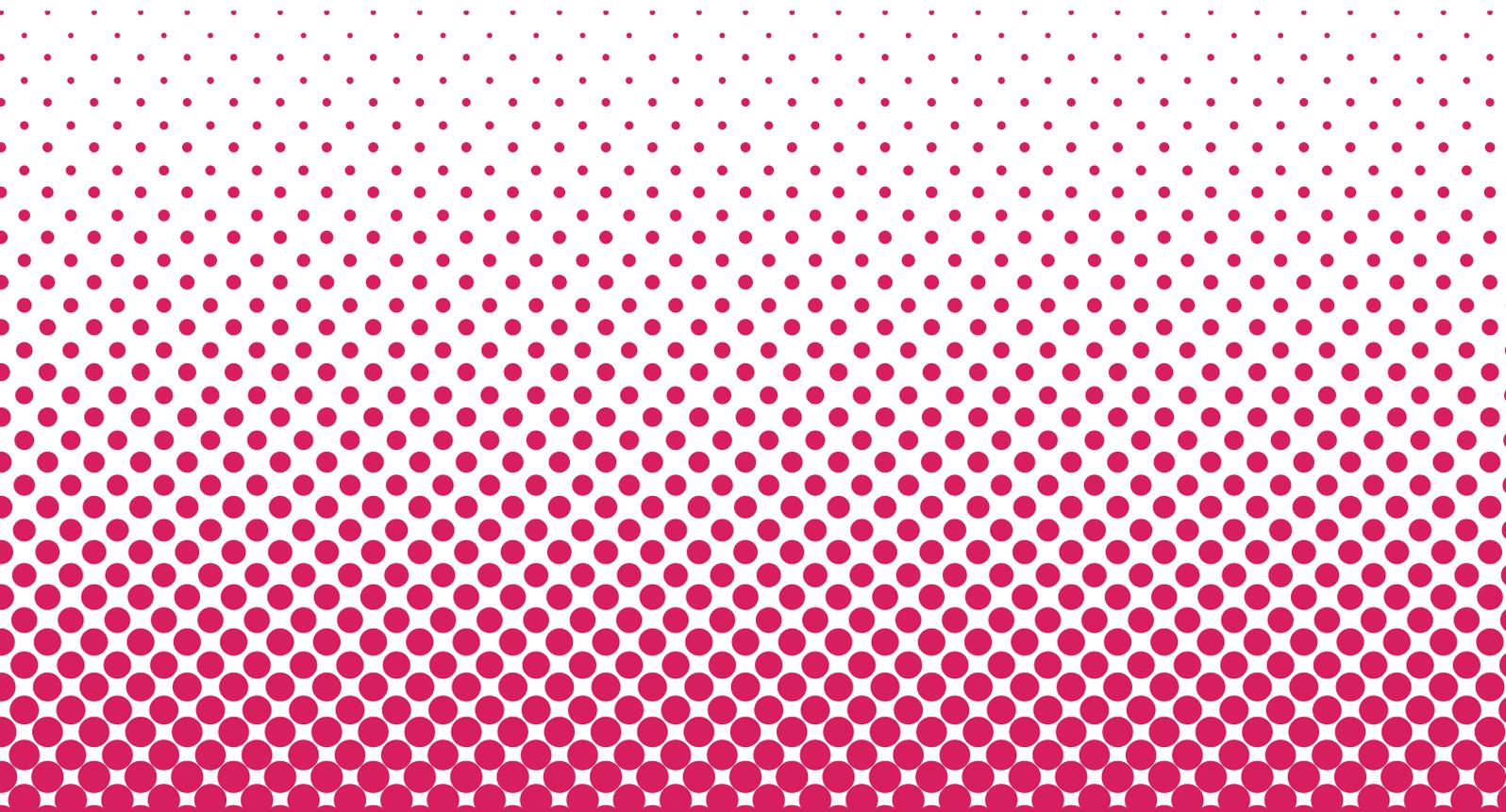


# The Influenza A(H1N1)2009 Pandemic in Sweden, 2009-2010

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A Report from the Swedish WHO National Influenza Centre





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# Foreword

This report summarizes the influenza A(H1N1)2009 pandemic in Sweden between April 24, 2009 and May 23, 2010. The report is published by the Swedish National Influenza Centre as part of its reporting to the World Health Organization (WHO).

The report is based on data from the various surveillance systems used during the pandemic. The systems are presented in some detail to facilitate the reader's understanding of the quality of the presented data.

The report has been written by staff at the Department of Diagnostics and Vaccinology (Microbial Typing Unit) and the Department of Analysis and Prevention (Epidemiology and Evaluation Unit) at the Swedish Institute for Communicable Disease Control.

For further information, please contact:

Mia Brytting, Head of the Swedish WHO National Influenza Centre.  
E-mail: [mia.brytting@smi.se](mailto:mia.brytting@smi.se).

Annika Linde, State Epidemiologist.  
E-mail: [annika.linde@smi.se](mailto:annika.linde@smi.se).



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# Sammanfattning

Denna rapport från Smittskyddsinstitutet (SMI) beskriver övervakningssystem, influensaaktivitet och karakterisering av influensavirus i Sverige under pandemisäsongen 2009/2010. Det är en återrapportering till Världshälsoorganisationen (WHO) som SMI gjort i rollen som nationellt influensacenter och den är därför skriven på engelska. Influensasäsongen 2009/2010 presenteras mera utförligt på svenska i SMI:s delrapport i *Influensa A(H1N1) 2009 – Delrapporterna från utvärderingen av förberedelser och hantering av pandemin*, som publicerades av Socialstyrelsen i mars 2011.<sup>1</sup>

Sammanfattningsvis presenterar rapporten metoder och data från SMI:s influensaövervakning under pandemin. SMI:s system för rapportering från vården, andra myndigheter, webbsidor och direktrapportering från befolkningen beskrivs, liksom metoder för mätning av vaccinationstäckning och immunitet mot influensan. Övervakningsresultaten presenteras i första hand i figurer, tabeller och diagram, och kommenteras i löpande text. Mikrobiologisk diagnostik och genetiska analyser presenteras relativt detaljerat, eftersom huvuduppdraget för ett nationellt influensacenter är att följa influensavirusutvecklingen virologiskt och förse WHO:s Europeiska referenslaboratorium med nationella influensastammar. Analyser av influensastammar från nationella centra tillsammans med epidemiologiska analyser som belyser virus spridningspotential ligger till grund för det årliga val av vaccinstammar som görs vid WHO.

Det första konstaterade svenska fallet av influensa A(H1N1)2009 inträffade i slutet på april 2009. Infektionen gjordes anmälningspliktig enligt smittskyddslagen i mitten på maj. En liten topp av anmälda fall inträffade i slutet på juni och utgjordes huvudsakligen av personer som smittats utomlands. En ny liten topp sågs i samband med skolstarten. I vecka 40 började en omfattande virusspridning bland skolungdom i Västerbotten och utbrottet spreds söderut under de kommande veckorna. Nationellt nådde epidemin sitt klimax veckorna 46 och 47.

Sammanlagt anmäldes mer än 11 000 fall av laboratorieverifierad influensainfektion. Den högsta incidensen sågs hos barn. För cirka 15% av de insjuknade krävdes sjukhusvård, och 136 patienter intensivvårdades. Sammanlagt 31 dödsfall (3,3 per miljon invånare) orsakade av den pandemiska influensan har identifierats. Detta är en internationellt sett låg siffra. 60% av befolkningen fick åtminstone en dos av vaccin (Pandemrix®) mot pandemiviruset. Vaccinet gavs sannolikt för sent för att kunna påverka antalet insjuknade i någon högre grad, men eftersom de som hörde till medicinska riskgrupper för svår sjukdom vaccinerades först kan vaccinationen ha påverkat antalet med svår sjukdom.

Ett urval av distriktsläkare från hela landet rapporterar varje vecka de antal patienter med influensaliknande symtom de undersökt under föregående vecka (sentinelrapporteringen; sentinel betyder ”fyr” eller ”spejare”). Andelen

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<sup>1</sup> Socialstyrelsen, *Influensa A(H1N1) 2009 – Delrapporterna från utvärderingen av förberedelser och hantering av pandemin*, 2011, Artikelnummer: 2011-3-17, ISBN: 978-91-86585-91-4, sidorna 119-174, <http://www.socialstyrelsen.se/publikationer2011/2011-3-17>

influenzasjuka personer i sentinelrapporteringen var något högre än under tidigare år, men skillnaden var betydligt mindre än när det gäller laboratorieverifierade fall.

En del av sentinelpatienterna provtas avseende influensa, och andelen positiva i sentinelprovtagningen (19%) överensstämde med andelen positiva i rutindiagnostiken i landet. Ett åldersmässigt representativt urval av Stockholms befolkning självrapporterar sedan några år influensaliknande sjukdom till SMI inom ramen för projektet Sjukrapport. Baserat på dessa rapporter och andelen positiva av patienter med influensaliknande sjukdom i sentinelprovtagningen uppskattas att ca 500 000 personer insjuknade i den pandemiska influensan i Sverige.

När genetisk information för det nytupptäckta H1N1-viruset blev tillgänglig etablerade SMI omgående en molekylär diagnosmetod. Initialt skötte SMI primärdiagnostiken av all influensa A(H1N1)2009, men metoden etablerades under sommaren på de flesta mikrobiologiska laboratorier i Sverige, och totalt analyserades nästan 51 000 prover, varav alltså drygt en femtedel med positivt resultat. SMI utförde fördjupad genetisk analys avseende vaccinlikhet och resistens mot tillgängliga antivirala medel på ca 90 prover. Samtliga undersökta stammar liknade vaccinstammen och var känsliga mot tillgängliga antivirala medel.

Sammanfattningsvis sågs omfattande influensasjuklighet hos barn under pandemin men sjukdomen påverkade inte samhällsfunktionerna. Pandemin gav ingen överdödlighet eftersom mycket få äldre insjuknade. Incidensen svårt sjuka och döda var låg i förhållande till vad som rapporterats från många andra länder och den omfattande vaccineringen av framförallt personer i de medicinska riskgrupperna kan ha bidragit till detta.

# Executive Summary

This report describes the 2009 influenza pandemic in Sweden and the virological and epidemiological methods used to collect data for analysis. It is published as a report from the Swedish Institute for Communicable Disease Control (*Smittskyddsinstitutet*, SMI) in its role as a WHO National Influenza Centre, in addition to making the Swedish data available internationally for anyone interested.

All aspects of the pandemic were covered through the various components of SMI's disease surveillance activities. Seroepidemiology was used to analyse the total number of infected and population-based reports to get an idea of the burden of influenza disease in the Society. The burden on the health care system could be estimated because the disease was included among mandatory reportable diseases and because sentinel surveillance also was used.

Through the statutory reporting system, all laboratory-confirmed cases were reported with full identity. In the reporting system, symptoms, severity, care level, and outcome are voluntary. Additional data on the reported cases were collected retrospectively and regionally. Sentinel reports on patients representing 6.5% of the Swedish population were received and sentinel sampling for microbiological analysis was performed according to the norms created by the European Influenza Surveillance Network. In addition, the intensity of disease activity from sentinel surveillance was predicted one half week beforehand by a system that analyses the number of web queries to a medical advice website concerning influenza.

All the methods used were established a minimum of two years before the pandemic, and the results from the pandemic could therefore be compared to those from previous years. In addition to surveillance data, aggregated numbers of vaccinations with Pandemrix®, the pandemic vaccine used in Sweden, were reported to SMI.

Two minor peaks of influenza A(H1N1)2009 activity occurred during summer and autumn 2009. The main epidemic, defined as >5 reported cases per 100,000 inhabitants, started in the northern part of the country in week 40 (end of September). During the coming weeks it spread southwards to reach its peak during weeks 46 and 47 (mid-November). The epidemic started among school children, followed by younger children. The incidence of laboratory-confirmed cases was highest among children, and the number of cases decreased with increasing age.

Population-based surveillance indicated that around 500,000 persons (6% of the population) fell ill with influenza during the pandemic. Slightly more than 11,000 laboratory-confirmed cases were reported, which is about five times the number seen during recent influenza seasons. However, the percentage reporting illness in the population was only slightly above seasonal levels, and most likely more people with mild symptoms than usual were sampled. 1,609 hospitalised cases were reported, of which 136 received intensive care. In total, 31 persons were reported to have died due to influenza. There was no excess mortality during the season.

Vaccination started week 40 and 60% of the population eventually received at least one dose of the Pandemrix® vaccine. Approximately 30% received the vaccine before the epidemic culminated. Comparisons are difficult to make, but it seems that figures for intensive care and death are relatively low for Sweden and, despite the late start, the high vaccination rate may have mitigated the pandemic.

A polymerase chain reaction for diagnosis of A(H1N1)2009 was established at SMI and used by most of the microbiology laboratories in the country performing influenza diagnostics. Almost 51,000 samples were analysed for influenza in Sweden during the 2009-2010 season and 21% of them were positive for influenza A or B. Of the positive samples, 96.9% were influenza A(H1N1)2009, 1.7% were influenza A(H3N2), and 1.4% were influenza B. One seasonal H1N1 strain was detected in a person arriving from India during the summer of 2009.

SMI received more than 2,600 sentinel samples, of which 504 were confirmed positive for influenza, with 96.4% of these positive for A(H1N1)2009, 0.4% for influenza A/H3N2, and 3.2% for influenza B. During the peak, more than 40% of the diagnostic samples analysed at the Swedish laboratories as well in the sentinel sampling were positive for influenza.

All characterised strains of influenza A(H1N1)2009 were sensitive to the neuraminidase inhibitors in use and were genetically similar to the vaccine strain.

# Agency Responsibilities for Influenza Containment

At the national level, pandemic preparedness in Sweden is coordinated by the National Board of Health and Welfare (*Socialstyrelsen*) and the Swedish Civil Contingencies Agency (*Myndigheten för samhällsskydd och beredskap*).

At the regional level, the County Medical Officers of Communicable Disease Control (*Smittskyddsläkarna*) are responsible for surveillance in the counties and for the practical measures taken to mitigate an outbreak. The regional microbiological laboratories and all hospital doctors with a suspected case of influenza A(H1N1)2009 are required by law to report the case. In the beginning of the pandemic, all suspected cases, whether admitted to hospital or not, were subject to mandatory reporting.

SMI is responsible for national epidemiological and microbiological surveillance of infectious diseases in Sweden. This report describes the surveillance data and the microbiological activities that took place at SMI. An interagency evaluation of the handling of the pandemic in Sweden has been published by the National Board of Health and Welfare.<sup>2</sup>

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<sup>2</sup> The National Board of Health and Welfare, *A(H1N1) 2009 – An evaluation of Sweden's preparations for and management of the pandemic*, 2011, ISBN 978-91-86885-37-3, Nr 2011-8-4, <http://www.socialstyrelsen.se/publikationer2011/2011-8-4/Sidor/default.aspx>

# Surveillance and Reporting Systems

The surveillance and reporting systems used during the influenza A(H1N1)2009 pandemic in Sweden are presented in Table 1 and briefly described in the text below.<sup>3</sup>

Table 1. Surveillance and Reporting Systems Used in Sweden during the Influenza A(H1N1)2009 Pandemic

System or Method	What is it?	What Does it Show?	Reported Estimates During Pandemic
Population-based Surveillance: Sjukrapport	A population-based cohort study in Stockholm, to which a random sample of the population is invited. Participants join by phone or internet and report symptoms when they get sick. Reported symptoms classify them as having influenza-like illness (ILI) or acute respiratory infection (ARI). Sjukrapport had ~5,500 participants during the pandemic.	A general picture of how many people have ILI and ARI in Sweden An estimate of how many of those with ILI had true influenza from 2009-W38 to 2009-W50 (14Sep09-13Dec09). A likely influenza rate was obtained through comparison with laboratory sentinel results in Stockholm. Sjukrapport data were used to extrapolate the proportion of positive samples to the entire population.	ARI cases: 1,965 ILI cases: 729 Average proportion sick per week: ARI: 1.71 % ILI: 0.63 % Time period: 2009-W38 to 2010-W5 (14Sep09 to 7Feb10)  Estimated number of people in Sweden sick from influenza, from 2009-W38 to 2009-W50: 240,000-600,000 (2.6-6.5% of the population)
"Web Search" (Webbsök)	An automated surveillance system that uses search data from the medical advice website, Vårdguiden. Using a statistical model, it estimates the proportion of patients with ILI each week, based on search terms like influenza and its symptoms.	The number of searches for information about influenza Serves as a complement to sentinel surveillance (see below).	During the pandemic, nearly 65,000 searches were completed using terms that indicated influenza.
Telephone Advice Line (1177)	A medical telephone advice line (phone number 1177) that covers 14 of Sweden's 20 counties (landsting). The age group (adult or child) and primary reason for calling is manually recorded for each call.	Primary reason for calling by age group (adults and children)	During the pandemic, ~318,000 calls were received regarding breathing difficulties, fever, sore throat, or cough.
Sentinel Surveillance	Selected general practitioners and primary care offices report the total number of patients and the number of patients with ILI each week. Approximate catchment population is reported in the beginning of the season.	The proportion of sentinel patients and catchment population with ILI	1,217 of 332,869 patients (0.4%) had ILI between 2009-W20 and 2010-W20 (11May09 to 23May10). This represents 0.2% of the 601,623 persons in the catchment population.

<sup>3</sup> Throughout this report, we use ISO standard week numbers to describe time periods.

Sentinel Laboratory Testing (see also <i>Sentinel Surveillance, above</i> )	Samples from a portion of ILI patients seen at sentinel offices are sent for laboratory confirmation. Some hospital clinics also send samples.	The proportion of sentinel patients with ILI that have influenza A(H1N1)2009	504 of the 2621 samples analysed (19.2%) were positive for influenza A(H1N1)2009 from 2009-W18 to 2010-W20 (27Apr09 to 23May10).
Mandatory Laboratory Reporting of Influenza A(H1N1)2009	All laboratories are required to report positive influenza A(H1N1)2009 diagnoses along with patient identity through Sweden's web-based case reporting system, SmiNet.	Number of laboratory-confirmed cases of influenza A(H1N1)2009	11,009 laboratory-confirmed cases of influenza A(H1N1)2009 were reported through SmiNet from 2009-W21 to 2010-W34 (18May09 to 29Aug10). All but nine of these occurred during 2009.
Aggregated Voluntary Laboratory Reporting of Denominator Data	All laboratories voluntarily report the number of samples analysed for influenza and the percentage of samples positive for influenza A(H1N1)2009 and seasonal influenza each week.	Denominator data used to identify the proportion of influenza A(H1N1)2009-positive samples	10856 of 51072 samples analysed (21%) were positive for influenza A(H1N1)2009 from 2009-W18 to 2010-W20 (27Apr09 to 23May10).
Mandatory Clinical Reporting – All Cases of Influenza A(H1N1)2009 (13May09 to 15Jul09)	Between 13May09 and 15Jul09, all cases of influenza A(H1N1)2009 identified within the health care system were to be reported through SmiNet, including a detailed description of symptoms for WHO/ECDC. As of 16Jul09, mandatory clinical reporting only concerns hospitalised cases.	All identified cases and their symptoms	Only 162 of 239 laboratory-reported cases of influenza A(H1N1)2009 (68%) were also reported clinically through SmiNet.
Mandatory Reporting of Hospital Admissions (16Jul09 to present)	As of 16Jul09, all hospitals are required to report admitted cases of verified influenza A(H1N1)2009 through SmiNet.	Proportion of reported influenza A(H1N1)2009 cases that were admitted to hospital	1,609 of 11,009 reported influenza A(H1N1)2009 cases (14.6%) were admitted to hospital.
Intensive Care Data (Partly retrospective reporting, 14Dec09 to 30Apr10)	Voluntary addition to mandatory reporting form in SmiNet. Retrospectively reported to SMI from a quality register for Intensive Care of Influenza Cases in Sweden (IRIS).	Severity of illness based on level of care (hospital, intensive care, respirator, or extracorporeal membrane oxygenation, ECMO) from SmiNet. About half the cases in IRIS have a score based on the Simplified Acute Physiology Score (SAPS-3) criteria.	136 patients (8.4%) required intensive care out of 1609 patients with influenza A(H1N1)2009 who were admitted to hospital. Data were combined from SmiNet (mandatory reporting) and IRIS, with 113 reported through SmiNet and 96 through IRIS.
Mandatory Reporting of Deaths and Official Death Registry	Local analysis of influenza as cause of death. Pathologists are required to report deaths from influenza A(H1N1)2009. The identities of reported influenza cases were matched to the official death registry.	Number of deaths from influenza A(H1N1)2009	31 deaths due to influenza A(H1N1)2009 identified.

Sero-epidemiology	Serologic analysis through hemagglutination inhibition was performed on samples from representative populations in all age groups. Has been performed on samples from 2007, October 2009, and May 2010.	Proportion by age group with antibodies that bind to receptor structure H of the influenza A(H1N1)2009 as a result of infection or vaccination, as well as the change in this proportion between 2007 and 2009/2010.	Over 50% of the population sampled in May 2010 had antibodies to influenza A(H1N1)2009. The proportion was highest among children aged 3 to 14 years, at 76%, and lowest among those aged 65 and over, at 26%.
Virus Characterisation	Virus characterisation of influenza strains continuously collected from various laboratories and of positive sentinel surveillance samples.	Similarity between examined influenza strains and the strains used in the influenza vaccine. Antiviral resistance among influenza strains.	116 A(H1N1)2009, 11 A(H3N2) and 11 influenza B strains were characterised regarding vaccine similarity and/or antiviral resistance. No strains were resistant to the approved neuraminidase inhibitors.
Vaccine Coverage	Voluntary weekly reports from the County Medical Officers of Communicable Disease Control (Smittskyddsläkarna) with number of administered influenza A(H1N1)2009 vaccines. If available, data are reported by age and risk group as well as dose number (first or second).	An approximate picture of the number of patients vaccinated against influenza A(H1N1)2009 each week. However, the system has many faults.	A total of 6,070,604 doses of influenza A(H1N1)2009 vaccine (Pandemrix®) were administered in the reporting counties (landsting). Extrapolated to the entire country, an estimated 5,560,000 people received at least one dose of the vaccine. This represents 60% of Sweden's population.

## Population-based Surveillance: Sjukrapport

A minority of influenza patients have symptoms that are severe enough to warrant a visit to the doctor. In an attempt to monitor influenza spread among the general population in the Stockholm area, SMI has started a population-based surveillance project called *Sjukrapport*, (roughly translated to “sick/illness report”), which has been in use during the winter season since 2007.

Each year, between 12,000 and 15,000 people living in Stockholm County (total population approximately 2,000,000) are invited to use the web or interactive voice response (IVR) system to join *Sjukrapport*, and then report symptoms of respiratory tract infection or fever as soon as possible after occurrence. With this number of invitees each year, the project manages to obtain a representative sample of around 5,000 and a significant representation in all age groups.<sup>4</sup> During the pandemic, *Sjukrapport* had around 5500 participants.

Upon reporting, participants are asked to respond to fourteen questions designed to differentiate influenza-like illness (ILI) from acute respiratory tract infection (ARI)

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<sup>4</sup> To read an evaluation of the *Sjukrapport* methodology, please read: Christin Bexelius, Hanna Merk, Sven Sandin, Olof Nyrén, Sharon Kühlmann-Berenzon, Annika Linde, Jan-Eric Litton, “Interactive Voice Response and web-based questionnaires for population-based infectious disease reporting”, *European Journal of Epidemiology*, Vol. 25 No 10 pp693-702, DOI: 10.1007/s10654-010-9484-y, <http://www.springerlink.com/content/391247X82031068R>

using the European Centre for Disease Prevention and Control (ECDC) case definitions. The results are presented as the percentage of *Sjukrapport* participants reporting ARI and ILI, as well as the percentage by age group.

During the pandemic, Sjukrapport data, along with the frequency of positives from sentinel laboratory testing in Stockholm County, were used to estimate the rate of influenza positives among the general population.

## “Web Search”

“Web Search” (*Webbsök*) is an automated surveillance system that uses search data from the medical advice website, *Vårdguiden*, and a statistical model to estimate the proportion of patients with ILI each week. The number of web queries using search words indicating influenza for the previous week is automatically transferred to SMI each Monday and used to predict the number of cases that will be reported in the sentinel surveillance system at the latest on Wednesday for the same week. Analysing the number of queries related to influenza-like symptoms through *Webbsök* has been shown to give an estimate of the progression of influenza activity in Sweden.<sup>5</sup> It has previously been shown that the graphs generated by the web search data are almost identical in shape to those generated by the sentinel surveillance system.

The system is a rapid and cheap complement to sentinel-reporting. Since it does not demand active reporting from anyone it is also sustainable in critical situations. Drawbacks of the system include the lack of information concerning sex, age, and location for the patients.

## Telephone Advice Line

*Sjukvårdsrådgivningen* (telephone number 1177) is a free of charge phone line for medical queries that is staffed by nurses. To be officially included in the service, a county has to join – but calls from people living in other counties than those officially included are also received. For each phone call, the answering nurse records the main symptom given by the patient and the patient’s county of residence. For some symptoms, age category (child or adult) is also recorded. These data are sent to SMI weekly. Influenza activity is estimated by analysis of seven symptoms thought to be related to the disease such as fever, sore throat, cough, and difficulty breathing.

## Sentinel Surveillance

Sweden’s sentinel surveillance system reflects the European norm for surveillance. Through the sentinel surveillance system, selected general practitioners and primary care offices (“units”) report the total number of patients and the number of patients with ILI each week. Each site also reports the approximate catchment population in the beginning of the season.

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<sup>5</sup> Hulth A, Rydevik G, Linde A, 2009, “Web Queries as a Source for Syndromic Surveillance”, *PLoS ONE*, 4(2): e4378, <http://www.plosone.org/article/info%3Adoi%2F10.1371%2Fjournal.pone.0004378>

The sentinel surveillance system normally runs from week 40 one year to week 20 the next (approximately October to May). When influenza A(H1N1)2009 appeared, SMI tested a prolongation of the sentinel system over the summer. However, there were not many reports during that period and a new recruitment of reporting units was made at the end of September 2009. As a result, the Swedish influenza sentinel surveillance system of 2009-2010 consisted of 64 reporting units with an estimated 601,623 listed patients, representing 6.5% of the Swedish population. The reporting units were recruited by the County Medical Officers of Communicable Disease Control (*Smittskyddsläkarna*). The units were geographically distributed throughout Sweden and all Swedish counties were represented. Date of visit, sex, and age of each patient were reported, as well as total number of visits to the clinic during the reporting week. Reports were made through the web-based reporting system SmiNet<sup>6</sup> to the County Medical Officers of Communicable Disease Control, and the Swedish National Influenza Centre at SMI.

## Sentinel Sampling

Sentinel sampling for laboratory analysis at SMI was performed at 55 units. Of these, 26 were enrolled in the sentinel surveillance system described above for ILI reporting. In addition, 8 primary care unit, 9 infectious disease emergency clinics and 12 paediatric clinics sent samples. The samples were accompanied by a reporting form compliant with the European Influenza Surveillance Network (EISN) standard.

## Mandatory Reporting of Influenza A(H1N1)2009

Between May 15 and July 15, 2009, all suspected cases of pandemic influenza were subject to mandatory sampling, reporting with full identity, and contact tracing. According to the law, independent reports were to be entered into SmiNet by both the clinician and the laboratory identifying the virus. After July 15, 2009, mandatory clinical reporting applied only to severe cases that were subject to hospital care, while all laboratory-confirmed cases were still to be reported.

The mandatory clinical reports were to contain “data of importance for the prevention of the spread of disease”. The patient data were sent to SMI and the counties. A clinical form, including questions on severity and suggested data of importance, was available through the system. However, the only mandatory pieces of information were the identity of the patient and of the reporting physician. Therefore, information on for example intensive care was sometimes missing from clinical reports. Additional data collection by the County Medical Officers of Communicable Disease Control continued through September 2010, when a pandemic data bank was assembled into a Microsoft Access database and closed for further update.

With ethical permission, the identities of patients reported in SmiNet were also compared to those registered in the register for Intensive Care of Influenza Cases in Sweden (IRIS), an independent intensive care register on influenza patients held by

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<sup>6</sup> P. Rolfhamre, A. Jansson, M. Arneborn, and K. Ekdahl, "SmiNet-2: Description of an internet-based surveillance system for communicable diseases in Sweden." *Euro Surveill.* 2006;11(5):103-7.

the Uppsala Clinical Research Centre at Uppsala University and managed by specialists in intensive care.

## Death Records

SMI obtains the total numbers of deaths, including age and sex of the deceased, from Statistics Sweden (*Statistiska centralbyrån*) through a weekly transfer. The data are regularly analysed for major aberrations that may be due to infectious disease. The mean weekly death rate for each influenza-free set of weeks between week 40 in the fall and week 20 in the spring between 1993 and 2009 has been calculated, and is used as a reference for the evaluation of weekly excess mortality due to influenza. Data are also delivered to the European project on Morbidity and Mortality (Momo).<sup>7</sup>

On May 15, 2009, influenza A(H1N1)2009 was made a legally reportable disease. A death due to this influenza occurring in a previously not reported case was to be reported by the pathologist identifying the case. However, the law did not require a report on an already reported case (for example, a hospitalised patient) upon death.

During the pandemic, the County Medical Officers of Communicable Disease Control also reported data on deaths due to influenza A(H1N1)2009 that they were informed about in various other ways. The personal identity numbers of all persons who died during the pandemic period were also run against the register of all patients reported to have had influenza at the end of December 2009. Matching personal identity numbers were sent to the County Medical Officers of Communicable Disease Control so that they could investigate whether the deaths were influenza-related. The definition used for an influenza-related death was “a death that would not have occurred at that point in time, unless the patient had contracted influenza.”

## Vaccination Reports

All Swedish residents were offered free vaccination with the adjuvanted GlaxoSmithKline vaccine “Pandemrix®” during the pandemic. The vaccination started with medical risk groups and health care staff. Thereafter, the rest of the population was vaccinated according to regional planning.

During the pandemic, a nationwide reporting system for vaccinations did not exist. SVEVAC, an SMI-based system for vaccination registration, including reporting of side-effects, was used for one fifth of the Swedish population, but the personal data of those vaccinated are only available for regional use. In the rest of the counties, the mode of registration varied substantially, but aggregated data on vaccination were reported to SMI through SmiNet. As a result, SMIs data will probably never be fully complete beyond the total number and age group of those given at least one dose.

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<sup>7</sup> A. Mazick, B. Gergonne, F. Wuillaume, K. Danis, A. Vantarakis, H. Uphoff, G. Spiteri, T. van 't Klooster, C. Junker, M. Holmberg, and K. Mølbak, “Higher All-cause Mortality in Children During Autumn 2009 Compared with the Three Previous Years: Pooled Results from Eight European Countries”, *Eurosurveillance*, Volume 15, Issue 5, 04 February 2010, <http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=19480>

However, ethically approved scientific studies on various aspects of the vaccination effort from various counties and Karolinska Institute are ongoing or completed.

## Seroepidemiology

Samples from a representative sample of the Swedish population were collected from excess material at selected Swedish laboratories for clinical chemistry in September 2009. They were analysed by hemagglutination inhibition for antibodies to influenza A/ H1N1California/7 2009. The results are summarized in Table 1, but the complete study will be presented elsewhere.<sup>8</sup>

## Other Sources of Information

Leave from work for the purpose of caring for sick children (*vård av barn, VAB*) is reportable to the Swedish National Social Insurance Agency (*Försäkringskassan*). During the pandemic, weekly reports on VAB were sent to SMI, along with reference data for the past three years.

Locally, different counties collected data from various sources to get information on the spread of the disease and its effect on society. Some of this local information was included to in the SMI influenza report (see below under Weekly Reports to Swedish Collaborators).

As noted above, detailed information on all influenza A(H1N1)2009 cases in intensive care were collected in a national quality register called IRIS.

## Weekly Reports to Swedish Collaborators

National and international influenza information, including WHO country reports, were collected and summarised in a weekly report and posted on the SMI web page each Thursday during the period May 2009 to May 2010.<sup>9</sup> The weekly reports were also sent as an electronic newsletter to all interested parties, including the County Medical Officers of Communicable Disease Control, Departments of Infectious Diseases in Sweden (*Smittskyddsenheterna*), microbiological laboratories, and the National Board of Health and Welfare (*Socialstyrelsen*).

## Weekly Reports to International Collaborators

The pandemic influenza reporting started in the end of April 2009 when the first case occurred. Following the routines set forth by ECDC, SMI provided weekly influenza information to the European Surveillance System (TESSy) at ECDC.<sup>10</sup> Swedish influenza data were also reported weekly to the WHO database EuroFlu.<sup>11</sup>

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<sup>8</sup> Mörner et al, submitted manuscript.

<sup>9</sup> The weekly influenza reports are available here: <http://www.smittskyddsinstitutet.se/publikationer/smis-nyhetsbrev/influensarapporter/sasongen-20092010/>

<sup>10</sup> Read more at: <http://ecdc.europa.eu/en/activities/surveillance/TESSy/Pages/TESSy.aspx?MasterPage=1>

<sup>11</sup> Read more at: <http://www.euroflu.org/>

Sequence data were deposited into the Global Initiative on Sharing Avian Influenza Data (GISAID) EpiFlu™ database.<sup>12</sup>

## Swedish Media

The Swedish media have had a long term interest in influenza and usually contact SMI for information on epidemiology and related issues. Media interest during the pandemic season was exceptional and probably affected influenza awareness and care-seeking behaviour among the population. Though sometimes exaggerated the media contacts generally resulted in correct and informative articles during the pandemic.

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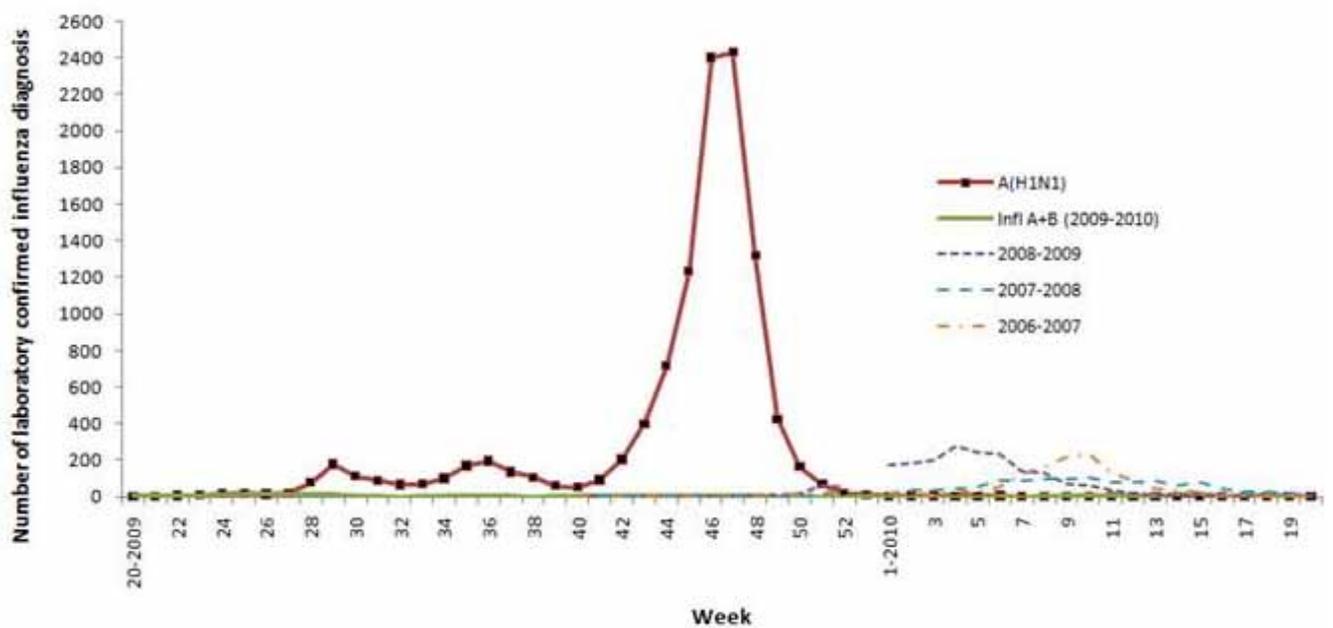
<sup>12</sup> Read more at: <http://platform.gisaid.org/>

# Epidemiological Data

## Mandatory reporting of laboratory confirmed cases

The first laboratory-confirmed case of influenza A(H1N1)2009 in Sweden was sampled on April 30 from a patient with onset of disease April 27. Three different peaks of laboratory-confirmed cases occurred during the season. Figure 1 shows the weekly number of laboratory-confirmed influenza diagnoses reported to SMI through voluntary and mandatory laboratory reporting (for seasons before the pandemic and the 2009-2010 season, respectively).

Figure 1. Weekly Laboratory-confirmed Influenza Diagnoses Reported to SMI through Voluntary Laboratory Reporting of Seasonal Influenza (2007-2009) and Mandatory Reporting of Influenza A(H1N1)2009 (May 2009-May 2010)



As shown, the first peak reached its maximum in week 29 (the week of July 13), with 179 laboratory-confirmed cases. Most (80%) of the cases had contracted the virus abroad. The second wave (197 cases) peaked in week 36 (the week of August 31), when people returned to schools and work after vacation. In week 40 (the week of September 28), an extensive spread of the virus in the north of Sweden began, as shown in Figure 2.

Figure 2. Weekly Incidence of Laboratory-confirmed Influenza A(H1N1)2009 by County (per 100,000 population)



The activity successively spread southwards, and in weeks 46 and 47 (mid-November), the pandemic reached its highest point with almost 2,500 laboratory-confirmed cases per week (seen as the highest peak in Figure 1). In total, 11,009 laboratory-confirmed cases were reported from April 9, 2009, to June 13, 2010. This is 5 to 10 times more than is reported in Sweden during years of seasonal influenza. Only 45 cases were reported during spring 2010.

Table 2 shows the case number and incidence rate of reported laboratory-confirmed influenza A(H1N1)2009 per county, while Figure 3 depicts the incidence data visually. The incidence of reported laboratory-confirmed cases varied from 51 to 210 per 100,000 among the counties, with a mean of 119 per 100,000 for the whole country. The highest incidence was noted in the northern and western parts of the country. Some of the variation among counties may be due to different routines for sampling, but there were also probably real differences in incidence, with lower incidence in the Southern part of the country, where the epidemic peaked later, when more people had been vaccinated.

Table 2. Number and Incidence  
of Reported Laboratory-confirmed Influenza A(H1N1)2009 per County

Region	Number of Cases	Incidence (per 100,000 population)	Population
Västerbotten	542	210.3	257,728
Jämtland	245	193.3	126,733
Stockholm	3,290	166.3	1,977,874
Södermanland	379	141.8	267,275
Västernorrland	342	140.5	243,411
Uppsala	459	140.4	326,831
Värmland	362	132.2	273,726
Örebro	331	119.3	277,515
Västra Götaland	1,811	116.3	1,557,241
Skåne	1,275	105.1	1,212,896
Dalarna	269	97.6	275,709
Kronoberg	169	92.8	182,108
Kalmar	202	86.5	233,448
Gävleborg	234	84.8	275,954
Blekinge	127	83.4	152,286
Norrboten	180	72.1	249,811
Gotland	40	70.2	57,012
Jönköping	212	63.3	335,120
Västmanland	150	60	249,886
Halland	174	59.3	293,399
Östergötland	215	50.8	422,895
Total	11,009	119.0	9,248,858

Figure 3. Incidence of Influenza A(H1N1)2009 per County (per 100,000 population)

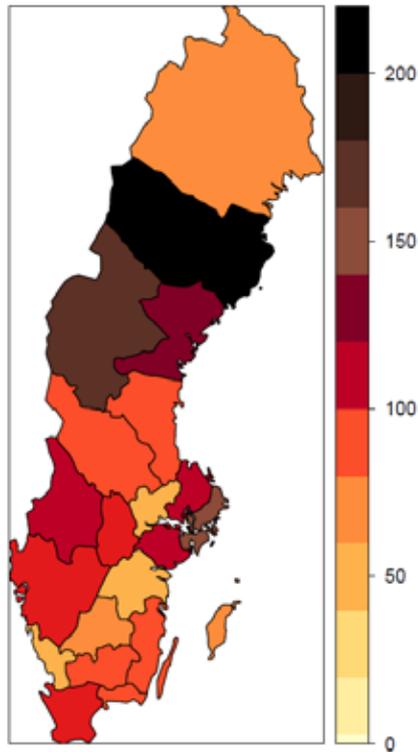


Figure 4 shows the weekly incidence per 100,000 population of laboratory-confirmed influenza A(H1N1)2009 per age group. The incidence was highest in children up to 14 years of age, with 300 per 100,000 population and the main outbreak started among school-children.

Figure 4. Weekly Incidence of Laboratory-confirmed Influenza A(H1N1)2009 per Age Group (per 100,000 population)

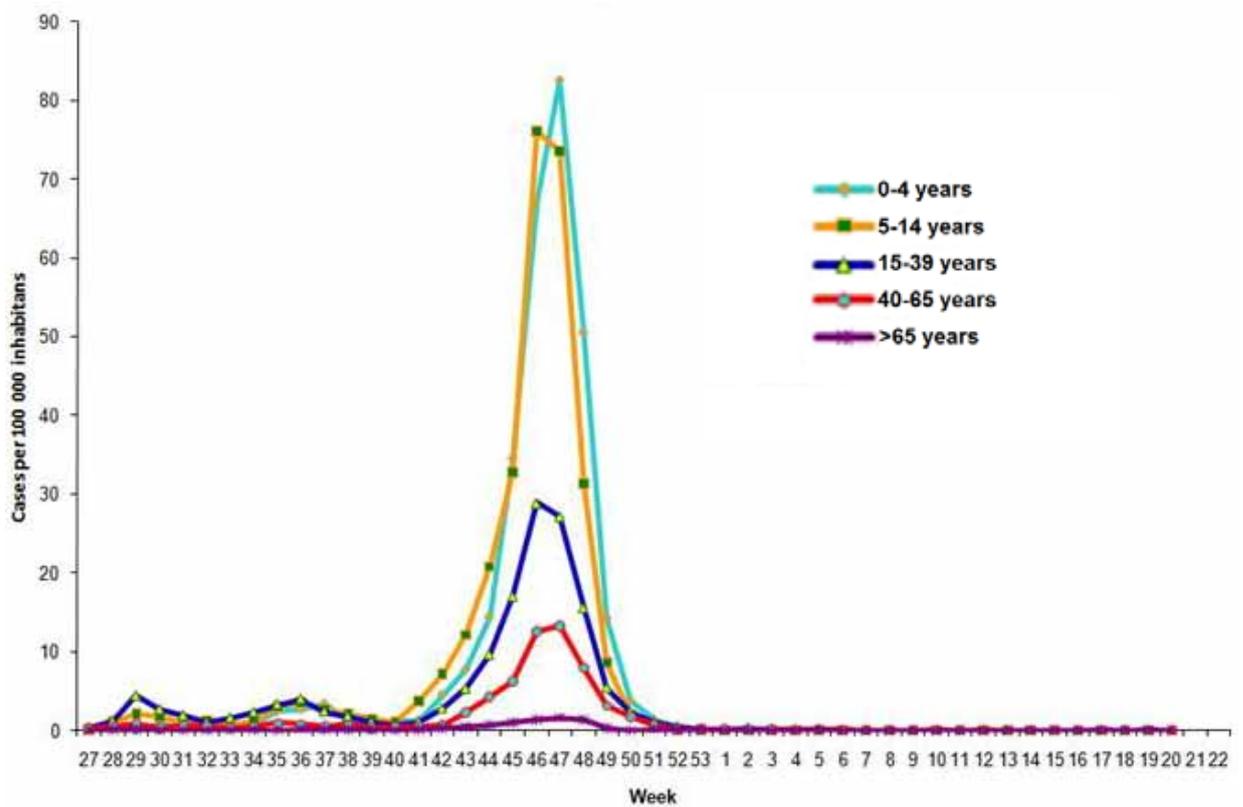


Table 3 shows the sex distribution of laboratory-confirmed cases of Influenza A(H1N1)2009. In summary the sex distribution varied with age. Up to the age of twenty, males dominated, and thereafter the majority were females (Table 3).

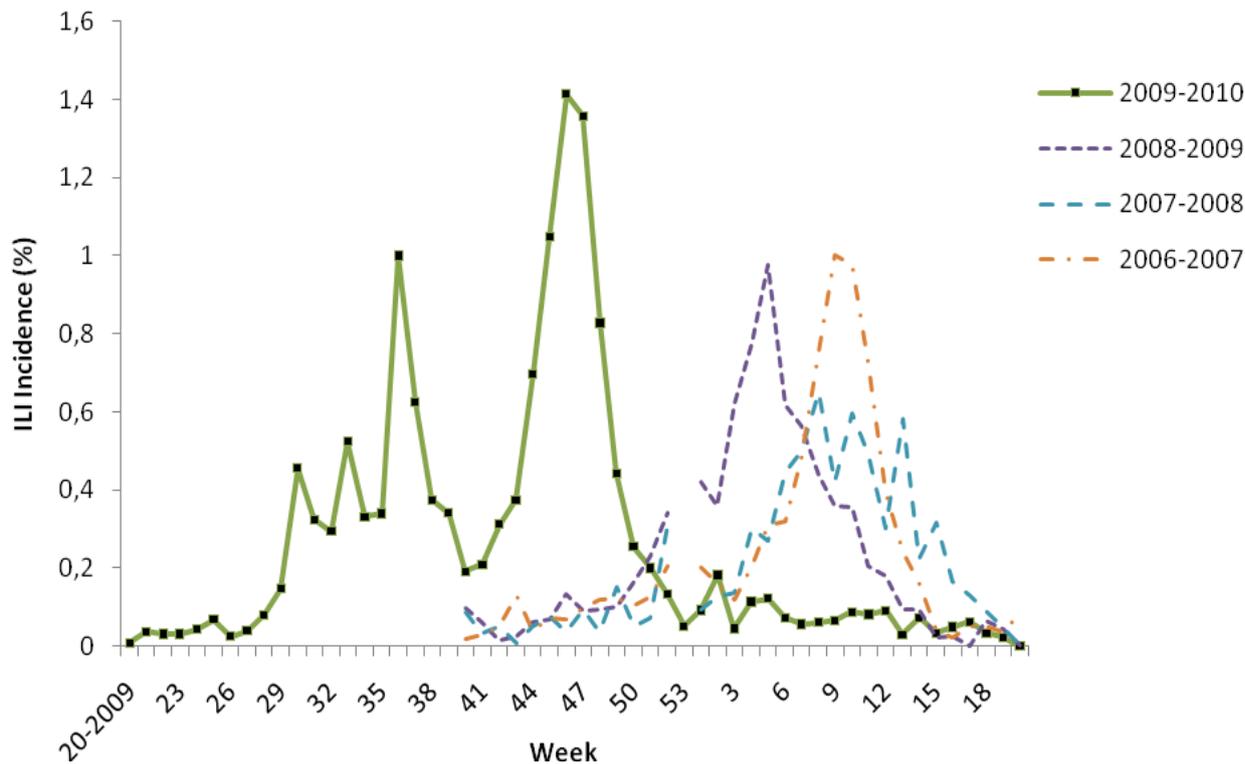
Table 3. Proportion of Influenza A(H1N1)2009 Positive Samples from Female and Male Cases by Age Group

Age Group	Female	Male
0-9	44.1%	55.6%
10-19	48.7%	51.1%
20-29	55.0%	44.2%
30-39	60.0%	39.9%
40-49	56.8%	43.0%
50-59	55.0%	44.8%
60-69	55.2%	44.8%
70-79	59.3%	40.7%
80-89	50.0%	50.0%
90-99	50.0%	50.0%
Total	51.0%	48.7%

## Sentinel Surveillance and Web Queries

Through the sentinel surveillance system, GPs of sentinel units report the number of patients they have seen each week and the proportion of these that had ILI symptoms. Figure 5 shows ILI incidence as reported by sentinel surveillance by week for the last four seasons. The 2009-2010 season is shown by the green line.

Figure 5. ILI Incidence (%) in Sweden from Sentinel Reporting by Week, Last Four Seasons

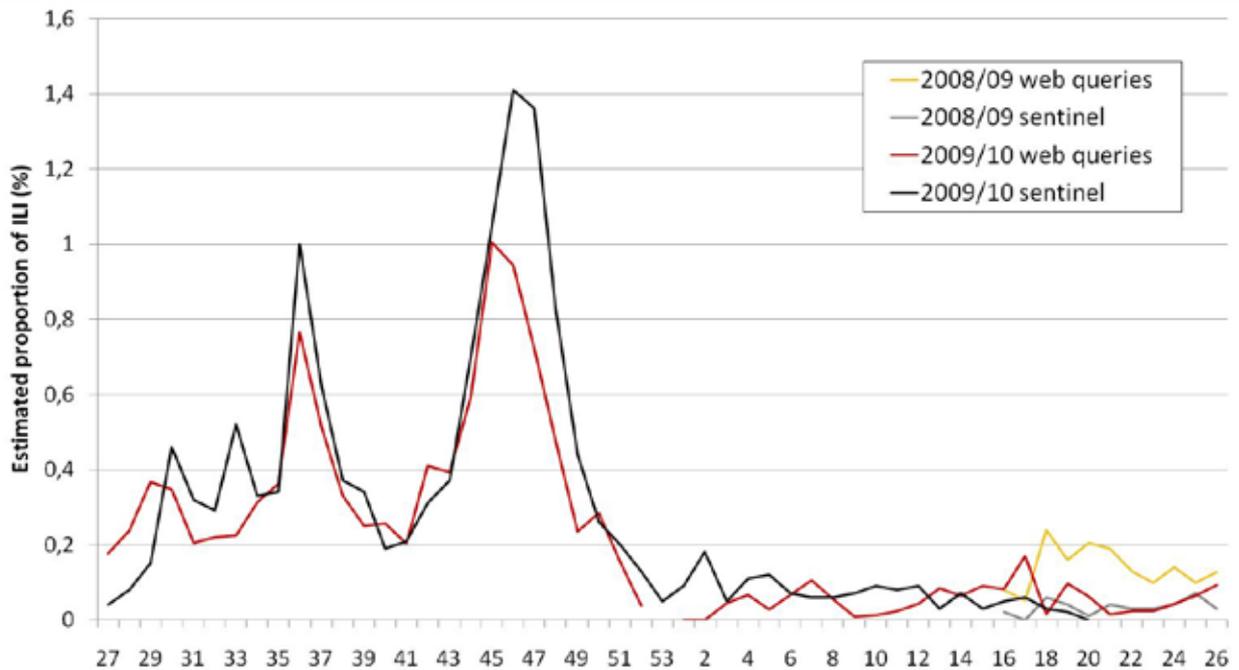


Four peaks are shown in this data. The two first in week 30 and 33 reflect the imported cases. The third occurred beginning of school around week 36 with a mixture of rhinovirus- and influenza virus infections interpreted as ILI. During this period very few sentinel units participated. The largest peak of the pandemic occurred around weeks 46 and 47. This pattern, apart from the double peak during the summer, is reflected throughout the surveillance systems used during the pandemic.

As described earlier, SMI's system *Webbsök* obtains the number of queries regarding influenza and influenza-related symptoms that have been submitted to the Swedish medical website *Vårdguiden* each week. *Webbsök* uses these data to predict the proportion of patients with ILI using a statistical model. Figure 6 shows the prediction of the proportion of patients with ILI based on *Webbsök*. The reported sentinel data are also displayed. The 2008-2009 season is shown in yellow (web) and grey (sentinel) and begins in week 16 (April). The 2009-2010 season is shown in red (web) and black (sentinel).<sup>13</sup>

<sup>13</sup> As several logs were missing from week 53, 2009, this week was omitted for the web query-based estimations.

Figure 6. Estimated Proportion of ILI from the *Webbsök* System and Corresponding Sentinel Data



## Serious Illness and Death

Table 4 shows the number of influenza A(H1N1)2009 cases and the incidence per 100000 population by severity level and age group. In total, 1609 persons were reported to have been hospitalised due to influenza A(H1N1)2009, corresponding to 14.6% of the laboratory-confirmed cases. In the over 65 age group, the incidence was 9 per 100,000 – a very low rate in comparison to other age groups. However, more than half of those over 65 were hospitalised due to influenza, in contrast to 6% for the group with the lowest rate of hospitalisation, those 5 to 14 years of age (Table 1).

Table 4. Number and Incidence (per 100,000 population) of Laboratory-confirmed Influenza A(H1N1)2009 Cases by Severity Level and Age Group

Age Group	Laboratory Confirmed		Admitted to Hospital		Admitted to Intensive Care		Dead
	Number	Incidence	Number	Incidence	Number	Incidence	
0-4	1,608	299	304	56.6	12	2.2	2
5-14	2,944	293	181	18.0	8	0.8	0
15-39	4,403	147	598	20.0	39	1.3	6
40-64	1,914	62	454	14.8	64	2.1	15
>65	140	9	72	4.4	12	0.7	8
Total	11,009	119	1,609	17.4	136	1.5	31

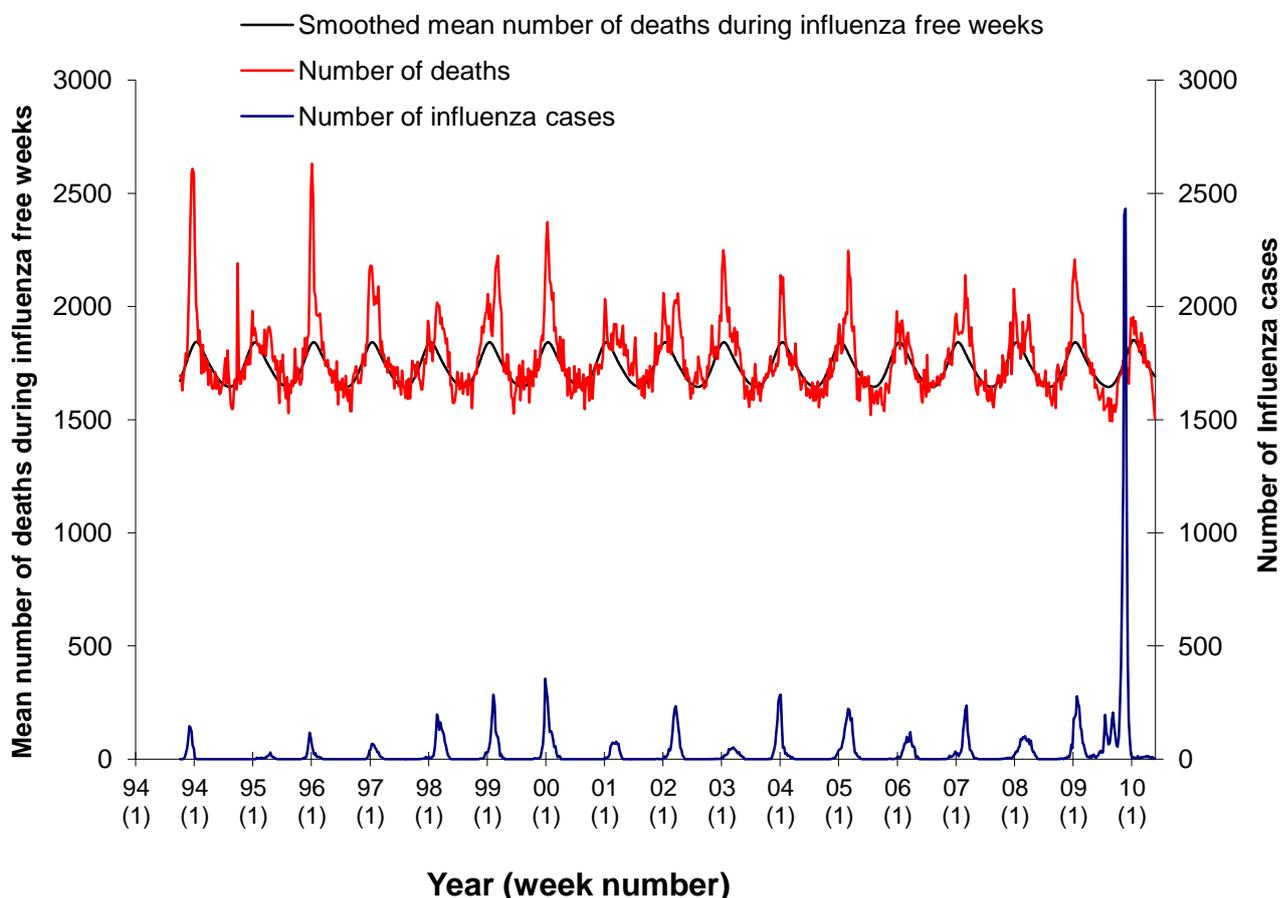
For 136 of the 1,609 hospitalized patients (8%), intensive care, respirator or extracorporeal membrane oxygenation (ECMO) treatment was reported either

through SmiNet or IRIS. A total of 18 patients received ECMO treatment (21-56 years of age, 11 male, 7 female). Eight of these were identified as belonging to one or more of the known medical risk groups.

Figure 7 shows the crude weekly mortality (red), weekly number of influenza diagnoses (blue), and the estimated mortality without the influenza-related excess (black) between 1994 and 2010.<sup>14</sup> As shown, the pandemic did not affect total mortality and there was no influenza-related total excess mortality during the 2009-2010 season.

In total, 31 persons were identified to have died of influenza A(H1N1)2009, which corresponds to a rate of 3.3 per 1,000,000 population. For 28 of these, information on medical risk was available, with and 21 of the 28 belonging to one or more of the known risk groups. Two of the dead were children. The relatively low rate of disease in the elderly explains the low death rate during the pandemic.

Figure 7. Crude Weekly Mortality, Weekly Influenza Diagnoses, and Estimated Mortality Without Influenza-related Excess, 1994-2010



## Population-wide Estimates

Figures 8 and 9 show the percentage of ARI and ILI among participants in the population-based surveillance project *Sjukrapport* by week and year from week 36

<sup>14</sup> In Figure 7, the x-axis labels mark the first week (1) of each year.

(September) to week 33 (August) for the past three influenza seasons. The sentinel surveillance data and the self-reporting data from *Sjukrapport* indicate that the many laboratory-confirmed cases reported during 2009 were due to an oversampling in comparison to earlier seasons. In total, 49,916 samples were analysed in the country, of which 11,009 were reported positive (see also Table 1). Denominator data on sampling from other seasons are lacking, but all laboratories reported that they received far more samples from out-patient clinics during the pandemic than during seasonal influenza.

Figure 8. Reported Acute Respiratory Infection in *Sjukrapport* by Week and Year Past Three Seasons

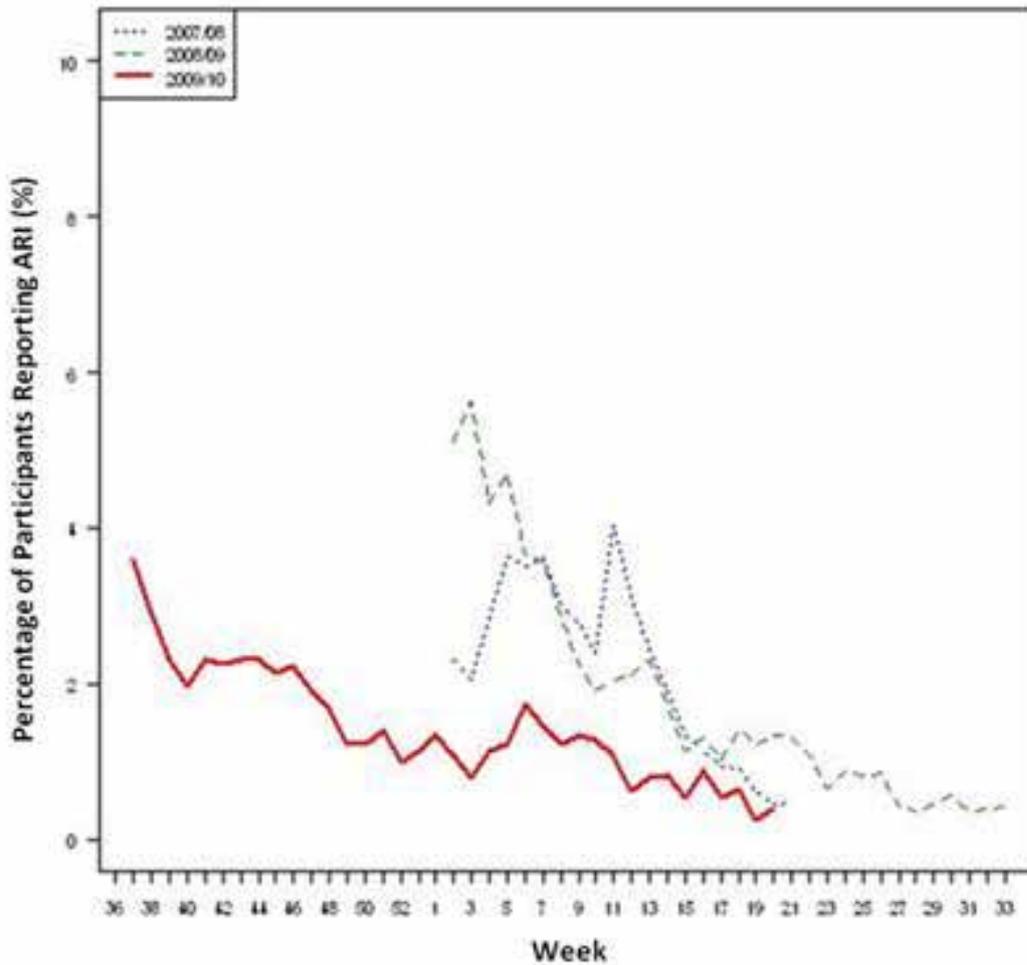
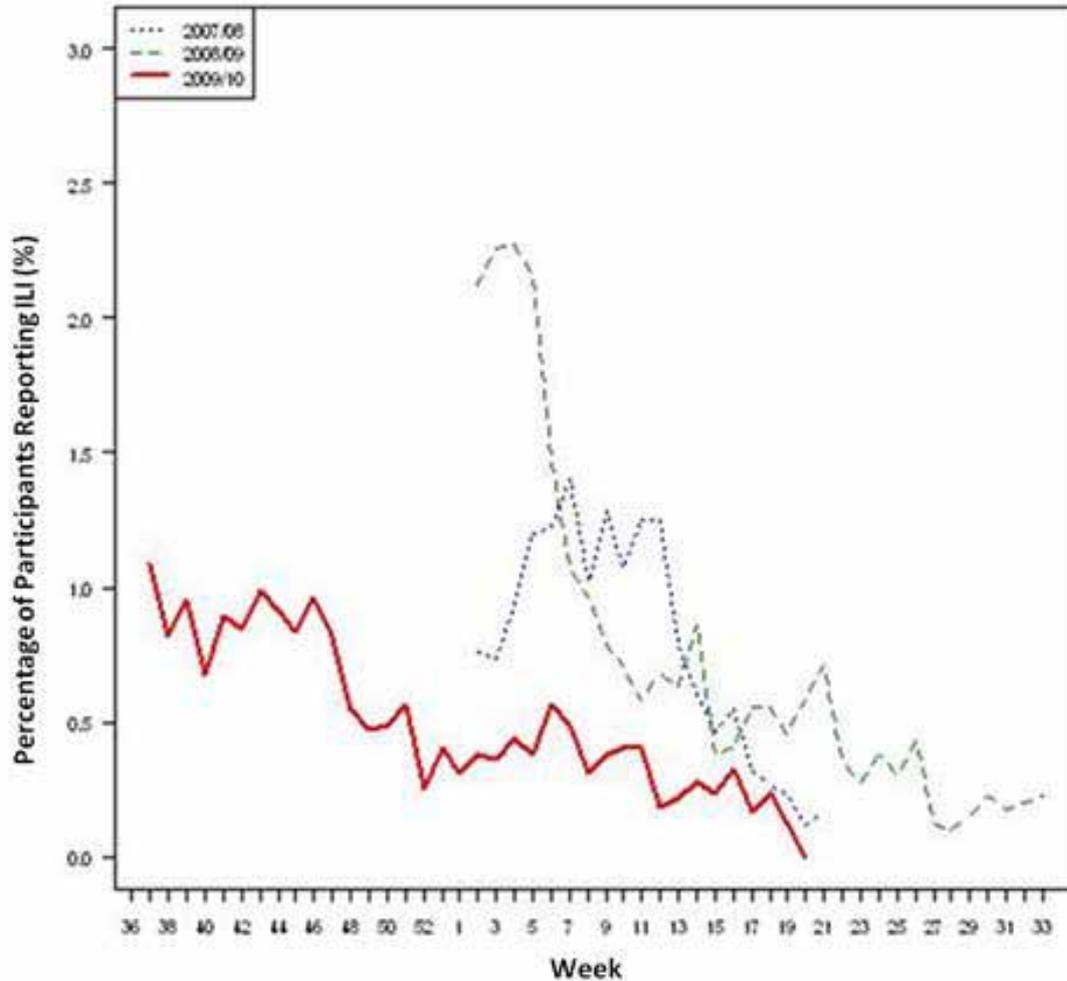


Figure 9. Reports of Influenza-like Illness in *Sjukrapport* by Week and Year, Past Three Seasons



All other surveillance systems (sentinel, *Sjukrapport*, web search, etc.) showed similar timing for the major peak of the epidemic as the laboratory-confirmed cases. However, the magnitude of the peaks in other reporting systems was more similar to what has been seen during seasonal influenza.

Figures 10 and 11 show the proportion of *Sjukrapport* participants reporting ARI and ILI during the 2009-2010 season by age group. Overall, the proportion reporting ARI and ILI was lower than the previous influenza season (as shown in Figures 8 and 9). Increased reporting was clearly discernable only for children, shown by the red line in Figures 10 and 11. Based on approximations using *Sjukrapport* data and sentinel surveillance data from Stockholm county, the total number of persons ill with influenza A(H1N1)2009 in Sweden has been estimated to have been around 500,000 (5.3% of the population).

Figure 10. Reports of Acute Respiratory Infection in *Sjukrapport* by Week and Age Group, 2009-2010 Season

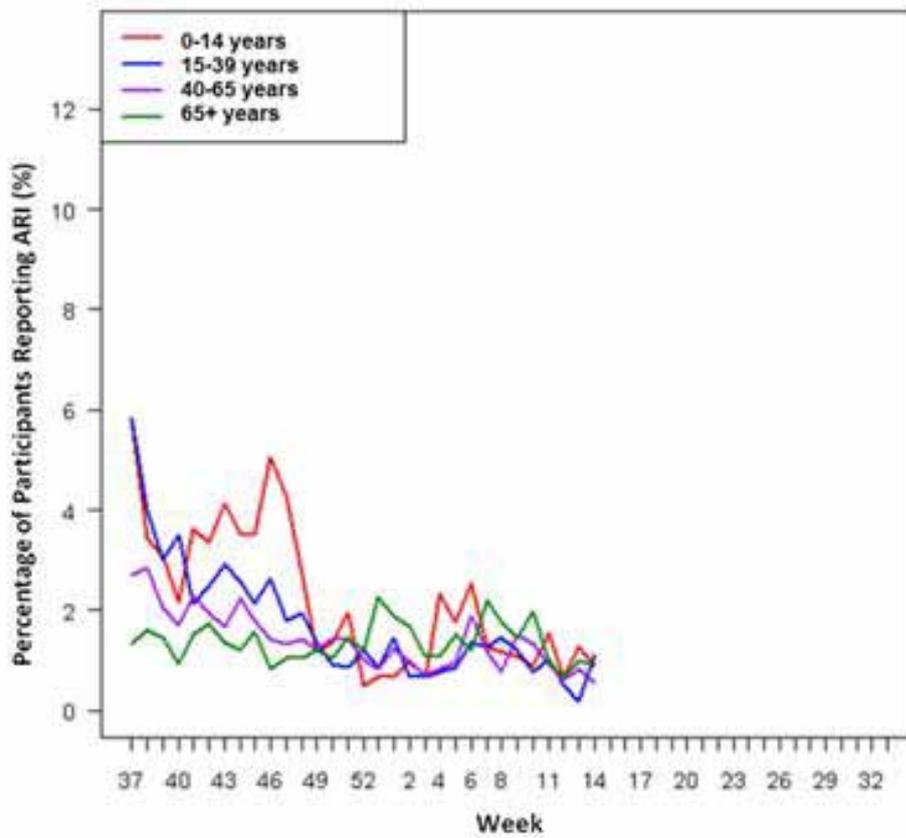
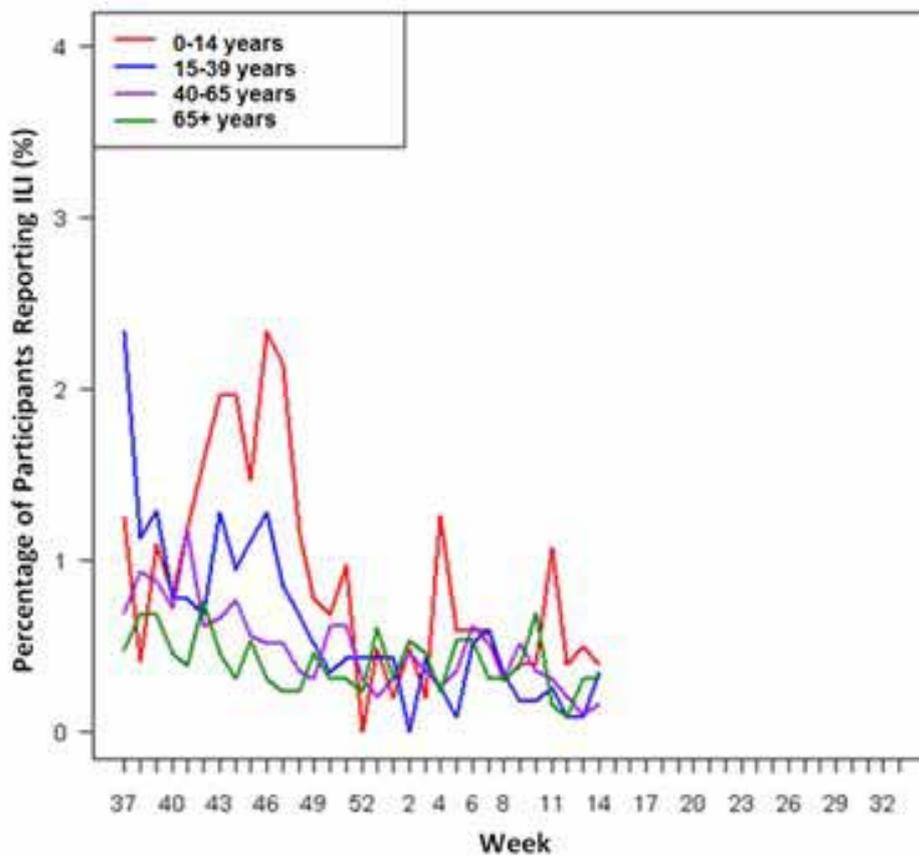
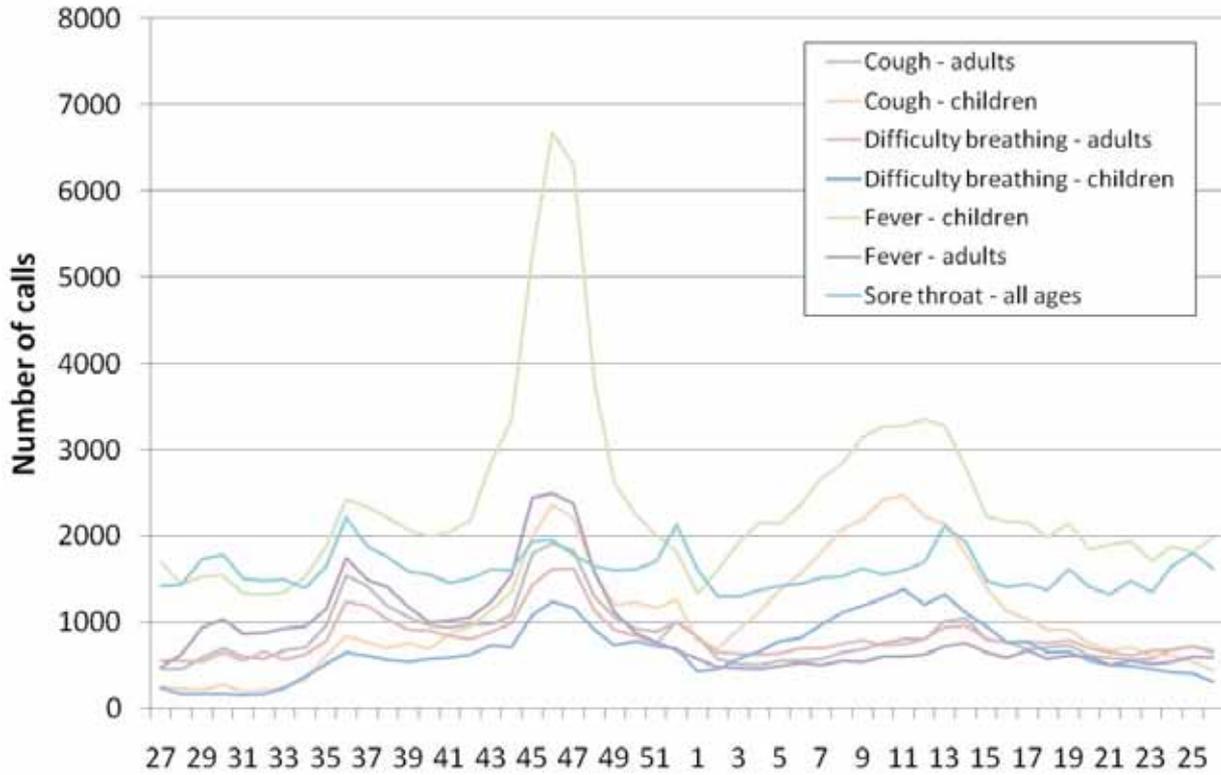


Figure 11. Reports of Influenza-like Illness in *Sjukrapport* by Week and Age Group, 2009-2010 Season



During the pandemic, about 318,000 calls were received by the medical advice line 1177 regarding symptoms of influenza. Figure 12 shows the primary reason for calling (number of calls per week per symptom). As shown, fever in children was the dominating question to the telephone advice line 1177.

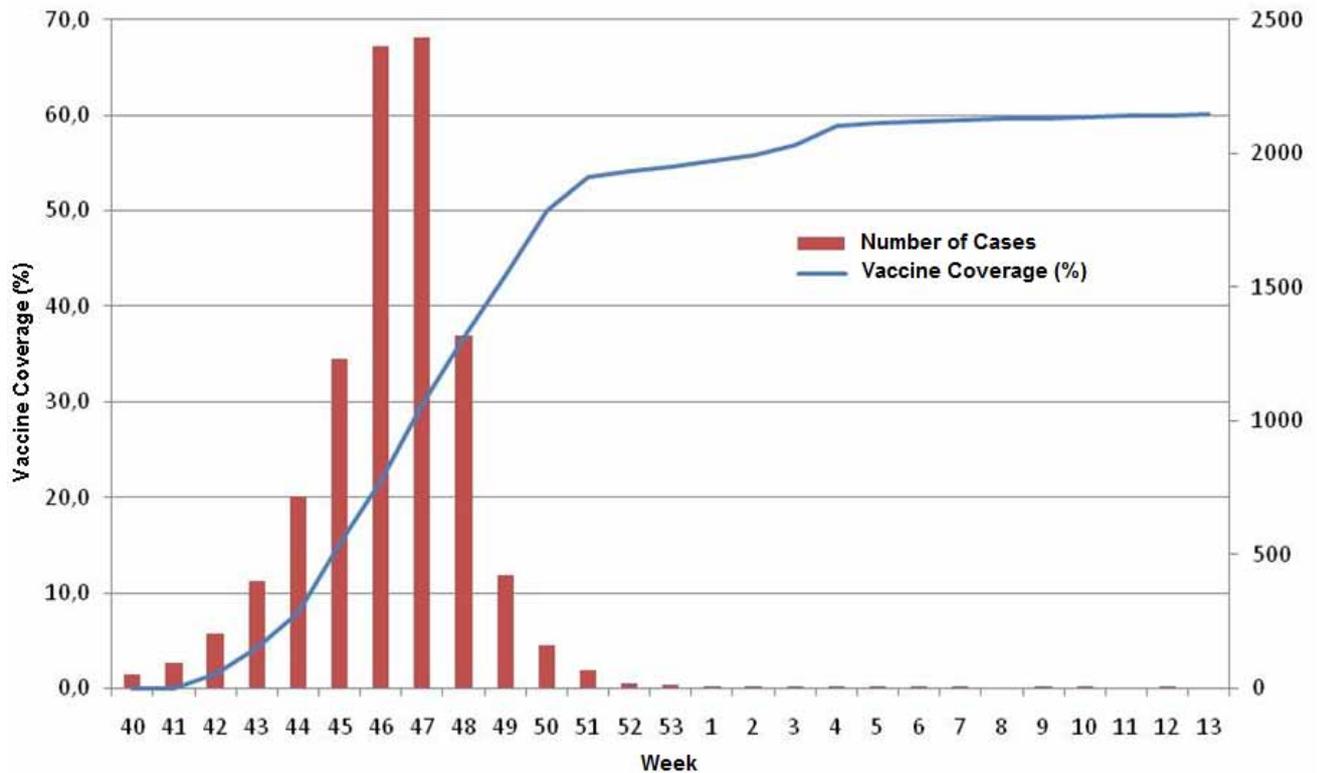
Figure 12. Primary Reason for Calling the Medical Advice Line 1177 (Number of Calls per Week per Symptom)



# Vaccination

During the pandemic, all Swedes were recommended vaccination with the influenza A(H1N1)2009 vaccine (Pandemrix®). Figure 13 shows cumulative vaccination coverage and influenza incidence per week. Vaccination started as soon as the vaccine reached the country in week 40, and during the initial period all delivered vaccine was used. The vaccine was first offered to medical risk groups and health care personnel.

Figure 13. Number of Reported Cases from the mandatory reporting and Cumulative Vaccination Coverage (%) by Week



The counties organised the vaccination campaign in different ways, but there were no major differences in vaccination incidence early during the pandemic. In week 44, two weeks before the peak of the epidemic, 10% of the population were vaccinated, as shown in Figure 13. Thus the vaccine may not have had a major impact on the spread of the virus, but may have affected the incidence of severe outcomes, since the vaccination started with medical risk groups..

A total of 6,070,604 doses of influenza A(H1N1)2009 vaccine were administered in the reporting counties. Extrapolated to the entire country, an estimated 5,560,000 people received at least one dose of the vaccine. This represents 60% of Sweden’s population.

Serologic analysis of a representative sample of Sweden’s population completed in May 2010, showed that over 50% of the population had antibodies to influenza A(H1N1) 2009 in May 2010. The proportion was the highest among children aged 3 to 14, at 76%, and the lowest among those aged 65 and over, at 26%.

# Virological Data

## Laboratory Reporting and Surveillance

In total, 51,072 samples were analysed for influenza in Sweden during 2009-2010 season and 21% of them were positive for influenza A or B. Of the positive samples, 96.9% were influenza A(H1N1)2009, 1.7% were influenza A(H3N2), and 1.4% were influenza B. One seasonal H1N1 strain was detected in a person arriving from India (during the summer of 2009). During the peak, more than 40% of the diagnostic samples analysed were positive for influenza.

During the 2009 pandemic, week 18 and forwards, there were 11,009 laboratory-confirmed cases of influenza A(H1N1)2009. SMI received samples from approximately 10% of these, either as sentinel samples (480), for primary diagnostics (228), or for virus characterisation from other laboratories (400).

## Sentinel Sampling and Surveillance

SMI received 2,621 sentinel samples, of which 504 were confirmed positive for influenza (19%). In total, 488 samples were positive for influenza A and 16 were positive for influenza B. Of the positive samples, 96.4% were positive for A(H1N1)2009, 0.4% for influenza A/H3N2, and 3.2% for influenza B. Out of the 488 influenza A positive samples, 482 were subtyped. In total, 6 of the samples had too low a concentration of vRNA for subtyping.

Figure 14 (see below) shows the number and percentage of sentinel samples positive for influenza A and B each week during the 2009-2010 season.

## Characterisation of Influenza Strains

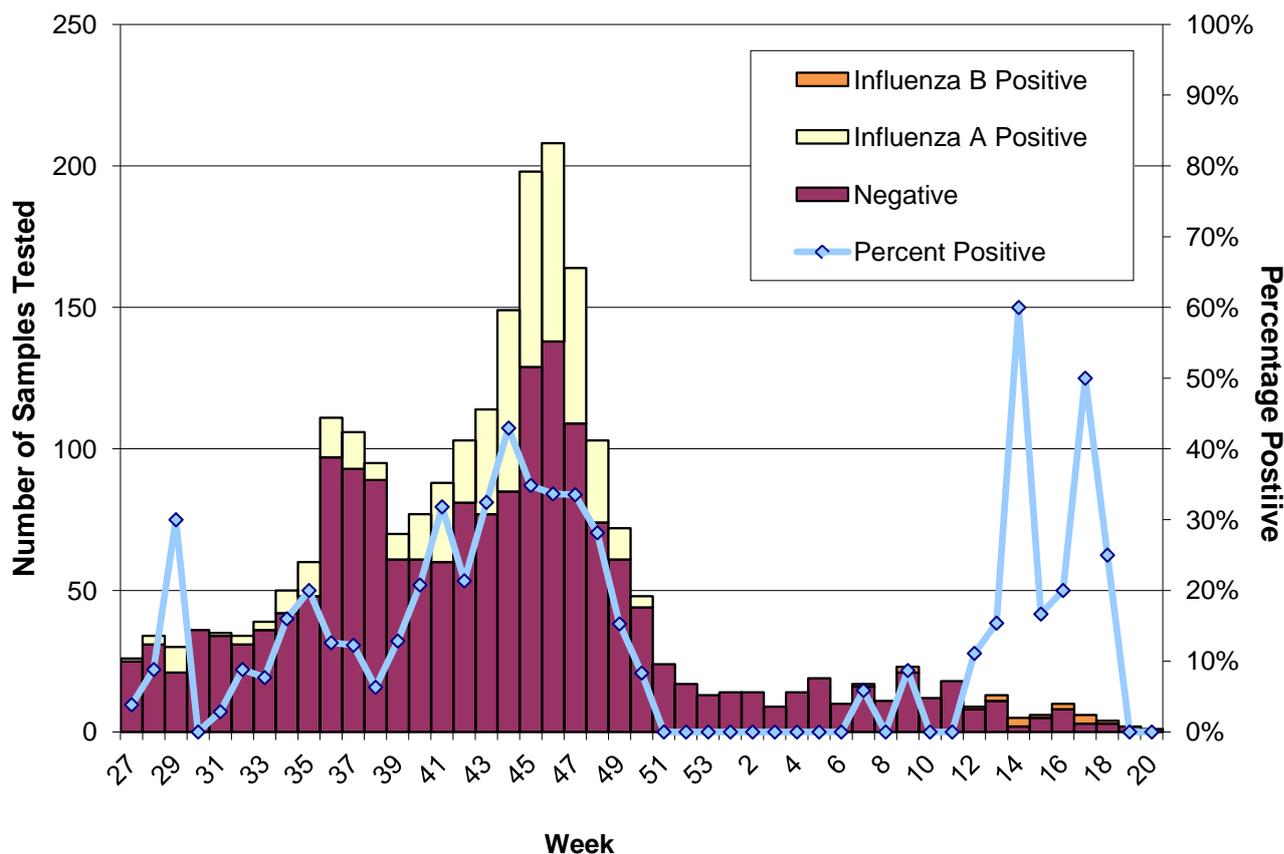
The majority of the characterisations performed at SMI use genotypic assays. The influenza A genome consists of eight gene segments encoding for ten proteins. SMI has continuously characterised five of these gene segments, encoding seven proteins. These are described below.

Hemagglutinin (HA) is characterized with respect to vaccine similarity and changes in receptor affinity. Special mutations within the HA gene allow the virus to alter its affinity to receptors in the lungs instead of the upper respiratory tract. The subtype-specific polymerase chain reaction (PCR) for influenza A targets the HA gene. A representative collection of samples were sent to the WHO Collaboration Centre (CC) laboratory in London for phenotypic characterisation of vaccine similarity with hemagglutination inhibition.

The neuraminidase (NA) gene is characterized for resistance to neuraminidase inhibitors (Tamiflu® and Relenza®). A phenotypic assay for determination of the antiviral sensitivity is also performed.

The polymerase gene (PB2) is characterized with respect to its ability to affect virus replication.

Figure 14. Number and Percentage of Sentinel Samples Positive for Influenza A and B, Weekly, 2009-2010 Season



The non-structural gene segment (NS) encodes for two proteins, NS-1 and NS-2/NEP. NS-1 has been characterized with respect to its ability to increase virulence by inhibition of the interferon pathway. NS-2/NEP is essential for nuclear export.

The matrix gene (MA) also encodes for two proteins, M1 and M2. The gene is used as the target for diagnosis of influenza infection in clinical samples. M1 is involved in viral assembly. M2 encodes for the ion channel and is normally characterized for resistance to amantadine. Analysis of this gene was not relevant for influenza A(H1N1)2009, since the virus was already initially resistant to amantadine.

Phenotypic analysis requires cultivated viruses (isolates). Today, only the laboratories at Umeå University and SMI isolate influenza. Therefore, SMI obtains a representative number of primary samples for isolation from all over Sweden.

During the pandemic, SMI encouraged Swedish laboratories to continuously send representative selections of positive samples. SMI also urged the laboratories to provide SMI with samples retrieved from patients who became severely ill, or who became ill despite vaccination, and samples from patients who did not respond to antiviral treatment, as well as samples from deceased patients.

### Characterisation of A(H1N1)2009

A total of 116 influenza A(H1N1)2009 samples, representing one percent of all laboratory-confirmed cases in Sweden, were genotypically characterized. Of these, 23 were sentinel samples and 93 were from laboratories and clinics. Among these

samples, 20 were from severely ill (ECMO/intensive care) or deceased persons, while 9 were from investigations of vaccine breakthroughs.

SMI sequenced HA from 62 strains, NA from 89 strains, NS from 37 strains, and PB2 from 25 strains. All strains showed high similarity to the vaccine strain in HA (see Attachment 1). Neither mutations causing resistance to the neuraminidase inhibitors nor mutations affecting the virulence (NS and PB2) were identified.

In addition, SMI also sequenced the matrix gene from 38 strains to validate the diagnostic system established by SMI for Swedish use. One nucleic acid change in a key position related to SMI's diagnostic method was identified.

Recommendations for changes in the analytic protocol to compensate for this change were sent to laboratories using the method.

SMI continued the effort to register the characterized protein and nucleotide sequences into the public database GISAID early on in an effort to contribute to an international information exchange. The first sequences (HA, NA and MA) were reported May 8, 2009.

SMI attempted to isolate virus from 93 samples found to be positive through nucleic acid analysis, and successfully obtained 52 isolates. These were characterized genotypically at SMI. Most of the isolates were sent to the WHO CC laboratory in Great Britain for further antigenic characterisation with ferret sera.

In addition to the genotypic characterisation, 48 of the genotypically sequenced samples were analysed for phenotypic resistance by studies of the effect of antivirals on viral growth. All strains were sensitive to the two neuraminidase inhibitors approved for treatment of influenza by both the genotypic and the phenotypic method.

## Characterisation of Seasonal Influenza A and B

Due to the pandemic, sentinel sampling was performed throughout the summer of 2009. Thus, influenza cases were detected outside the regular influenza season. Influenza B was found to cause outbreaks after week 20 (May 2009), and travel-related, seasonal influenza infections were found to be quite common during the summer. The pandemic influenza became completely dominant in sentinel sampling during the autumn.

From week 18 of 2009 (end of April) to week 20 of 2010 (mid-May), 22 strains were characterized by SMI (11 influenza A(H3N2) strains and 11 influenza B strains).

The influenza A(H3N2) strains circulating during the season 2008-2009 were found to be like the vaccine strain A/Brisbane/10/2007. During the summer of 2009, the influenza A(H3N2) strains drifted and became A/Perth/16/2009-like. The clade distribution was: two H3/Brisbane/10/2007-like; four A/Perth/16/2009-like; and five A/Victoria/208/2009-like (see Attachment 2). All of the influenza A(H3N2) strains were sensitive (genotypically and phenotypically) to both the neuraminidase inhibitors but resistant to amantadine due to mutation S31N in M2.

In total, 11 influenza type B strains were characterised (see Attachment 3). Nine of these were B/Brisbane/60/2008-like (B/Victoria/2/1987 lineage; V) and two were

B/Florida/4/06-like (B/Yamagata/16/88 lineage; Y). All strains were sensitive (genotypically and phenotypically) to the neuraminidase inhibitors. Additionally, six influenza B samples were detected using Y and V specific real time PCR. All six samples were determined to be of B/Victoria/2/1987 lineage.

## Diagnostic Methods and Quality Assurance

On May 5, 2009, the first influenza A(H1N1)2009 case in Sweden, with onset of disease in the end of April, was diagnosed by reverse transcriptase (RT) PCR, and Sanger sequencing. The HA and NA sequences were compared to sequence data reported from WHO by the United States Centers for Disease Prevention and Control (CDC).

Samples submitted after May 8 were diagnosed by real-time one-step RT-PCR for influenza A(H1N1)2009 and matrix A established by SMI. The systems were implemented in several laboratories in Sweden during the summer of 2009. During spring and summer 2009, 1,000 samples were analysed for the purpose of primary diagnostics at SMI. From the end of August, a majority of the regional laboratories performed diagnostics for influenza A(H1N1)2009.

In the middle of June and in October 2009, quality assurance panels for PCR and immunofluorescence (IF) were distributed to the Swedish laboratories. SMI has continuously sequenced samples in order to validate the stability of the target genes (M1 and HA) for the PCR. Laboratories using SMI's system that found samples giving deviating results sent them to SMI for validation of the system. SMI assisted laboratories that established their own diagnostic system by sequencing some of their samples in order to validate their methods.

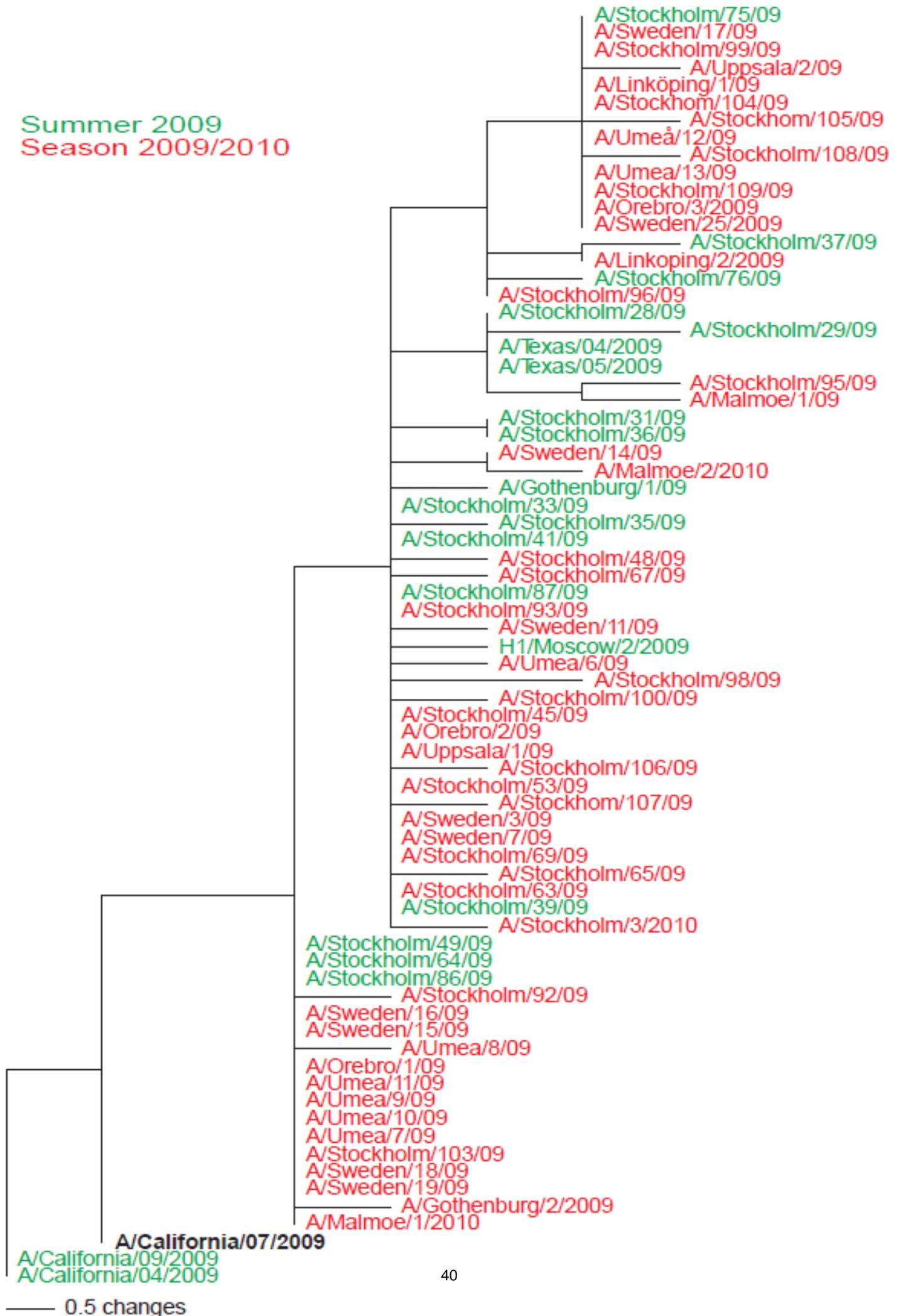
## Conclusion

The major strength of Swedish surveillance during the pandemic was the mandatory reporting system. The vaccination campaign was a great success. The usefulness of having a population-based surveillance system established before the onset of the pandemic (*Sjukrapport*) for evaluation of the pandemic's impact on society and as a source of denominator data was obvious. However, the system needs to cover all Sweden and to be improved. The sentinel system does not function well in Sweden since patients with influenza visit general practitioners and clinics less frequently than in many other countries. The systems for reporting intensive care and deaths also need improvement.

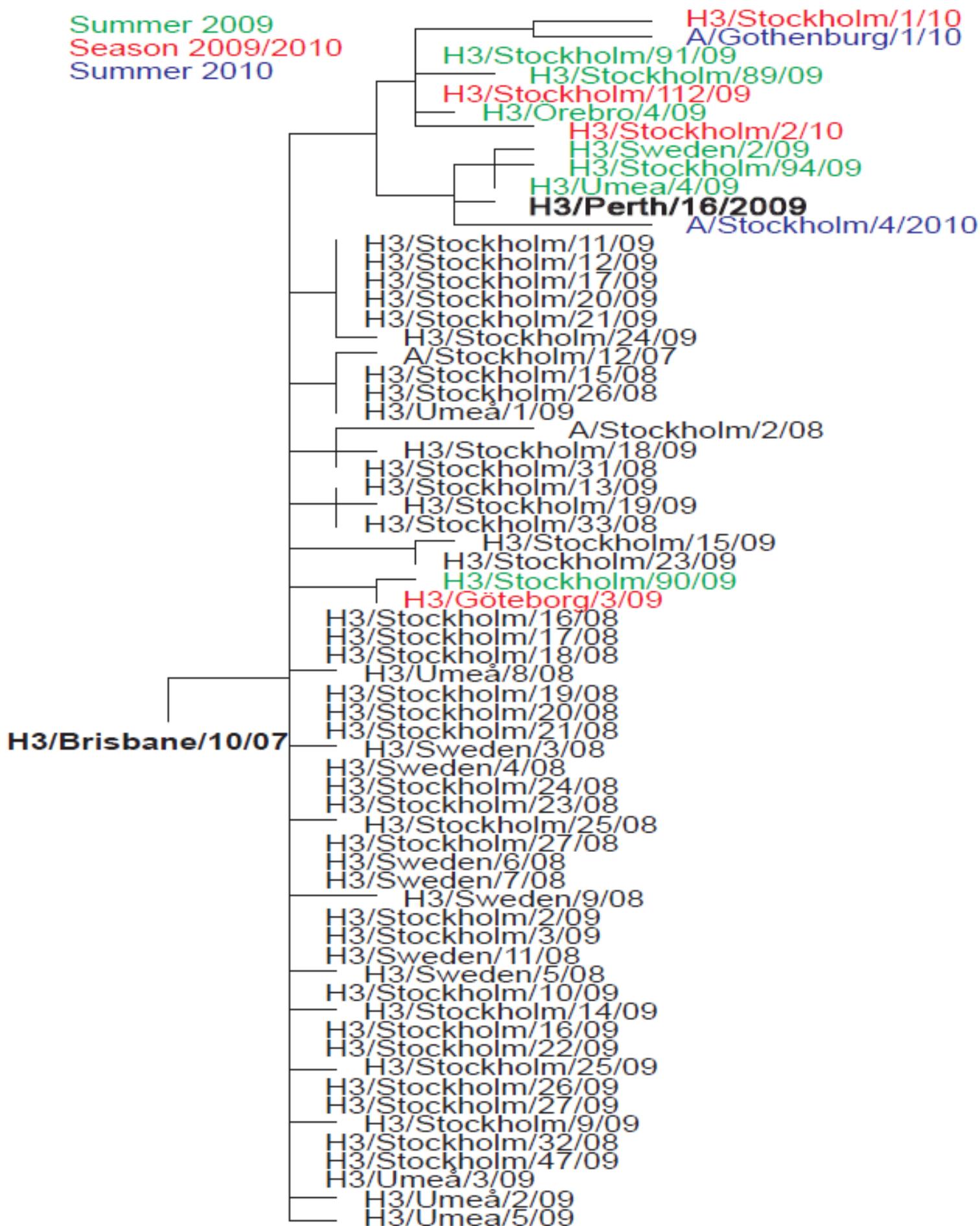
Viral diagnostics and typing were established early during the pandemic, and functioned extremely well. The main problem was obtaining enough strains and sera from infected individuals. The strains characterized were all similar to strains from the rest of Europe, and no antiviral resistance was identified.

The major traits of the 2009 pandemic were similar in Sweden to what has been noted in many other countries. Mainly young people were infected and most of the infected got a mild disease, but still the relative number of patients that needed intensive care due to primary viral pneumonia was high – especially among medical risk groups. The vaccination rate was higher in Sweden than in all other countries. Despite this, the vaccine arrived too late for vaccination to have a major impact on the spread of the virus. However, the comparatively low incidence in Sweden of severe respiratory tract infections and influenza deaths indicate that it may have reduced the number of patients with severe disease.

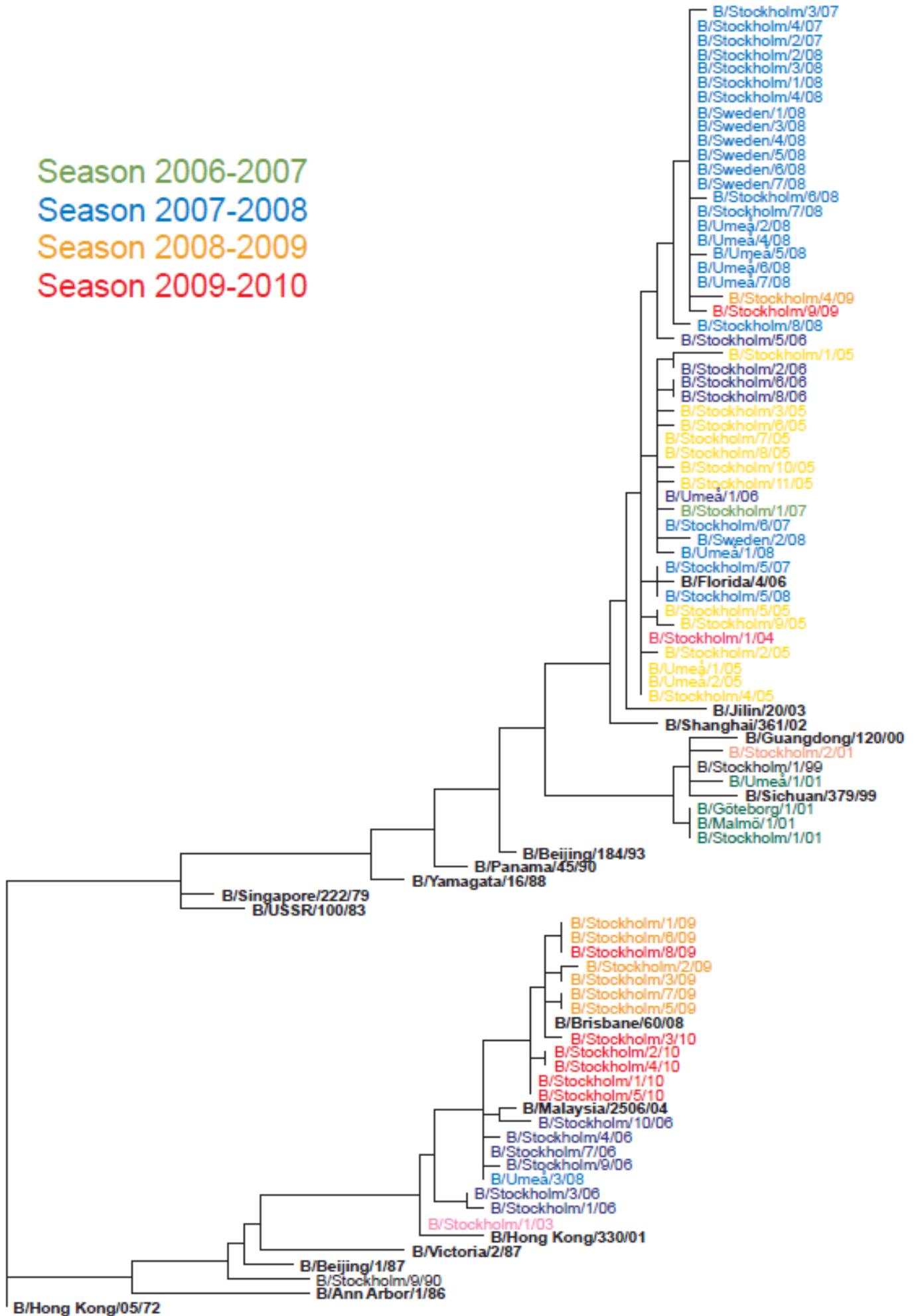
Attachment 1. The phylogenetic tree of the amino acid sequences of HA of A/H1N1 (2009).



Attachment 2. The phylogenetic tree of the amino acid sequences of HA of A/H3N2.



Attachment 3. The phylogenetic tree of the amino acid sequences of HA of influenza B.





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