Available online at www.sciencedirect.com
ScienceDirect
Vaccine 25 (2007) 7363–7371
Vaccine
www.elsevier.com/locate/vaccine

Inequalities in uptake of influenza vaccine by deprivation and risk group: Time trends analysis

Carol Coupland [a,*], Sally Harcourt [b], Yana Vinogradova [a], Gillian Smith [b], Carol Joseph [c], Mike Pringle [a], Julia Hippisley-Cox [a]

[a] *Division of Primary Care, Tower Building, University of Nottingham, University Park, Nottingham NG7 2RD, United Kingdom*
[b] *Health Protection Agency, West Midlands, 9th Floor Ladywood House, 45 Stephenson Street, Birmingham B2 4DY, United Kingdom*
[c] *Respiratory Diseases Department, Health Protection Agency, Centre for Infections, 61 Colindale Avenue, London NW9 5EQ, United Kingdom*

Received 31 July 2006; received in revised form 18 July 2007; accepted 9 August 2007
Available online 5 September 2007

Abstract

The aim of this study was to investigate influenza immunisation rates in the United Kingdom over a 6-year period and examine trends in uptake by deprivation, ethnicity, rurality and risk group. Influenza immunisation rates were determined from 1999/2000 to 2004/2005 using a large general practice database (QRESEARCH). There was a relative increase of 59.5% in the overall influenza vaccination rate over the study period. In 2004/2005, 70.2% of all patients aged 65 and over were vaccinated, compared with 29.3% of patients in a clinical risk group aged less than 65. Males, patients from deprived areas and from areas with a higher proportion of non-White residents had slightly lower vaccination rates overall. This general practice based study suggests that substantial increases in influenza vaccination rates have occurred across all risk groups, but that increased focus should be given to immunising high-risk patients below the age of 65.
© 2007 Elsevier Ltd. All rights reserved.

Keywords: Influenza immunisation; Risk groups; Time trends; Deprivation

1. Introduction

Influenza and its related illnesses remain a major cause of preventable morbidity and mortality in the elderly worldwide [1]. Influenza can also be a serious health problem to people in high-risk groups who already suffer from chronic diseases such as diabetes mellitus, chronic heart disease, respiratory disease and renal disease.

Immunisation against influenza is an important means of reducing morbidity and mortality amongst patients at high risk including the elderly [2]. Since the late 1960s influenza vaccination has been recommended in the United Kingdom (UK) for patients of all ages from selected high-risk groups, including the elderly with underlying medical conditions as well as those living in long stay residential homes where the spread of influenza is likely to be rapid. In 1998 influenza vaccination was recommended for all persons aged 75 years and over regardless of predisposing risk conditions. In 2000 this policy was modified to include all persons aged 65 years and over. The risk group categories in people aged under 65 years have also been expanded over time in an attempt to reduce the morbidity from influenza in these groups. Improvement in the delivery of influenza vaccination is seen as an important aspect of preventive care for primary healthcare teams [3]. A target for uptake of the vaccine in older people was introduced by the Department of Health in 2000/2001. Initially this was set at 60%, rising to 65% the following year and 70% in 2002/2003 and subsequent years.

Studies have been conducted in the UK and Europe looking at the uptake of the influenza vaccine amongst the elderly and in the high-risk groups [4–7]. A rapid reporting scheme was introduced in England to ascertain uptake in people aged 65 and over in the winters of 2000/2001. Monthly data on vaccination uptake showed that Department of Health target rates were met but also showed that there was consider-

* Corresponding author. Tel.: +44 115 8466916; fax: +44 115 8466904.
E-mail address: Carol.Coupland@nottingham.ac.uk (C. Coupland).

0264-410X/$ – see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.vaccine.2007.08.032

able variation in uptake at local levels [2]. Local differences in vaccination uptake may be due to a number of factors including socio-economic deprivation, ethnicity and rurality, if that were the case local and national campaigns to increase uptake may need to take these factors into account. However there has been relatively little research into the effect of socio-economic status, rurality or ethnicity on the uptake of influenza immunisation [8]. A study looking at uptake rates in 73 British practices [4] between 1997 and 2000 found that influenza immunisation uptake was lower amongst women, people aged 85 years and over compared to people aged under 80, and those in most deprived areas compared to the least deprived. However this study was restricted to people aged 75 and over, and only covered a relatively short time period.

This research project used information from 413 practices contributing to the QRESEARCH database to investigate influenza immunisation rates in the UK in patients of all ages over a period of 6 years and examined trends in uptake by sex, deprivation, rurality, ethnicity of area of residence and risk group.

2. Materials and methods

We used the QRESEARCH primary care database to undertake this study. The full QRESEARCH database (http://www.qresearch.org/) currently contains the anonymised primary care clinical records of over 10 million people registered at any time in the last 16 years with 525 UK general practices. Consent to provide data for QRESEARCH was sought from all UK practices using the EMIS medical records system. The consenting practices form a representative sample of 6% of all of all UK general practices, and there are practices in every Strategic Health Authority and each Health Board in England, Wales and Scotland.

The information recorded on the QRESEARCH database includes patient demographic data (year of birth, sex, socio-economic data derived from the UK 2001 Census), characteristics (height, weight, smoking status), symptoms, clinical diagnoses, consultations, referrals, prescribed medications and results of investigations. Detailed analyses have compared QRESEARCH practices with all UK practices and found that practices contributing to QRESEARCH are somewhat larger than UK practices overall but are similar in other respects [9]. The database has been validated by comparing birth rates, death rates, consultation rates, prevalence and mortality rates with other data sources including the General Household Survey, the General Practice Research Database and prevalence data from the new GMS contract for General Practitioners. There was good correspondence for all of these measures, although the QRESEARCH population is slightly older. We used version 9 of the QRESEARCH database for this analysis.

Our study period consisted of the 6 years between 1 April 1999 and 1 April 2005. We included practices with complete data for the entire period from 1 April 1999 to 1 April 2005 in the analysis to ensure practices had complete data prior to the start of the study period. Our study population consisted of all patients registered on 1 April each year who had been registered for the whole of the previous 3 months. Temporary residents were excluded.

We identified patients in each of the risk group categories for influenza vaccination defined by the Department of Health. These patients were defined as those eligible for receiving an influenza vaccination and included all patients aged 65 and over. The clinical risk categories based on medical conditions were identified using the relevant Read codes (list available from the authors). Both practising GPs and health protection epidemiologists selected Read codes which conformed to the risk categories. Given the changes to the risk group categories over the study period of the project we used the risk group categories identified for the 2003/2004 vaccination season (Appendix A) and extended these back through the study period.

The QRESEARCH database contains Townsend scores as measures of deprivation. These have been derived for each patient using data from the 2001 Census based on their output area of residence derived from their postcode. Output areas consist of approximately 125 households and are nested within electoral wards. An ethnicity measure was also derived for each patient which was the percentage of White residents in their output area of residence using data from the 2001 Census. We derived a binary measure of rurality for each patient based on the Countryside Agency rurality index assigned at output area of residence.

Our study outcome was the proportion of patients who received an influenza vaccination during each vaccination interval between 1 September of each year in the study period and 31 March of the following year. We determined the crude vaccination rates for each patient group across each vaccination interval in the study period. We also determined the age–sex standardised vaccination rate for each patient group using the UK Census population in 5-year age–sex bands for 2001 as the reference population.

We undertook a modified Poisson regression analysis [10] to determine relative risks (with 95% confidence intervals) for uptake of influenza vaccination for different patient groups over the study period. We included the following variables in the multivariate analysis: year; sex; deprivation in fifths (with higher fifths representing more deprived areas); ethnicity of the patient's area of residence (four levels: <90%, 90–96.9%, 97–98.9%, 99–100% White); rurality of the patient's area of residence (two levels: urban/rural). We undertook separate analyses of patients in a risk group (including all patients aged 65 and over) and patients not in a risk group. We tested interactions between year and deprivation and ethnicity to determine whether there was any evidence of changing inequalities.

Table 1
Total populations and percentages vaccinated by risk groups for each vaccination period[a] from 1999/2000 to 2004/2005

	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005	Increase (%)[b]
Total population	2,808,428	2,832,151	2,862,243	2,888,881	2,906,852	2,926,217	
% vaccinated	10.8	14.4	14.8	14.9	16.2	17.2	59.5
Total population at risk (including aged >65)	795,492	812,820	829,443	846,342	857,627	863,213	
% vaccinated	32.3	43.7	44.7	44.9	48.7	52.1	61.3
Total population aged 65 and over	464,547	468,692	472,715	477,856	479,463	480,969	
% vaccinated	43.2	60.7	62.8	63.8	67.8	70.2	62.5
Total population at risk aged under 65	330,945	344,128	356,728	368,486	378,164	382,244	
% vaccinated	17.0	20.6	20.7	20.4	24.4	29.3	72.3
Total chronic heart disease patients	110,899	116,093	120,336	123,637	125,587	125,630	
% vaccinated	54.5	67.6	69.3	70.0	73.5	76.8	40.8
Total patients with diabetes	109,261	108,938	108,132	107,198	104,635	101,273	
% vaccinated	42.7	54.3	57.2	59.5	65.9	73.1	71.1
Total immunosuppressed patients	66,192	67,840	70,459	71,997	76,961	80,214	
% vaccinated	39.6	48.0	48.5	49.0	52.3	55.5	40.1
Total patients with renal disease	5281	5688	6188	6624	7264	7659	
% vaccinated	41.5	51.6	53.4	53.6	58.7	61.3	47.6
Total respiratory patients	302,968	320,379	336,909	352,529	365,701	373,568	
% vaccinated	23.6	28.4	28.6	28.2	31.6	36.1	53.3

[a] Vaccination period is from 1 September to 31 March.
[b] Relative percent increase from 1999/2000 to 2004/2005.

3. Results

3.1. Study population

There were 413 practices meeting our inclusion criteria with complete data between 1 April 1999 and 1 April 2005. There were 2.9 million registered patients in these practices on 1 April 2005 who had also been registered for the whole of the preceding 3 months. Of these, 504,362 patients (17.2%) had been vaccinated with influenza vaccine between 1 September 2004 and 31 March 2005 (Table 1). This represents a relative increase of 59.5% compared with the proportion of the total population vaccinated between 1 September 1999 and 31 March 2000 where 10.8% had been vaccinated.

3.2. Vaccination uptake in risk groups

Overall, just over half (52.1%) of all the patients in a risk group (including all those aged 65 and over) were vaccinated in 2004/2005, compared with 32.3% in 1999/2000 (Table 1) representing a relative increase of 61.3%. In 2004/2005, 70.2% of all patients aged 65 and over were vaccinated, and 29.3% of all patients aged less than 65 who were in a clinical risk group.

There has been a substantial rise in the percentage vaccinated in each individual risk group over the study period (Fig. 1). The lowest vaccination rates for the 2004/2005 season were for patients with respiratory disease (36.1%) and immunosuppressed patients (55.5%) and the highest rates were for patients with coronary heart disease (76.8%) and with diabetes (73.1%). The biggest rise over the 6-year period was observed for patients with diabetes where there has been a 71.1% relative increase in vaccination rates, and the smallest relative increase was for immunosuppressed patients where there was a 40.1% increase.

3.3. Vaccination uptake by sex

The crude vaccination rate was lower in males than in females across the study period (Fig. 2 and Table 2), for example, in 2004/2005 it was 17.5% lower than the female rate (15.6%/18.9%). This difference was largely accounted for by differences in age, and age-standardised rates were only 3.6% lower in males in 2004/2005 (Table 2).

In a multivariable analysis, after adjusting for year, deprivation, area level ethnicity, rurality, 10-year age band and risk group, males had a 9.6% (95% CI 9.4–9.7%) lower vaccination rate overall compared with females (Table 3).

3.4. Vaccination uptake by level of deprivation

The crude vaccination rate was lower in patients from deprived areas than in patients from affluent areas across the study period (9.0% lower in 1999/2000 and 25.9% lower in 2004/2005 relative to the rate in affluent areas). This difference was largely accounted for by differences in age and sex, as age–sex standardised rates were similar in patients from deprived and affluent areas (Table 2 and Fig. 3).

In a multivariable analysis, after adjusting for year, sex, area level ethnicity, rurality, risk group and ageband, patients from the most deprived areas had a 3.3% (95% CI 3.0–3.6%)

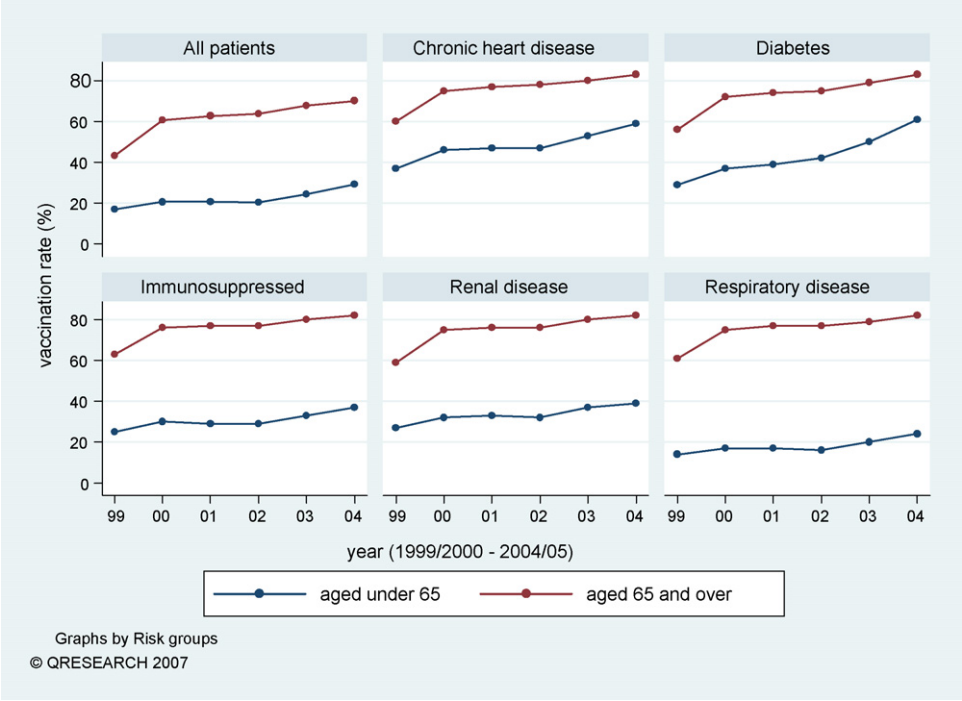

Fig. 1. Crude rates of influenza vaccination for patients aged under 65 and 65 and over by year and risk group.

lower vaccination rate overall compared with those from the most affluent areas (Table 3). There was some evidence of an interaction between deprivation and year with a slight widening over time from a 2.0% lower vaccination rate in patients from deprived areas in 1999/2000 to a 4.4% lower rate in 2004/2005 (data not shown).

3.5. Vaccination uptake by ethnicity of area of residence

Vaccination uptake in patients by ethnicity of their area of residence is shown in Table 2 and Fig. 3. Crude uptake rates for the total population were substantially higher in patients from areas where 99–100% of the population are

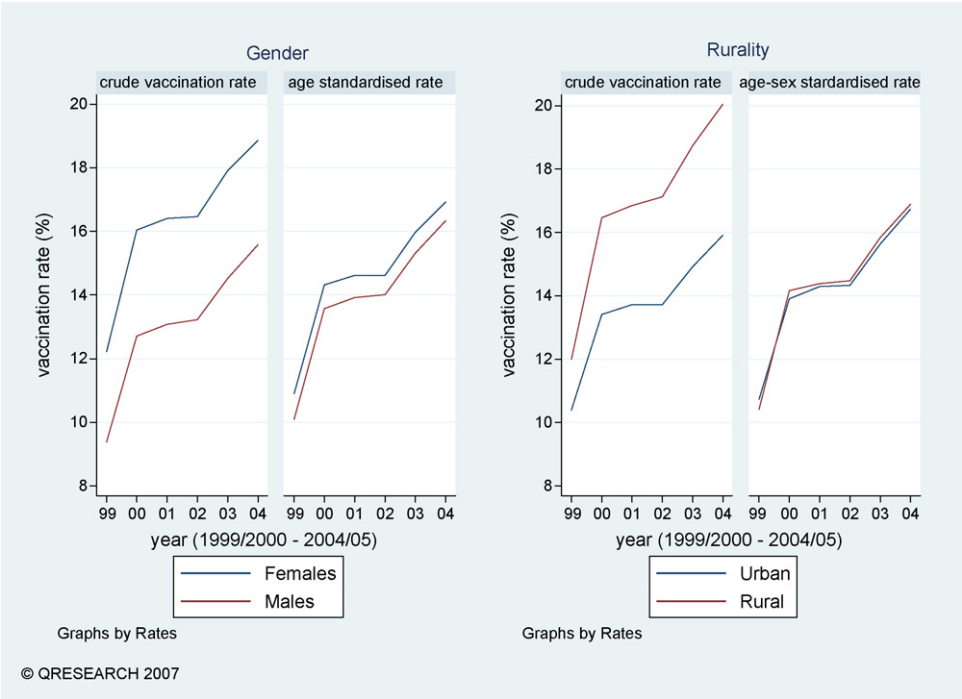

Fig. 2. Crude and age–sex standardised influenza vaccination rates by year and in males and females, and in urban and rural areas.

Table 2
Total populations and percentages vaccinated by patient characteristics for each vaccination period[a] from 1999/2000 to 2004/2005

	1999/2000	2000/2001	2001/2002	2002/2003	2003/2004	2004/2005	Increase (%)[b]
Total male patients	1,385,588	1,398,700	1,415,857	1,431,436	1,441,697	1,451,993	
% vaccinated	9.4	12.7	13.1	13.2	14.5	15.6	66.3
% vaccinated standardised[c]	10.1	13.6	13.9	14.0	15.3	16.3	62.0
Total female patients	1,422,840	1,433,451	1,446,386	1,457,445	1,465,155	1,474,224	
% vaccinated	12.2	16.0	16.4	16.5	17.9	18.9	54.5
% vaccinated standardised[c]	10.9	14.3	14.6	14.6	16.0	16.9	55.3
Total patients in affluent areas[d]	607,193	612,052	617,883	622,286	626,538	623,747	
% vaccinated	11.1	15.2	15.8	16.2	17.9	19.3	74.0
% vaccinated standardised[c]	10.3	13.9	14.2	14.3	15.6	16.6	61.0
Total patients in deprived areas[e]	511,136	519,200	528,769	535,998	542,488	552,691	
% vaccinated	10.1	12.8	12.9	12.7	13.6	14.3	41.9
% vaccinated standardised[c]	10.9	14.0	14.5	14.4	15.8	16.9	54.4
Total patients in White areas[f]	1,088,866	1,094,802	1,103,539	1,112,405	1,120,685	1,121,051	
% vaccinated	12.2	16.6	17.1	17.4	18.9	20.2	64.9
% vaccinated standardised[c]	10.5	14.1	14.4	14.5	15.8	16.8	60.1
Total patients in mixed areas[g]	504,316	513,972	523,280	534,832	539,138	553,701	
% vaccinated	8.4	10.6	10.7	10.5	11.4	12.2	45.2
% vaccinated standardised[c]	10.3	13.3	13.6	13.6	15.0	16.1	56.8
Total patients in urban areas	1,611,163	1,628,691	1,647,025	1,663,423	1,673,215	1,688,628	
% vaccinated	10.4	13.4	13.7	13.7	14.9	15.9	53.3
% vaccinated standardised[c]	10.7	13.9	14.3	14.3	15.6	16.7	56.1
Total patients in rural areas	974,024	981,056	992,808	1,003,784	1,014,081	1,012,897	
% vaccinated	12.0	16.5	16.9	17.1	18.8	20.1	67.3
% vaccinated standardised[c]	10.4	14.2	14.4	14.5	15.8	16.9	62.0

[a] Vaccination period is from 1 September to 31 March.
[b] Relative percent increase from 1999/2000 to 2004/2005.
[c] Age–sex standardised to UK population in 2001 (age standardised for males and females).
[d] Lowest fifth of Townsend deprivation scores.
[e] Highest fifth of Townsend deprivation scores.
[f] 99–100% White population in area of residence.
[g] <90% White population in area of residence.

White (overall uptake was 20.2% in 2004/2005) and were lowest in areas where <90% of the population are White (12.2% in 2004/2005), however the age–sex standardised rates were closer in magnitude (16.8% vs. 16.1% in 2004/2005).

In the multivariable analysis, after adjusting for year, sex, deprivation, rurality, 10-year age band and risk group, patients from areas where <90% of the population are White had a 4.1% (95% CI 3.7–4.4%) lower vaccination rate overall compared with those from areas where 99–100% of the population are White (Table 3).

3.6. Vaccination uptake in rural versus urban patients

In every year, the crude uptake rate of influenza vaccination was higher in patients from rural areas than urban areas (15.4% higher in 1999/2000 and 26.4% higher in 2004/2005). This difference was largely accounted for by differences in age and sex, as age–sex standardised rates were very similar (Table 2 and Fig. 2).

3.7. Comparisons of vaccination uptake between patients in a risk group and not in a risk group

Table 4 shows that the increase in vaccination rates over time occurred predominantly in patients in a risk group (including all those aged 65 and over) with a relative increase of 64.6% (95% CI 64.0–65.2%) between 1999/2000 and 2004/2005, compared with an increase of 7.6% (95% CI 6.3–8.9%) among patients not in a risk group.

In those not in a risk group males were 33.2% (95% CI 32.8–33.7%) less likely to be vaccinated than females, whereas among those in a risk group men were only 1.2% (95% CI 1.0–1.4%) less likely to be vaccinated. Among patients not in a risk group those in more deprived areas were 10.0% (95% CI 8.5–11.4%) more likely to be vaccinated than patients from affluent areas, but in patients in a risk group those from deprived areas were 2.1% (95% CI 1.8–2.5%) less likely to be vaccinated than patients from affluent areas. Among patients not in a risk group those from areas where <90% of the population are White were 10.7% (95% CI 9.3–12.1%) more likely to be vaccinated than patients from areas where 99–100% of the population are White, but among

Table 3
Unadjusted and adjusted relative risks for vaccination in all patients by year and patient characteristics

	Unadjusted relative risk[a]	95% confidence interval	Adjusted relative risk[b]	95% confidence interval
Year				
1999/2000	1		1	
2000/2001	1.324	1.318–1.330	1.311	1.306–1.316
2001/2002	1.356	1.350–1.362	1.332	1.327–1.337
2002/2003	1.365	1.359–1.371	1.330	1.325–1.335
2003/2004	1.489	1.482–1.495	1.443	1.438–1.449
2004/2005	1.590	1.583–1.597	1.539	1.534–1.545
Females	1		1	
Males	0.800	0.798–0.802	0.904	0.903–0.906
Deprivation (Townsend scores in fifths)				
Lowest fifth (most affluent)	1		1	
Second	0.990	0.986–0.993	0.993	0.990–0.996
Third	0.973	0.970–0.977	0.996	0.993–0.998
Fourth	0.909	0.906–0.912	0.977	0.974–0.980
Highest fifth (most deprived)	0.799	0.796–0.802	0.967	0.964–0.970
Ethnicity grouping of area of residence				
99–100% White	1		1	
97–98.9% White	0.898	0.895–0.900	1.007	1.005–1.010
90–96.9% White	0.822	0.819–0.824	1.020	1.017–1.023
<90% White	0.619	0.617–0.621	0.959	0.956–0.963
Rurality				
Urban	1		1	
Rural	1.234	1.231–1.237	1.005	1.002–1.007
In a risk group (other than aged >65)				
No	1		1	
Yes	4.403	4.393–4.413	2.233	2.228–2.238

[a] Adjusted for year only, the relative risks for year are unadjusted.
[b] Adjusted for all other variables in the table and 10 year age band.

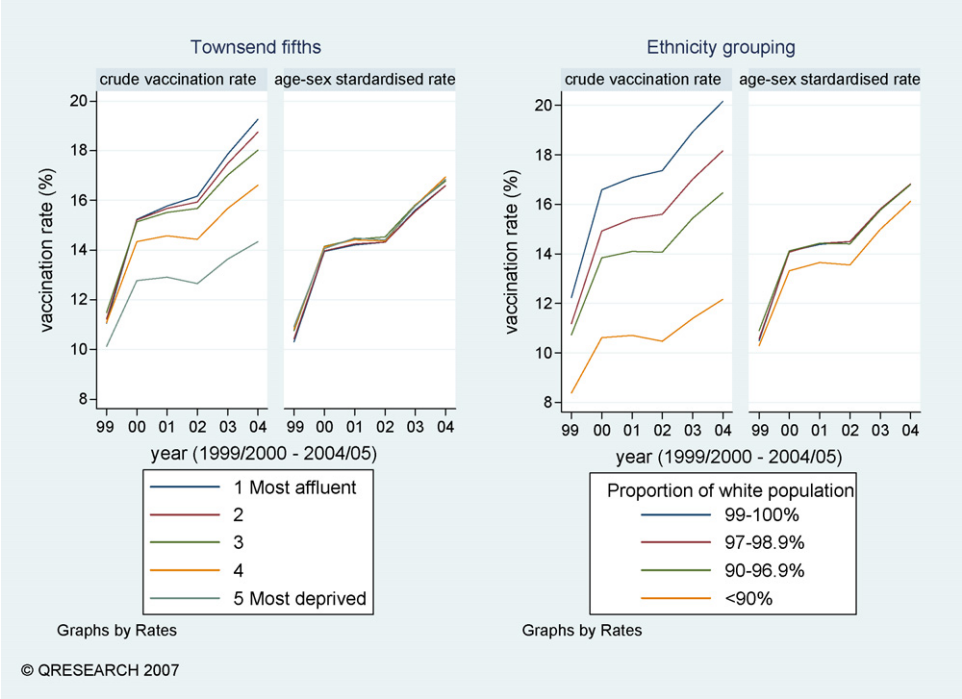

Fig. 3. Crude and age–sex standardised influenza vaccination rates by deprivation and ethnicity grouping of area of residence.

Table 4
Adjusted relative risks for vaccination by year and patient group for patients in a risk group and not in a risk group

	Patients not in a risk group		Patients in a risk group (including aged >65)	
	Adjusted relative risk[a]	95% confidence interval	Adjusted relative risk[a]	95% confidence interval
Year				
1999/2000	1		1	
2000/2001	1.095	1.081–1.108	1.356	1.351–1.361
2001/2002	1.056	1.042–1.069	1.393	1.388–1.398
2002/2003	0.985	0.973–0.998	1.407	1.402–1.412
2003/2004	1.081	1.068–1.094	1.529	1.523–1.534
2004/2005	1.076	1.063–1.089	1.646	1.640–1.652
Females	1		1	
Males	0.668	0.663–0.672	0.988	0.986–0.990
Deprivation (Townsend fifths)				
Lowest fifth (most affluent)	1		1	
Second	1.002	0.991–1.012	0.997	0.995–1.000
Third	1.109	1.097–1.121	0.993	0.990–0.996
Fourth	1.078	1.066–1.091	0.986	0.983–0.989
Highest fifth (most deprived)	1.100	1.085–1.114	0.979	0.975–0.982
Ethnicity grouping of area of residence				
99–100% White	1		1	
97–98.9% White	1.026	1.016–1.036	1.000	0.998–1.003
90–96.9% White	1.142	1.130–1.154	0.991	0.988–0.994
<90% White	1.107	1.093–1.121	0.928	0.925–0.931
Rurality				
Urban	1		1	
Rural	1.010	1.001–1.019	1.000	0.998–1.002

[a] Adjusted for all other variables in the table and 10-year age band.

patients in a risk group those from areas where <90% of the population are White were 7.2% (95% CI 6.9–7.5%) less likely to be vaccinated. There was little effect of rurality on vaccination rates in either group.

4. Discussion

This paper reports findings from a large population-based study designed to examine trends in the uptake of influenza vaccination over a 6-year period in primary care. There was a marked increase (59.5%) in the overall population uptake of influenza vaccine over the 6-year period and a 62.5% increase in uptake in people aged 65 years and over, with 70% vaccinated in 2004/2005. In 2004/2005 however only 29% of all patients in a clinical risk group aged less than 65 were vaccinated. Overall males, patients from deprived areas and from areas with a higher proportion of non-White residents had lower vaccination rates. There was little effect of rurality on vaccination rates.

These findings show that people aged 65 and over are well targeted. This group of patients were first included in the influenza vaccination policy in 2000 [11] which had previously included clinical risk groups and since 1998 all people aged 75 and over. General practitioners received an item of service fee for every vaccination given to patients aged 65 years and over, which exceeded levels of reimbursement for patients in high-risk groups aged less than 65 years. Also national targets were set for achieving uptake of 70% in these people. This policy had a substantial impact on vaccination rates in people aged 65 and over, resulting in a steep increase between 1999/2000 and 2000/2001.

In contrast although the influenza vaccination policy has included people in a high-risk group who are aged less than 65 for a longer period of time we found that less than a third of these patients had been vaccinated at the end of the study period. No targets have been set for vaccination uptake in these patients. Health promotion campaigns for influenza immunisation in recent years have focussed particularly on the elderly and this work suggests that more emphasis should be placed on the identification and immunisation of younger 'high-risk' groups. In more recent years item of service payments have been offered to general practitioners for administering the vaccination to high-risk patients aged less than 65 years. National monitoring of uptake in this group began in 2004 which may lead to increasing uptake in these patients. Recent Department of Health figures for uptake in England however still show a much lower uptake of 42% in high-risk patients aged under 65 compared with 74% in those aged 65 and over for 2006/2007[12].

Studies of influenza vaccination in other countries have also reported increasing vaccination rates in people aged 65 and over, such as an increase from 50.1% in 1993 to 63.7% in 2003 in Spain [13] and from 30.5% in 1985 to 65.5% in 2002 in the USA, although a levelling off of rates was observed in the USA after 1997 [14].

In our study certain 'high-risk' groups, for example, those of all ages with coronary heart disease and diabetes achieved a high uptake by 2004/2005 (77% and 73%, respectively), yet those with underlying respiratory disease achieved an uptake of only 36% by the end of the study period. The number of patients identified as having underlying respiratory disease (prevalence 12.8% in 2004/2005) far exceeded the number of patients with coronary heart disease or diabetes (prevalence less than 5%). It could be that the denominator population identified for those with underlying respiratory disease includes people with mild respiratory disease, which the general practitioner or the patient may not consider serious enough to warrant immunisation. We attempted, for example, only to include those asthmatics on regular steroid therapy, but there are inevitable difficulties in identifying a consistent Read code list which accurately reflects underlying respiratory disease serious enough to warrant immunisation.

In patients not in a risk group, women were 37% more likely to be vaccinated than men, whereas in high-risk groups women and men had similar immunisation rates overall. These findings are similar to those of another study [5], which found that uptake rates for females exceeded those for males up to the age of 65 after which rates between the sexes were similar, irrespective of risk. However, our findings differ from those of Breeze et al. [4] who found that women had lower vaccination uptake than men, but their study was only in patients aged 75 and over. If we restrict our analysis to patients aged 75 and over the vaccination rate in men is slightly higher than that in women (3.7% higher, 95% CI 3.5–4.0%). Generally across all age groups women, with higher overall consultation rates, may be more likely to be immunised even if they are not in a defined risk group. In addition, influenza immunisation is recommended for health care workers directly involved in patient care and social care staff, a group with a higher proportion of females than males. It is recommended that the vaccination of health and social care staff should be through relevant occupational health departments and such workers are not advised to go to their GP for immunisation unless they fall into one of the underlying risk groups or GPs have been specifically contracted to provide this service. It may be however that more women health and social care staff, who would have been classified in this study as not being in a risk group, are receiving vaccination in general practice. We have no means of identifying the size of this group in this study. In 2005, people who are the main carers for an elderly or disabled person whose welfare may be at risk if the carer falls ill were included in the groups for whom influenza vaccine is recommended [15]. Again we cannot identify carers in the QRESEARCH database.

Whilst there appeared to be differential uptake by ethnicity, deprivation and rurality for the population as a whole, this was much less marked once we had taken account of age and sex. Our measure of ethnicity was derived according to the local population in the area of residence of the patient, rather than being related to the individual patient so this relationship may not hold at patient level. However studies from the United States have also shown racial and ethnic disparities in influenza vaccination rates [14,16]. This work indicates a need to ensure influenza vaccine messages are reaching ethnic minority populations.

When we examined vaccine uptake gradients for patients who were not in a risk group, we found that patients from deprived areas had a 10% higher uptake rate than those from affluent areas. For patients in a risk group however, the pattern was reversed with slightly lower uptake rates in patients from deprived areas (2.1% lower rate). A similar pattern was observed for the area level ethnicity term: among patients not in a risk group there was a higher uptake in patients from areas with a higher proportion of non-White residents (11% higher) whereas among patients in a risk group there was a lower uptake among patients from areas with a higher proportion of non-White residents (7% lower).

We have used an extremely large population to obtain these results, and they illustrate the increasing potential of the electronic, coded records in general practice to support epidemiological research. The trends observed are unlikely to have occurred by chance, and the demographic characteristics of the study population are similar to the UK as a whole. Influenza vaccination was recorded by medical staff rather than based on patient self-reported measures and since it was encouraged through target payments is likely to be well recorded. Our overall figures for uptake are similar to those derived from the General Practice Research Database [5] and to the Department of Health national monitoring uptake figures [12]. A recent study has shown very similar estimates of vaccination rates when comparing data recorded by general practitioners with self-reported telephone responses [17]. Our study design was not subject to response bias or recall bias since the data were routinely collected general practice data on all registered patients. We used a standard measure for deprivation which was assigned at relatively small geographical areas to compare the trends in the rates of influenza vaccination in affluent and deprived populations. Our measure of ethnicity was based on the proportion of White people in the area of residence of the patient rather than the self-assigned ethnic group of the patient themselves which is not generally recorded so caution is needed in interpretation of the ethnicity results. The QRESEARCH database cannot identify carers or health care workers, both regarded as high-risk groups.

This general practice based study suggests that substantial increases in influenza vaccination rates have occurred across all risk groups but that increased focus should be given to immunising high-risk patients below the age of 65.

Acknowledgements

We thank the practices contributing to the QRESEARCH database and David Stables (EMIS computing) for support

in setting QRESEARCH up. We thank Gavin Langford for the data extraction.

Contributors: CC designed and carried out the statistical analysis, contributed to the interpretation and drafting of the paper. SH contributed to the initial study design, data definitions, analysis, drafting and interpretation. GS originated the idea for the study, contributed to the design, analysis plan, interpretation and drafting. YV contributed to the analysis, interpretation and drafting. CJ was a member of the stakeholders group, and contributed to interpretation, made suggestions for further analysis, and commented on drafts of the paper. MP contributed to the initial hypothesis, study design, interpretation and drafting of the paper. JHC contributed to refinement of the hypothesis, study design, specification for the data extraction, interpretation and wrote the first draft of the paper.

Ethical approval: Trent MREC and the QRESEARCH Scientific Board.

Funding: Health Protection Agency, UK.

Names of guarantors: Carol Coupland and Julia Hippisley-Cox.

Appendix A. Clinical Risk Groups 2003/2004

All those aged over 6 months in the following risk groups:

Chronic respiratory disease including asthma: this includes chronic obstructive pulmonary disease (COPD), including chronic bronchitis and emphysema, bronchiectasis, cystic fibrosis, interstitial lung fibrosis, pneumoconiosis, asthma requiring continuous or repeated use of inhaled or systemic steroids or with previous exacerbations requiring hospital admission.

Chronic heart disease: this includes chronic ischaemic heart disease, congenital heart disease and hypertensive heart disease requiring regular medication and follow-up (but excluding uncomplicated controlled hypertension), and chronic heart failure.

Chronic renal disease: including nephritic syndrome, chronic renal failure, renal transplantation.

Diabetes: diabetes mellitus requiring insulin or oral hypoglycaemic drugs.

Immunosuppression: due to disease or treatment, including asplenia or splenic dysfunction, and also including systemic steroids equivalent to 20 mg prednisolone daily for more than 2 weeks.

Source: Department of Health, Chief Medical Officer. Adult immunisation update. PL CMO (2003) 6; 8 August 2003.

References

[1] Nicholson KG, Wood JM, Zambon M. Influenza. Lancet 2003;362(9397):1733–45.
[2] Nichol KL. The efficacy, effectiveness and cost-effectiveness of inactivated influenza virus vaccines. Vaccine 2003;21:1769–75.
[3] Siriwardena AN, Rashid A, Johnson MR, Dewey ME. Cluster randomised controlled trial of an educational outreach visit to improve influenza and pneumococcal immunisation rates in primary care. Br J Gen Practice 2002;52(482):735–40.
[4] Breeze E, Mangtani P, Fletcher AE, Price GM, Kovats SJR. Trends in influenza vaccination uptake among people aged over 74 years 1997–2000: survey of 73 general practices in Britain. BMC Family Practice 2004;5:8.
[5] Joseph C, Goddard N, Gelb D. Influenza vaccine uptake and distribution in England and Wales using data from the General Practice Research Database, 1989/90–2003/04. J Public Health 2005;27(4):371–7.
[6] Jimenez-Garcia R, Hernandez-Barrera V, Carrasco Garrido P, del Pozo SV-F, de Miguel AG. Influenza vaccination among cardiovascular disease sufferers in Spain: related factors and trend, 1993–2003. Vaccine 2006;24(23):5073–82.
[7] American Diabetes Association. Influenza and pneumococcal immunisation in diabetes. Diab Care 2004;27:S111.
[8] Sarria-Santamera A, Timoner J. Influenza vaccination in old adults in Spain. Eur J Public Health 2003;13(2):133–7.
[9] Hippisley-Cox J, Vinogradova Y, Coupland C, Pringle M. Comparison of key practice characteristics between general practices in England and Wales and general practices in the QRESEARCH database. University of Nottingham; 2005.
[10] Zou G. A modified Poisson regression approach to prospective studies with binary data. Am J Epidemiol 2004;159:702–6.
[11] Department of Health. Major changes to the policy on influenza immunisation. CMO's Update 26. May 2000.
[12] Department of Health. Influenza immunisation programme 2007/2008. PL CMO (2007) 3. London; 2007.
[13] de Andres AL, Garrido PC, Hernandez-Barrera V, del Pozo SV-F, de Miguel AG, Jimenez-Garcia R. Influenza vaccination among the elderly Spanish population: trend from 1993 to 2003 and vaccination-related factors. Eur J Public Health 2007;17(3):272–7.
[14] Lu P-J, Singleton JA, Rangel MC, Wortley PM, Bridges CB. Influenza vaccination trends among adults 65 years or older in the United States, 1989–2002. Arch Intern Med 2005;165(16):1849–56.
[15] Department of Health. The influenza immunisation programme. PL CMO (2005) 2. London; 2005.
[16] Centers for Disease Control and Prevention. Racial/ethnic disparities in influenza and pneumococcal vaccination levels among persons aged > or = 65 years—United States, 1989–2001. MMWR 2003;52:958–62.
[17] Muller D, Nguyen-Van-Tam JS, Szucs TD. Influenza vaccination coverage rates in the UK: a comparison of two monitoring methods during the 2002–2003 and 2003–2004 seasons. Public Health 2006;120(11):1074–80.