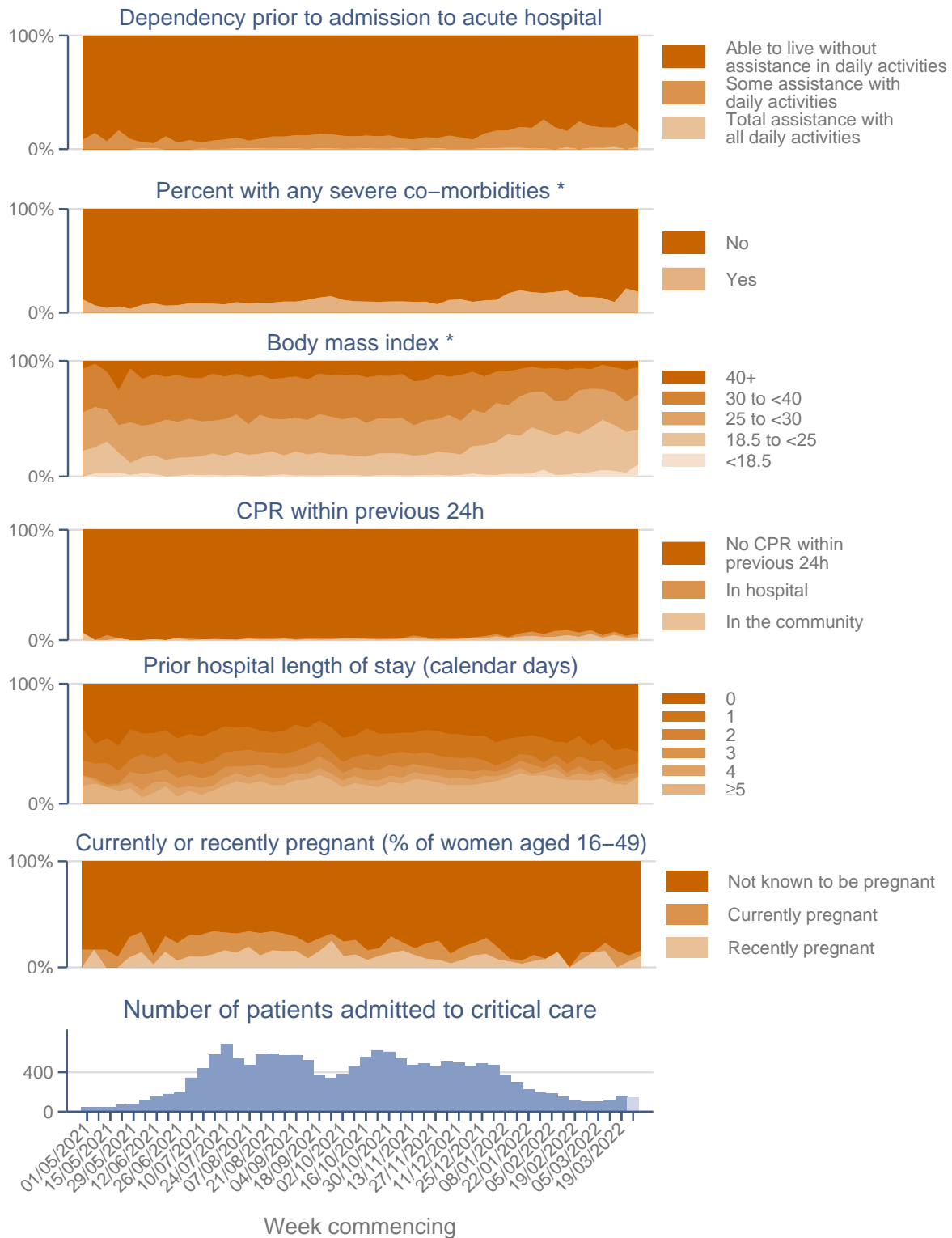


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**Figure 53. Weekly trend in patient characteristics (demographics) – distributions**

Weekly trend in the distribution of patient characteristics (demographics) for patients critically ill with confirmed COVID-19.

\* Please see Definitions on page 95. Shading indicates incomplete week.

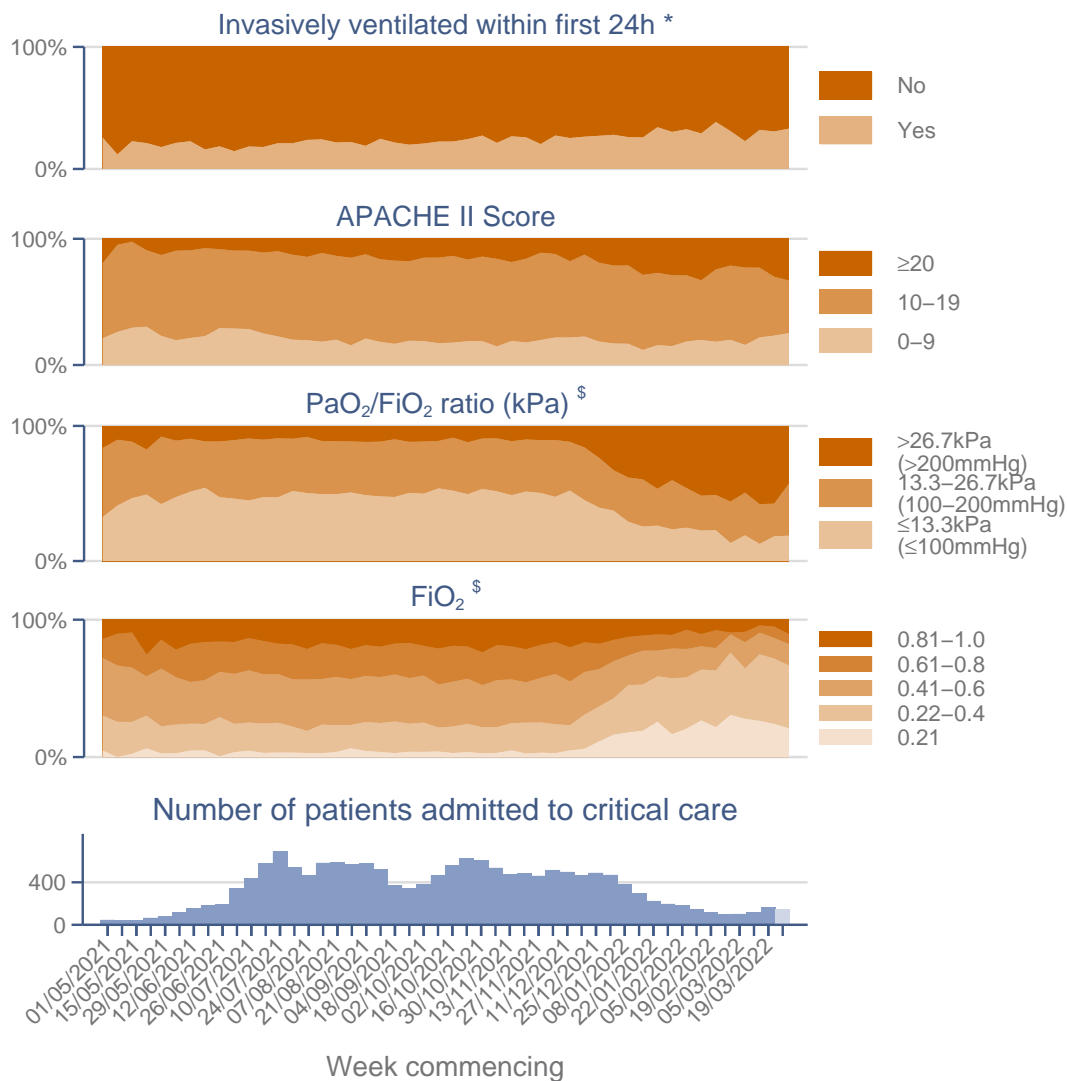


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**Figure 54. Weekly trend in patient characteristics (medical history) – distributions**

Weekly trend in the distribution of patient characteristics (medical history) for patients critically ill with confirmed COVID-19.

\* Please see Definitions on page 95. Shading indicates incomplete week.



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**Figure 55. Weekly trend in patient characteristics (indicators of acute severity) – distributions**

Weekly trend in the distribution of patient characteristics (indicators of acute severity) for patients critically ill with confirmed COVID-19.

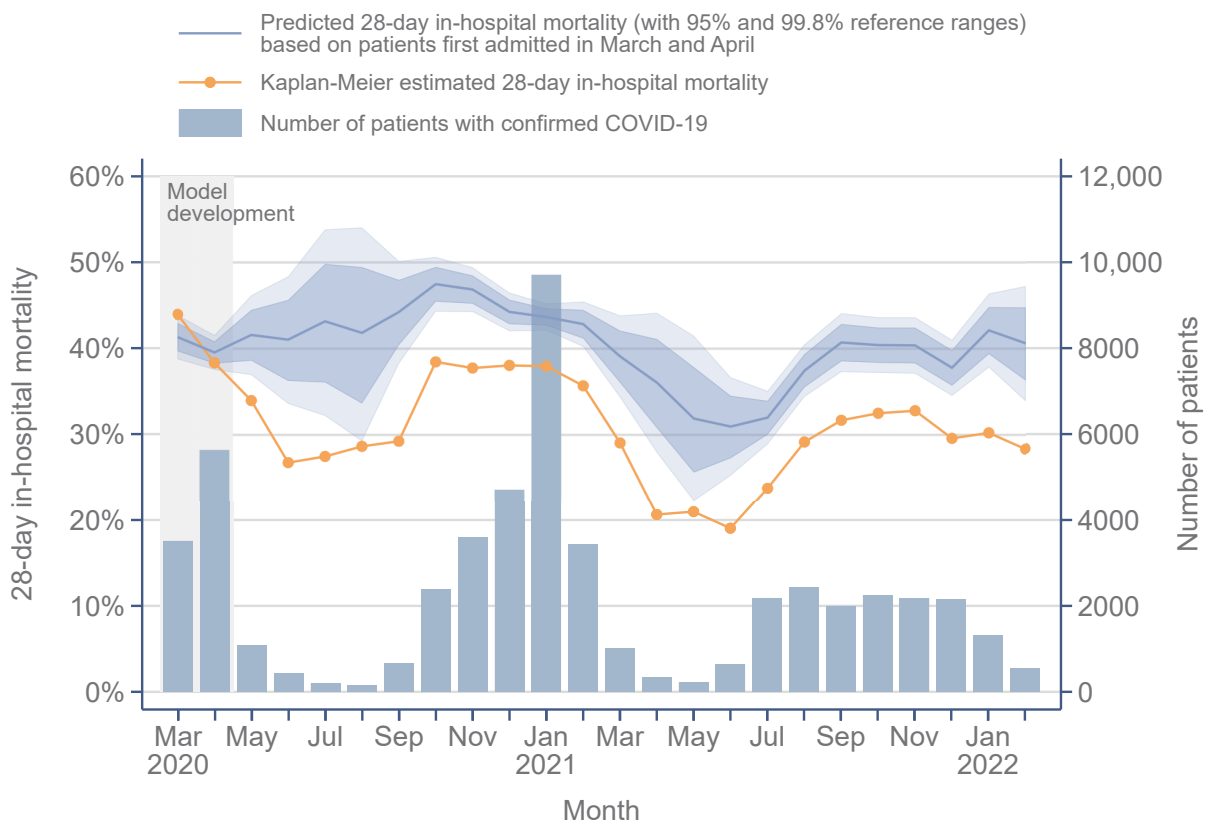
\* Please see Definitions on page 95. Shading indicates incomplete week.

§ Derived from the arterial blood gas with the lowest PaO<sub>2</sub> during the first 24 hours of critical care.

## Risk-adjusted 28-day in-hospital mortality

Changes in mortality over time may be driven in part by changes in the characteristics of patients admitted to critical care, i.e. their average predicted risk of death at the time of admission (due to illness severity, comorbidities or demographic risk factors). To adjust for changes in the predicted risk of death over time, we developed a risk prediction model for 28-day in-hospital mortality using all patients critically ill with COVID-19 first admitted from 1 March to 30 April 2020 (Ferrando-Vivas et al, 2021). We validated the model using both the same patients and patients admitted from 1 May to 31 August 2020.

Figure 56 shows observed 28-day in-hospital mortality by month compared with predicted 28-day in-hospital mortality based on the characteristics and outcomes of patients admitted during March and April 2020. Although predicted mortality has varied, most recently decreasing substantially as the patients admitted to critical care have become younger on average, the observed mortality has remained lower than predicted since May 2020.



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### Figure 56. Risk-adjusted 28-day in-hospital mortality

Kaplan-Meier based estimates of observed 28-day in-hospital mortality for patients critically ill with confirmed COVID-19 compared with predicted mortality from a prediction model developed using data for patients admitted during March and April 2020. If the observed outcomes are as predicted by the model, then we would expect the observed mortality to lie within the 95% reference range 19 times out of 20 and within the 99.8% reference range 998 times out of 1000.

## Definitions

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**Reason for transfer** between critical care units is categorised as:

- Comparable critical care: transfer for similar care as provided in the transferring critical care unit
- Repatriation: returning a patient to their original unit, hospital or area
- More-specialist critical care: transfer for specialist critical care not available in the transferring critical care unit

**Critical care transfer groups** are groups of local critical care units developed to reduce the number of long distance transfers that take place and to ensure that transfers are contained within the critical care network or, by special agreement, between hospitals at the borders of adjacent networks.

**Ethnicity** is recorded using the ethnic category codes from the 2001 census and grouped as:

- White: White – British; White – Irish; White – any other
- Mixed: Mixed – white and black Caribbean; Mixed – white and black African; Mixed – white and Asian; Mixed – any other
- Asian: Asian or Asian British – Indian; Asian or Asian British – Pakistani; Asian or Asian British – Bangladeshi; Asian or Asian British – any other
- Black: Black or black British – Caribbean; Black or black British – African; Black or black British – any other
- Other: Other ethnic group – Chinese; Any other ethnic group
- Not stated or not recorded

**Index of Multiple Deprivation (IMD)** is based on the patient's usual residential postcode (assigned at the level of Lower Layer Super Output Area) according to:

- English Index of Multiple Deprivation 2019 for postcodes in England
- Welsh Index of Multiple Deprivation 2019 for postcodes in Wales
- Northern Ireland Multiple Deprivation Measure 2017 for postcodes in Northern Ireland

**Urban/rural classification** is based on the patient's usual residential postcode (assigned at the level of Output Area) and categorised according to 2011 census categories as:

- Urban: the majority of the population lives within settlements with a population of more than 10,000 people, subcategorised according to dwelling densities for every 100m x 100m square and the density in squares at varying distances around each square as either Major conurbation, Minor conurbation, or City or town
- Rural: the majority of the population lives within settlements with a population of less than 10,000 people (combining the categories Town and fringe, Village, and Hamlet or isolated dwellings)

**Body mass index** is calculated as the weight in kilograms divided by the height in metres squared. Weight and height values may have been measured or estimated.

**Dependency prior to admission to acute hospital** is assessed as the best description for the dependency of the patient in the two weeks prior to admission to acute hospital and prior to the onset of the acute illness, i.e. “usual” dependency. It is assessed according to the amount of personal assistance they receive with daily activities (bathing, dressing, going to the toilet, moving in/out of bed/chair, continence and eating).

**Very severe comorbidities** must have been evident within the six months prior to critical care and documented at or prior to critical care:

- Cardiovascular: symptoms at rest
- Respiratory: shortness of breath with light activity or home ventilation
- Renal: renal replacement therapy for end-stage renal disease
- Liver: biopsy-proven cirrhosis, portal hypertension or hepatic encephalopathy
- Metastatic disease: distant metastases
- Haematological malignancy: acute or chronic leukaemia, multiple myeloma or lymphoma
- Immunocompromise: chemotherapy, radiotherapy or daily high dose steroid treatment in previous six months, HIV/AIDS or congenital immune deficiency

**Invasive ventilation** during the first 24 hours was defined as mechanical ventilation (identified by the recording of a ventilated respiratory rate, indicating that all or some of the breaths or a portion of the breaths were delivered by a mechanical device) and sedation (receiving continuous or intermittent doses of agents to produce and maintain a continuous decreased level of consciousness with or without paralysing agents) at any time during the first 24 hours and not reported as having zero days of advanced respiratory support.

**Organ support** is recorded as the number of calendar days (00:00-23:59) on which the support was received at any time, defined as:

- Advanced respiratory: invasive ventilation, BPAP via trans-laryngeal tube or tracheostomy, CPAP via trans-laryngeal tube, extracorporeal respiratory support
- Basic respiratory: >50% oxygen by face mask, close observation due to potential for acute deterioration, physiotherapy/suction to clear secretions at least two-hourly, recently extubated after a period of mechanical ventilation, mask/hood CPAP/BPAP, non-invasive ventilation, CPAP via a tracheostomy, intubated to protect airway
- Advanced cardiovascular: multiple IV/rhythm controlling drugs (at least one vasoactive), continuous observation of cardiac output, intra-aortic balloon pump, temporary cardiac pacemaker
- Basic cardiovascular: central venous catheter, arterial line, single IV vasoactive/ rhythm controlling drug
- Renal: acute renal replacement therapy, renal replacement therapy for chronic renal failure where other organ support is received
- Liver: management of coagulopathy and/or portal hypertension for acute on chronic hepatocellular failure or primary acute hepatocellular failure
- Neurological: central nervous system depression sufficient to prejudice airway, invasive neurological monitoring, continuous IV medication to control seizures, therapeutic hypothermia



## Publications

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The following publications, based on Case Mix Programme data for patients critically ill with confirmed COVID-19, are published, in press or in preprint:

- Richards-Belle A, Orzechowska I, Doidge J, Thomas K, Harrison DA, Koelewyn A, Christian MD, Shankar-Hari M, Rowan KM, Gould DW. Critical care outcomes, for the first 200 patients with confirmed COVID-19, in England, Wales and Northern Ireland: a report from the ICNARC Case Mix Programme. *J Intensive Care Soc* 2020; doi:[10.1177/1751143720961672](https://doi.org/10.1177/1751143720961672)
- Richards-Belle A, Orzechowska I, Gould DW, Thomas K, Doidge JC, Mouncey PR, Christian MD, Shankar-Hari M, Harrison DA, Rowan KM. COVID-19 in critical care: epidemiology of the first epidemic wave across England, Wales and Northern Ireland. *Intensive Care Med* 2020; 46:2035-47. doi:[10.1007/s00134-020-06267-0](https://doi.org/10.1007/s00134-020-06267-0)
- Ferrando-Vivas P, Doidge J, Thomas K, Gould DW, Mouncey P, Shankar-Hari M, Young JD, Rowan KM, Harrison DA. Prognostic Factors for 30-day Mortality in Critically Ill Patients with Coronavirus Disease 2019: An Observational Cohort Study. *Crit Care Med* 2021; 49:102-11. doi:[10.1097/CCM.0000000000004740](https://doi.org/10.1097/CCM.0000000000004740)
- Doidge JC, Gould DW, Ferrando-Vivas P, Mouncey PR, Thomas K, Shankar-Hari M, Harrison DA, Rowan KM. Trends in intensive care for patients with COVID-19 in England, Wales and Northern Ireland. *Am J Respir Crit Care Med* 2021; 203:565-74. doi:[10.1164/rccm.202008-3210C](https://doi.org/10.1164/rccm.202008-3210C)
- Wilcox ME, Rowan KM, Harrison DA, Doidge JC. Does Unprecedented ICU Capacity Strain, As Experienced During the COVID-19 Pandemic, Impact Patient Outcome? *Crit Care Med* 2022; doi:[10.1097/CCM.0000000000005464](https://doi.org/10.1097/CCM.0000000000005464)
- Ferrando-Vivas P, Doidge J, Thomas K, Gould DW, Mouncey P, Shankar-Hari M, Young JD, Rowan KM, Harrison DA. Development and validation of a prediction model for 28-day in-hospital mortality in critically ill patients with COVID-19. *Preprints.org* 2021; doi:[10.20944/preprints202102.0059.v1](https://doi.org/10.20944/preprints202102.0059.v1)
- Harrison DA, Gould DW, Rowan KM. Potential impact of the UK vaccination strategy on the numbers of patients becoming critically ill with COVID-19. *OSF Preprints* 2021; doi:[10.31219/osf.io/yks8c](https://doi.org/10.31219/osf.io/yks8c)

The following publications, based on external data sources linked with Case Mix Programme data for patients critically ill with confirmed COVID-19, are published, in press or in preprint:

- Hippisley-Cox J, Young D, Coupland C, et al. Risk of severe COVID-19 disease with ACE inhibitors and angiotensin receptor blockers: cohort study including 8.3 million people. *Heart* 2020; 106:1503-11. doi:[10.1136/heartjnl-2020-317393](https://doi.org/10.1136/heartjnl-2020-317393)
- Pairo-Castineira E, Clohisey S, Klaric L, et al. Genetic mechanisms of critical illness in Covid-19. *Nature* 2021; 591:92-8. doi:[10.1038/s41586-020-03065-y](https://doi.org/10.1038/s41586-020-03065-y)
- Forbes H, Morton CE, Bacon S, et al. Association between living with children and outcomes from covid-19: OpenSAFELY cohort study of 12 million adults in England. *BMJ* 2021; 372:n628. doi:[10.1136/bmj.n628](https://doi.org/10.1136/bmj.n628)
- Aveyard P, Gao M, Lindson N, et al. Association between pre-existing respiratory disease and its treatments and severe COVID-19: a population cohort study. *Lancet Respir Med* 2021; doi:[10.1016/S2213-2600\(21\)00095-3](https://doi.org/10.1016/S2213-2600(21)00095-3)
- Mathur R, Rentsch CT, Morton C, et al. Ethnic differences in SARS-CoV-2 infection and COVID-19-related hospitalisation, intensive care unit admission, and death in 17 million adults in England: an observational cohort study using the OpenSAFELY platform. *Lancet* 2021; 397:1711-24. doi:[10.1016/S0140-6736\(21\)00634-6](https://doi.org/10.1016/S0140-6736(21)00634-6)

- Patone M, Thomas K, Hatch R, et al. Mortality and critical care unit admission associated with the SARS-CoV-2 lineage B.1.1.7 in England: an observational cohort study. *Lancet Infect Dis* 2021; doi:[10.1016/S1473-3099\(21\)00318-2](https://doi.org/10.1016/S1473-3099(21)00318-2)
- Edwards JM, Nolan JP, Soar J, et al. Impact of the COVID-19 pandemic on in-hospital cardiac arrests in the UK. *Resuscitation* 2022; 173:4-11. doi:[10.1016/j.resuscitation.2022.02.007](https://doi.org/10.1016/j.resuscitation.2022.02.007)
- Gao M, Aveyard P, Lindson N, et al. Association between smoking, e-cigarette use and severe COVID-19: a cohort study. *Int J Epidemiol* 2022; doi:[10.1093/ije/dyac028](https://doi.org/10.1093/ije/dyac028)
- MacKenna B, Kennedy NA, Mehkar A, et al. Risk of severe COVID-19 outcomes associated with immune-mediated inflammatory diseases and immune modifying therapies: a nationwide cohort study in the OpenSAFELY platform. *medRxiv* 2021; doi:[10.1101/2021.09.03.21262888](https://doi.org/10.1101/2021.09.03.21262888)

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