

Phylogeny of influenza A(H1)pdm09 viruses, detected in Portugal between 2009 and 2016

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Background:

Influenza A(H1)pdm09 viruses show a constant antigenic pattern since its emergence in the 2009 pandemics. However these viruses have been increasing their genetic diversity. This fact supports the need for continuous monitoring of genetic characteristics of influenza A(H1)pdm09 viruses, which can suddenly acquire new antigenic properties or decrease their susceptibility to antiviral drugs.

Methods:

From the 2009 pandemic until 2016, the Portuguese NIC has detected 1634 influenza A(H1)pdm09 viruses in the scope of the Portuguese Influenza Surveillance Programme. During this period, 586 viruses were isolated and characterised antigenically by HI assays. Genetic characterisation was also performed for 195 viruses by HA1 subunit sequencing.

Results:

- All studied influenza A(H1)pdm09 viruses revealed no antigenic diversity, being antigenically similar to the vaccine strain A/California/7/2009.
- 2009** - viruses belonged to a single genetic group 1 (A/Hong Kong/2212/2010).
- 2010/2011** - Portuguese pandemic viruses showed genetic diversity, being distributed by 4 genetic groups (3,4,5, and 6), acquiring one or two amino acid changes in antigenic sites.
- 2011/12** - were first detected A(H1)pdm09 from group 7 (A/St. Petersburg/100/2011).
- 2012/13** - majority of circulating viruses belonged to the subgroup 6C (represented by A/Estonia/76677/2013) harbouring 2 amino acid substitutions in antigenic sites of hemagglutinin (S185T and S203T).
- 2013/2014** - all A(H1)pdm09 viruses clustered in the subgroup 6B (A/South Africa/3626/2013) and fixed 3 amino acid changes located in antigenic sites of HA (K163Q, S185T and S203T).
- 2015/2016** - within 6B group, new A(H1)pdm09 viruses have emerged giving rise to a new subgroup 6B.1 represented by the strain A/New York/61/2015. Most viruses presented an additional amino acid substitution in HA antigenic sites: S71P in 6B group and S162N in 6B.1 subgroup.

Table I - Amino acid substitutions observed in the HA1 subunit of influenza A(H1)pdm09 viruses comparing to the vaccine strain A/California/7/2009. Hemagglutinin antigenic sites are highlighted.

Antigenic sites		Amino acid positions		Strains		Season/Clade	
		1-131	132-223	224-323	324-399		
CA	132	133	134	135	136	137	138
CA	152	153	154	155	156	157	158
CA	172	173	174	175	176	177	178
CA	192	193	194	195	196	197	198
CA	212	213	214	215	216	217	218
CA	232	233	234	235	236	237	238
CA	252	253	254	255	256	257	258
CA	272	273	274	275	276	277	278
CA	292	293	294	295	296	297	298
CA	312	313	314	315	316	317	318
CA	332	333	334	335	336	337	338
CA	352	353	354	355	356	357	358
CA	372	373	374	375	376	377	378
CA	392	393	394	395	396	397	398
CA	412	413	414	415	416	417	418
CA	432	433	434	435	436	437	438
CA	452	453	454	455	456	457	458
CA	472	473	474	475	476	477	478
CA	492	493	494	495	496	497	498
CA	512	513	514	515	516	517	518
CA	532	533	534	535	536	537	538
CA	552	553	554	555	556	557	558
CA	572	573	574	575	576	577	578
CA	592	593	594	595	596	597	598
CA	612	613	614	615	616	617	618
CA	632	633	634	635	636	637	638
CA	652	653	654	655	656	657	658
CA	672	673	674	675	676	677	678
CA	692	693	694	695	696	697	698
CA	712	713	714	715	716	717	718
CA	732	733	734	735	736	737	738
CA	752	753	754	755	756	757	758
CA	772	773	774	775	776	777	778
CA	792	793	794	795	796	797	798
CA	812	813	814	815	816	817	818
CA	832	833	834	835	836	837	838
CA	852	853	854	855	856	857	858
CA	872	873	874	875	876	877	878
CA	892	893	894	895	896	897	898
CA	912	913	914	915	916	917	918
CA	932	933	934	935	936	937	938
CA	952	953	954	955	956	957	958
CA	972	973	974	975	976	977	978
CA	992	993	994	995	996	997	998
CA	1012	1013	1014	1015	1016	1017	1018
CA	1032	1033	1034	1035	1036	1037	1038
CA	1052	1053	1054	1055	1056	1057	1058
CA	1072	1073	1074	1075	1076	1077	1078
CA	1092	1093	1094	1095	1096	1097	1098
CA	1112	1113	1114	1115	1116	1117	1118
CA	1132	1133	1134	1135	1136	1137	1138
CA	1152	1153	1154	1155	1156	1157	1158
CA	1172	1173	1174	1175	1176	1177	1178
CA	1192	1193	1194	1195	1196	1197	1198
CA	1212	1213	1214	1215	1216	1217	1218
CA	1232	1233	1234	1235	1236	1237	1238
CA	1252	1253	1254	1255	1256	1257	1258
CA	1272	1273	1274	1275	1276	1277	1278
CA	1292	1293	1294	1295	1296	1297	1298
CA	1312	1313	1314	1315	1316	1317	1318
CA	1332	1333	1334	1335	1336	1337	1338
CA	1352	1353	1354	1355	1356	1357	1358
CA	1372	1373	1374	1375	1376	1377	1378
CA	1392	1393	1394	1395	1396	1397	1398
CA	1412	1413	1414	1415	1416	1417	1418
CA	1432	1433	1434	1435	1436	1437	1438
CA	1452	1453	1454	1455	1456	1457	1458
CA	1472	1473	1474	1475	1476	1477	1478
CA	1492	1493	1494	1495	1496	1497	1498
CA	1512	1513	1514	1515	1516	1517	1518
CA	1532	1533	1534	1535	1536	1537	1538
CA	1552	1553	1554	1555	1556	1557	1558
CA	1572	1573	1574	1575	1576	1577	1578
CA	1592	1593	1594	1595	1596	1597	1598
CA	1612	1613	1614	1615	1616	1617	1618
CA	1632	1633	1634	1635	1636	1637	1638
CA	1652	1653	1654	1655	1656	1657	1658
CA	1672	1673	1674	1675	1676	1677	1678
CA	1692	1693	1694	1695	1696	1697	1698
CA	1712	1713	1714	1715	1716	1717	1718
CA	1732	1733	1734	1735	1736	1737	1738
CA	1752	1753	1754	1755	1756	1757	1758
CA	1772	1773	1774	1775	1776	1777	1778
CA	1792	1793	1794	1795	1796	1797	1798
CA	1812	1813	1814	1815	1816	1817	1818
CA	1832	1833	1834	1835	1836	1837	1838
CA	1852	1853	1854	1855	1856	1857	1858
CA	1872	1873	1874	1875	1876	1877	1878
CA	1892	1893	1894	1895	1896	1897	1898
CA	1912	1913	1914	1915	1916	1917	1918
CA	1932	1933	1934	1935	1936	1937	1938
CA	1952	1953	1954	1955	1956	1957	1958
CA	1972	1973	1974	1975	1976	1977	1978
CA	1992	1993	1994	1995	1996	1997	1998
CA	2012	2013	2014	2015	2016	2017	2018
CA	2032	2033	2034	2035	2036	2037	2038
CA	2052	2053	2054	2055	2056	2057	2058
CA	2072	2073	2074	2075	2076	2077	2078
CA	2092	2093	2094	2095	2096	2097	2098
CA	2112	2113	2114	2115	2116	2117	2118
CA	2132	2133	2134	2135	2136	2137	2138
CA	2152	2153	2154	2155	2156	2157	2158
CA	2172	2173	2174	2175	2176	2177	2178
CA	2192	2193	2194	2195	2196	2197	2198
CA	2212	2213	2214	2215	2216	2217	2218
CA	2232	2233	2234	2235	2236	2237	2238
CA	2252	2253	2254	2255	2256	2257	2258
CA	2272	2273	2274	2275	2276	2277	2278
CA	2292	2293	2294	2295	2296	2297	2298
CA	2312	2313	2314	2315	2316	2317	2318
CA	2332	2333	2334	2335	2336	2337	2338
CA	2352	2353	2354	2355	2356	2357	2358
CA	2372	2373	2374	2375	2376	2377	2378
CA	2392	2393	2394	2395	2396	2397	2398
CA	2412	2413	2414	2415	2416	2417	2418
CA	2432	2433	2434	2435	2436	2437	2438
CA	2452	2453	2454	2455	2456	2457	2458
CA	2472	2473	2474	2475	2476	2477	2478
CA	2492	2493	2494	2495	2496	2497	2498
CA	2512	2513	2514	2515	2516	2517	2518
CA	2532	2533	2534	2535	2536	2537	2538
CA	2552	2553	2554	2555	2556	2557	2558
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CA	2612	2613	2614	2615	2616	2617	2618
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CA	2812	2813	2814	2815	2816	2817	2818