Public Health England

Protecting and improving the nation's health

Seasonal influenza vaccine uptake in children of primary school age: winter season 2015 to 2016

End of season report

Final data for 1 September 2015 to 31 January 2016

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Executive summary

In 2012, the Joint Committee on Vaccination and Immunisation recommended the roll-out of a universal childhood influenza vaccine programme with a newly licensed live attenuated influenza vaccine. This programme will ultimately target all children 2-16 years of age with the aim of not only directly protecting the children themselves, but also protecting the remainder of the population (ie the vulnerable elderly) by reducing transmission in the population.

This document describes and reports on the cumulative uptake of influenza vaccine in children of primary school age during the 2015 to 2016 influenza vaccine season, with a focus on the results from the final end of season data submitted to Public Health England at school-level between March-April 2016. The school-level data returns presented in this report include analysis on consents, refusals, contraindications, and population level ecological predictors of low vaccine uptake.

The overall uptake in school years 1 and 2 was 55.1% in those areas using a school delivery model and 30.1% for those using a primary care/pharmacy model. The overall uptake in pilot areas for children in school years 1-6 was 55.6%, with a pattern of decreasing uptake with increasing age. Ecological population level predictors of uptake found that lower uptake in both children of school years 1 and 2 age across England and children school years 1 to 6 in pilot areas was significantly and independently associated with both increasing deprivation and ethnicity. The lowest uptake was reported in the most deprived deciles of deprivation or areas with the largest proportion of black or minority ethnic groups.

Background

Seasonal influenza is a very common infection among infants and children. Healthy children under five years of age have the highest influenza hospital admission rates compared to other age-groups[1]. The United Kingdom (UK) has a long standing selective influenza vaccination programme targeted at all those 65 years and over, under 65 and in a clinical risk group, and pregnant women. Based on the recommendations of the Joint Committee on Vaccination and Immunisation (JCVI) in 2012, England is in the process of implementing a universal paediatric influenza vaccination programme to ultimately cover all children 2-16 years of age[2]. The programme is being introduced incrementally across a number of influenza seasons.

In 2013 to 2014 vaccination against influenza with a newly licensed live attenuated influenza vaccine (LAIV) was first offered nationally across the UK to all children aged two and three years of age through GP practices. Additionally Public Health England (PHE) commissioned a pilot vaccination programme to cover children of primary school-age (4-11 years). The programme ran in seven geographically distinct pilots areas (Bury, Cumbria, Gateshead, Newham, Havering, South East Essex, and Leicester*). The purpose of the pilots was to undertake an operational evaluation including of different modes of vaccine delivery, specifically school based vs. primary care delivery (GP practice/pharmacy). Pilot regions offered LAIV to healthy and at-risk children in whom the vaccine was not contraindicated. The pilot achieved a final overall uptake of 52.5%, ranging from 35.8% to 71.5% between individual pilot areas[3].

In 2014 to 2015 the national programme was further extended to include vaccination of all children two to four years of age through GP practices. In addition the 2014 to 2015 season saw the extension of the school-age pilot vaccination programme to 14 areas across England targeting a) primary school age children 4-11 years of age, b) secondary school children aged 11-13 years or c) both groups. Pilot areas primarily delivered the programme through schools with the exception of two areas which used a pharmacy based model with GP involvement (Cumbria and Arden, Herefordshire and Worcestershire). In addition, one local authority (LA) followed a primary care GP delivery model (Leeds). London, with the exception of Havering LA, covered special schools only. The pilot achieved a final uptake of 53.2% for children of primary and secondary school age children (4-13 years)[4].

During the 2015 to 2016 vaccine campaign all children in England of school years 1 and 2 age were offered influenza vaccine as well as children of school years 1 to 6 age in pilot areas. Cumulative school-level vaccine uptake data were manually submitted through ImmForm for all children of school age on a monthly basis. Vaccine uptake was recorded locally at school level and then reported to ImmForm by LA /Area Team (AT)

and year group (Annexe A). At the end of the influenza season (March-April), final vaccination data was collected at school-level across England and submitted to PHE including additional information on consents, refusals, and contraindications.
*Leicester city, East Leicestershire and Rutland

Methods

End of season data for 2015 to 2016 were collected at a school-level and submitted to PHE between March-April 2016 by ATs. The majority of schools used a data collection tool created by PHE where data were entered for each child in the school. These data were aggregated into school totals which were provided to the LA. The end of season collection variables requested are outlined in Annexe B.

Key indicators

Uptake

End-of-season programme uptake was calculated based on the number of children in the target population who were reported to have received at least one dose of influenza vaccine during the campaign period (1 September 2015 until 31 January 2016). Second doses were not counted. The target population was defined as the number of primary school age children (5-7 years) born between 1 September 2008 and 31 August 2010 eligible for vaccination across England as well as the number of primary school age children (5-11 years) born between 1 September 2004 to 31 August 2010 resident in the selected pilot areas.

Predictors of uptake

To assess how population level predictors may be associated with vaccine uptake, the postcode of each school and the urban/rural data were matched using the GeoConvert: UK Data Service Census Support tool to various predictors available at 2011 census Office for National Statistics (ONS)[5].

Data on religion, ethnicity by age, sex, and Lower Super Output Area level (LSOA) were downloaded from Nomis (provided by the ONS)[6]. Religion and ethnicity predictors were calculated for those aged 0 to 15 years old.

Each LOSA had a population range of 1,000 – 3,000 and were used to assess potential ecological associations with uptake[7]. The Index of Multiple Deprivation (IMD) is an overall score assigned to each LSOA summarising its relative level of deprivation based

on seven topic areas: income, employment, health, education, crime, service access and living environment[7]. IMD scores were calculated and, based on the distribution, categorically grouped into deciles.

Information on ethnic constitution of each LSOA is available according to the following categories: White/Mixed/Asian/Black/Other[8]. The proportion of LSOA classified as belonging in a black or minority ethnic (BME, defined as non-white British) categorically grouped into quartiles.

Information on the religious constitution of each LSOA is available with the categories of Christian/Buddhist/Hindu/Jewish/Muslim/Sikh/Other/None[9]. Proportions were analysed, focusing on Jewish and Muslim because of the issues reported the previous seasons around the use of porcine gelatine in the vaccine. The proportion of LSOA identifying as Jewish was grouped into 0% and >0% (95% of schools were in an area with Jewish population less than 1%) and Muslim into 0%, 1-5% and 6%+.

Classification of the LSOA as rural (Town and fringe/Village or hamlet/Isolated dwelling) or urban (Major conurbation/Minor conurbation/City and town) was available from the ONS 2011 census[5].

Vaccine uptake was calculated by each of these population characteristics. A linear regression analysis was undertaken to assess whether any of the population characteristics were significantly related to uptake. Uptake in primary schools was linearly regressed against the same population-level variables (area, deprivation, ethnicity, religious constitution and rurality) to determine if changes in uptake could be explained. Variables significant in univariate analysis ($p<0.01$) were included in a multiple linear regression model to provide adjusted estimates and the model fit was assessed. This method was previously used by Green et. al[10].

Consent, refusal and non-responders

Parental consent forms for influenza vaccination were sent to parents through schools. The return of these forms was recorded by the school/local authorities and information on consents, refusals, and no returns was submitted to PHE at the end of the season. Not all areas returned consent, refusal, and no return data and not all schools within each LA identified these groups consistently. Additionally, some areas merged consent/refusal/no return data for all vaccinating year groups.

Consent – Calculated from number of consent forms returned by all children in a year group, divided by the final denominator for that year group. Consent is defined as direct parental consent to vaccinate. In some cases consents include children who are contraindicated for vaccination with LAIV.

Refusal – Calculated from number of forms returned refusing consent by all children in a year group, divided by the final denominator for that year group. Refusal is recorded as direct refusal to vaccinate. In some cases refusals include children who are contraindicated for the vaccination with LAIV.
No return – Calculated from the number of forms not returned in a year group (non-responders), divided by the final denominator for that year group. Non-responders were defined as parents that did not return consent forms whose children were subsequently not vaccinated. Non-responder counts were either provided by the school level data submission or calculated from the final denominator by subtracting the count of consents and refusals. No returns may also include children contraindicated for vaccination with LAIV.

Contraindications

Children contraindicated for vaccination with LAIV (ie children in clinical risk groups) were identified prior to the use of LAIV in the 2015 to 2016 study. Risk groups are clinically outlined in Green Book[11]. The numbers of children contraindicated for vaccination were recorded, and then aggregated by risk group.

Contraindications were split into two groups: Prior Contraindications and On-day Contraindications. The first describes pre-existing contraindications to vaccination that parents were aware of eg severe asthma. The second describes contraindications described on the day of vaccination eg a child being congested. Not all area recorded data for all risk groups, and not all schools within each pilot site identified risk groups consistent with the end of season data return variables. Children contraindicated for vaccination with LAIV were either offered injectable quadrivalent inactivated influenza vaccine on site by providers or referred to their general practice for vaccination.

Data limitations

It is important to note that there were differences in missing data and data return among the pilot areas in 2014 to 2015 and the 2015 to 2016 season.

Years 1 and 2 across England

A total of 127 LAs were included and 26 LAs were not included in the school age surveillance. Of these latter, data was not returned for 15 LAs, and there were eight LAs that used a GP delivery model and two LAs that used a pharmacy delivery model (Annex C). Data for Bassetlaw and Nottinghamshire were collected independently. The remaining 126 LAs provided vaccine uptake at a school level, however, some areas were not accounted for due to missing information or when the numerator was greater than the denominator (Annex D). A total of 153 schools in London and eight schools in

South Yorkshire and Bassetlaw returned data for years 1 and 2 combined, therefore these schools were only assessed when combining years 1 and 2 data for the entire country.

Pilot areas

All 11 LAs in the pilot areas returned data.
The schools in Havering LA either presented data for years 1 to 2, 3 to 6 or 1 to 6 combined. As a result the data were used for when assessing vaccine uptake by individual year group.
Greater Manchester only provided data for school years 1 and 2, therefore vaccine uptake was not assessed for years 3 to 6 in this area and these year groups could not be compared to the other pilot areas.

Uptake predictors

For the linear regression analyses of children of school years 1 and 2 age, a total of 11,073 of the 14,016 (79.0%) schools were used for analyses with 2,943 schools (21.0%) missing. A total of 11,073 were matched with IMD and urban/rural classifications while 2,262 schools were unable to be matched and could therefore not be used for analysing uptake predictors. A further 218 schools were unable to be matched to data on religion and ethnicity.

For the linear regression analyses of children of school years 1-6 age in pilot areas, a total of 1,066 of 1,306 (81.6%) of schools were used for the analyses with 204 schools (18.4%) missing. A total of 1,066 schools were matched to IMD and urban/rural classifications while 240 schools were unable to be matched. The same 240 schools could not be matched to LSOA for religion and ethnicity classifications.

Results

Uptake (school years 1 and 2 across England)

A total of 82.4% (126/153) LAs used a school delivery model as their main mode of delivery returned data. Of these areas, an estimated 593,805 of 1,077,531 children of school years 1 and 2 age in England received at least one dose of influenza vaccine during the period 1 September 2015 to 31 January 2016 in schools. Overall uptake for children in school year 1 and 2 age vaccinated in schools in these areas was 55.1% with uptake ranging from 40.2% in London to 66.8% in North Yorkshire and Humber (Table 1)

A total of 5.9% (9/153) LAs used a GP delivery model as their main mode of delivery. An estimated 32.9% (28,489 of 86,533) of children of school years 1 and 2 age in England received at least one dose of influenza vaccine during the period of 1 September 2015 to 31 January 2016 by GP delivery models. Finally, a total of 1.3% (2/153) LAs used pharmacies as their main mode of delivery. An estimated 16.1% (2,772/17,178) of children of school years 1 and 2 age in England received at least one dose of influenza vaccine during the period of 1 September 2015 to 31 January 2016 by pharmacy delivery models (Table 2).

The remaining 10.5% (16/153) LAs did not provide data for the analysis. These 16 LAs have an estimated population size of 147,085 children.

Table 1. Estimated proportion of children school years 1 and 2 age in England vaccinated with at least one dose of influenza vaccine. England, 1 September 2015 to 31 January 2016 by Area Team

Area team[a,b]	LA Response Rate (%)	No. of children eligible for vaccination	No. of children vaccinated with at least 1 dose of influenza vaccine	Vacccine uptake (%)
Arden, Herefordshire and Worcestershire	100.0	38,851	25,128	64.7
Bath, Gloucestershire, Swindon and Wiltshire	0.0	-	-	-
Birmingham and the Black Country	100.0	67,821	33,081	48.8
Bristol, North Somerset, Somerset and South Gloucestershire	50.0	16,784	8,670	51.7
Cheshire, Warrington and Wirral	25.0	12,677	7,909	62.4
Cumbria, Northumberland, Tyne and Wear	71.4	30,368	17,001	56.0
Derbyshire and Nottinghamshire	100.0	46,242	27,522	59.5
Devon, Cornwall and Isles of Scilly	25.0	2,576	1,219	47.3
Durham, Darlington and Tees	100.0	27,986	16,661	59.5
East Anglia	100.0	56,627	33,445	59.1
Essex	100.0	44,089	26,589	60.3
Greater Manchester	100.0	74,941	40,220	53.7
Hertfordshire and the South Midlands	100.0	76,313	43,792	57.4
Kent and Medway	100.0	44,441	24,525	55.2
Lancashire	100.0	35,778	18,803	52.6
Leicestershire and Lincolnshire	100.0	42,449	24,935	58.7
London	81.3	170,675	68,548	40.2
Merseyside	60.0	10,863	5,909	54.4
North Yorkshire and Humber	100.0	37,885	25,323	66.8
Shropshire and Staffordshire	100.0	35,846	22,909	63.9
South Yorkshire and Bassetlaw	60.0	18,087	11,296	62.5
Surrey and Sussex	50.0	25,616	14,853	58.0
Thames Valley	87.5	38,798	23,346	60.2
Wessex	100.0	60,519	39,328	65.0
West Yorkshire	100.0	61,299	32,793	53.5
Total	**82.3**	**1,077,531**	**593,805**	**55.1**

[a] Denominators represent the number of children school years 1 and 2 age eligible for vaccination. Denominators are based on school-roll figures obtained directly from schools unless unavailable then Department of Education January 2016 school census figures were used.

[b] A total of 16 LAs that provided vaccinations via a school delivery model did provide any school level data. Total of 9 LAs, including all 4 LAs in Bath, Gloucestershire, Swindon and Wiltshire provided vaccinations through a GP model and are not included. Finally, 2 LAs provided vaccinations through a pharmacy model and are not included.

Table 2. Estimated proportion of children school years 1 and 2 age in England vaccinated in GP clinics or pharmacies with at least one dose of influenza vaccine. England, 1 September 2015 to 31 January 2016 by Area Team

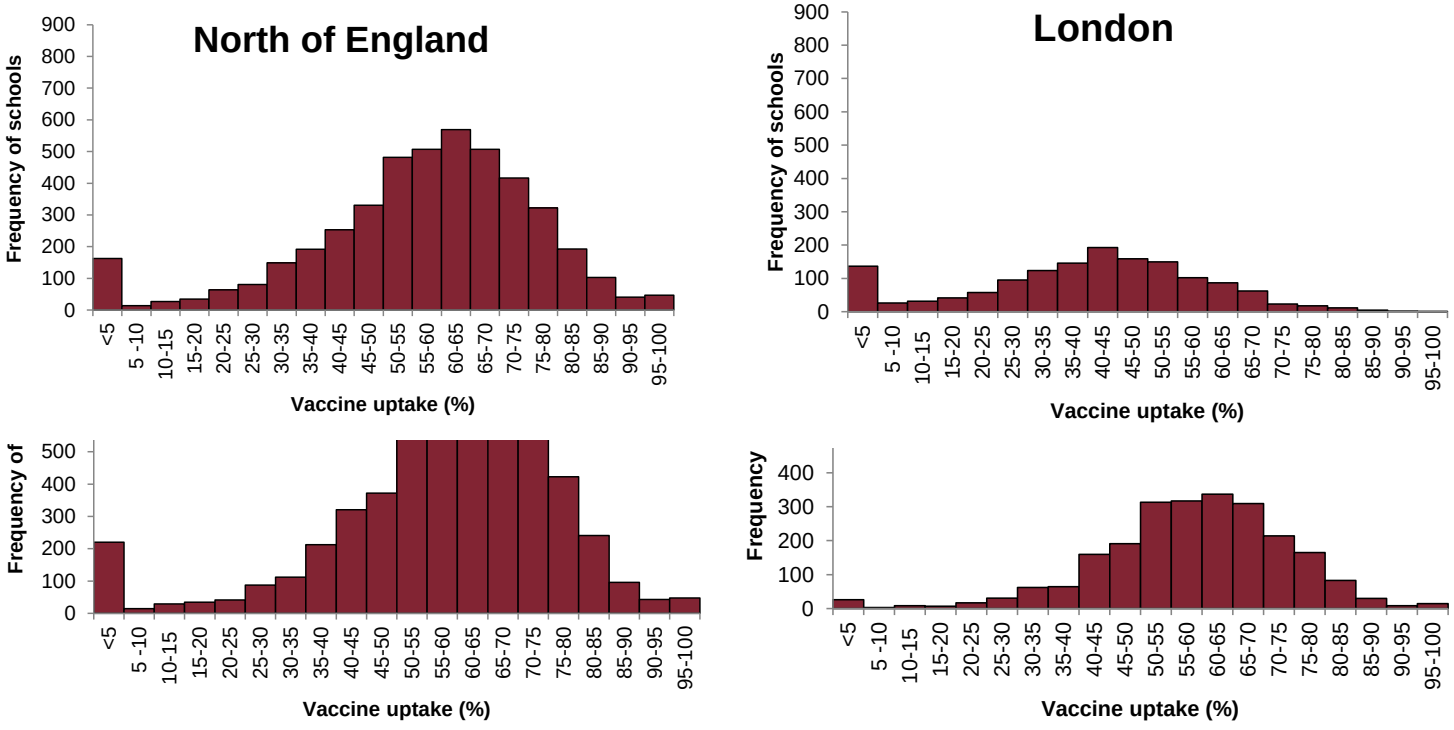
Area team	LA Response Rate (%)	Mode of delivery	No. of children eligible for vaccination[b,c]	No. of children vaccinated with at least 1 dose of influenza vaccine	Vacccine uptake (%)
Bath, Gloucestershire, Swindon and Wiltshire	100.0	GP	36,010	12,251	34.0
Bristol, North Somerset, Somerset and South Gloucestershire	50.0	Pharmacy	17,178	2,772	16.1
Devon, Cornwall and Isles of Scilly	100.0	GP[a]	34,326	10,831	31.6
Thames Valley	12.5	GP	16,197	5,407	33.4
Total	**55**		**103,711**	**31,261**	**30.1**

[a] Devon LA provided GP-level and school-level data.
[b] GP delivery model denominators were derived from GP systems and were based on the number of patients registered with a GP practice located within the LAs geographical boundary, as defined by child age on 1 September 2015.
[C] Pharmacy delivery model denominators were based on all eligible children in school in the LA geography and children educated out of school in the LA geography defined by child age on 1 September 2015 using the local education authority (LEA) population figures (ie school roll).

Uptake by PHE region

Vaccine uptake for children of school years 1 and 2 age vaccinated in schools in England varied across PHE regions. Uptake at school level ranged from 0 to 100%. In the North of England, of the 4,497 primary schools reporting vaccine uptake data for years 1 and 2, the median uptake was 59.3% (with interquartile range of 47.1% to 69.9%). In London, of the 1,474 schools reporting vaccine uptake data for schools years 1 and 2, the median uptake was 41.7% (with interquartile range of 28.7% to 52.9%). In the Midlands and East, of the 5,694 schools that reporting vaccine uptake data for school years 1 and 2, the median uptake was 60.3% (with interquartile range of 49.2% to 70.1%). Finally, in the South of England, of the 2,363 schools reporting vaccine uptake, the median uptake was 59.6% (with interquartile range of 50.0% to 68.8%) (Figure 1).

Figure 1. School delivery influenza vaccine uptake for children of school years 1 and 2 age in all four PHE regions from 1 September 2015 to 31 January 2016



Predictors of uptake (School years 1 and 2 across England)

The results of the unadjusted univariate analysis for children of school years 1 and 2 age indicated that the largest effect was seen for ethnicity and deprivation and religious beliefs (Table 4). Areas with an ethnic population of 34% or more had a 22.0% lower uptake compared to areas with a minority population of <5%.The more deprived an area, the lower the uptake, with those in the least deprived decile of deprivation showing uptake 18.7% greater than those in the most deprived decile. In terms of religious beliefs, uptake was 18.2% lower when 6%+ of the LSOA population identified as Muslim relative to 0%, while a 4.0% lower vaccine uptake was observed if the LSOA contained Jewish residents compared to none. A lower uptake was seen in urban relative to rural areas, with a difference in uptake of 8.1% and an increase was seen in pilot areas by 4.6% than in non-pilot areas. Finally, uptake by PHE region compared to the North of England indicate that uptake was not significantly higher in Midlands and East and the South of England. However, a significantly lower uptake was seen in London with a difference of 17.5% (Table 4).

After adjusting for all area level characteristics in the multivariable regression analysis (Figure 3), the largest independent predictor was seen for deprivation. The association was strongest for those in the most deprived decile. Areas in least deprived decile of deprivation had a 14.8% higher uptake than those in the most deprived decile. Areas with a BME population of 34% or more had 9.9% lower uptake compared to areas with a BME population of <5%.The association with Muslim populations decreased but remained significant. Areas with a Muslim population of 6%+ had an uptake 3.7% lower than those with 0% Muslim population. Similarly, a significantly lower uptake persisted in urban areas compared to rural (0.9% lower). These results are similar to those seen in the first year of the pilot vaccination programme in 2014 to 2015[4] were all independently associated with low vaccine uptake in children.

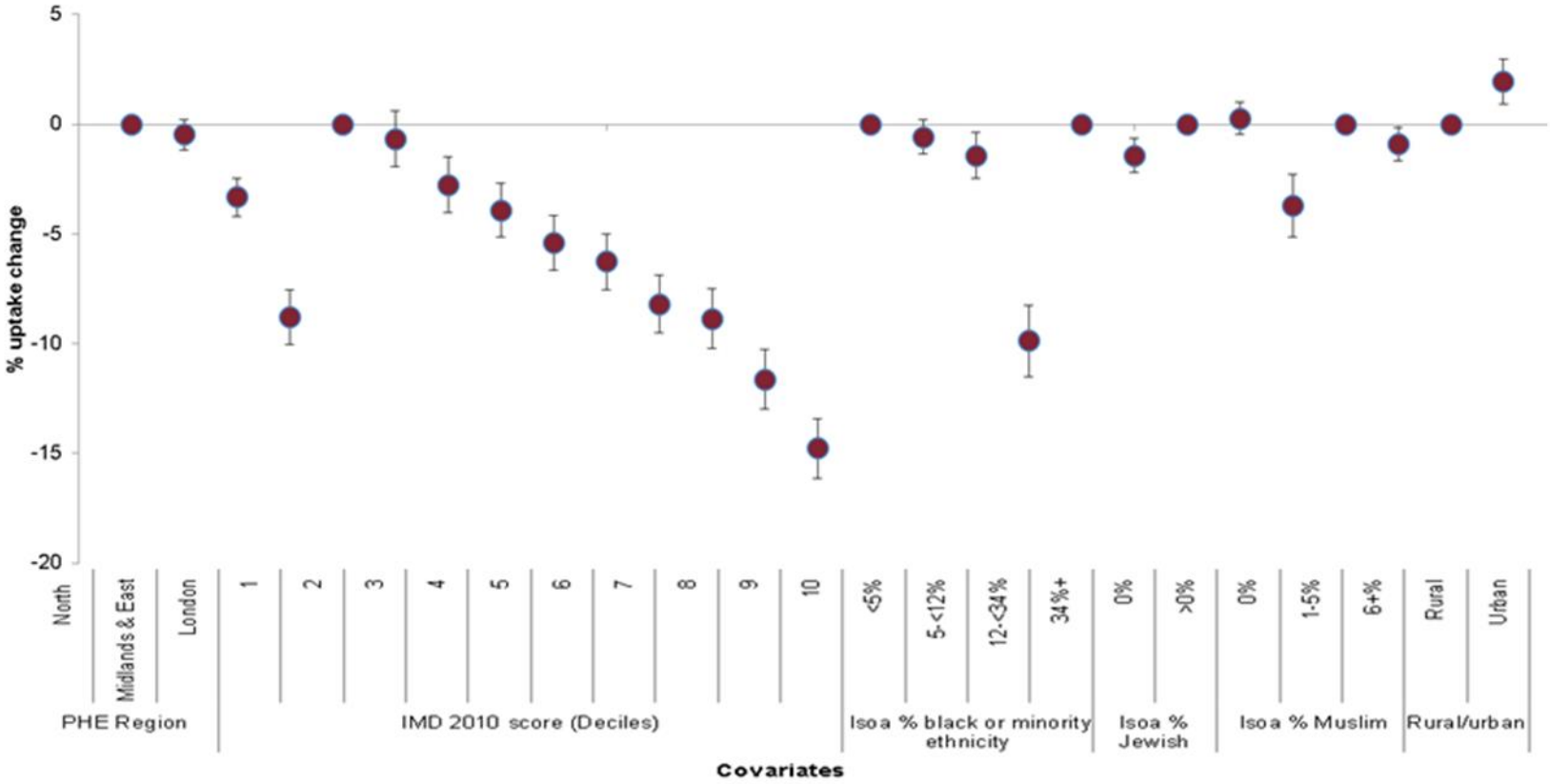
During the 2014 to 2015 season vaccine uptake was 14.1% lower in the lowest quintile of deprivation, and areas with BME >34% had 8.5% lower vaccine uptake than areas with <5% BME for 4 to 11 year olds in Pilot areas across England[4]. The results were also similar to findings in 2014 to 2015[4] for Muslim and Jewish populations where Muslim populations 6+%had 5.8% lower vaccine uptake than areas with 0% Muslim populations and areas with >0% Jewish populations had 1.4% lower uptake than populations with 0% Jewish population for children ages 4-11 years old in pilot areas in England. A significantly higher uptake in pilot areas than in non-pilot areas was also observed where pilot areas had a 1.9% higher vaccine uptake. Finally, after adjusting for area-level characteristics relative to the North of England, uptake in Midlands and East of England were insignificantly different. Uptake in the South of England was significantly higher with a 3.3% increase than in the North of England. However, London was significantly lower, with 8.8% lower uptake.

Table 4. Vaccine uptake unadjusted/adjusted impact on uptake determined through linear regression for children schools years 1 and 2 age across England, 1 September 2015 to 31 January 2016

				Unadjusted		Adjusted (R2= 26.5%)[a]	
Covariate		Number of children	Crude uptake (%)	Estimated % uptake change (95% CI)	p-value[a]	Estimated % uptake change (95% CI)	p-value
PHE Region of School	North	136,053	57.2	Baseline		Baseline	
	Midlands and East	188,439	58.4	0.89 (0 .166 to 1.62)	0.016	-0.48 (-1.17 to 0.21)	0.174
	South	84,245	59.5	0.19 (-0.74 to 1.11)	0.691	-3.33 (-4.20 to -2.47)	<0.001
	London	49,027	40.8	-17.54(-18.68 to -16.40)	<0.001	-8.81 (-10.06 to -7.56)	<0.001
IMD 2010 Score of school (decile)	Least deprived	54,370	65.8	Baseline		Baseline	
		51,326	63.6	-0.54 (-1.92 to 0.83)	0.439	-0.67 (-1.94 to 0.60)	0.302
		46,517	62.9	-2.28 (-3.65 to -0.92)	0.001	-2.76 (-4.03 to -1.49)	<0.001
		50,070	59.8	-3.81 (-5.13 to -2.48)	<0.001	-3.93 (-5.16 to -2.70)	<0.001
		46,517	57.6	-5.83 (-7.17 to -4.50)	<0.001	-5.40 (-6.64 to -4.16)	<0.001
		47,903	55.6	-7.36 (-8.72 to -6.00)	<0.001	-6.27 (-7.54 to -5.01)	<0.001
		40,551	52.6	-10.80 (-12.22 to -9.38)	<0.001	-8.19 (-9.51 to -6.87)	<0.001
		40,554	50.0	-12.57 (-14.01 to -11.13)	<0.001	-8.86 (-10.21 to -7.51)	<0.001
		39,795	47.2	-16.30 (-17.74 to -14.84)	<0.001	-11.62 (-13.00 to -10.24)	<0.001
	Most deprived	40,609	44.4	-18.69 (-20.09 to -17.29)	<0.001	-14.77 (-16.13 to -13.41)	<0.001
School Isoa % black or minority ethnicity	<5%	159,015	62.6	Baseline		Baseline	
	5 to <12%	125,363	61.1	-1.21 (-1.94 to -0.48)	0.001	-0.58 (-1.37 to 0.20)	0.142
	12 to <34%	102,186	56.4	-5.63 (-6.44 to -4.81)	<0.001	-1.43 (-2.47 to -0.39)	0.007
	34+ %	71,200	39.2	-22.03 (-22.90 to -21.15)	<0.001	-9.87 (-11.51 to -8.24)	<0.001
School Isoa % Jewish	0%	376,617	56.6	Baseline		Baseline	
	>0%	81,147	51.9	-4.02 (-4.87 to -3.16)	<0.001	-1.43 (-2.21 to -0.66)	<0.001
School Isoa % Muslim	0%	112,818	62.3	Baseline		Baseline	
	1 to 5%	247,288	60.3	-1.82 (-2.50 to -1.13)	<0.001	0.26 (-0.47 to 1.00)	0.481
	6+%	97,658	42.4	-18.24 (-19.10 to -17.38)	<0.001	-3.70 (-5.14 to -2.27)	<0.001
Rural/Urban school	Rural	89,000	63.7	Baseline		Baseline	
	Urban	368,764	54.1	-8.08 (-8.76 to -7.40)	<0.001	-0.92 (-1.66 to -0.17)	0.016
Pilot status	Non-pilot	413,303	55.3	Baseline		Baseline	
	Pilot	44,461	60.0	4.57 (3.42 to 5.72)	<0.001	1.93 (0.91 to 2.96)	<0.001

[a] Adjusted for PHE region, IMD score, Isoa % black or minority ethnicity, Isoa % Jewish, Isoa Muslim, Rural/Urban school, and Pilot status

Figure 3. Adjusted linear regression % uptake change values with corresponding 95% confidence intervals for population-level predictors for children schools years 1 and 2 age in England, 1 September 2015 to 31 January 2016



Uptake (school years 1 to 6 in pilot areas across England)

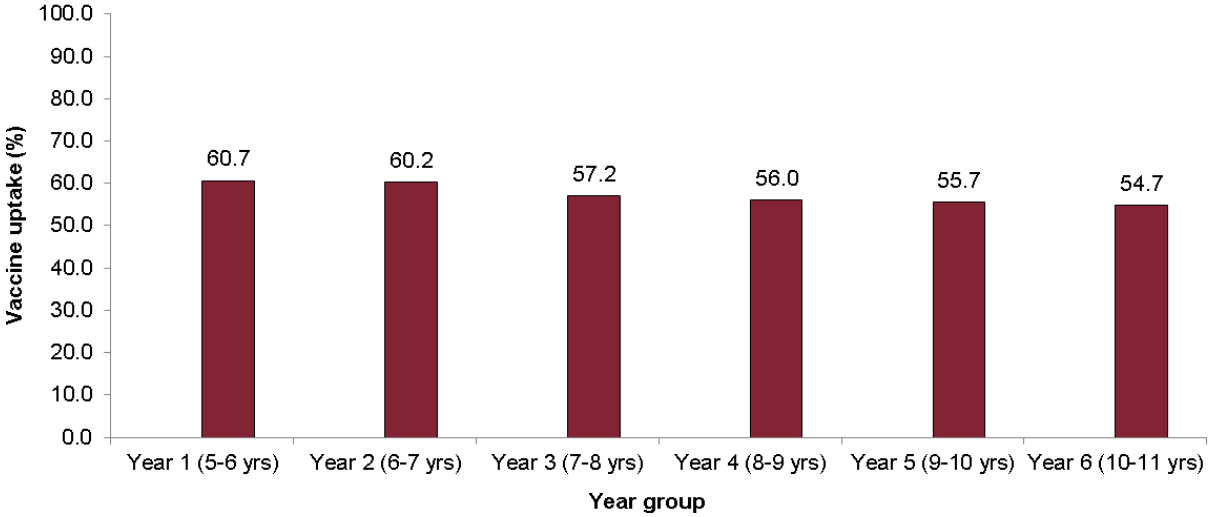
All of the pilot areas returned data for school level uptake. An estimated 152,829 children of school years 1 to 6 age in England out of 275,114 eligible received at least one dose of influenza vaccine during the period 1 September 2015 to 31 January 2016 in schools. Overall uptake for children in school year 1 to 6 age vaccinated in schools was 55.6% with uptake ranging from 34.8% in London to 76.7% in Greater Manchester (Table 3). Vaccine uptake in the pilot areas ranged from 60.7% in year 1 to 54.7% in year 6, with an overall decreasing uptake with increasing age (Figure 2).

Table 3. Estimated proportion of children school years 1 to 6 age by pilot area with at least one dose of influenza vaccine. England, 1 September 2015 to 31 January 2016

Area team	LAs responding (%)[a,b]	No. of children eligible for vaccination	No. of children vaccinated with at least 1 dose of influenza vaccine	Vacccine uptake (%)
Cumbria, Northumberland, Tyne and Wear	100	42,319	22,834	54.0
Essex	100	127,737	73,238	57.3
Greater Manchester	100	4,931	3,781	76.7
Leicestershire and Lincolnshire	100	76,041	44,586	58.6
London	100	24,086	8,390	34.8
Total	**100**	**275,114**	**152,829**	**55.6**

[a] Greater Manchester did not provide any data for children in schools years 3 to 6.
[b] Data from London only provided data in aggregate form by years 1-2, 1-6 or 3-6. The overall total uptake was calculated using the aggregated values.

Figure 2: Estimated proportion of children school years 1 to 6 age in pilot areas across England vaccinated with at least one dose of influenza vaccine by year group from 1 September 2015 to 31 January 2016[a,b].



[a] Data from London was excluded as it was not provided for each individual year group.
[a] Greater Manchester did not provide any data for children in schools years 3 to 6.

Predictors of uptake (School years 1 to 6 in pilot areas across England)

The results of the unadjusted univariable analysis for children school years 1- 6 ages showed that the largest effect in area level characteristics was seen for PHE region and ethnicity (Table 5). London experienced a 25.3% lower vaccine uptake than in the North of England. There was a decreasing trend in vaccine uptake as the BME population increased. Areas with a BME population of 34% or more had 14.8% lower uptake than those with a BME population of <5%. Generally the more deprived an area, the lower the uptake, with those in the second most deprived decile and the most deprived of deprivation having 13.6% and 12.8% lower uptake than those in the least deprived decile, respectively. Uptake was 9.5% lower when 6%+ of the LSOA population identified as Muslim relative to 0%.

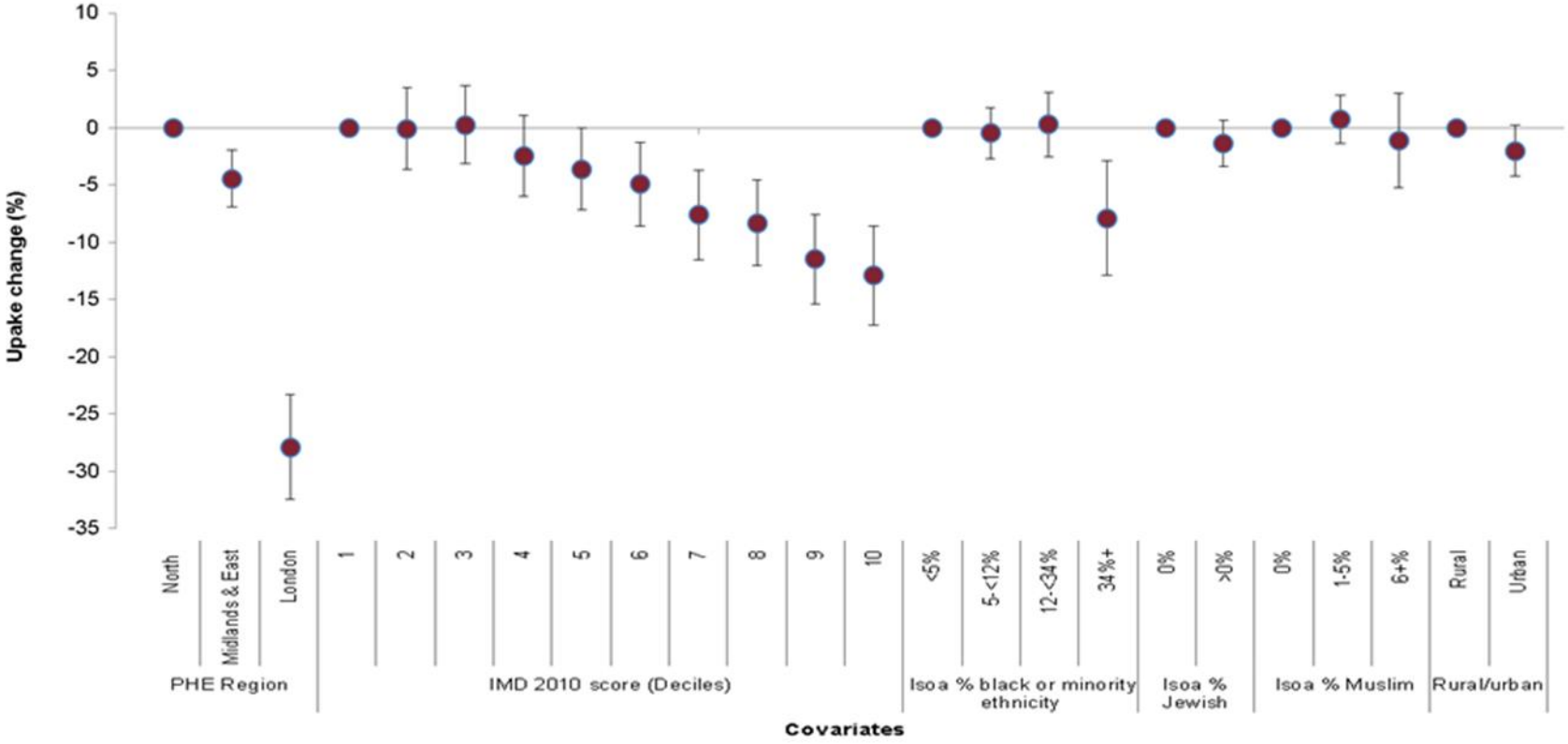
After adjusting for all area level characteristics in the multivariable regression analysis (Table 5, Figure 4) PHE region and deprivation score were significant factors for lower uptake along with ethnicity. Vaccine uptake was 27.9% lower in London compared to the North of England. Deprivation remained significant, with those in the least deprived decile of deprivation showing uptake 12.9% lower than those in the most deprived decile. Areas with a BME population of 34% or more had 7.9% lower uptake compared to areas with a BME population of <5%. After adjusting for other predictors, Jewish population, Muslim population, and rural vs. urban schools were no longer significant predictors of low uptake.

Table 5. Vaccine uptake unadjusted/adjusted impact on uptake determined through linear regression for children schools years 1 to 6 age in pilot areas across England, 1 September 2015 to 31 January 2016

Covariate		Number of children	Crude uptake (%)	Unadjusted		Adjusted (R2= 23.5%)[a]	
				Estimated % uptake change (95% CI)	p-value[a]	Estimated % uptake change (95% CI)	p-value
PHE Region of School	North	17,809	56.3	Baseline		Baseline	
	Midlands and East	101,301	58.4	-0.90 (-3.19 to 1.38)	0.439	-4.47 (-6.95 to -1.99)	<0.001
	London	5,415	34.5	-25.27 (-29.83 to -20.72)	<0.001	-27.88 (-32.48 to -23.28)	<0.001
IMD 2010 Score of school (decile)	Least deprived	13,814	63.5	Baseline		Baseline	
		14,862	60.6	-1.41 (-5.24 to 2.42)	0.471	-0.09 (-3.64 to 3.45)	0.958
		17,492	61.3	-0.74 (-4.46 to 2.97)	0.696	0.25 (-3.17 to 3.67)	0.885
		13,464	59.3	-2.43 (-6.28 to 1.42)	0.216	-2.46 (-6.02 to 1.10)	0.175
		11,941	58.4	-3.83 (-7.71 to 0.05)	0.053	-3.60 (-7.17 to -0.03)	0.048
		12,347	56.9	-5.60 (-9.59 to -1.60)	0.006	-4.93 (-8.61 to -1.25)	0.009
		9,953	53.3	-9.12 (-13.36 to -4.88)	<0.001	-7.62 (-11.55 to -3.70)	<0.001
		12,626	49.8	-10.97 (-13.35 to -4.88)	<0.001	-8.31 (-12.03 to -4.58)	<0.001
		11,171	49.8	-13.58 (-17.72 to -9.43)	<0.001	-11.47 (-15.39 to -7.54)	<0.001
	Most deprived	6,855	46.5	-12.83 (-17.27 to -8.38)	<0.001	-12.91 (-17.22 to -8.59)	<0.001
School Isoa % black or minority ethnicity	<5%	45,099	61.2	Baseline		Baseline	
	5 to <12%	39,902	58.7	-2.87 (-5.00 to -0.74)	0.008	-0.48 (-2.69 to 1.74)	0.673
	12 to <34%	29,741	52.4	-6.74 (-9.07 to -4.41)	<0.001	0.27 (-2.57 to 3.12)	0.852
	34+ %	9,783	43.5	-14.84 (-18.33 to -11.36)	<0.001	-7.88 (-12.84 to -2.92)	0.002
School Isoa % Jewish	0%	96,675	57.0	Baseline		Baseline	
	>0%	27,850	54.3	-2.26 (-4.41 to -0.11)	0.040	-1.37 (-3.35 to 0.61)	0.176
School Isoa Muslim	0%	32,030	60.5	Baseline		Baseline	
	1 to 5%	76,570	57.1	-2.68 (-4.74 to -0.61)	0.011	0.71 (-1.38 to 2.79)	0.505
	6+%	15,925	46.9	-9.54 (-12.54 to -6.55)	<0.001	-1.10 (-5.22 to 3.02)	0.600
Rural/Urban school	Rural	2,457	60.7	Baseline		Baseline	
	Urban	122,068	56.3	-6. 49 (-8.50 to -4.48)	<0.001	-2.00 (-4.20 to 0.20)	0.075

[a] Adjusted for PHE region, IMD score, Isoa % black or minority ethnicity, Isoa % Jewish, Isoa Muslim, and Rural/Urban school

Figure 4. Adjusted linear regression % uptake change values with corresponding 95% confidence intervals for population-level predictors for children schools years 1 to 6 age in pilot areas across England, 1 September 2015 to 31 January 2016



Consents/refusals/non-responders and contraindications (school years 1 and 2 across England)

Data for consent, refusal and no return information was completed for 84.1% (11,793/14,029) of primary schools reporting vaccine uptake for schools years 1 and 2 (Table 6). Some schools provided solely consent data. Incomplete data where the total number of consents, refusal and no return were not equal to the denominator were not included. The overall consent rate was 59.4% ranging from 46.7% to 100.0%. Overall the percentage of non-returns (30.6%) was greater than the percentage of parent refusals (10.0%).

Table 6. Proportion of primary school children in years 1 and 2 consenting, refusing, and not responding to vaccination in schools that provided consent, refusal and no return data within England, 1 September 2015 to 31 January 2016

Area team[a]	Number of chidlren eligible for influenza vaccine (Denominator)[b]	Consented[c] (%)	Refused (%)	No return (%)
Arden, Herefordshire and Worcestershire	76	100.0	0.0	0.0
Birmingham and the Black Country	67,324	52.9	10.1	37.0
Bristol, North Somerset, Somerset and South Gloucestersh	16,784	52.0	2.7	45.3
Cheshire, Warrington and Wirral	12,677	65.6	8.6	25.8
Cumbria, Northumberland, Tyne and Wear	30,349	58.9	4.1	36.9
Derbyshire and Nottinghamshire	23,826	59.9	7.4	32.7
Devon, Cornwall and Isles of Scilly	2,456	51.3	0.0	48.7
Durham, Darlington and Tees	27,833	63.5	7.7	28.8
East Anglia	56,531	60.9	11.7	27.5
Essex	44,054	63.1	7.9	29.1
Greater Manchester	20,778	58.7	7.2	34.1
Hertfordshire and the South Midlands	76,098	60.2	11.3	28.6
Kent and Medway	44,353	63.3	13.2	23.5
Lancashire	35,512	52.3	14.1	33.5
Leicestershire and Lincolnshire	42,427	61.1	8.6	30.3
London	110,750	46.7	11.2	42.1
Merseyside	10,863	57.6	7.7	34.7
North Yorkshire and Humber	37,664	67.0	5.1	27.9
Shropshire and Staffordshire	25,752	67.4	8.5	24.1
South Yorkshire and Bassetlaw	17,769	62.0	8.2	29.8
Surrey and Sussex	25,525	61.8	14.8	23.4
Thames Valley	38,559	62.6	13.6	23.8
Wessex	57,431	76.3	11.4	12.3
West Yorkshire	60,658	56.1	10.4	33.5
Total	**886,049**	**59.4**	**10.0**	**30.6**

[a] Bath, Gloucestershire, Swindon and Wiltshire AT is not included due to solely providing a GP delivery model. All 27 LAs that were excluded from the study are not presented in the table.
[b] Excluding schools with missing or incomplete consent form data Ie ((school denominator) ≠ Σ (consents + refusal + no return))
[c] Including children contraindicated for influenza vaccine

Contraindications and precautions were reported by parents and/or guardians prior to or on the day of vaccination. A total of 0.7% (7,898/1,077,531) of children of school years 1 and 2 age who were offered vaccines through school delivery models across England

from 1 September 2015 to 31 January 2016 were contraindicated. On the day contraindications resulted in 71.1% of all contraindications (Table 7). The 'Child not well' on the day of the vaccination was the highest percentage (16.0%) of all medical related contraindication. Non-medical reasons for children not being vaccinated on the day of vaccination such as child absent or child refused were also recorded by a subset of teams of which 1.2% (12,455/1,077,531) children of school years 1 and 2 age were reported as being absent and 0.3% (2,881/1,077,531) children of school years 1 and 2 age refused vaccination on the day of the session.

Of the contraindications noted prior to the vaccine delivery day, the most common prior contraindications were 'immunosuppression within the family' (n=348) and 'confirmed egg allergy' (n=347) representing 4.4% and 4.4% of all contraindications respectively. Children contraindicated prior to vaccination may either have been referred to their general practice for vaccination or received the quadrivalent inactivated influenza vaccine (Fluarix Tetra) on site.

Table 7. Total prior, on day, other and unknown contraindications to influenza vaccination for children school years 1 and 2 age across England from 1 September 2015 to 31 January 2016

Contraindication	No. of children contraindicated	% of total contraindications
Prior	**1,056**	**13.4**
Immunosupression (family)	348	4.4
Confirmed egg allergy	347	4.4
Severe asthma	127	1.6
Another vaccine given/due	110	1.4
Immunosupression (personal)	63	0.8
Previous allergy to flu vaccine	35	0.4
Cardiac disease/ Salicylate therapy	26	0.3
On Day	**1,318**	**16.7**
On day: Child not well	1,261	16.0
On day: Allergies	57	0.7
Other & Unknown	**5,524**	**69.9**
Other	4,612	58.4
Unknown	912	11.5
Total	**7,898**	**100.0**

Consents/refusals/non-responders and Contraindications (school years 1 to 6 in pilot areas across England)

Data were returned on 92.6% of primary schools reporting vaccine uptake for schools years 1 to 6 (1,221/1,319) in pilot areas with complete information on consents, refusals, and no returns (Table 8). The overall consent rate was 57.7% ranging from 36.8% to 60.7%. Overall there was a greater non return rate than parent refusal rate. Overall the percentage of non-return (35.4%) was greater than the percentage of parent refusals (6.4%).

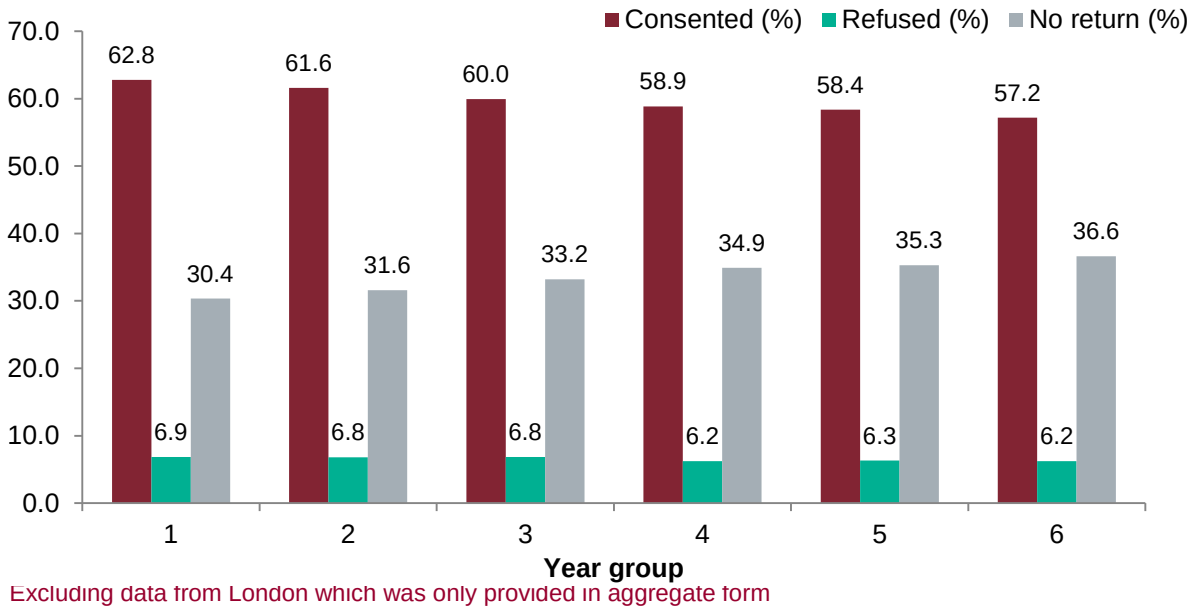
Table 8. Proportion of primary school children in years 1 and 2 consenting, refusing, and not responding to vaccination within England, 1 September 2015 to 31 January 2016

Area team[a]	Number of children eligible for influenza vaccine (Denominator)[b]	Consented[c] (%)	Refused (%)	No return (%)
Cumbria, Northumberland, Tyne and Wear	42,319	57.0	0.0	43.0
Essex	127,737	60.2	7.5	32.1
Leicestershire and Lincolnshire	76,041	60.7	8.6	30.7
London	24,086	36.8	5.5	54.8
Total	**270,183**	**57.7**	**6.4**	**35.4**

[a] Bath, Gloucestershire, Swindon and Wiltshire AT is not included due to solely providing a GP delivery model. All 27 LAs that were excluded from the study are not presented in the table.
[b] Excluding schools with missing or incomplete consent form data Ie ((school denominator) ≠ Σ (consents + refusal + no return))
[c] Including children contraindicated for influenza vaccine

A slight decrease in consent and increase in no return was observed as the year groups increased. Refusal rates remained consistent as the year groups increased (Figure 5).

Figure 5. Estimated number of consent, no return, and refusal rates for children school years 1-6 age in pilot areas within England, 1 September 2015 to 31 January 2016



Excluding data from London which was only provided in aggregate form

Contraindications and precautions were reported by parents and/or guardians prior to or on the day of vaccination. A total of 0.6%% (1,778/275,114) of children of school years 1 to 6 age who were offered vaccines through school delivery models in pilot areas across England from 1 September 2015 to 31 January 2016 contraindicated. On the day contraindications resulted in 76.8% of all contraindications (Table 9). The 'Child not well' on the day of the vaccination was the highest percentage (21.5%) of all medical related contraindication. Children contraindicated prior to vaccination may either have been referred to their general practice for vaccination or received the quadrivalent inactivated influenza vaccine (Fluarix Tetra) on site. Non-medical reasons for children not being vaccinated on the day of vaccination such as child absent or child refused were also recorded by a subset of teams of which 1.4% (3,741/255,114) children of school years 1 to 6 age in pilot areas were reported as being absent and 0.2% (505/275,114) children of school years 1 to 6 age in pilot areas refused vaccination on the day of the session.

Of contraindications noted prior to the vaccine delivery day, the most common prior contraindications were 'immunosuppression within the family' (n=20) and 'confirmed egg allergy' (n=20) representing 0.3% and 0.3% of all contraindications respectively.

Table 9. Total prior, on day, other and unknown contraindications to influenza vaccination for children school years 1- to 6 age across England from 1 September 2015 to 31 January 2016

Contraindication	Number of children contraindicated	% of total contraindications
Prior	**63**	**3.5**
Confirmed egg allergy	20	1.1
Immunosupression (family)	20	1.1
Immunosupression (personal)	12	0.7
Severe asthma	6	0.3
Cardiac disease/ Salicylate therapy	3	0.2
Previous allergy to flu vaccine	2	0.1
Another vaccine given/due	0	0.0
On Day	**391**	**21.9**
On day: Child not well	385	21.5
On day: Allergies	6	0.3
Other & Unknown	**1,334**	**74.6**
Unknown	977	54.6
Other	357	20.0
Total	**1,788**	**100.0**

Discussion

The 2015 to 2016 influenza season saw the successful extension of the national childhood influenza vaccination programme to children of years 1 and 2 age across England. Promising uptake levels were achieved across most areas in children of school years 1 and 2 age, demonstrating the feasibility of rolling out the programme to further year groups nationally.

For children years 1 and 2 age vaccine uptake was found to be the lowest in London and highest in North Yorkshire and Humber.

For the Pilot areas, vaccine uptake varied by year group, which was also observed during the 2013 to 2014 and 2014 to 2015 influenza seasons[3, 4]. Vaccine uptake decreased as the year groups increased in age. Among all pilot areas the lowest vaccine uptake was in London and the highest vaccine uptake was in Greater Manchester.

Analysis on the ecological predictors of uptake suggest that low uptake children of school years 1 and 2 age is significantly and independently associated with deprivation and ethnicity, with the lowest uptake being reported in the most deprived decile of deprivation or areas with a larger BME population. Areas identifying with the Muslim faith reported significantly lower uptake in children school year 1 and 2 age. These results are similar to those found in the first year of the pilot vaccination programme in 2014 to 2015[4] where areas with 6+% had 5.8% lower vaccine uptake for children ages 4-11 years in pilot areas across England.

Ecological analysis of children school years 1 to 6 age in pilot areas indicate that lower uptake is significantly and independently associated with PHE region, deprivation and ethnicity, with the lowest uptake being reported in London, areas in the most deprived decile of deprivation or in areas with larger BME population. The level of association between vaccine uptake and deprivation and ethnicity are similar to those found in the first year of the pilot vaccination programme in 2013 to 2014[3] and in 2014 to 2015[4]. Areas identifying with Muslim or Jewish faith were not significantly associated with lower uptake in children school year 1 to 6 age. Comparing to the 2014 to 2015 season pilot areas, areas with Muslim and Jewish faith were independently associated with lower vaccine uptake.

Consent, refusal and non-response rates for children school years 1 and 2 age indicate that consent rates, refusal rates and no return rates varied among the different AT. The overall no return rate was 30.6%. A reduction in no return would increase the overall consent and vaccine uptake.

Among the pilot areas, consent, refusal, and non-response rates indicate that decreasing uptake appears to be linked mainly to an increase in non-response rates and a decrease in consent forms as school year group age increases. These differences in response and refusal rates may be a reflection of parental perceptions of the importance of influenza vaccination for older children. Younger children are typically more likely to suffer complications from influenza than older children, and are therefore a higher risk group[12, 13]. Further work is required to understand and address these differences.

Data on contraindications were variable in children schools year 1 and 2 age and in children ages 1-6 in pilot areas. Most contraindications occurred on the day of the vaccination campaign and the most common contraindication was child not well on the day of the campaign. The most common contraindications reported prior to the day of vaccination were ‘immunosuppression of a family member’ and ‘egg allergy’ in both pilot and non-pilot areas.

The childhood influenza vaccination programme continues to show promising uptake levels with population level impact of the programme in terms of prevention of influenza as the roll out of the campaign progresses[13]. The programme is continually strengthened through the further roll out of the programme, which is seeing a further extension in the 2016 to 2017 season. From October 2016 all children of school years 1, 2, and 3 age in England have been offered LAIV vaccination mainly through a school-based programme. As seen in previous years, all children aged two, three, and four years on 31 August 2016 have been offered influenza vaccination through GPs. Additionally the five pilot areas that have been piloting the primary school vaccination programme over the past two seasons have continued to offer LAIV to all primary school-age children. The evaluation of the season will continue to inform the best strategy to roll out influenza vaccination to all target ages in seasons to come.

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Annexes

Annexe A: Year Group Cohort Definitions

Academic Year Group	Age range 1st Sept. 2015	Birth Date Range	
		Born From	Born To
1	Age 5-6	01/09/2009	31/08/2010
2	Age 6-7	01/09/2008	31/08/2009
3	Age 7-8	01/09/2007	31/08/2008
4	Age 8-9	01/09/2006	31/08/2007
5	Age 9-10	01/09/2005	31/08/2006
6	Age 10-11	01/09/2004	31/08/2005

Annexe B: End of season data collection variables

Category	Data Type	Description
School URN	Count (interger)	Department of Education's register of educational establishments in England and Wales school specific URN code (Edubase)
School name	Categorical (School Name)	LA Registered School Name
Year group	Categorical (1-6)	Year group cohorts as defined in Annexe A.
Denominator (provisional pre-filled LEA figures)	Count (interger)	The PROVISIONAL denominator is based on the January 2016 Department of Education school census figures and is therefore only a PROVISIONAL estimate of the total no. of children eligible for influenza vaccination in the LA geography. This denominator should be updated with the Actual denominator.
Denominator (actual if different)	Count (interger)	The ACTUAL denominator will replace the PROVISIONAL denominator and should reflect the total no. of children eligible for influenza vaccination in the LA geography based on school roll figures as reported directly by schools (including home school students in the LA.)
Difference if amended	Count (interger)	Difference between the actual and provisional denominators
Parental consent total	Count (interger)	Consent forms/parental attendance on the day
Parental refusal	Count (interger)	Consent forms returned indicating refusal for consent
No. Form Returned total	Count (interger)	The number of non-responders through no form returned/non-attendance
No. Vaccinated with one dose of LAIV since 1 September 2015	Count (interger)	Total doses of nasal LAIV vaccine given to children on the day(s) of the vaccine campaign
%	Calculated field =No. vaccinated with one dose LAIV since 1 September 2015 / Denominator (acutal if different)	Percentge uptake
No. vaccinated with one dose of TIV since 1 September 2015	Count (interger)	Total doses of TIV vaccines given to children on the day(s) of the vaccine campaign
%	Calculated field =No. vaccinated with one dose TIV since 1 September 2015 / Denominator (acutal if different)	Percentge uptake
No. that have received flu vaccine since 1 september 2015	Count (interger)	Total doses of all vaccines given to children on the day(s) of the vaccine campaign
%	Calculated field =No. that have received flu vaccine since 1 September 2015 / Denominator (acutal if different)	Percentge uptake
Cosented but not given	Count (interger)	Total number of children that consent but did not receive the vaccine
Total GP referrals	Count (interger)	Total number of children who were referred to the GP for vaccination
No. Yellow Cards Issued	Count (interger)	Total number of children who were issued a yellow card

Annexe B: End of season data collection variables

Contraindications	Data Type	Description
Total No. of contraindications	Count (interger)	Total number of children with contraindications
Previous allergy to flu vaccine	Count (interger)	Total number of children who have an allergy to flu vaccine
Egg Allergy	Count (interger)	Total number of children who have an egg allergy
Severe asthma	Count (interger)	Total number of children who have severe asthma
Another live vaccine given/due	Count (interger)	Total number of children who have/had another live vaccine due/given
Immunosupression (personal)	Count (interger)	Total number of children with an immunosupression
Immunosupression (family)	Count (interger)	Total number of children who have a family member with an immunosupression
Cardiac disease/ salicylate therapy	Count (interger)	Total number of children with a cardiac disease/ salicylate therapy
On day: child unwell	Count (interger)	Total number of children who were unwell on the day of the vaccination campaign
On day: child absent	Count (interger)	Total number of children who were absent on the day of the vaccination campaign
On day: child refused	Count (interger)	Total number of children who refused the vaccine on the day of the vaccination campaign
On day: allergies	Count (interger)	Total number of children who had allergies on the dat of the vaccination campaign
Other	Count (interger)	Other contraindications not previously stated
Comments	Text	Comments

Annexe C: Table of Local Authorities that were not included in the study due to missing data, or having a GP or Pharmacy mode of delivery.

Area Team	Local Authority
Missing Data	
Cheshire, Warrington and Wirral	Cheshire West
	Cheshire East
Cumbria, Northumberland, Tyne and Wear	Northumberland
	North Tyneside
London	Islington
	Haringey
	Southwark
	Lambeth
	Newham
	Richmond*
Merseyside	Liverpool
	Sefton
South Yorkshire and Bassetlaw	Barnsley
	Sheffield
	East Sussex
Surrey and Sussex	Surrey
GP mode of delivery	
Bath, Gloucestershire, Swindon and Wiltshire	Bath and North East Somerset
	Gloucestershire
	Swindon
	Wiltshire
Devon, Cornwall and Isles of Scilly	Devon
	Kernow (Cornwall and Isles of Scilly)
	Plymouth
Thames Valley	Oxfordshire
Pharmacy mode of delivery	
Bristol, North Somerset, Somerset and South Gloucestershire	Bristol, City Of
	South Gloucestershire

* Richmond provided data which were unable to be used for the analyses

Annexe D: Number of schools that did not submit any data or had submitted data where the numerator was greater than the denominator.

Area Team	Local Authority	No. schools with blank data	No. of schools where numerator was greater than denomiator
Derbyshire and Nottinghamshire	Notingham	1	-
	Derbyshire	-	2
	Nottinghamshire	-	5
Hertfordshire and the South Midlands	Northamptonshire	-	2
London	Barking and Dagenham	-	1
	Ealing	-	4
	Havering	-	1
	Lewisham	1	-
	Tower Hamlets	44	-
	Waltham Forest	-	1
North Yorkshire and Humber	Kingston upon Hull, City Of	-	1
	North Yorkshire	-	42
	York	-	2
Shropshire and Staffordshire	Shropshire	-	34
	Telford and Wrekin	-	5
South Yorkshire and Bassetlaw	Doncaster	-	1
Total		**46**	**101**