

Supplementary Table S1. Average Sequence Depth & Coverage (A/H1N1).

Sample	Accession	PB2	PB1	PA	HA	NP	NA	MP	NS
A/WH/20230309-5/2023 A/H1N1	EPI_ISL_20239865	36636.9 (96.3%)	25802.9 (98.7%)	8713.74 (98.8%)	44159.5 (98.7%)	12030.4 (98.6%)	35149.3 (98.7%)	98234.7 (98.7%)	67432.4 (98%)
A/WH/20230310-13/2023 A/H1N1	EPI_ISL_20239867	151479 (98.7%)	101779 (98.7%)	111963 (98.8%)	419305 (98.7%)	198022 (98.8%)	444963 (98.7%)	242091 (98.8%)	1099800 (98.7%)
A/WH/20230310-2/2023 A/H1N1	EPI_ISL_20239866	231585 (98.8%)	213781 (98.7%)	122665 (98.8%)	386007 (98.7%)	262607 (98.8%)	277000 (98.7%)	1102700 (98.6%)	774510 (98.6%)
A/WH/20230311-6/2023 A/H1N1	EPI_ISL_20239868	252124 (98.7%)	145928 (98.7%)	153057 (98.8%)	364957 (98.7%)	150453 (98.7%)	319288 (98.7%)	141198 (98.8%)	793907 (98.7%)
A/WH/20230314-27/2023 A/H1N1	EPI_ISL_20239961	276808 (96.7%)	0	3502.17 (98.8%)	185950 (96.6%)	1595.43 (98.7%)	88355.8 (95%)	511441 (98.7%)	166714 (98.5%)
A/WH/20230314-36/2023 A/H1N1	EPI_ISL_20239962	193441 (98.7%)	43584.1 (98.7%)	98424.1 (98.8%)	0	45983 (98.5%)	152250 (98.7%)	168236 (97.5%)	197011 (98.4%)
A/WH/20230314-9/2023 A/H1N1	EPI_ISL_20239960	260826 (98.7%)	0	117703 (98.7%)	932663 (98.7%)	27858.6 (98.8%)	1102570 (98.7%)	915907 (98.8%)	205693 (98.7%)
A/WH/20230319-6/2023 A/H1N1	EPI_ISL_20239963	9878.93 (98.7%)	592.236 (98.7%)	7976.28 (98.8%)	13495.7 (98.7%)	5390.55 (98.8%)	15762.2 (95%)	37291.6 (92.6%)	31786.9 (98.7%)
A/WH/20230320-9/2023 A/H1N1	EPI_ISL_20239964	127638 (98.5%)	36703.5 (98.5%)	49202.3 (98.6%)	159736 (98.7%)	23725.6 (94.7%)	197226 (98.6%)	509836 (98.7%)	330276 (91.2%)
A/WH/20230326-4/2023 A/H1N1	EPI_ISL_20239960	884.852 (98.5%)	4547.23 (98.7%)	2866.84 (98.8%)	2038.69 (98.7%)	3844.05 (98.8%)	1056.43 (94.6%)	10343.8 (82%)	15152.9 (98.6%)

Supplementary Table S2. Average Sequence Depth & Coverage (A/H3N2).

Sample	Accession	PB2	PB1	PA	HA	NP	NA	MP	NS
A/WH/20230 307- 1/2023 A/H3 N2	EPI_ISL_2023 8018	223700 (98.6%)	69129.6 (98.8%)	174329 (98.8%)	310454 (98.7%)	214459 (98.8%)	295739 (98.7%)	1504550 (98.8%)	228059 (98.7%)
A/WH/20230 308- 11/2023 A/H 3N2	EPI_ISL_2023 8019	136901 (94.8%)	82182.3 (93%)	154895 (98.7%)	110871 (98.7%)	24699 (98.4%)	0	45748.3 (98.6%)	15952.3 (98.8%)
A/WH/20230 311- 5/2023 A/H3 N2	EPI_ISL_2023 9487	200491 (98.6%)	102591 (98.5%)	550768 (98.8%)	296773 (98.6%)	270247 (98.8%)	180753 (98.7%)	1159510 (98.8%)	373298 (98.7%)
A/WH/20230 314- 30/2023 A/H 3N2	EPI_ISL_2023 9489	196676 (98.6%)	96742.9 (98.7%)	200951 (98.8%)	255930 (98.7%)	220299 (98.8%)	263692 (98.7%)	111692 (98.8%)	12238.1 (98.6%)
A/WH/20230 314- 33/2023 A/H 3N2	EPI_ISL_2023 9497	49763.3 (97.7%)	44628.3 (96%)	98764.2 (98.3%)	4.25279 (66.3%)	108661 (98.7%)	125841 (98.7%)	315433 (98.6%)	280.823 (98.7%)
A/WH/20230 321- 12/2023 A/H 3N2	EPI_ISL_2023 9512	211044 (98.7%)	128516 (98.7%)	208988 (98.8%)	235447 (98.7%)	41658.6 (98.6%)	74267.4 (98.7%)	400814 (98.7%)	139903 (98.6%)
A/WH/20230 326- 7/2023 A/H3 N2	EPI_ISL_2023 9513	5029.72 (98.7%)	5094.65 (98.7%)	25423 (98.7%)	100771 (98.7%)	1580.62 (98.8%)	15937 (98.7%)	59496.1 (91.5%)	1797.05 (98.7%)
A/WH/20231 122- 1/2023 A/H3 N2	EPI_ISL_2023 9514	128045 (98.7%)	441.944 (98.7%)	7681.86 (98.7%)	39811 (98.7%)	340.824 (98.7%)	0	22554 (98.7%)	9744.25 (46.9%)
A/WH/20231 220- 1/2023 A/H3 N2	EPI_ISL_2023 9515	75117.2 (98.7%)	26405.9 (98.7%)	98615.7 (98.8%)	70090.3 (98.7%)	1615.65 (95.9%)	20288.5 (98.7%)	11867.3 (98.8%)	21909.1 (98.7%)

A/WH/20231 220- 2/2023 A/H3 N2	EPI_ISL_2023 9774	46209.4 (98.7%)	70149.4 (98.7%)	13269 (98.8%)	15763 (98.7%)	23702 (98.8%)	4877.79 (98.7%)	119205 (98.6%)	411.595 (98.6%)
A/WH/20231 220- 3/2023 A/H3 N2	EPI_ISL_2023 9775	25993.9 (98.7%)	27502.4 (98.8%)	20738 (98.8%)	37223.9 (98.7%)	0	71218.7 (98.7%)	158920 (91.6%)	31874.8 (98.7%)
A/WH/20231 231- 2/2023 A/H3 N2	EPI_ISL_2023 9776	591904 (98.7%)	153173 (98.7%)	412092 (98.8%)	353817 (98.7%)	155441 (98.8%)	222617 (98.7%)	682591 (98.5%)	129800 (98.7%)
A/WH/20230 308- 14/2023 A/H 3N2	EPI_ISL_2023 8020	170008 (98.78%)	101389 (98.8%)	200150 (98.80%)	459876(95.9 9%)	193804 (98.71%)	335859 (98.78%)	129126 (98.60%)	371016 (98.78%)

Supplementary Table S3. Amino acid substitutions in antigenic sites of HA gene of H1N1.

Antigenic sites	Ca2				Sb		RBS									
Amino acid position	137	154	159	166	202	233	240	277	294	330	373	408	416	435	444	468
A/Victoria/4897/2022	T	S	R	I	I	A	R	E	A	R	D	T	H	V	V	H
A/WH/20230309-5/2023 A/H1N1 2023-03-09 HA		P	K			T	Q	D	T		E					N
A/WH/20230310-13/2023 A/H1N1 2023-03-10 HA	A	P	K	V	V	T	Q	D	T		E			I		N
A/WH/20230310-2/2023 A/H1N1 2023-03-10 HA			K			T	Q	D	T		E					N
A/WH/20230311-6/2023 A/H1N1 2023-03-11 HA		P	K			T	Q	D	T		E	I			I	N
A/WH/20230314-27/2023 A/H1N1 2023-03-14 HA		P	K			T	Q	D	T		E					N
A/WH/20230314-9/2023 A/H1N1 2023-03-14 HA		P	K			T	Q	D	T	K	E		N			N
A/WH/20230319-6/2023 A/H1N1 2023-03-19 HA		T	K			T	Q	D	T		E					N
A/WH/20230320-9/2023 A/H1N1 2023-03-20 HA		P	K			T	Q	D	T		E					N
A/WH/20230326-4/2023 A/H1N1 2023-03-26 HA		P	K			T	Q	D	T		E					N

Supplementary Table S4. Amino acid substitutions in antigenic sites of HA gene of H3N2.

Antigenic sites	M-N				E								A				A	A	A				A	B				B	B	B
Amino acid position	3	9	37	41	66	69	78	95	99	108	110	112	120	137	138	147	156	158	160	166	172	175	176	180						
A/Hong Kong/4801/2014	T	Y	P	I	E	D	E	F	K	K	Y	S	D	N	N	T	I	R	S	R	H	Y	K	L						
A/WH/20230307-1/2023 A/H3N2 2023-03-07 HA	A	N	P		K	N	G	F	E	R	N			K	D	K	K	G			S	N	I	Q						
A/WH/20230308-11/2023 A/H3N2 2023-03-08 HA		N	P			G	G	F	E	R	N	N	G	K	N	K		G			S	N	I	Q						
A/WH/20230311-5/2023 A/H3N2 2023-03-11 HA	A	N	P		K	N	G	F	E	R	N			R		K	K	G			S	N	I	Q						
A/WH/20230314-30/2023 A/H3N2 2023-03-14 HA	A	N	P		K	N	G	F	E	R	N			K	D	K	K	G			S	N	I	Q						
A/WH/20230321-12/2023 A/H3N2 2023-03-21 HA	A	N	P		K	N	G	F	E	R	N			K		K	K	G			S	N	I	Q						
A/WH/20230326-7/2023 A/H3N2 2023-03-26 HA		N	P			G	G	F	E	R	N	N	G	K		K	K	G			S	N	I	Q						
A/WH/20231122-1/2023 A/H3N2 2023-11-22 HA	A	N	P		K	N	G	F	E	R	N			K		K	K	G			S	N	I	Q						
A/WH/20231220-1/2023 A/H3N2 2023-12-20 HA	A	N	P	V	K	N	G	F	E	R	N			K		K	K	G			S	N	I	Q						
A/WH/20231220-2/2023 A/H3N2 2023-12-20 HA	A	N	P		K	N	G	F	E	R	N			K		K	K	G	N		S	N	I	Q						
A/WH/20231220-3/2023 A/H3N2 2023-12-20 HA	A	N	P		K	N	G	L	E	R	N			K	D	K	K	G			S	N	I	Q						
A/WH/20231231-2/2023 A/H3N2 2023-12-31 HA	A	N	S		K	N	G	L	E	R	N			K	D	K	K	G		K	S	N	I	Q						

Antigenic sites	L. P	B	B	B	B	B	B	RBS	C				M-N											
Amino acid position	187	202	206	208	209	210	211	239	255	292	315	327	363	394	422	434	447	500	521	538	545	550		
A/Hong Kong/4801/2014	N	G	D	I	F	P	Y	I	P	K	R	H	V	N	I	I	L	G	V	I	V	F		
A/WH/20230307-1/2023 A/H3N2 2023-03-07 HA	K	D	N	F	S	L	F	V				Q		S	V			E		M	I			
A/WH/20230308-11/2023 A/H3N2 2023-03-08 HA	K	D	N		S	L	F			R		Q			V			E		M	I			
A/WH/20230311-5/2023 A/H3N2 2023-03-11 HA	K	D	N	F	S	L	F	V				Q		S	V		M	E		M	I			
A/WH/20230314-30/2023 A/H3N2 2023-03-14 HA	K	D	N	F	S	L	F	V				Q		S	V			E		M	I			
A/WH/20230321-12/2023 A/H3N2 2023-03-21 HA	K	D	N	F	S	L	F	V				Q		S	V			E	I	M	I			
A/WH/20230326-7/2023 A/H3N2 2023-03-26 HA	K	D	N		S	L	F			R	K	Q			V			E		M	I			
A/WH/20231122-1/2023 A/H3N2 2023-11-22 HA	K	D	N	F	S	L	F	V				Q		S	V			E	I	M	I			
A/WH/20231220-1/2023 A/H3N2 2023-12-20 HA	K	D	N	F	S	L	F	V				Q	M	S	V	V		E		M	I	L		
A/WH/20231220-2/2023 A/H3N2 2023-12-20 HA	K	D	N	F	S	L	F	V				Q	M	S	V			E	I	M	I			
A/WH/20231220-3/2023 A/H3N2 2023-12-20 HA	K	D	N	F	S	L	F	V	S	E		Q		S	V			E		M	I			
A/WH/20231231-2/2023 A/H3N2 2023-12-31 HA	K	D	N	F	S	L	F	V	S	E		Q		S	V			E		M	I			

continued

Supplementary Table S5. Amino acid substitutions in NA gene of influenza virus A(H1N1).

Amino acid position	50	72	77	86	200	216	247	257	382
A/Victoria/4897/2022	D	T	R	A	S	I	S	R	E
A/WH/20230309-5/2023 A/H1N1 2023-03-09 NA	N	I	K	T	N				G
A/WH/20230310-13/2023 A/H1N1 2023-03-10 NA	N					V		K	G
A/WH/20230310-2/2023 A/H1N1 2023-03-10 NA	N				N				G
A/WH/20230311-6/2023 A/H1N1 2023-03-11 NA	N				N				G
A/WH/20230314-27/2023 A/H1N1 2023-03-14 NA	N		K	T	N				G
A/WH/20230314-36/2023 A/H1N1 2023-03-14 NA	N				N				G
A/WH/20230314-9/2023 A/H1N1 2023-03-14 NA	N				N		N		G
A/WH/20230319-6/2023 A/H1N1 2023-03-19 NA	N		K	T	N				G
A/WH/20230320-9/2023 A/H1N1 2023-03-20 NA	N				N				G
A/WH/20230326-4/2023 A/H1N1 2023-03-26 NA	N				N				G

Supplementary Table S6. Amino acid substitutions in NA gene of influenza virus A(H3N2).

Amino acid position	26	53	93	100	126	149	150	215	220	231	245	247	264	267	303	308	315	329	331	339	344	346	370	380	392	399	400	463	465	468	469
QO3350820.1/A/ Hong Kong/4801/201 4	I	C	G	F	P	V	R	V	K	I	S	S	H	T	V	K	S	N	S	D	E	G	S	I	T	D	R	D	N	P	I
A/WH/20230307- 1/2023 A/H3N2 20 23-03-07 NA					L		H		N	V	N	T	Y	K	I		R	S		N	K	D		V	I			N	S	H	T
A/WH/20230308- 14/2023 A/H3N2 2 023-03-08 NA					L		H		N	V	N	T		K	I		R	S		N	K	D		V	I			N	S	H	T
A/WH/20230311- 5/2023 A/H3N2 20 23-03-11 NA					L		H		N	V	N	T		K	I		R	S		N	K	D	A	V	I			N	S	H	T
A/WH/20230314- 30/2023 A/H3N2 2 023-03-14 NA					L		H	L	N	V	N	T		K	I		R	S		N	K	D		V	I			N	S	H	T
A/WH/20230314- 33/2023 A/H3N2 2 023-03-14 NA					L		H		N	V	N	T		K	I		R	S		N	K	D		V	I			N	S	H	T
A/WH/20230321- 12/2023 A/H3N2 2 023-03-21 NA					L	A	H		N	V	N	T		K	I		R	S	G	N	K	D		V	I			N	S	H	T
A/WH/20230326- 7/2023 A/H3N2 20 23-03-26 NA					L				N	V	N	T		K	I		R	G		N	K			V	I			N	S	H	
A/WH/20231220- 1/2023 A/H3N2 20 23-12-20 NA	T				L		H		N	V	N	T		K	I		R		G	N	K	D		V	M			N	S	H	T
A/WH/20231220- 2/2023 A/H3N2 20 23-12-20 NA			S	L	L		H		N	V	N	T		K	I		R	S	G	N	K	D		V	I			N	S	H	T
A/WH/20231220- 3/2023 A/H3N2 20 23-12-20 NA					L		H		N	V	N	T		K	I	R	R	S		N	K	D		V	I		K	N	S	H	T
A/WH/20231231- 2/2023 A/H3N2 20 23-12-31 NA		Y			L		H		N	V	N	T		K	I	R	R	S		N	K	D		V	I	G		N	S	H	T

Supplementary Table S7. N-glycosylation sites of HA and NA gene (A/H1N1).

Gene Position	N-Glycosylation site	
	HA 293	NA 50
A/Victoria/4897/2022	NAT	DKS
A/WH/20230309-5/2023	NTT	NKS
A/WH/20230310-13/2023	NTT	NKS
A/WH/20230310-2/2023	NTT	NKS
A/WH/20230311-6/2023	NTT	NKS
A/WH/20230314-27/2023	NTT	NKS
A/WH/20230314-9/2023	NTT	NKS
A/WH/20230319-6/2023	NTT	NKS
A/WH/20230320-9/2023	NTT	NKS
A/WH/20230326-4/2023	NTT	NKS
A/WH/20230314-36/2023		NKS

Supplementary Table S8. N-glycosylation sites of HA and NA gene (A/H3N2).

Gene	N-Glycosylation site						
	HA	HA	HA	HA	NA	NA	NA
Position	109	138	160	499	245	329	463
A/Hong Kong/4801/2014	YSS	NES	SSS	NGT	SAS	NDS	DLN
A/WH/20230307-1/2023	YSS	DES	SSS	NET	NAT	SDS	NLS
A/WH/20230311-5/2023	NSN	NES	SSS	NET	NAT	SDS	NLS
A/WH/20230314-30/2023	YSS	DES	SSS	NET	NAT	SDS	NLS
A/WH/20230321-12/2023	YSS	NES	SSS	NET	NAT	SDS	NLS
A/WH/20230326-7/2023	NSN	NES	SSS	NET	NAT	SDG	NLS
A/WH/20231220-1/2023	YSS	NES	SSS	NET	NAT	NDG	NLS
A/WH/20231220-2/2023	YSS	NES	NSS	NET	NAT	SDG	NLS
A/WH/20231220-3/2023	YSS	DES	SSS	NET	NAT	SDS	NLS
A/WH/20231231-2/2023	YSS	DES	SSS	NET	NAT	SDS	NLS
A/WH/20230308-14/2023					NAT	SDS	NLS
A/WH/20230314-33/2023					NAT	SDS	NLS
A/WH/20231122-1/2023	YSS	NES	SSS	NET			
A/WH/20230308-11/2023	YSS	NES	SSS	NET			