

## Supplementary Digital Content

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Table S1: Demographic characteristics of vaccinated solid organ and islet transplant recipients at 31 March 2022, by vaccine type.

Variable	Vaccine type												p-value
	AZ spine only		mRNA spine only		AZ spine + mRNA booster		mRNA spine + mRNA booster		AZ spine + 2 mRNA boosters		mRNA spine + 2 mRNA boosters		
	N	%	N	%	N	%	N	%	N	%	N	%	
<b>Total</b>	2285	5.7	1537	3.8	11 086	27.7	7639	19.1	9637	24	7908	19.7	
<b>Transplant type</b>													
Kidney <sup>a</sup>	1638	5.7	1110	3.9	7718	27	5516	19.3	6692	23.4	5891	20.6	<0.0001
SPK <sup>b</sup>	79	5.2	39	2.5	434	28.4	307	20.1	392	25.6	279	18.2	
Liver	374	5.4	246	3.6	2041	29.5	1312	19	1729	25	1221	17.6	
Heart	97	5.6	75	4.3	520	29.9	307	17.6	444	25.5	297	17.1	
Lung <sup>c</sup>	81	7.4	51	4.7	327	29.9	170	15.6	300	27.4	164	15	
Intestinal and multiorgan <sup>d</sup>	16	6.6	16	6.6	46	19.1	27	11.2	80	33.2	56	23.2	
<b>Ethnicity</b>													
White	1445	4.7	896	2.9	8027	26.3	5443	17.8	8202	26.8	6559	21.5	<0.0001
Asian	444	9.9	363	8.1	1532	34.3	1053	23.5	565	12.6	515	11.5	
Black	256	12.9	169	8.5	721	36.2	500	25.1	170	8.5	176	8.8	
Other	60	5.6	59	5.5	321	29.9	294	27.4	175	16.3	163	15.2	
Unknown	80	4	50	2.5	485	24.4	349	17.6	525	26.5	495	24.9	
<b>Age (years)</b>													
16-49	1057	8	720	5.5	4092	31.1	2843	21.6	2393	18.2	2035	15.5	<0.0001
50+	1228	4.6	817	3	6994	25.9	4796	17.8	7244	26.9	5873	21.8	
<b>Sex</b>													
Male	1394	5.7	933	3.8	6896	28.3	4681	19.2	5759	23.6	4710	19.3	0.001
Female	891	5.7	604	3.8	4190	26.7	2958	18.8	3878	24.7	3198	20.3	
<b>Time from transplant</b>													
<90 days	42	5.1	26	3.2	359	44	260	31.9	69	8.5	60	7.4	<0.0001
90 days - 1 year	155	7.9	115	5.8	556	28.2	424	21.5	375	19	348	17.6	
>1 year	2088	5.6	1396	3.7	10 171	27.3	6955	18.6	9193	24.6	7500	20.1	
<b>NHS region</b>													
East of England	235	4.8	134	2.7	1341	27.2	821	16.6	1382	28	1021	20.7	<0.0001
London	507	7.5	397	5.9	2000	29.5	1822	26.9	891	13.2	1158	17.1	
Midlands	459	6.3	293	4	2080	28.5	1257	17.2	1779	24.4	1420	19.5	

North East and Yorkshire	345	5.4	205	3.2	1722	27.2	999	15.8	1855	29.3	1212	19.1
North West	290	6.2	235	5	1260	26.9	1119	23.9	788	16.8	985	21.1
South East	288	4.7	173	2.8	1651	27	1039	17	1619	26.5	1346	22
South West	161	4.1	100	2.5	1032	26	582	14.7	1323	33.4	766	19.3

<sup>a</sup>Includes single kidney, en-bloc kidney and double kidney transplants

<sup>b</sup>Simultaneous pancreas-kidney transplants, including pancreas only, islet only and simultaneous islet-kidney transplants

<sup>c</sup>Includes single lung, double lung, partial lung and heart-lung transplants

<sup>d</sup>Includes if any other organ was transplanted with the intestine as well as liver-kidney, heart-lung-liver, liver-pancreas, heart-kidney, heart-liver, and lung-liver transplants

AZ – ChAdOx1-S vaccine, mRNA – BNT162b2 and mRNA-1273 vaccines

Table S2: Demographic characteristics of solid organ and islet transplant recipients with SARS-CoV-2 infection and death within 28 days of the latest positive test, by vaccination status and vaccine type, 7 December 2020 to 31 March 2022. AZ, ChAdOx1-S vaccine; mRNA, BNT162b2 or mRNA-1273 vaccines.

Variable	Unvaccinated			AZ spine only			mRNA spine only			AZ spine + mRNA booster			mRNA spine + mRNA booster			AZ spine + 2 mRNA boosters			mRNA spine + 2 mRNA boosters			p-value
	Cases		Deaths	Cases		Deaths	Cases		Deaths	Cases		Deaths	Cases		Deaths	Cases		Deaths	Cases		Deaths	
	N	N	%	N	N	%	N	N	%	N	N	%	N	N	%	N	N	%	N	N	%	
<b>Total</b>	1764	210	11.9	2157	160	7.4	1308	105	8	3214	95	3	2488	58	2.3	778	8	1	745	6	0.8	
<b>Transplant type</b>																						
Kidney <sup>a</sup>	1333	155	11.6	1567	117	7.5	966	74	7.7	2279	67	2.9	1891	45	2.4	546	4	0.7	587	6	1	0.54
SPK <sup>b</sup>	58	8	13.8	91	3	3.3	54	3	5.6	137	3	2.2	102	1	1	28	0	0	27	0	0	
Liver	279	27	9.7	318	16	5	175	13	7.4	495	10	2	314	9	2.9	119	2	1.7	80	0	0	
Heart	57	8	14	110	7	6.4	70	10	14.3	171	9	5.3	100	1	1	43	1	2.3	31	0	0	
Lung <sup>c</sup>	34	12	35.3	59	17	28.8	33	5	15.2	114	6	5.3	67	2	3	36	1	2.8	14	0	0	
Intestinal and multi-organ <sup>d</sup>	3	0	0	12	0	0	10	0	0	18	0	0	14	0	0	6	0	0	6	0	0	
<b>Ethnicity</b>																						
White	1029	122	11.9	1550	114	7.4	964	79	8.2	2527	71	2.8	1929	40	2.1	689	8	1.2	641	6	0.9	0.05*
Asian	357	45	12.6	337	27	8	181	14	7.7	316	11	3.5	248	7	2.8	31	0	0	53	0	0	
Black	224	28	12.5	147	12	8.2	80	7	8.8	172	5	2.9	97	3	3.1	7	0	0	9	0	0	
Other	79	6	7.6	48	2	4.2	34	0	0	74	4	5.4	82	2	2.4	13	0	0	12	0	0	
Unknown	75	9	12	75	5	6.7	49	5	10.2	125	4	3.2	132	6	4.5	38	0	0	30	0	0	
<b>Age (years)</b>																						

16-49	745	27	3.6	996	25	2.5	574	12	2.1	1296	8	0.6	1033	0	0	262	1	0.4	268	1	0.4	0.07
50+	1019	183	18	1161	135	11.6	734	93	12.7	1918	87	4.5	1455	58	4	516	7	1.4	477	5	1	
<b>Sex</b>																						
Male	1064	135	12.7	1299	108	8.3	775	71	9.2	1926	66	3.4	1473	43	2.9	449	7	1.6	422	2	0.5	0.33
Female	700	75	10.7	858	52	6.1	533	34	6.4	1288	29	2.3	1015	15	1.5	329	1	0.3	323	4	1.2	
<b>Time from transplant</b>																						
<90 days	47	7	14.9	35	1	2.9	26	0	0	39	0	0	38	0	0	5	0	0	5	0	0	0.18
90 days - 1 year	103	9	8.7	116	8	6.9	81	1	1.2	165	2	1.2	115	2	1.7	39	0	0	36	0	0	
>1 year	1614	194	12	2006	151	7.5	1201	104	8.7	3010	93	3.1	2335	56	2.4	734	8	1.1	704	6	0.9	
<b>NHS region</b>																						
East of England	177	33	18.6	233	19	8.2	120	5	4.2	420	6	1.4	292	6	2.1	122	0	0	103	1	1	0.001
London	537	47	8.8	319	16	5	244	19	7.8	509	13	2.6	504	7	1.4	75	0	0	119	0	0	
Midlands	333	47	14.1	460	43	9.3	229	22	9.6	599	22	3.7	436	16	3.7	125	2	1.6	132	1	0.8	
North East and Yorkshire	169	18	10.7	403	33	8.2	216	21	9.7	512	17	3.3	343	5	1.5	140	0	0	99	0	0	
North West	207	22	10.6	272	19	7	231	16	6.9	325	15	4.6	367	8	2.2	67	3	4.5	88	0	0	
South East	246	26	10.6	285	14	4.9	166	15	9	486	10	2.1	355	10	2.8	133	0	0	135	3	2.2	
South West	95	17	17.9	185	16	8.6	102	7	6.9	363	12	3.3	191	6	3.1	116	3	2.6	69	1	1.4	

<sup>a</sup>Includes single kidney, en-bloc kidney and double kidney transplants

<sup>b</sup>Simultaneous pancreas-kidney transplants, including pancreas only, islet only and simultaneous islet-kidney transplants

<sup>c</sup>Includes single lung, double lung, partial lung and heart-lung transplants

<sup>d</sup>Includes if any other organ was transplanted with the intestine as well as liver-kidney, heart-lung-liver, liver-pancreas, heart-kidney, heart-liver, and lung-liver transplants



Table S3: SARS-CoV-2 infection incidence rates and risk-adjusted incidence rate ratios in solid organ and islet transplant recipients by vaccine status, demographic variables, and month during the Omicron-dominant period, 20 December 2021 to 31 March 2022.

Variable	Unvaccinated		Two doses		Three doses		Four doses		Risk-adjusted incidence rate ratio (95% CI)	p-value
	Cases	Incidence rate per 100 000 person-days	Cases	Incidence rate per 100 000 person-days	Cases	Incidence rate per 100 000 person-days	Cases	Incidence rate per 100 000 person-days		
<b>Transplant type</b>										
Kidney <sup>a</sup>	181	150.2	519	172.2	3559	190.7	1139	243.5	1.00	..
SPK <sup>b</sup>	10	136.2	24	174.8	210	200.4	55	243.6	0.94 (0.83-1.06)	0.3
Liver	47	135.2	104	143.5	706	142.9	200	198.6	0.80 (0.74-0.86)	<0.001
Heart	12	200.2	35	242.8	239	208.6	75	279.4	1.12 (1.00-1.25)	0.05
Lung <sup>c</sup>	4	242.3	14	139.7	166	234.5	50	298.8	1.14 (1.00-1.31)	0.05
Intestinal and Multiorgan <sup>d</sup>	2	153.0	6	172.6	26	190.4	12	246.5	0.93 (0.70-1.25)	0.6
<b>Ethnicity</b>										
White	135	127.1	409	160.4	3823	186.5	1337	246.5	1.00	..
Asian	34	159.6	161	191.0	493	176.0	84	240.1	0.91 (0.84-0.99)	0.04
Black	58	198.1	83	175.3	230	188.2	16	137.2	0.96 (0.86-1.08)	0.5
Other	20	249.1	27	182.2	136	184.1	26	219.8	0.96 (0.83-1.11)	0.6
Unknown	9	134.2	22	156.1	224	162.5	68	176.0	0.87 (0.78-0.99)	0.03
<b>Age</b>										
16-49 years	148	171.7	428	214.5	2051	259.5	539	372.3	1.00	..
50+ years	108	126.7	274	126.9	2855	152.3	992	200.5	0.60 (0.56-0.63)	<0.001
<b>Sex</b>										
Male	149	136.2	382	149.8	2880	176.3	876	230.1	1.00	..
Female	107	172.4	320	199.3	2026	196.5	655	253.2	1.15 (1.08-1.21)	<0.001
<b>Region</b>										
East of England	24	157.7	65	150.2	608	180.1	226	268.9	0.94 (0.85-1.05)	0.3
London	98	187.3	178	179.7	847	192.4	195	236.6	1.00	..
Midlands	46	178.3	151	190.4	886	185.7	258	232.0	0.96 (0.87-1.05)	0.3
North East and Yorkshire	24	95.8	85	146.7	755	183.8	239	204.8	0.84 (0.76-0.92)	0.0004
North West	28	146.4	98	186.6	605	198.9	158	257.0	0.99 (0.90-1.10)	0.9

South East	22	105.7	82	157.8	744	177.4	269	252.1	0.92 (0.83-1.01)	0.09
South West	14	106.4	43	136.5	461	167.7	186	241.9	0.87 (0.78-0.97)	0.02
<b>Month</b>										
December 21	67	304.0	248	137.2	1120	133.3	92	161.4	0.62 (0.57-0.68)	<0.001
January 22	101	187.8	292	299.9	1965	241.0	254	473.8	1.06 (0.99-1.04)	0.1
February 22	40	85.8	66	94.9	800	140.1	1185	564.6	0.54 (0.50-0.58)	<0.001
March 22	48	97.9	96	141.4	1021	233.1	1185	315.7	1.00	..

<sup>a</sup>Includes single kidney, en-bloc kidney and double kidney transplants

<sup>b</sup>Simultaneous pancreas-kidney transplants, including pancreas only, islet only and simultaneous islet-kidney transplants

<sup>c</sup>Includes single lung, double lung, partial lung and heart-lung transplants

<sup>d</sup>Includes if any other organ was transplanted with the intestine as well as liver-kidney, heart-lung-liver, liver-pancreas, heart-kidney, heart-liver, and lung-liver transplants



Table 4: Risk-adjusted survival model for death within 28 days of a SARS-CoV-2 infection in solid organ and islet transplant recipients, including vaccination status, 7 December 2020 to 31 March 2022.

Variable	Cases	Deaths		Hazard ratio	95% hazard ratio confidence limits	p-value
		N	%			
<b>Vaccination status at last positive test (p&lt;0.0001)</b>						
No vaccine	1764	210	11.9	1	..	..
Two vaccine doses	3465	265	7.6	0.67	0.46-0.98	0.04
Three vaccine doses	5702	153	2.7	0.46	0.30-0.69	0.0002
Four vaccine doses	1523	14	0.9	0.18	0.09-0.35	<0.0001
<b>Dominant variant period (p&lt;0.0001)</b>						
Omicron	7704	155	2	1	..	..
Alpha	1321	182	13.8	3.12	2.04-4.78	<0.0001
Delta	3429	305	8.9	2.86	2.18-3.76	<0.0001
<b>Age at last positive test (years)</b>						
16-49	4891	69	1.4	1	..	..
50+	7563	573	7.6	5.7	4.43-7.35	<0.0001
<b>Sex</b>						
Male	7408	432	5.8	1	..	..
Female	5046	210	4.2	0.79	0.66-0.93	0.005
<b>Time from transplant (p=0.07)</b>						
More than 1 year	11 604	612	5.3	1	..	..
Up to 90 days	195	8	4.1	0.66	0.33-1.33	0.3
90 days to 1 year	655	22	3.4	0.67	0.44-1.02	0.06
<b>Ethnicity (p=0.03)</b>						
White	9329	440	4.7	1	..	..
Asian	1523	104	6.8	1.34	1.07-1.67	0.01
Black	736	55	7.5	1.53	1.11-2.09	0.008
Other	342	14	4.1	0.96	0.55-1.68	0.9
Unknown	524	29	5.5	1.03	0.71-1.51	0.9
<b>Transplant type (p&lt;0.0001)</b>						
Kidney <sup>a</sup>	9169	468	5.1	1	..	..
SPK <sup>b</sup>	497	18	3.6	0.83	0.51-1.33	0.4
Liver	1780	77	4.3	0.82	0.64-1.05	0.1
Heart	582	36	6.2	1.46	1.03-2.07	0.03
Lung <sup>c</sup>	357	43	12	3.03	2.21-4.16	<0.0001
Intestinal + multi-organ <sup>d</sup>	69	0	0	..	..	..

<i>NHS region (p=0-0001)</i>						
London	2307	102	4.4	1	..	..
North East and Yorkshire	1882	94	5	1.45	1.07-1.97	0.02
North West	1557	83	5.3	1.47	1.08-2.01	0.01
Midlands	2314	153	6.6	1.91	1.46-2.49	<0.0001
East of England	1467	70	4.8	1.55	1.12-2.14	0.008
South East	1806	78	4.3	1.27	0.93-1.74	0.1
South West	1121	62	5.5	1.8	1.29-2.53	0.0006

<sup>a</sup>Includes single kidney, en-bloc kidney and double kidney transplants

<sup>b</sup>Simultaneous pancreas-kidney transplants, including pancreas only, islet only and simultaneous islet-kidney transplants

<sup>c</sup>Includes single lung, double lung, partial lung and heart-lung transplants

<sup>d</sup>Includes if any other organ was transplanted with the intestine as well as liver-kidney, heart-lung-liver, liver-pancreas, heart-kidney, heart-liver, and lung-liver transplants

Table S5: Risk-adjusted survival model for death within 28 days of a SARS-CoV-2 infection in solid organ and islet transplant recipients, including vaccination status and vaccine type, 7 December 2020 to 31 March 2022.

Variable	Cases	Deaths		Hazard ratio	95% hazard ratio confidence limits	p-value
		N	%			
<b>Vaccination status at last positive test (p&lt;0-0001)</b>						
Unvaccinated	1764	210	11.9	1	..	..
AZ spine only	2157	160	7.4	0.66	0.44-0.97	0.04
mRNA spine only	1308	105	8	0.69	0.46-1.04	0.08
AZ spine + mRNA booster	3214	95	3	0.5	0.32-0.76	0.002
mRNA spine + mRNA booster	2488	58	2.3	0.4	0.25-0.64	<0.0001
AZ spine + 2 mRNA boosters	778	8	1	0.19	0.09-0.43	<0.0001
mRNA spine + 2 mRNA boosters	745	6	0.8	0.16	0.07-0.40	<0.0001
<b>Variant (p&lt;0-0001)</b>						
Omicron	7704	155	2	1	..	..
Alpha	1321	182	13.8	3.13	2.04-4.79	<0.0001
Delta	3429	305	8.9	2.87	2.18-3.77	<0.0001
<b>Age at last positive test (years)</b>						
16-49	4891	69	1.4	1	..	..
50+	7563	573	7.6	5.7	4.43-7.34	<0.0001
<b>Sex</b>						
Male	7408	432	5.8	1	..	..
Female	5046	210	4.2	0.79	0.67-0.93	0.005
<b>Time from transplant (p=0.07)</b>						
More than 1 year	11 604	612	5.3	1	..	..
Up to 90 days	195	8	4.1	0.66	0.33-1.33	0.3
90 days to 1 year	655	22	3.4	0.67	0.43-1.02	0.06
<b>Ethnicity (p=0.03)</b>						
White	9329	440	4.7	1	..	..
Asian	1523	104	6.8	1.34	1.07-1.67	0.01
Black	736	55	7.5	1.52	1.11-2.08	0.009
Other	342	14	4.1	0.96	0.55-1.68	0.9
Unknown	524	29	5.5	1.04	0.71-1.51	0.9
<b>Transplant type (p&lt;0-0001)</b>						
Kidney <sup>a</sup>	9169	468	5.1	1	..	..
SPK <sup>b</sup>	497	18	3.6	0.83	0.52-1.33	0.4
Liver	1780	77	4.3	0.82	0.64-1.05	0.1

Heart	582	36	6.2	1.45	1.03-2.06	0.04
Lung <sup>c</sup>	357	43	12	3.02	2.2-4.14	<0.0001
Intestinal + multiorgan <sup>d</sup>	69	0	0	..	..	..
<b>NHS region (p=0.0001)</b>						
London	2307	102	4.4	1	..	..
North East and Yorkshire	1882	94	5	1.45	1.07-1.97	0.02
North West	1557	83	5.3	1.48	1.08-2.02	0.01
Midlands	2314	153	6.6	1.91	1.46-2.5	<0.0001
East of England	1467	70	4.8	1.55	1.12-2.14	0.008
South East	1806	78	4.3	1.27	0.93-1.74	0.1
South West	1121	62	5.5	1.79	1.28-2.52	0.0007

<sup>a</sup>Includes single kidney, en-bloc kidney and double kidney transplants

<sup>b</sup>Simultaneous pancreas-kidney transplants, including pancreas only, islet only and simultaneous islet-kidney transplants

<sup>c</sup>Includes single lung, double lung, partial lung and heart-lung transplants

<sup>d</sup>Includes if any other organ was transplanted with the intestine as well as liver-kidney, heart-lung-liver, liver-pancreas, heart-kidney, heart-liver, and lung-liver transplants

Figure S1: Time from effective date of latest vaccination to last reported positive SARS-CoV-2 test in days, 7 December 2020 to 31 March 2022.

