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Epidemiology of the 2009 influenza pandemic in Spain. The Spanish Influenza Surveillance System

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A B S T R A C T

In accordance with European Centre for Disease Prevention and Control recommendations, the Spanish Influenza Surveillance System (SISS) maintained its activity during the summer of 2009, and since July 2009 the pandemic virus activity was monitored by the SISS. In this paper, we describe the epidemiological and virological characteristics of the 2009 pandemic in the Spain through the SISS.

Spain experienced a transmission of the new A(H1N1)pdm09 influenza virus during the summer of 2009, which gradually increased, resulting in the pandemic wave in early autumn of that year. The reproductive number R0, estimated during the growth phase of the pandemic wave (1.32; 95% confidence interval [95%CI], 1.29-1.36), showed a transmissibility comparable to preceding pandemics. There was an almost complete replacement of the previous seasonal A(H1N1) influenza virus by the pandemic virus A(H1N1) pdm09.

The pandemic virus produced a greater burden of illness than seasonal influenza in children younger than 15 years old, while the incidence in those older than 64 years was lower compared with previous inter-pandemic seasons. Nevertheless, in Spain the 2009 pandemic was characterized as mild, considering the duration of the pandemic period and the influenza detection rate, both in the range of those observed in previous inter-pandemic seasons. Also, the case fatality ratio (CFR) was estimated at 0.58 deaths/1,000 confirmed ILI cases (95%CI, 0.52-0.64), in the range of the two previous pandemics of 1957 and 1968, with the highest CFR observed in the older than 64 years age group. In the 2009 pandemic there was a higher percentage of pandemic confirmed deaths in the younger ages, compared to seasonal influenza, since only 28% of the reported deaths occurred in persons aged 64 years and older.

Epidemiología de la pandemia de gripe 2009 en España. El Sistema Español de Vigilancia de Gripe

Palabras clave:
Gripe pandémica
Virus de la gripe A(H1N1)pmd09
Vigilancia
Severidad

R E S U M E N

De acuerdo con las recomendaciones del Centro Europeo para la Prevención y Control de Enfermedades (ECDC), el Sistema de Vigilancia de la Gripe en España (SVGE) mantuvo su actividad durante el verano de 2009 y desde julio de 2009 la actividad del virus pandémico fue vigilada por el SVGE. En este artículo se describen las características epidemiológicas y virológicas de la pandemia de 2009 en España a través del SVGE.

Durante el verano de 2009 España experimentó una transmisión del nuevo virus de la gripe A(H1N1) pdm09, que fue aumentando gradualmente dando lugar a la onda pandémica a principios de otoño de ese año. El número reproductivo básico R0, estimado durante la fase de crecimiento de la onda pandémica

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(1,32; intervalo de confianza [IC] del 95%, 1,29-1,36), mostró una capacidad de transmisión similar a la de pandemias de gripe precedentes. Se produjo un reemplazamiento casi completo del virus de la gripe estacional previo, A(H1N1), por el nuevo virus pandémico A(H1N1)pdm09.
En comparación con las temporadas interpandémicas anteriores, este virus afectó más a los niños menores de 15 años, mientras que la incidencia de gripe en las personas mayores de 64 años fue más baja. En España la pandemia de 2009 se caracterizó por su carácter leve, con una duración del período pandémico y una tasa de detección viral en el rango de lo observado en las temporadas interpandémicas anteriores. También la tasa de letalidad, estimada en 0,58 muertes/1.000 casos confirmados de gripe (IC del 95%, 0,52-0,64), se situó en el rango de las 2 pandemias anteriores de 1957 y 1968. Las mayores tasas de letalidad se observaron en el grupo etario de mayores de 64 años. En comparación con la gripe estacional, hubo un porcentaje más alto de muertes debidas a gripe pandémica en las edades más jóvenes, mientras que sólo el 28% de las muertes notificadas ocurrió en personas mayores de 64 años.

Introduction

The emergence of a new influenza virus in Mexico and California in April 2009 was declared by the World Health Organization (WHO) as a Public Health Emergency of International Concern, after it became evident that the new virus met the WHO criteria for a pandemic strain. On April 27th, the WHO declared the pandemic phase 4 shortly after Spain reported the first confirmed case of the influenza A(H1N1)pmd09 infection in Europe.[1] Increased transmission of the new virus in at least 2 countries from the same WHO region led WHO to declare pandemic phase 5 on April 29th and pandemic phase 6 on June 11th.[2]

The surveillance strategy for human cases infected with the new virus was adapted to the pandemic progress in Spain, according to the National Pandemic Influenza Preparedness Plan[3,4] and international surveillance recommendations.[5] Following the WHO alert of pandemic phase 5, the European Centre for Disease Prevention and Control (ECDC) and WHO jointly recommended intensifying the containment measures and extending the influenza surveillance within the routine surveillance systems established prior to the pandemic. After pandemic phase 6 declaration, the mitigation phase implemented in Spain was characterized by a gradual transition from case-based reporting to surveillance of severe cases and influenza sentinel surveillance.[6]

The aim of this paper is to describe the epidemiology of the 2009 pandemic in Spain through the information provided by the Spanish Influenza Surveillance System (SISS), as well as to characterize the impact on the morbidity and mortality of the Spanish population in relation to the previous inter-pandemic influenza seasons.

Reinforcement of the Spanish Influenza Surveillance System

The SISS has been in place since 1996 to provide timely epidemiological and virological information on influenza activity in Spain,[7] and it is integrated into the European Influenza Surveillance Network.[8] In 2009, the SISS comprised 17 networks of sentinel physicians (in 17 Spanish regions), coordinated by the National Centre of Epidemiology, and 17 network-affiliated laboratories, coordinated by the National Influenza Reference Laboratory (National Centre of Microbiology, WHO National Influenza Centre), as well as Epidemiology and Public Health Units belonging to each Spanish region.[9] On a weekly basis, sentinel general practitioners (GPs) and pediatricians (PDs) report cases of influenza-like illness (ILI) detected in their reference populations following the European Union ILI case definition.[10] For virological influenza surveillance, sentinel physicians take nasal or nasopharyngeal swabs and send them to the network-affiliated regional laboratories for influenza virus detection. In addition to the specimens taken by sentinel physicians, laboratories also collect and analyze specimens from non-sentinel sources (e.g. hospitals, collaborating laboratories).[9] When the assay to detect specifically the influenza A(H1N1)pdm09 virus is not available at the regional laboratories, specimens are sent to the National Influenza Reference Laboratory for virological studies.

At the beginning of 2009 pandemic, two independent assays were used for detection of the influenza A(H1N1)pmd09 virus: *a)* a multiplex reverse transcription (RT)-nested PCR assay for generic detection of Influenza A, B and C designed in the nucleoprotein gene, and *b)* a multiplex RT-nested PCR assay for sub-typing the hemagglutinin gene of influenza A viruses. Amplified products from both RT-PCR assays were sequenced and identification of the influenza A(H1N1)pmd09 virus was performed after sequence analysis.[11] For the molecular characterization of resistance to antivirals, analyses of matrix and neuraminidase genes were also performed in selected clinical samples and available isolates.

Information collected in the SISS included data on demographic, clinical and virological characteristics, seasonal and pandemic vaccination status, chronic conditions and pregnancy. Data were reported weekly and were included in a web-based application (http://vgripe.isciii.es/gripe). The analysis of the information obtained from the SISS by the National Centre of Epidemiology provided timely information on the evolution of influenza activity at regional and national levels.

In line with ECDC recommendations, SISS maintained its activity during the summer of 2009, and since July 2009[6] influenza A(H1N1) pdm09 virus activity has been monitored through the influenza sentinel surveillance. In order to meet this challenge, the SISS was reinforced in several ways. First, the Spanish regional sentinel networks in the SISS increased the number of participating GPs and PDs in influenza surveillance, with 647 GPs and 220 PDs. This change increased by 22% the population under surveillance compared to the preceding season, thus reaching 2.5% of the total Spanish population in September 2009.[9,12] Secondly, sentinel physicians were advised to swab all patients meeting the influenza case definition. In order to manage the quantity of specimens collected, the swabbing strategy changed during the surveillance period, from all cases to a systematic sampling, according to network resources and SISS-affiliated laboratory capacities. Finally, systematic swabbing of patients was introduced in the entire SISS, facilitating the unbiased selection of ILI patients for swabbing. In this way, the virological information better represented the distribution of influenza cases in the community. The proportion of swabbed ILI patients increased from an average of 16% in the previous influenza season to 70% in summer 2009 and to 38% during the entire pandemic period (from weeks 20/2009 to 20/2010).[12]

Epidemiological and virological characteristics of the 2009 pandemic. Comparison with previous influenza seasons

Following the initial influenza A(H1N1)pdm09 cases detected in Spain, the increase in the detection of outbreaks in various settings by the end of June 2009 indicated the spread of the pandemic virus into the community.[13] During the entire summer of 2009, there was

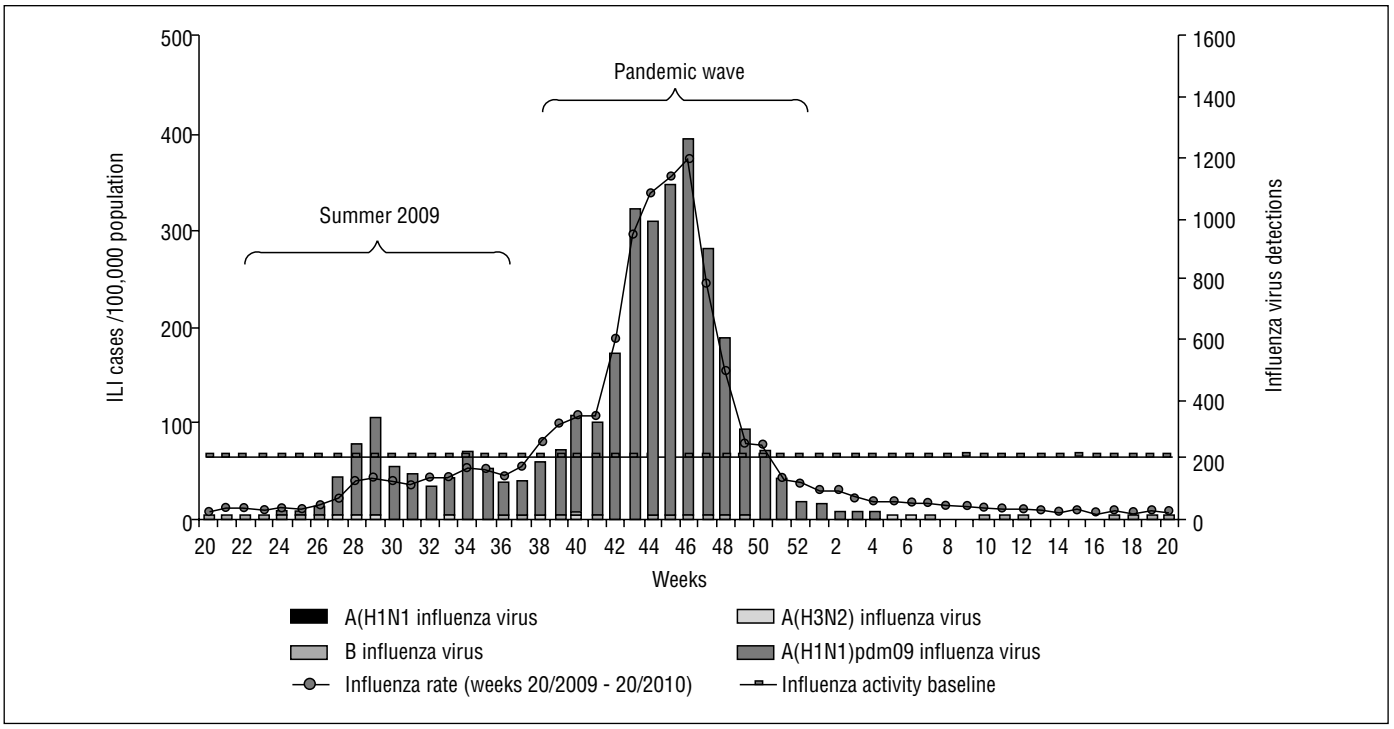

Figure 1. Weekly influenza rates and influenza virus detections during the 2009 pandemic in Spain. Spanish Influenza Surveillance System.

a sustained circulation of the pandemic virus in Spain, which was predominant in all Spanish regions,[14] unlike the low influenza activity observed in the summer of previous inter-pandemic periods.[15] Weekly influenza rates increased steadily in summer 2009, remaining above the usual levels (Fig. 1), although they did not surpass the influenza baseline until week 38/2009 (20-26 September).

The pandemic wave started in Spain in the early autumn (week 40/2009), when in addition to incidence rates above the epidemic threshold (Fig. 1), the percentage of positive samples of influenza virus reached the median of this virological indicator (42%) in the preceding eight inter-pandemic seasons.[14] The peak influenza rates were reached six weeks later (week 46/2009), with 372 cases per 100,000 population, returning to values under baseline threshold in week 51/2009 (13-19 December). The influenza virus identified almost exclusively during all the pandemic period was the influenza A(H1N1)pdm09 virus. Since January 2010, only a sporadic circulation of influenza virus type B has been observed (Fig. 1).

The basic reproductive number R0 was estimated in the growth phase of the pandemic in Spain as 1.32 (95% confidence interval [95%CI], 1.29-1.36),[16] in the range of the estimates obtained in various countries.[17,18] In addition, these figures are consistent with those found in inter-pandemic influenza seasons[19] and are in the low range of the R0 estimates in previous pandemics.[20,21] Thus, the 2009 pandemic showed comparable transmissibility to preceding seasons.

The mild character of the 2009 pandemic in Spain is suggested by the maximum influenza rate at the peak of the pandemic wave, with values of influenza activity in the range of those observed in previous inter-pandemic influenza seasons[15] (Table 1). In addition, the duration of the pandemic period in the season 2009-10 was 11 weeks (Table 1), which was similar to the duration of the epidemic period during the eight previous influenza seasons, ranging from 7 to 14 weeks.[12] However, total influenza rate ratios in the 2009 pandemic were higher compared with previous influenza seasons (Table 2), in Spain and in all but four Spanish regions that have sentinel networks integrated within the SISS.

The most affected age groups by the 2009 pandemic in Spain were children younger than 15 years old, especially the 5-14 age

Table 1
Characteristics of the pandemic wave 2009 and the previous influenza seasons. Spain. Spanish Influenza Surveillance System

Season	Week peak	Duration of the wave (weeks)	Maximum influenza rate*	Dominant type/subtype influenza virus
2001-2002	04/2002	10	397.19	AH3N2/B
2002-2003	04/2003	14	139.54	B /AH1N1
2003-2004	47/2003	10	225.02	AH3N2
2004-2005	02/2005	13	542.86	AH3N2/B
2005-2006	11/2006	7	166.07	AH1N1/B
2006-2007	06/2007	8	259.69	AH3N2/B
2007-2008	02/2008	12	202.76	AH1N1/B
2008-2009	53/2008	11	218.31	AH3N2/B
2009-2010	46/2009	11	372.72	A(H1N1)pdm09

*Cases/100,000 population.

Table 2
Total and age-specific influenza rate ratios in the 2009 pandemic in relation to previous influenza seasons. Spain. Spanish Influenza Surveillance System

	Global and age specific influenza rate ratio (95%CI)*				
Sentinel network*	Age groups (years)				
	0-4	5-14	15-64	>64	Global
Andalucía	1.7 (1.5-1.9)	2.4 (2.2-2.5)	1.6 (1.5-1.8)	0.8 (0.6-1.1)	1.8 (1.7-1.9)
Aragón	1.8 (1.6-2.1)	2.3 (2.1-2.5)	1.3 (1.2-1.4)	0.7 (0.4-1.0)	1.7 (1.6-1.8)
Principado de Asturias	1.5 (1.3-1.8)	1.9 (1.7-2.0)	1.0 (0.9-1.1)	0.3 (0.2-0.5)	1.3 (1.2-1.3)
Islas Baleares	3.4 (2.5-4.7)	2.9 (2.5-3.4)	0.7 (0.6-0.8)	0.6 (0.4-1.0)	1.1 (1.0-1.2)
Canarias	1.6 (1.2-2.1)	2.1 (1.9-2.5)	0.9 (0.8-1.0)	0.2 (0.2-0.4)	1.1 (1.0-1.2)
Cantabria	1.3 (0.9-1.9)	1.3 (1.1- 1.6	1.0 (0.9-1.2)	0.4 (0.3-0.7)	1.1 (1.0-1.2)
Castilla-La Mancha	1.8 (1.5-2.2)	2.0 (1.8-2.2)	0.9 (0.8-0.9)	0.6 (0.5-0.8)	1.1 (1.1-1.2)
Castilla y León	2.3 (1.7-2.9)	2.2 (1.9-2.6)	0.7 (0.6-0.9)	0.3 (0.2-0.6)	1.2 (1.1-1.3)
Cataluña	1.5 (1.3-1.7)	2.8 (2.5-3.1)	1.8 (1.6-2.0)	1.4 (0.9-2.4)	2.0 (1.9-2.2)
Comunidad Valenciana	2.7 (2.3-3.3)	2.7 (2.4-3.0)	0.9 (0.8-1.0)	0.8 (0.6-1.2)	1.5 (1.4-1.6)
Extremadura	4.5 (3.2-6.3)	3.9 (3.3-4.6)	1.1 (1.0-1.2)	0.6 (0.4-0.8)	1.5 (1.4-1.7)
Comunidad de Madrid	1.5 (1.3-1.7)	1.8 (1.6-2.0)	1.1 (1.0-1.1)	0.3 (0.2-0.5)	1.2 (1.2-1.3)
Comunidad Foral de Navarra	2.3 (2.0-2.6)	3.0 (2.8-3.3)	1.0 (0.9-1.1)	0.6 (0.5-0.8)	1.6 (1.5-1.7)
País Vasco	0.7 (0.6-0.9)	1.5 (1.4-1.7)	1.1 (1.0-1.2)	0.7 (0.4-1.1)	1.2 (1.1-1.3)
La Rioja	1.0 (0.8-1.4)	2.6 (2.2-3.0)	1.1 (0.9-1.2)	0.3 (0.1-0.6)	1.4 (1.3-1.5)
Ceuta	12.5 (4.3-35.9)	2.0 (1.3-3.3)	0.8 (0.5-1.2)	0.9 (0.2-4.5)	1.3 (1.0-1.8)
Spain	1.6 (1.5-1.6)	2.1 (2.0-2.1)	1.1 (1.1-1.1)	0.5 (0.5-0.6)	1.4 (1.3-1.4)

95%CI: 95% confidence interval.
*Total and age-specific influenza rate ratios and comparison of influenza rates among the pandemic season 2009-10 and the previous eight influenza seasons were obtained with Poisson regression. We used 9 weeks for each season, the week of the epidemic peak, the 4 preceding weeks and the 4 following weeks of the peak week. Seasons 2001-2002 until 2008-2009 were included for Spain and the number of seasons participating in the Spanish Influenza Surveillance System for the Spanish sentinel networks (range: 2 to 8 seasons).

group, with a maximum cumulative influenza incidence of 7,550 and 5,240 ILI cases per 100,000 inhabitants for the 5-14 and 0-4 age groups, respectively.[12] In Spain, these are the most affected age groups in the inter-pandemic influenza seasons,[15] but compared with previous historical seasons, children from 0-4 and 5-14 age groups experienced significantly higher influenza incidence rates in the 2009 pandemic (Table 2). Moreover, people older than 64 years experienced lower influenza incidence rates in the 2009 pandemic than in previous inter-pandemic seasons. Similar differences among the age groups affected in the 2009 pandemic related to previous influenza seasons were observed in the various Spanish regions, either in the 0-4 age group (in all Spanish regions but four), the 5-14 age group or in the older than 64 years age group (in all Spanish regions but one) (Table 2). Therefore, the influenza A(H1N1)pmd09 virus produced a greater burden of illness than seasonal influenza in children. In contrast, the incidence in those over 64 years was lower in the 2009 pandemic than in previous inter-pandemic seasons. A possible explanation for this lies in a certain degree of protection against influenza A(H1N1)pmd09 virus infection for the older population who was previously exposed to antigenically similar influenza strains that circulated in the first half of the century.[22,23]

The pandemic wave of 2009 presented two noteworthy aspects in Spain. First, the early initiation time, starting in the early autumn, as opposed to the end of December or beginning of January, in which the epidemic wave started in 70% of the influenza inter-pandemic seasons[12] (Fig. 2). The early peak of the 2009 pandemic has been discussed by other authors along with the emergence of a novel influenza virus,[24] as occurred in the season 2003-04 in Spain (Fig. 2) and in Europe.[15,25] At that time, there was a predominant circulation of the A/Fujian/411/02 strain, which was antigenically different from the vaccine virus and children in particular had limited immunity.[25]

Secondly, the pandemic influenza A(H1N1)pdm09 virus displaced the previous circulating seasonal influenza virus, as occurred in most affected countries in Europe and in the rest of the world.[26,27] This behavior contrasts with the pattern of a mixed circulation of influenza viruses usually observed in the inter-pandemic influenza seasons[15] (Fig. 3). In Spain, the influenza activity was associated during the 2009 pandemic with an almost exclusive circulation of the influenza A(H1N1)pdm09 virus (Fig. 3). From week 20/2009 until week 20/2010, 11,249 respiratory samples were submitted by the sentinel GPs/PDs, of which 4,685 tested positive for the influenza virus (42%), 98% of which were influenza type A and more than 95% of the identified viruses were A(H1N1)pdm09.[14] This influenza detection rate was in the range of the percentage of positive samples for influenza in the previous inter-pandemic influenza seasons,[12] which is another argument supporting the mild nature of the 2009 pandemic in Spain.

Severity of the 2009 pandemic

A national strategy for the surveillance of severe hospitalized cases of laboratory-confirmed influenza was approved in Spain by the Public Health Commission of the Spanish Ministry of Health on June 2009. A total of 4,307 influenza severe cases from all Spanish regions were reported to the Coordinating Centre for Health Alerts and Emergencies, including 341 deaths.[13] The evolution of the pandemic and severe hospitalized cases and deaths followed the progress of the influenza A(H1N1)pdm09 pandemic wave in Spain.[12,13] Among the most frequently reported underlying risk conditions, respiratory disease was identified, followed by morbid obesity, which was significantly associated with death in adults.[13]

The total number of pandemic-confirmed deaths by age group, as well as the estimated number of influenza A(H1N1)pdm09-confirmed

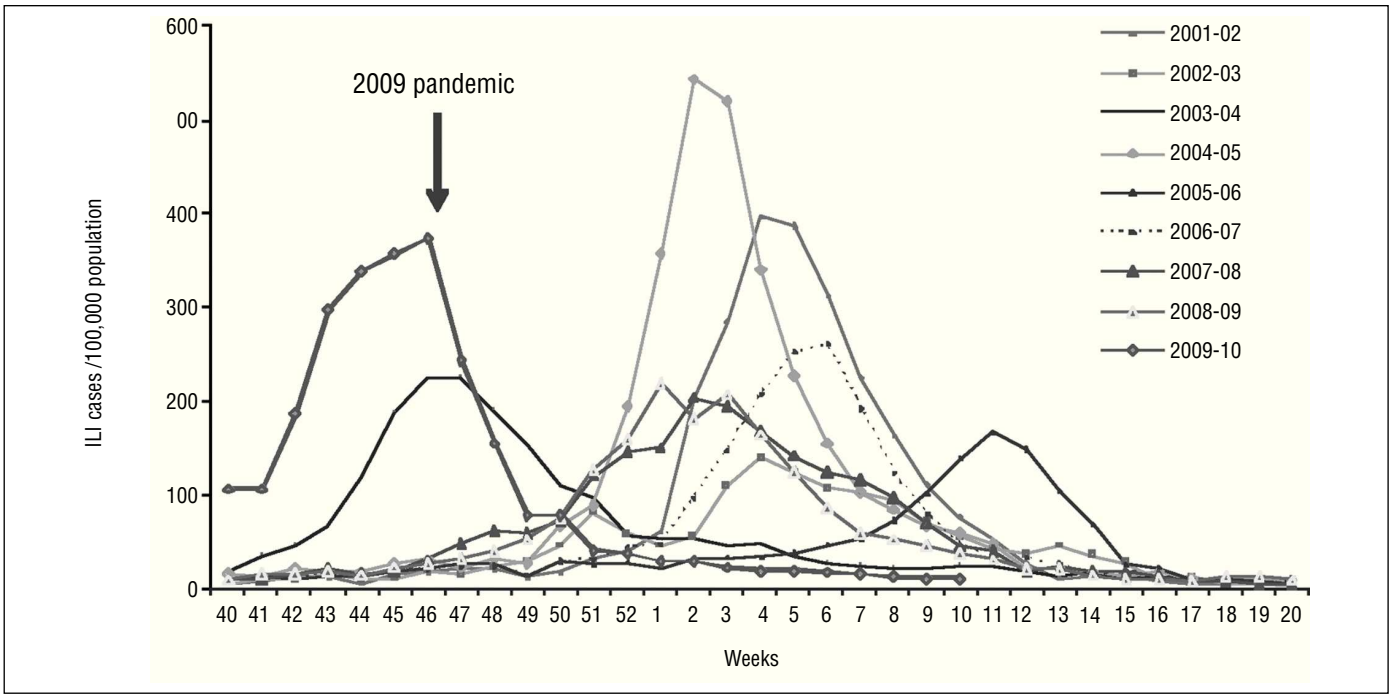

Figure 2. Time presentation of the 2009 pandemic and the eight previous influenza seasons. Spain. Spanish Influenza Surveillance System.

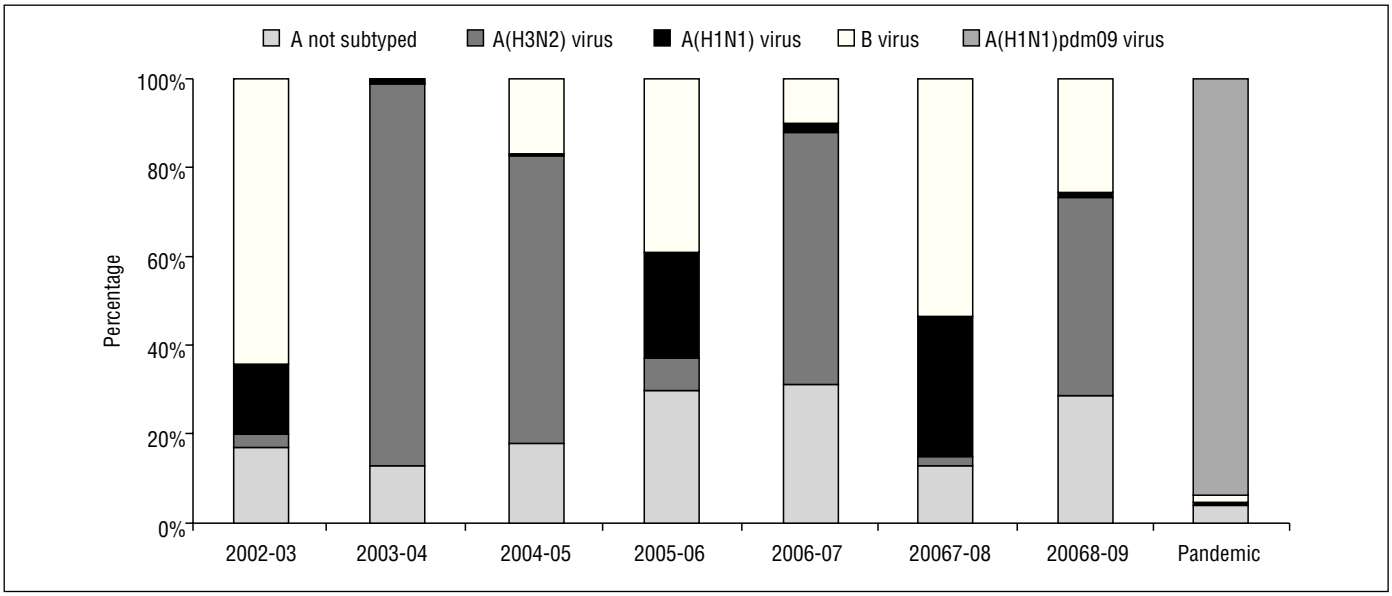

Figure 3. Percentage of influenza circulating viruses by type/subtype. Seasons 2002-2003 to 2009-2010. Spain.

ILI cases in the community are shown in Table 3. We present here updated data of the former estimates[12,16] obtained before the final validation of several surveillance pandemic databases. During the pandemic period, 341 pandemic confirmed deaths were reported, resulting in a CFR estimate of 0.58 deaths/1,000 confirmed ILI cases (95%CI, 0.52-0.64). The highest CFR was estimated in the older than 64 years age group with 11.60 deaths/1,000 confirmed ILI cases (95%CI, 9.07-14.61), while the lowest CFR was obtained in the 5-14 age group (0.06 deaths/1,000 confirmed ILI cases (95%CI, 0.03-0.10). Therefore, as we mentioned before, there may be a substantial proportion of older adults immune to the pandemic virus, as a consequence of prior exposure to an antigenically similar influenza virus. However, once these persons were infected by the influenza A(H1N1)pdm09 virus, they experienced the most severe illness and the highest CFR.

The severity of the 2009 pandemic was considered mild worldwide,[23,28] with a similar pattern of CFR by age group as in the two previous pandemics of 1957 and 1968, but with lower figures.[28,29] Our data concurred with the previously reported CFR for the 2009 pandemic.[23,28]

Mortality rates by age group are also presented in Table 3. The total mortality rate was estimated at 7.56 pandemic deaths/1,000,000 population (95%CI, 6.78-8.41), in the same range as those reported in other countries[18,30] with the lowest mortality rates in the 5-14 age group (3.23 pandemic deaths/1,000,000 population; 95%CI, 1.77-5.42) (Table 3).

To characterize the severity of the 2009 pandemic in Spain, and due to the lack of National mortality data with causes for the pandemic period, we compared the pandemic confirmed deaths with mortality data from the previous influenza seasons (with

Table 3
Influenza case fatality rates and population mortality rates by age group. April 2009-April 2010. Spain

Age group (years)	Estimated number of pandemic confirmed cases*	Number of pandemic confirmed deaths	Influenza case fatality rate (deaths/1,000 pandemic confirmed cases) (95%CI)	Population mortality rate (deaths/1,000,000 population) (95%CI)
0-4	48,996	16	0.33 (0.19-0.53)	6.75 (3.86-11.00)
05-14	224,411	14	0.06 (0.03-0.10)	3.23 (1.77-5.42)
15-64	312,556	239	0.76 (0.67-0.87)	7.79 (6.83-8.84)
>64	6,206	72	11.60 (9.07-14.61)	9.33 (7.30-11.70)
Total	592,169	341	0.58 (0.52-0.64)	7.56 (6.78-8.41)

95%CI: 95% confidence interval.
*Source: Spanish Influenza Surveillance System. Estimates obtained from weekly influenza-like illness incidence corrected by weekly influenza A(H1N1)pdm09 detection rate.

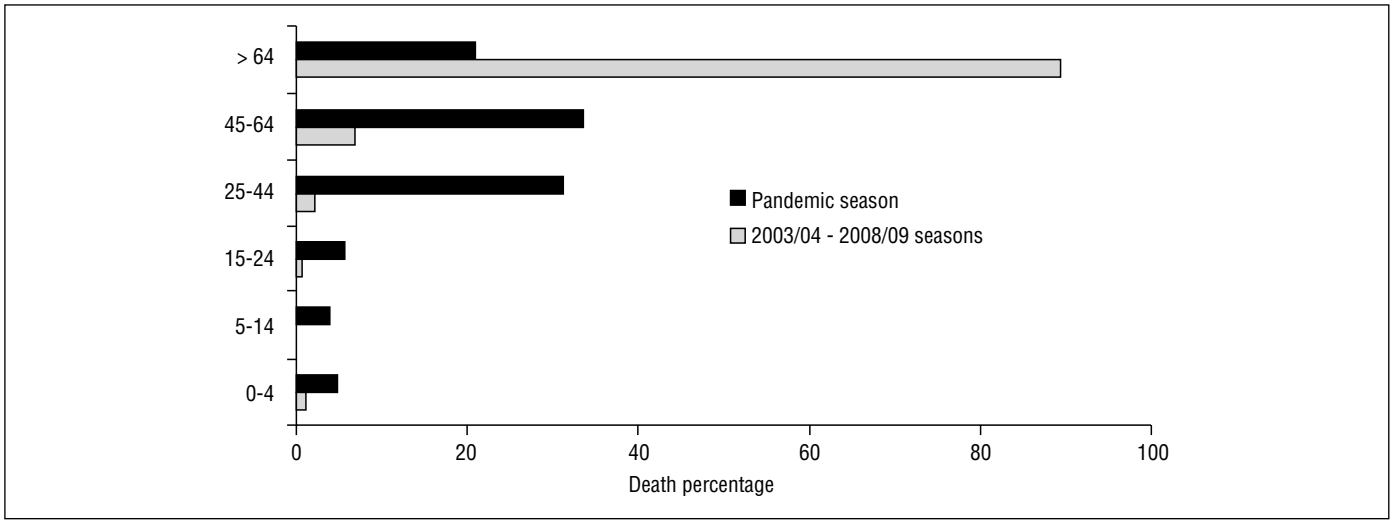

Figure 4. Age distribution of deaths related to influenza. Comparison of the 2009 pandemic and five previous influenza seasons (2003-2004 to 2007-2008), Spain.
Source: seasonal influenza cause of death were obtained from the National mortality data for the period 2003 to 2008, provided by the National Statistics Institute (ICD-10: J09-J11). Confirmed pandemic deaths were obtained from the Register of severe pandemic influenza cases and deaths of the Spanish Ministry of Health and Social Policy (April 2009-April 2010).

influenza as the main cause of death). The age distribution of pandemic confirmed deaths offered a considerably different pattern than in the preceding influenza seasons. While in previous inter-pandemic seasons, 90% of influenza-related deaths occurred in persons aged 65 years and older,[31] during the 2009 pandemic nearly 65% of pandemic confirmed deaths were concentrated in young adults who were 25-64 years old and only 28% of confirmed deaths were registered in older than 64 years of age (Fig. 4).

However, we must be cautious when interpreting this comparison, since the influenza burden mortality estimated in the elderly during the inter-pandemic seasons are not directly comparable with laboratory-confirmed deaths estimates during the 2009 pandemic. In both cases, the current burden of influenza may be underestimated. On the one hand, many influenza-related deaths occurred in patients with underlying conditions in which signs of influenza infection were already difficult to detect. On the other hand, it is likely that the number of pandemic-confirmed deaths reported in Spain underestimated the true burden of pandemic mortality.[13] With these limitations, we observed a shift in the pattern by age of the pandemic-confirmed deaths towards young adults. Moreover, children and young adults, as well as persons aged 65 years and older, showed the maximum mortality rates, reflecting the aspect of premature mortality that several authors previously reported.[16,32]

Conclusions

After an initial summer 2009 transmission of the the influenza A(H1N1)pmd09 virus, the pandemic wave started early in Spain, in the autumn showing a comparable transmissibility as that of the preceding previous pandemics. A mild character of the 2009 pandemic in Spain was suggested by the duration of the pandemic period and the percentage of samples that tested positive for influenza, both of which were comparable to those observed in the previous inter-pandemic influenza seasons. However, compared with previous historical seasons, in the 2009 pandemic individuals younger than 15 years old experienced higher influenza rates, while the transmission was lower in people older than 64 years. The influenza A(H1N1)pdm09 virus displaced the previous seasonal influenza virus and once the pandemic wave subsided, only a sporadic circulation of influenza virus type B was observed.

The 2009 pandemic was also characterized in Spain by mild severity in terms of the case-fatality ratio, with a higher proportion of pandemic confirmed deaths in the younger ages. However, although older people appeared to be protected following prior exposure to similar influenza virus, those that became infected experienced the highest case fatality rate of any age group.

The SISS was able to rapidly adapt to the national and international surveillance requirements and play a decisive role in the surveillance of the 2009 pandemic in Spain. Improvements implemented during the pandemic season in the SISS will be useful to future surveillance of seasonal or pandemic influenza waves.

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Conflicts of interest

All authors declare that they have no conflicts of interest in this article.

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Annex

Members of the Spanish Influenza Surveillance System (SISS)

– General practitioners and pediatricians of the SISS belonging to the Spanish sentinel influenza networks of: Andalucía, Aragón, Principado de Asturias, Islas Baleares, Canarias, Cantabria, Castilla-La Mancha, Castilla y León, Cataluña, Comunidad Valenciana, Extremadura, Comunidad de Madrid, Comunidad Foral de Navarra, País Vasco, La Rioja, Ceuta y Melilla.
– Epidemiologist members of the SISS belonging to: Servicio de Epidemiología, Consejería de Salud de la Junta de Andalucía; Servicio de Vigilancia en Salud Pública, Dirección General de Salud Pública, Aragón; Dirección General de Salud Pública y Planificación, Consejería de Salud y Servicios Sanitarios, Principado de Asturias; Servicio de Epidemiología, Dirección General de Salud Pública, Islas Baleares; Sección de Epidemiologia, Consejería de Sanidad, Trabajo y Servicios Sociales de Canarias; Sección de Epidemiología, Consejería de Sanidad, Trabajo y Servicios Sociales de Cantabria; Servicio de Epidemiología, Consejería de Sanidad de Castilla-La Mancha; Dirección General de Salud Pública e Investigación, Desarrollo e Innovación, Consejería de Sanidad de Castilla y León; Servicio de Vigilancia Epidemiológica, DGSP, Departament de Salut, Generalitat de Catalunya; Àrea d'Epidemiologia, Conselleria de Sanitat, Comunidad Valenciana; Servicio de Epidemiología, Dirección de Salud Pública, Servicio Extremeño de Salud; Direccion Xeral de Innovación e Xestión da Saúde Publica de Galicia; Dirección General de Atención Primaria de la Comunidad de Madrid; Servicio de Epidemiología, Consejería de Sanidad de la Región de Murcia; Sección de Vigilancia de Enfermedades Transmisibles, Instituto de Salud Pública de Navarra; Servicio de Vigilancia Epidemiológica, Consejería de Sanidad del País Vasco; Servicio de Epidemiología y Prevención Sanitaria, Dirección General de Salud Pública y Consumo del gobierno de La Rioja; Sección de Vigilancia Epidemiológica,

Consejería de Sanidad y Bienestar Social de Ceuta; Servicio de Epidemiología, Consejería de Bienestar Social y Sanidad de Melilla; Centro Nacional de Epidemiología.

– Virologists members of the SISS belonging to: Centro de Gripe de la OMS del Centro Nacional de Microbiología del Instituto de Salud Carlos III (CNM, Majadahonda, Madrid); Centro de Gripe de la OMS del Hospital Clínico Universitario de Valladolid, Castilla y León; Centro de Gripe de la OMS del Hospital Clínico de Barcelona, Cataluña; Laboratorio del Hospital Virgen de las Nieves de Granada, Andalucía; Laboratorio del Hospital Miguel Servet de Zaragoza, Aragón; Laboratorio del Hospital Universitario Central de Asturias de Oviedo; Laboratorio del Hospital Son Espases de Palma de Mallorca, Islas Baleares; Laboratorio del Hospital Dr. Negrín de Las Palmas, Canarias; Laboratorio del Hospital Universitario Marqués de Valdecilla de Santander, Cantabria; Instituto Valenciano de Microbiología, Comunidad Valenciana; Laboratorio del Hospital San Pedro de Alcántara de Cáceres, Extremadura; Servicio de Microbiología del Hospital Universitario Ramón y Cajal, Madrid, Comunidad de Madrid; Laboratorios de Microbioloxía CH de Vigo y de Ourense, Galicia; Laboratorio del Hospital Virgen de la Arrixaca, Región de Murcia; Laboratorio de Microbiología de la Clínica Universitaria de Navarra y Laboratorio de Microbiología del Complejo Hospitalario de Navarra, Pamplona, Navarra; Laboratorio de Microbiología, Hospital Donostia, País Vasco; Laboratorio de Virología del Hospital San Pedro de Logroño, La Rioja; Laboratorio de Microbiología del Hospital de INGESA, Ceuta.