Influenza A(H1N1)pdm09 in England, 2009 to 2011: a greater burden of severe illness in the year after the pandemic than in the pandemic year

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Influenza pandemics are often perceived as single-year events, but the burden of previous influenza pandemics has in reality been spread over a number of years. The aim of this paper is to compare the burden of influenza in the pandemic year 2009/10 with that in the year immediately after (2010/11) in England. We compared four measures of disease. There was a greater burden of severe illness in 2010/11 compared with 2009/10: more deaths (474 vs 361), more critical care admissions (2,200 vs 1,700), and more hospital admissions (8,797 vs 7,879). In contrast, there were fewer general practice consultations in 2010/11 compared with 2009/10 (370,000 vs 580,000). There was also much less public interest in influenza, as assessed by number of Google searches. This is a worrying finding, as by the time of the second influenza season, much had been learnt about the potential impact of the influenza A(H1N1)pdm09 virus and an effective vaccine developed. We suggest that a widespread assumption of 'mildness' led to insufficient ongoing action to prevent influenza and hence to avoidable influenza-related deaths. This offers a lesson to all countries, both for future influenza seasons and for pandemic preparedness planning.

Introduction

The public perception of influenza pandemics tends to be as single-year events. Contingency plans also assume that a new virus emerges and sweeps through the population, causing infection and death over a single year [1-4]. History, however, tells a different story. Previous pandemics have involved waves over multiple years, each causing pronounced mortality [1]. The 1968/69 pandemic was described as the 'smouldering pandemic'. In England and other European countries, its burden was greater in the 1969/70 influenza season than in the 1968/69 season [5].

When illness associated with the influenza A(H1N1)pdm09 virus (initially dubbed 'swine flu') was detected in April 2009, the public health response in England was intensive. In an initial containment phase, all contacts of cases were identified and treated with antiviral medication, to minimise spread of the virus. Schools were closed or partially closed. When increasing levels of influenza put serious pressure on the capacity of general practices to cope, a novel telephone and Internet-based system was introduced to mitigate this. This system, the National Pandemic Flu Service, ensured the public had ready access to antivirals. A widespread social marketing campaign, 'Catch it. Bin it. Kill it', emphasised the importance of hygiene measures (cough etiquette, hand washing) [6]. The pandemic also received extensive media coverage.

Fortunately the virus, and the pandemic, was milder than many had initially feared. Some criticised the government measures in the United Kingdom as a costly overreaction [7,8], though a formal inquiry into the management of the pandemic called the overall response 'highly satisfactory' [9].

In contrast, in the year after the pandemic, early comments from both from the Health Protection Agency and Department of Health were generally reassuring about the likely impact of influenza in the coming weeks [10,11]. The usual national advertising campaign to promote the seasonal influenza vaccine was not run [12]. When the number of severe cases rose and there were influenza-related deaths, the government was consequently criticised for complacency [13].

This study uses a number of objective measures to assess how the burden of influenza A(H1N1)pdm09 in the year after the pandemic compared with that in the pandemic year itself.

Methods

Using published sources, we compared the burden of influenza in the pandemic year (2009/10) with that in the following year (2010/11) using four measures that were replicable across the two years. We also assessed public interest in influenza and antiviral usage over the same time period.

General practice consultations

The Royal College of General Practitioners (RCGP) has undertaken surveillance of influenza-like illness (ILI) (clinically defined) in general practice for over 40 years. The system uses around 100 sentinel general practices across England, covering a population of approximately 800,000. The system extracts summary information (based on read codes [14]) from general practice electronic records. This is used to estimate the rate of ILI consultations in the population of England as a whole. These estimates, by age and week of consultation, were supplied by the RCGP Research & Surveillance Centre. We used these, together with mid-2009 population estimates from the Office for National Statistics [15], to estimate the total number of ILI consultations in England in each year.

Hospital admissions

Information on hospital admissions was extracted from Hospital Episode Statistics (HES) [16]. This database contains details of all admissions to National Health Service (NHS) hospitals in England. Admission details are coded locally and uploaded to a central database. Two particular codes are used for influenza-related admissions: International Classification of Diseases (ICD) codes J10: influenza due to other identified influenza virus or J11: influenza, virus not identified). Instances of these codes were extracted by age and by week of hospital admission.

Intensive care admissions

During the pandemic and the following year, all acute NHS hospitals reported both influenza-related critical care bed occupancy data (in 'bed-days') and the number of critical-care beds occupied at 8 a.m. on Wednesday mornings by age group to the Department of Health. These data recorded both suspected and confirmed cases of influenza. Suspected cases were those who were being treated for influenza on the basis of clinical suspicion but awaiting laboratory microbiological confirmation. Confirmed cases were those in whom the diagnosis had been confirmed by a specific microbiological test.

A national surveillance system in the pandemic year calculated the mean influenza-related length of stay in critical care as seven days [17]. We therefore estimated the number of admissions to critical care by dividing the total number of reported critical care bed days by seven. Critical care bed occupancy data were only recorded from 12 July 2009 to 21 February 2010 and from 20 December 2010 to 20 January 2011.

Deaths

During the pandemic year, a special reporting system provided details of influenza-related deaths to England's Chief Medical Officer [18-20]. Deaths were considered influenza-related if the virus had been laboratory-confirmed, if influenza was recorded on the death certificate, or both. During the following year, the Health Protection Agency ran a similar system. Its definition of an influenza-related death was slightly narrower, requiring both laboratory confirmation and the recording of influenza on the death certificate [21].

Public interest in influenza

A proxy chosen for public awareness of – and interest in – influenza was Google data on the rate at which particular search terms were used in its Internet search engine. We downloaded data describing the volume of searches for the term 'flu' by week in the United Kingdom. The absolute number of searches was not made available, thus the data describe the relative volume between weeks.

Defining the influenza season

In England, the influenza season runs from the start of October to the start of April, with peak activity typically in December and January [22]. As the pandemic virus circulated outside the usual influenza season, however, we defined the pandemic year as starting when general practice consultations due to ILI first rose above 30 per 100,000 people per week, the threshold for normal seasonal influenza activity. In the year following the pandemic, we defined the start as being the usual start of an influenza season, i.e. the start of October. For both years, we defined the season end as the end of February. Thus the two seasons analysed were 29 June 2009 to 28 February 2010 (pandemic year) and 4 October 2010 to 27 February 2011 (second year).

Antiviral prescribing data

Data describing the number of antiviral medication (oseltamivir and zanamivir) courses dispensed by pharmacists in the community in England were provided by the NHS Business Services Authority. Equivalent data were published by the National Pandemic Flu Service, describing the number of courses dispensed through this service, which was established specifically for the pandemic. Data on the number of courses of antiviral medication (oseltamivir or zanamivir) dispensed were published by the National Pandemic Flu Service.

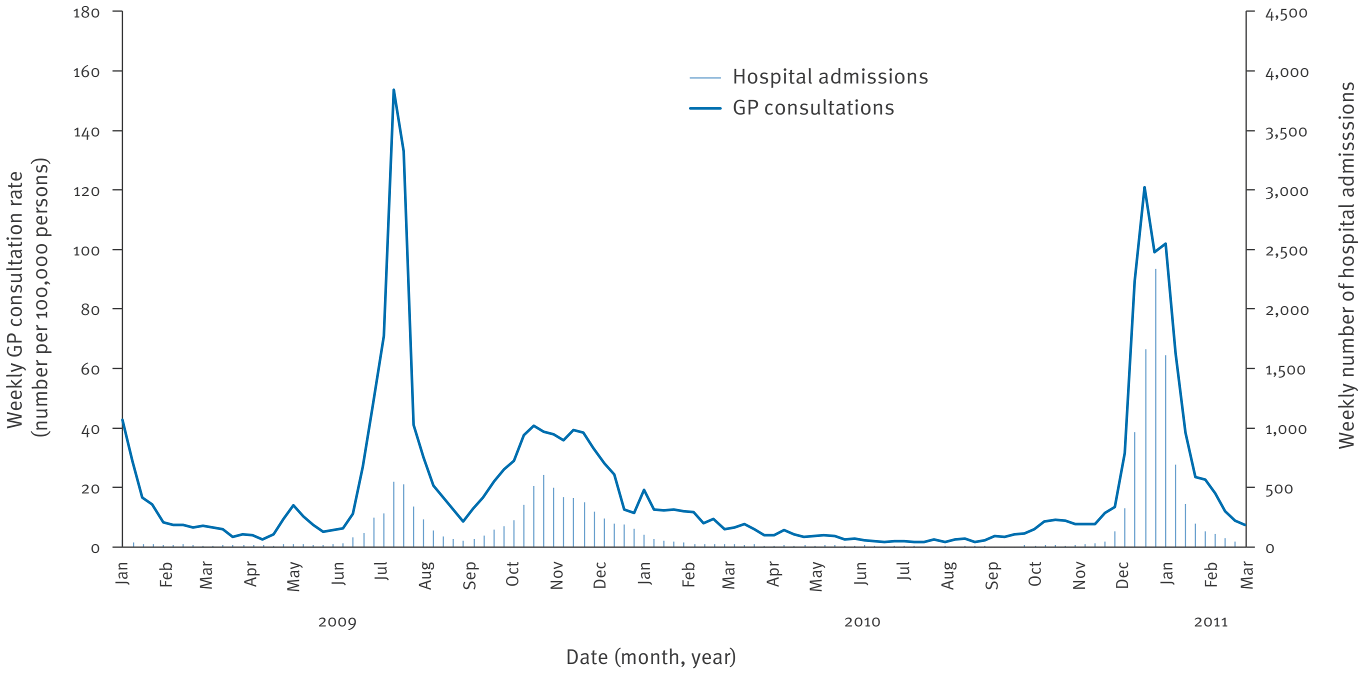
Oseltamivir and zanamivir are prescription-only medications. An electronic record of all prescriptions processed by community pharmacists is sent to the central NHS Prescription Services, in order for the pharmacist to receive reimbursement. These data are pooled to produce the total number of prescriptions of each discrete pharmaceutical item listed in the British National Formulary [23]. Although the data do not include private prescriptions, by including all prescriptions issued by the NHS, they will include the vast majority of prescriptions issued in the community in England.

Results

Three distinct waves of influenza activity occurred during the two-year period (Figures 1 and 2): two during the pandemic year (2009/10) and a single wave in the second year (2010/11).

Figure 1

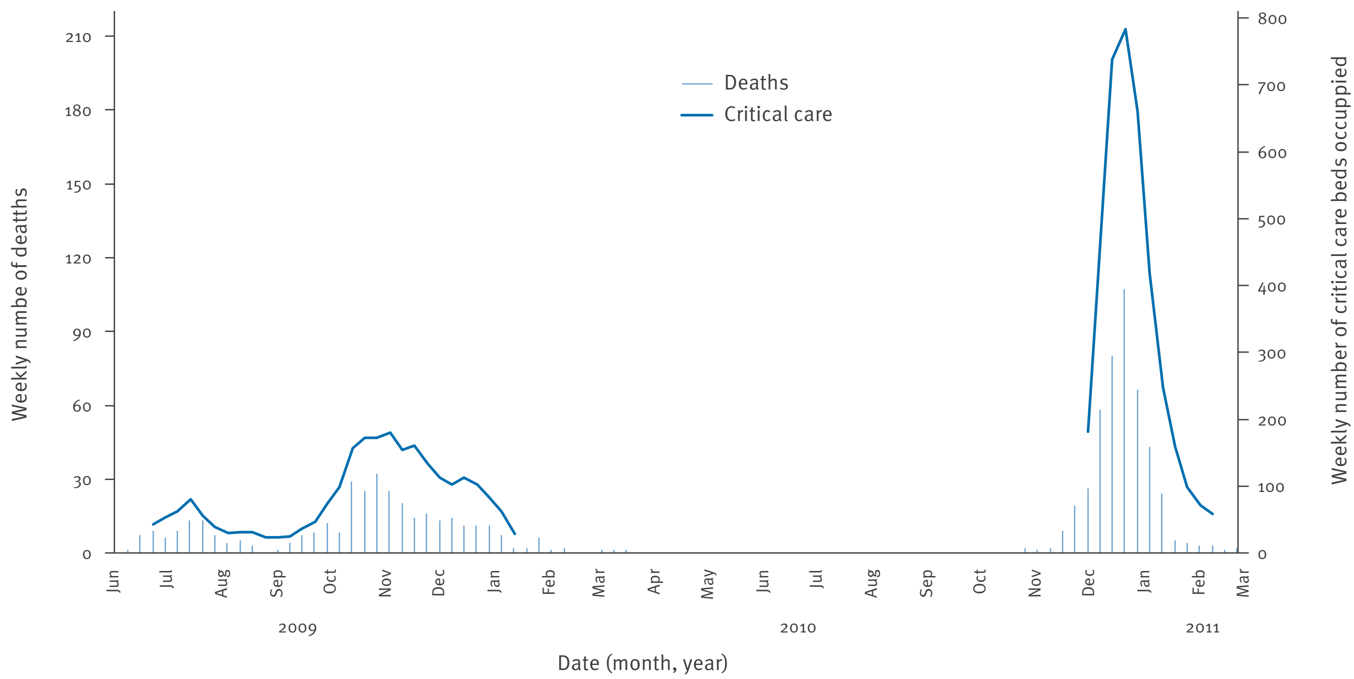
Influenza-related general practice consultations and hospital admissions, England, 5 January 2009–13 March 2011



GP: general practice.

Figure 2

Influenza-related critical care admissions and deaths, England, 15 June 2009–13 March 2011



The first wave occurred in July and August 2009, peaking 12 weeks after the first case of influenza A(H1N1) pdm09 was reported in England. This wave was characterised by a short sharp rise and fall in influenza activity, as assessed both by general practice consultations and hospital admissions.

The second wave occurred in autumn 2009. There was a gradual and prolonged rise in influenza activity that lasted for several weeks. Assessed by general practice consultations, the incidence of influenza in the community was lower than in the first wave. However, rates of influenza activity in hospital were much greater than those in the first wave.

Table 1

Influenza-related general practice consultations, hospital admissions, critical care admissions and deaths, England, pandemic year 2009/10 and second year 2010/11[a]

Type of influenza-related event	Number of events	
	Pandemic year 2009/10[a]	Second year 2010/11[a]
Number of general practice consultations	580,000	370,000
Number of hospital admissions	7,879	8,797
Number of critical care admissions	1,700	2,200
Number of deaths	361	474[b] (436)

[a] Pandemic year: 29 June 2009 to 28 February 2010. Second year: 4 October 2010 to 27 February 2011.

[b] Deaths reported by the Health Protection Agency from 4 October 2010 to 4 May 2011. The number in parentheses is the estimated number of deaths due to influenza A(H1N1), based on 91.9% of all influenza-related deaths in the United Kingdom being attributable to influenza A(H1N1) [21].

The third wave occurred in December 2010 and January 2011 and was characterised by a short sharp rise and fall in influenza activity. This wave was associated with greater peaks in hospital and critical care admissions than either of the previous two waves.

Overall, the burden of severe illness caused by influenza (deaths, critical care and hospital admissions) was greater in the second year than the pandemic year (Table 1). There were approximately 10% more hospital admissions, 30% more deaths and 30% more critical care admissions in the second year than in both waves of the pandemic year combined. The reverse was true for general practice consultations: there were approximately 35% fewer of these in the second year than in the pandemic year.

Influenza activity in the second year was concentrated far more intensively than in the pandemic year. Most of the activity was concentrated in an eight-week period. The busiest four weeks in the second year involved three times as many hospital admissions as the busiest four weeks in the pandemic year (20 December 2010 to 16 January 2011: 1,643 admissions per week; 2 November 2009 to 30 November 2009: 510 admissions per week). Similarly, there were over three times as many critical care admissions per week over the same periods (mean critical care bed occupancy: 661 vs 170). The peak weekly hospital admission rate in the second year was more than three times that of the pandemic year (week ending 2 January 2011: 2,334 admissions; week ending 3 October 2009: 604 admissions). The peak critical care bed occupancy in the second year was four times that of the pandemic year (851 beds on 4 January 2011, compared with a peak of 196 in November 2009).

Table 2

The age distribution of influenza-related general practice consultations, hospital admissions, critical care admissions and deaths, England, pandemic 2009/10 and second year 2010/11[a]

Type of influenza-related event	Number of events (%) by age group				Chi-square test p value
	0–4 years	5–14 years	15–64 years	≥65 years	
Number of general practice consultations					
Pandemic year[a]	61,000 (11)	94,000 (16)	390,000 (67)	34,000 (6)	<0.001
Second year[a]	25,000 (7)	42,000 (11)	280,000 (74)	27,000 (7)	
Number of hospital admissions					
Pandemic year	1,790 (27)	1,182 (15)	4,429 (56)	478 (6)	<0.001
Second year	1,551 (18)	461 (5)	5,797 (66)	988 (11)	
Mean number of critical care beds occupied[b]					
Pandemic year	7.8 (10)	4.9 (5)	59 (73)	8.7 (11)	0.067
Second year	15.8 (4)	7.9 (2)	280 (80)	47 (13)	
Number of deaths					
Pandemic year (England only)	22 (6)	35 (10)	240 (66)	64 (18)	0.004
Second year (United Kingdom)[c]	25 (4)	25 (4)	415 (71)	122 (21)	
Population in England (millions)	3.2 (6)	5.9 (11)	34.3 (66)	8.4 (16)	

[a] Pandemic year: 29 June 2009 to 28 February 2010. Second year: 4 October 2010 to 27 February 2011.

[b] Counted at 8 a.m. on Wednesdays.

[c] Only includes those for whom age at death was known.

For every 10,000 general practice consultations in 2009/10 there were 136 hospital admissions, 29 critical care admissions and six deaths. The respective numbers for 2010/11 were approximately twice as great, being 238 hospital admissions, 59 critical care admissions and 13 deaths. In contrast, measures of severe illness had similar ratios between the two seasons. For every 1,000 hospital admissions in 2009/10 there were 215 critical care admissions and 45 deaths. In 2010/11, the respective numbers were 250 critical care admissions and 53 deaths.

In the second year, the younger age groups (0–4 years, 5–15 years) were less prominently affected than in the pandemic year. The burden shifted towards working-age people (16–64 years) and the elderly (Table 2, chi-square $p<0.001$ for general practice consultations and hospital admissions). This shift was seen consistently across all measures of influenza activity.

Public interest in influenza, indicated by volume of Internet searches, showed four peaks of activity (Figure 3). The first occurred in April 2009, when the new strain of the virus was first widely publicised, leading to worldwide concern about an imminent pandemic. The second peak in interest occurred in July 2009, coinciding with the first wave of influenza activity in England. Two further, smaller peaks coincided with the second and third waves of influenza activity in England. Public interest relative to the burden of influenza (as measured by number of hospital admissions per week) was relatively high during the first wave of activity, lower during the second wave of activity and very low in the third wave. Public interest in influenza was four times as great in July 2009 as in January 2011, whereas the rate of hospital admission was four times as great in January 2011 as in July 2009.

During the pandemic year, the National Pandemic Flu Service operated from 23 July 2009 to 11 February 2010. It dispensed 1,161,157 courses of antiviral medication during this time. Community pharmacists dispensed fewer courses: 10,610 in the pandemic year (June to February) and 38,692 in the second year (October to February). Overall, 30 times more courses of antiviral medication were dispensed in the pandemic year than in the following year (1,171,767 vs 38,692 courses).

Discussion

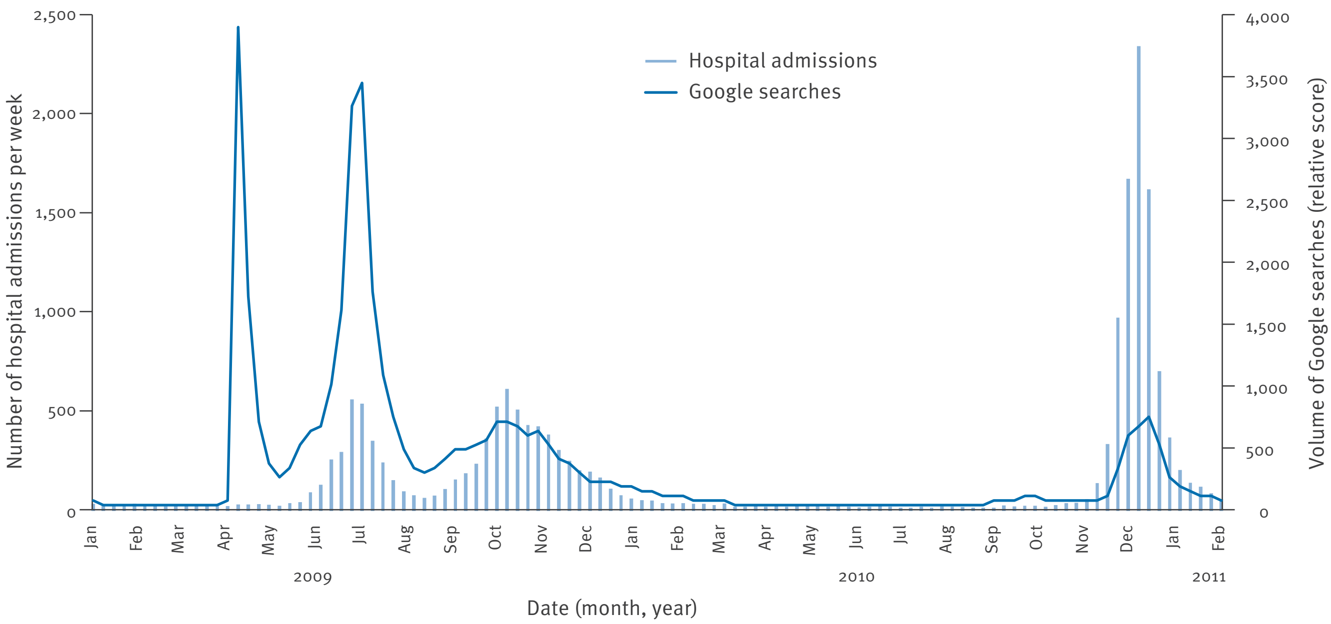
In England, influenza A(H1N1)pdm09 caused more hospital admissions, more critical care admissions and more deaths in its second year of circulation than in the pandemic year itself. There were fewer general practice consultations and there was less public interest in influenza in the second year than in the pandemic year. This is a worrying finding given that an effective vaccine was available for the duration of the influenza season following the pandemic year.

Ascertainment bias is unlikely

We looked at whether systematic differences in the methods of ascertainment or changes to the definitions of any of the measures analysed between the two years could explain this difference. The case definition of a death was actually narrower in the second year than in the pandemic year. For hospital and critical care admissions, the case definitions and ascertainment methods were the same in both years. However, the system for reporting critical care admissions in the second year was not established until mid-December,

Figure 3

Hospital admissions for influenza and Google searches for ‘flu’, England, 19 January 2009–27 February 2011



after many admissions are likely to have occurred. For all these reasons, both deaths and critical care admissions are likely to have been underestimated in the second year relative to the pandemic year. It therefore seems unlikely that systematic differences in ascertainment can explain the principal finding of our study.

Could ascertainment of deaths, critical care and hospital admissions have been increased by enhanced clinical awareness of influenza, leading to greater testing for, and diagnosis of, the disease? This seems highly implausible. Public awareness and clinical awareness of influenza was markedly lower in the second year. Why would England be alone among western countries in experiencing a phenomenon of increased clinical diagnosis and reporting of influenza in the second year relative to the pandemic year? No such effect was found in the United States, Canada, Australia or New Zealand. If anything, clinical ascertainment of cases in England is likely to have been greater in the pandemic year, when there was huge media interest in this novel event and clinicians' awareness of the circulation of the virus was high. Moreover, there was a great deal of communication between the government and front-line clinicians. This would all suggest that the true difference between the two years was in fact greater than that reported here.

The methods of influenza surveillance in general practice in England are long established and unchanged in recent years. The existence of the National Pandemic Flu Service from July 2009 until February 2010 was intended to reduce the burden on general practice. No equivalent system existed in the second year. General practice consultation rates are therefore likely to be relatively suppressed in the pandemic year compared with the second. Again, this suggests that the difference between the two years reported here is a highly conservative estimate.

Finally, all three measures of severe illness showed similar changes. We have also heard anecdotal accounts from intensive care physicians that the 2010/11 influenza season brought with it serious cases of influenza in previously healthy young individuals on a scale that appeared worse than in the pandemic itself. Taken together, this leaves little room for doubt that there was a genuine increase in hospital and critical care admissions and in deaths between the two years.

Most countries did not suffer a worse second year

International comparisons are somewhat difficult because of uncertainty about the quality of surveillance across the two years. Those comparisons that can be made suggest that England's experience is unusual. In the second year, the United States experienced lower peak ILI consultations (4.6% vs 7.7% of weekly outpatient visits), fewer paediatric deaths (105 vs 282) and a lower hospitalisation rate (19.1 per 100,000 population vs 29.0 per 100,000 population) than in the pandemic year [24]. New Zealand reported a lower peak ILI rate (150 per 100,000 in 2010 vs 275 per 100,000 in 2009), fewer hospital admissions (998 vs 1,517) and fewer deaths (16 vs 35) [25]. Similar patterns were seen in Canada and Australia [26-28].

The European picture is less clear [29], but many European countries have reported fewer cases of severe illness and fewer deaths in the second year [30,31]. Only the experience of Ireland, Greece and the other UK nations looks similar to that of England. Ireland had small increases in the numbers hospitalised, treated in critical care and dying [32,33]. Greece experienced more intensive care admissions and fatal cases in the post-pandemic season than in the pandemic season (368 vs 294 and 180 vs 149 respectively), although the magnitude was not on the same scale as in England [34]. Broadly, the English pattern was replicated in the other UK nations, with higher peak levels of influenza activity in 2010/11 and similar or slightly more deaths (69 deaths in Scotland in 2009/10 vs 63 in 2010/11, Wales 28 vs 34, Northern Ireland 18 vs 31) [9,21].

Government response was the major difference between the two years

What could explain the greater burden of severe illness in the second year? The virus has been closely observed. Its genetic composition had not changed [21]. Influenza B virus was more evident in the second year than in the pandemic year. It was the causative agent detected in 24.1% of positive influenza specimens (compared with just 0.3% in the pandemic year) but accounted for just 6.6% of deaths [21]. There were anecdotal reports of serious illness caused by coinfection in the second year, but the total number of these reports is not great [2,35,36]. While the small shift in age distribution towards older age groups, who are more prone to the severe effects of influenza, will have contributed to the greater burden of severe illness [34], similar shifts have been seen elsewhere but not resulted in a greater burden of severe illness [28]. Peak transmission in the second year occurred later in the year, when the weather in England was colder and drier. This may have had a role in facilitating greater transmission of the virus in the second year [37-39].

However, the most notable difference between the two years was the government response. The public health response in the pandemic year was highly assertive. Strong public awareness and education campaigns were run. Extensive and rolling media coverage throughout the duration of the emergency is likely to have enhanced public understanding. Antiviral drugs were widely used for symptomatic individuals and (in the early phase) their contacts. Schools were closed, with antiviral treatment of cases and contacts. Unlike previous influenza pandemics, a vaccine was made available and used before the end of the pandemic year.

In contrast, in the influenza season that followed the pandemic year, the approach was laissez-faire. The traditional influenza public awareness campaign was cancelled. There was no attempt to warn about the likelihood that the pandemic virus would be circulating (thus affecting younger age groups). There was no drive to vaccinate children, although it is unclear to what extent this was influenced by emerging concerns about pandemic vaccine safety in children and adolescents [40,41]. The National Pandemic Flu Service was not activated and antivirals were not used extensively.

The 30-fold difference in antiviral usage between the two years is profound. The widespread use of antiviral medication in the community combined with public awareness during the pandemic year is likely to have led to early treatment. This is likely to be important in preventing adverse outcomes, such as hospitalisation, critical care admission and death [42,43]. A reduction in virus transmission, particularly among children [43-45], from widespread antiviral use may also have contributed to the reduced burden of severe illness in the pandemic year. Other public health measures may also have had an important impact on the emerging disease [46,47].

Some countries took a very proactive approach to immunisation in the second year. New Zealand achieved record levels of immunisation [25]. In the United States, the Centers for Disease Control and Prevention emphasised the special importance of vaccination, extending its availability to all healthy adults [48].

In England, when the virus began to circulate in early December 2010, uptake of vaccine among the eligible groups aged six months to 65 years was only about 40% [49]. The final uptake figures, at around 50%, were comparable to the pandemic year [50]. Given that this group was at increased risk of severe complications in comparison with a typical influenza season, it is disappointing that higher levels of immunisation were not achieved, particularly as influenza causes more deaths among those aged under 65 years than any other vaccine-preventable disease [19,51,52].

Reduction in general practice consultation rates

What might account for the reduction in general practice consultation rates between the two years? These rates are driven by the incidence of influenza and by the proportion of those affected who seek care. Given the greater burden of severe illness in the second year without any change in the virus itself, it seems unlikely that the incidence of influenza was lower in the second year than in the pandemic year. Consistent with the demonstrated lower level of public interest, it seems likely that the public were less likely to consult when symptomatic in the second year.

A lower rate of general practice consultations might itself have contributed to higher rates of severe illness. It is likely to have contributed to delayed and lower use of antivirals. It is also possible that the detection of superimposed bacterial illness or other severe illness may have been delayed.

Predictable age distribution: younger than those with typical seasonal influenza

Both years saw a high ratio of young to elderly influenza deaths in comparison with that seen in a typical influenza season. The second year saw a small shift away from the younger age groups towards adults of working age. This is consistent with past influenza behaviour. Analysing historical influenza mortality data from the United States, Simonsen et al. have shown that a marked shift in mortality away from the elderly to the young has occurred in the first year of previous pandemics [53]. This shift persists, slowly drifting back towards the elderly over a period of 10 to 20 years. Influenza A(H1N1)pdm09 is so far behaving similarly. This shows the importance not only of remaining vigilant after the first passing of the pandemic wave, but also of maintaining heightened vigilance for several years after.

Conclusion

England experienced a greater burden of severe illness due to influenza A(H1N1)pdm09 in the second year of its circulation than in the pandemic year. The difference appears to be real rather than fallacious. By the time of the second influenza season, much had been learnt about the potential impact of the virus and an effective vaccine developed. Despite this, a large number of deaths, critical care and hospital admissions occurred, many of these in otherwise healthy people of working age. The differences in the government response over the two years were striking and likely to have contributed to the increased impact of the disease in the second year.

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