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Seasonal influenza vaccine uptake in children of primary school age: Winter season 2017 to 2018

Final data for 1 September 2017 to 31 January 2018

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Key points

This report describes the final influenza vaccine uptake and ecological predictors for vaccine uptake for the paediatric influenza vaccination programme targeted at children of primary school age in England from 2017 to 2018.

Providers returned school level vaccine uptake data for a total of 133 Local Authorities in England, covering all 14 Local NHS England teams on administered from 1 September 2017 to end of 31 January 2018.

Cumulative school level vaccine uptake from 1 September 2017 to 31 January 2018 for the national programme in England was:

- 58.3% (1,754,584/3,008,729) in children in reception to year 4 across England
- 61.3% (186,287/303,842) in children in reception to year 6 in pilot areas across England with a pattern of decreasing uptake with increase age

Results from ecological population level predictors of uptake analyses indicate:

- vaccine uptake is significantly and independently associated with increasing deprivation, ethnicity and areas with the largest Muslim populations
- after adjusting for a range of risk factors, the largest effects were seen for deprivation and ethnicity; uptake in the most deprived decile was 17.6% lower than the least deprived decile and uptake in populations with the highest ethnicity had a 10.2% lower uptake than those with the lowest ethnicity levels
- areas with the largest (≥6%) Muslim population had a lower uptake than non-Muslim populations before and after risk adjustment
- pilot areas had a significantly higher uptake than non-pilot areas before and after risk adjustment

Background

Seasonal influenza is a very common infection among infants and children. Healthy children under 5 years of age have the highest influenza hospital admission rates compared to other age-groups[1]. The United Kingdom (UK) has a long standing influenza vaccination programme targeting for all those 65 years and over, those under 65 years in a clinical risk group, and pregnant women. The influenza vaccine programme was extended to include children, following the recommendations of the Joint Committee on Vaccination and Immunisation (JCVI) in 2012. From the 2013/14 season, a phased paediatric influenza vaccination programme was introduced in England involving a new cohort being introduced each season to eventually cover all children 2-16 years of age[2].

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 2 and 3 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) that ran in 7 geographically distinct areas. Pilot regions offered LAIV to healthy and at-risk children in whom the vaccine was not contraindicated. The pilots achieved a final overall uptake of 52.5%, ranging from 35.8% to 71.5% between individual pilot areas[3].

Since 2013 to 2014, the national programme has been extended annually to include additional school year cohorts. In 2016 to 2017, children aged 2-4 years were offered the vaccine through GP practices and all children in England of school years 1, 2 and 3 age were offered influenza vaccine primarily through school delivery models. Children in school years 1 to 6 (ages 4 to 11 years) in 5 selected pilot areas were also offered the vaccine. The overall uptake in school years 1, 2 and 3 was 55.4%, while the overall uptake in pilot areas for children in school years 1-6 was 60.3%[4].

During the 2017 to 2018 season, the programme was extended to include children in reception (ages 4 rising to 5 years) and in school year 4 (ages 8 rising to 9 years) through school delivery models (Annexe A). Children aged 2-3 years old were offered the vaccine through GP practices. 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 Local Authority (LA). At the end of the influenza season, final vaccination data was collected at school-level across England and submitted to PHE including additional information on consents, refusals, and contraindications. The final school-level data were used to evaluate influenza vaccine uptake and for analyses on various predictors of vaccine uptake.

Methods

End of season data for 2017 to 2018 were collected at the school-level and submitted to PHE between May-June 2018. This is an enhanced data collection incorporating mandatory data items on influenza uptake included in routine reporting, and additional vaccine and census based population data items. The majority of data providers collecting data at the school levels used a standardised data collection tool developed by PHE. This allows data to be entered for each child in the school. The tool aggregates the child level data into school totals per LA. Only the school totals per LA is sent to PHE for onward analysis. The end of season data items requested for this study are outlined in Annex B.

Uptake

End-of-season programme uptake was calculated based on the number of children in the target population who were reported to have received one dose of influenza vaccine during the campaign period (1 September 2017 until 31 January 2018). Second doses were not counted. The target population was defined as the number of primary school age children (aged 4-8, rising to 9 years) born between 1 September 2008 and 31 August 2013 eligible for vaccination across England as well as the number of primary school age children (4-11 years, but not older) born between 1 September 2006 to 31 August 2013 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 GeoConvert: UK Data Service Census Support tool to various predictors census 2011 census Office for National Statistics (ONS)[5].

Data on religion, ethnicity, age and sex, by Lower Super Output Area level (LSOA) were downloaded from Nomis (a web service commissioned by ONS)[6]. Religion and ethnicity predictors were included in a regression model to evaluate their association with influenza vaccine uptake for those aged 0 to 15 years old.

Each LSOA is associated with a postcode and comprised a resident population range of 1,000 – 3,000[7]. The Index of Multiple Deprivation (IMD) is an overall score assigned to each LSOA summarising its relative level of deprivation based on 7 topic areas: income, employment, health, education, crime, service access and living environment[8]. The 2015 updated 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 black or minority ethnic residents (BME, defined as non-white British) in each LSOA was divided into quartiles.

Information on the religious constitution of each LSOA is available for Christian/Buddhist/Hindu/Jewish/Muslim/Sikh/Other/None[9] as reported in the original 2011 census. Populations that reported as belonging to the Jewish and Muslim faiths were also of interest due to concerns over the use of porcine gelatine in the vaccine. As 95% of schools were in an area where Jewish communities accounted for less than 1% of the local population, LSOAs identifying as were grouped according to whether the percentage of the local population of Jewish faith fell into one of 2 demographic groups: 0% or >0). Similarly, LSOAs were grouped according to whether the percentage of the Muslim population fell into one of 3 demographic groups: 0%, 1-5% and 6%+ groups.

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 identify population factors associated with influenza vaccine 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. All the variables 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], as well for the previous 3 influenza vaccine uptake reports[11-13].

Consent, refusal, refused by previously vaccinated 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.

Refused but previously vaccinated: Calculated from the number of forms returned refusing the vaccine because the child has been previously vaccinated during the current influenza season, divided by the final denominator for that year group.

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 based on the risk groups clinically outlined in Green Book[14]. The number of children contraindicated for vaccination were recorded and aggregated by risk group.

Contraindications were split into 2 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 areas 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 the data returned between the school cohorts in 2017/18 and those in the 2015 to 2016, 2016 to 2017 among children school years reception to 4 in England. The same was found in pilot areas.

Reception to year 5 across England

For this study, data for Bassetlaw and Nottinghamshire were collected independently thus resulting in 2 separate LAs. Additionally, due to small numbers data for City of London and Hackney were merged as well as for Leicestershire and Rutland, and Cornwall and the Isles of Scilly resulting in 3 LAs contributing to the total of 150 LAs. The Isles of Scilly was the only LA that used a GP delivery model and therefore was not included in this study. However, school level data were submitted for Cornwall and analysed in this study. Some school entries were excluded due to missing information for one or more variables included in the study or when the numerator was greater than the denominator (Annex D). Some schools also returned data for years reception, 1, 2, 3 and 4 combined; therefore these schools were only assessed when combining all school years. Data for children in reception in Rutland, Leicestershire and Leicester were combined with data from foundation years and therefore could not be included in the analyses.

Pilot areas

All pilot area data with the exception for Sunderland LA were returned. Data for children in reception in Rutland, Leicestershire and Leicester was combined with data from foundation years and therefore could not be included in the analyses.

Uptake predictors

For the linear regression analysis of children in school years reception to 4, a total of 13,307 of the 16,680 (79.8%) school-level data by age cohort were used. A total of 3,170 were unable to be matched to LSOA classification and, therefore, could not be used for analysing uptake predictors. A further 203 schools were unable to be matched due to having a zero as a denominator. Although not indicated, these schools were most likely catch-up clinics or home-educated students who were not vaccinated in during the school campaign.

For the linear regression analyses of children in school years reception to 6 in pilot areas, a total of 1,005 of 1,202 (83.6%) of schools were used for the analysis.

A total of 6 schools were unable to be matched due to having zero as a denominator. A further 191 schools were unable to be matched to LSOA classification and, therefore, could not be used for analysing uptake predictors. Although not indicated, these schools were most likely catch-up clinics or home-educated students who were not vaccinated in during the school campaign. All schools were able to be matched to LSOA classification.

Results

Uptake (school years reception to 5 across England)

Based on data from schools delivering the childhood influenza vaccine programme, a total of 88.7% (133/150) LAs returned data. An estimated 1,754,584 of 3,008,729 children in school years reception to 4 in England received the influenza vaccine during the period 1 September 2017 to 31 January 2018 in schools giving an overall uptake of 58.3% in school delivery areas with uptake ranging from 48.1% in London to 70.0% in Wessex (Table 1). Overall vaccine uptake by individual year group was 61.3%, 60.0%, 59.4%, 54.7 % and 54.5% for children in school years reception, 1, 2, 3 and 4 respectively (Annex E).

The Isles of Scilly LA (merged with Cornwall data to create the Kernow LA) use a GP delivery model and therefore were not included in the analyses. School level data was returned for the Cornwall LA and were included in the analyses.

The remaining 11.3% (17/150) LAs used a school delivery model, but did not provide data for the analysis in this report – so excluded. An estimated 62.0% (189,398/ 305,350) of children in school years reception to year 4 in England were reported to have received at least one dose of influenza vaccine during the period of 1 September 2017 to 31 January 2018 in these 17 LAs. This does not include data for Sunderland as they were unable to provide any figures this season.

Table 1. Estimated proportion of children in school years reception to 4 in England vaccinated with the influenza vaccine through a school delivery model. England, 1 September 2017 to 31 January 2018 by NHS England Local Team.

NHS England Local Team[a,b]	LA Response Rate (%)	No. of children eligible for vaccination	No. of children vaccinated with at least 1 dose of influenza vaccine	Vaccine uptake (%)
North	**76.5**	**709,660**	**432,778**	**61.0**
Cumbria and North East	92.3	146,779	90,376	61.6
Lancashire	100.0	90,514	52,689	58.2
Greater Manchester	100.0	184,967	111,379	60.2
Yorkshire and Humber	81.3	266,804	163,917	61.4
Cheshire and Merseyside	11.1	20,596	14,417	70.0
Midlands and East	**97.1**	**995,564**	**575,291**	**57.8**
North Midlands	100.0	215,273	128,964	59.9
Central Midlands	100.0	291,927	157,887	54.1
West Midlands	100.0	277,154	154,830	55.9
East	85.7	211,210	133,610	63.3
London	**100.0**	**521,707**	**251,060**	**48.1**
London	100.0	521,707	251,060	48.1
South	**87.9**	**781,798**	**495,455**	**63.4**
South Central	100.0	226,020	150,854	66.7
South West	62.5	116,999	68,075	58.2
Wessex	85.7	147,491	104,582	70.9
South East	100.0	291,288	171,944	59.0
Total	**88.7**	**3,008,729**	**1,754,584**	**58.3**

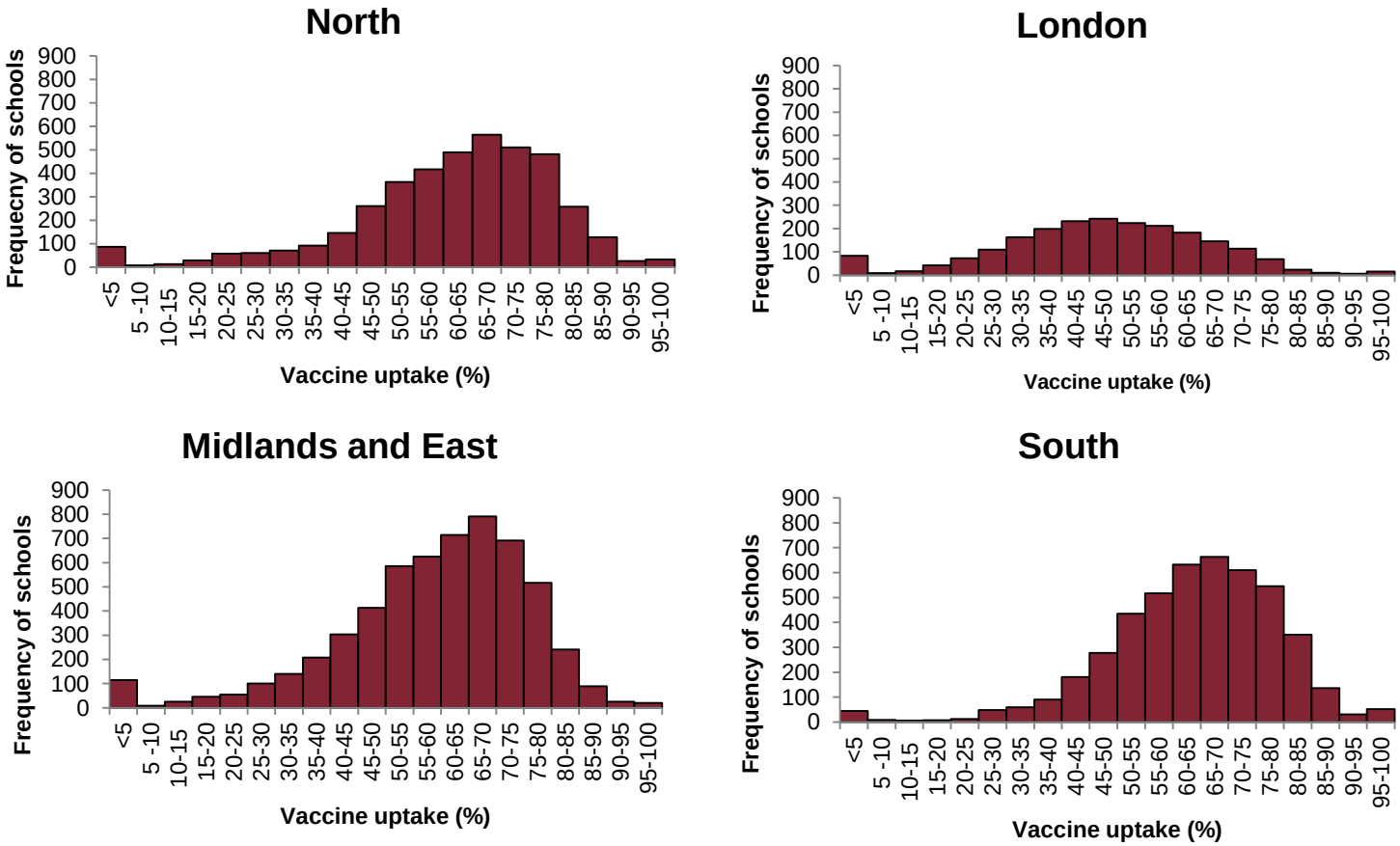
[a] Denominators represent the number of children in school years reception to 4 eligible for vaccination. Denominators are based on school-roll figures obtained directly from schools unless unavailable then Department of Education January 2017 school census figures were used.

[b] A total of 17 LAs that provided vaccinations via a school delivery model did not provide any school level data. A total of 3 LAs provided vaccinations through a GP delivery model and are not included.

Uptake by PHE region

Vaccine uptake for children in school years reception to 4 vaccinated in schools in England varied across the 4 PHE regions. The region median and interquartile range (IQR) are as follows: 64.6% in the North of England (IQR: 52.8% to 73.9%s) based on data from, 4,089 primary schools, 47.9% in London (IQR: 36.2% to 60.4%) based on data from 2,167 schools, 61.4% in the Midlands and East (IQR: 50.0% to 70.9%) based on data from 5,716 schools and 65.2% in South of England (IQR: 55.0% to 74.3%) based on data from 4,709 (Figure 1).

Figure 1. School delivery influenza vaccine uptake for children of school years reception to 4 in all four PHE regions from 1 September 2017 to 31 January 2018.



Predictors of uptake (School years reception to 4 across England)

The results of the unadjusted (univariate) and risk adjusted (multivariable) models are shown in table 2. Figure 2 shows a graphical display of the risk adjusted estimates.

Using available data the risk adjusted model showed that deprivation, ethnicity, and populations belonging to certain religious faiths, rurality, region, and pilot areas all remained independent predictors of lower uptake. The largest effects were seen for deprivation and ethnicity.

Uptake in the most deprived decile was lower than the least deprived decile (baseline group) before and after risk adjustment. Similarly in populations with the highest ethnicity proportion, uptake in that group was considerably lower than those with the lowest ethnicity proportion (baseline) before and after risk adjustment.

LSOAs with the largest (≥6%) Muslim population had a lower uptake than non-Muslim populations before and after risk adjustment.

LSOAs with the highest proportion of Jewish faith residents had a lower vaccine uptake than populations without Jewish residents before and after risk adjustment. However, a borderline significance was reached in the adjusted analyses. Pilot areas had a significantly higher uptake than in non-pilot areas before and after risk adjustment.

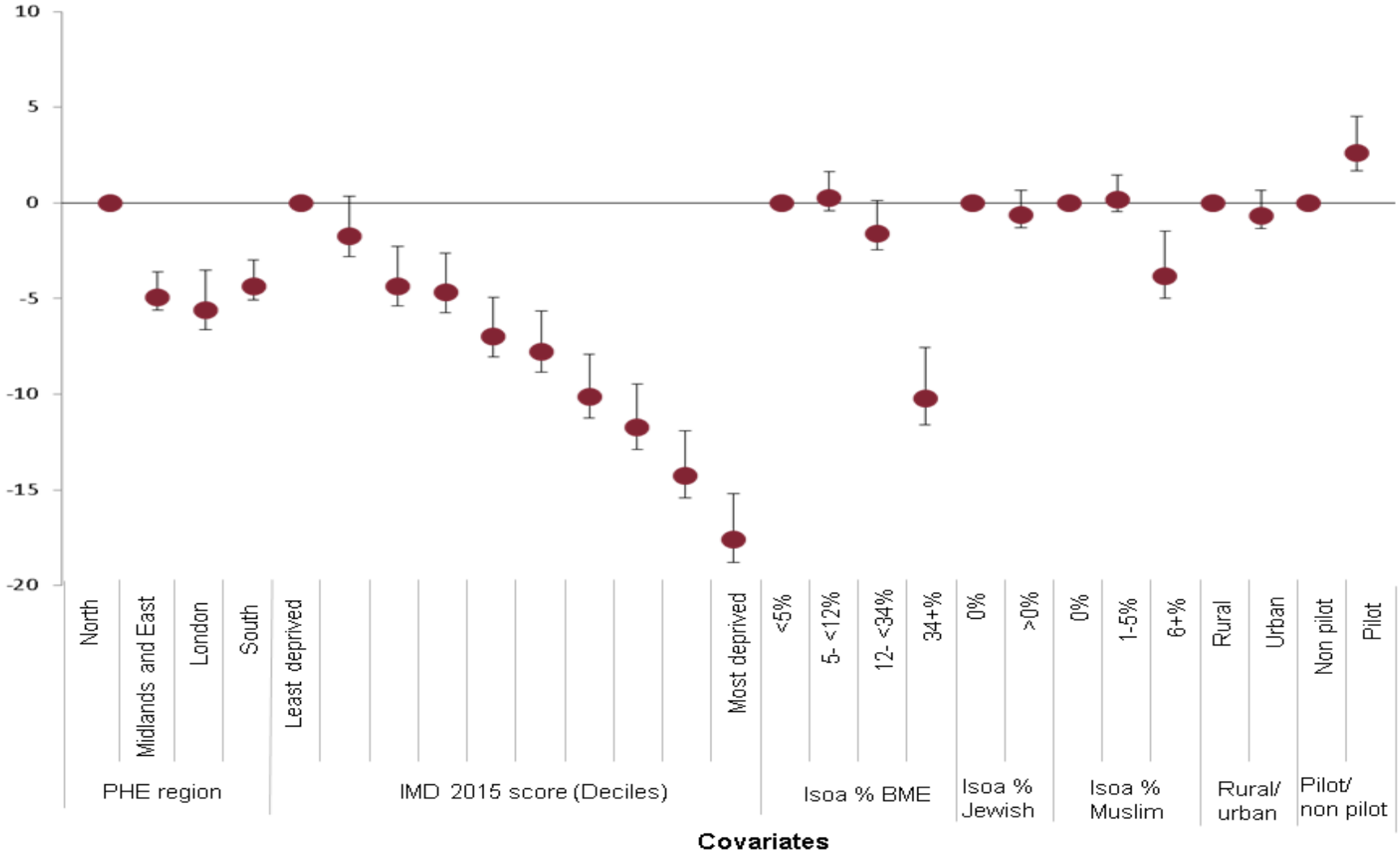
Interestingly, the PHE South region had a marginally higher uptake in the unadjusted analysis but the direction of effect switched after risk adjustment (4.4% lower than the North).

Table 2. Vaccine uptake and unadjusted/adjusted impact on uptake determined through linear regression for children of school years reception to year 4 across England, September 1 2017 to 31 January 2018.

Covariate		Number of children	Crude uptake (%)	Unadjusted		Adjusted (R2= 28.7%)[a]	
				Estimated % uptake change (95% CI)	p-value	Estimated % uptake change (95% CI)	p-value
PHE Region of School	North	702,404	61.0	Baseline	-	Baseline	-
	Midlands and East	979,489	58.0	-2.55 (-3.20 to -1.90)	<0.001	-4.94 (-5.61 to -4.28)	<0.001
	London	521,865	48.1	-13.20 (-14.05 to -12.35)	<0.001	-5.60 (-6.64 to -4.57)	<0.001
	South	796,425	63.5	1.31 (0.66 to 1.99)	<0.001	-4.37 (-5.07 to -3.67)	<0.001
IMD 2010 Score of school (decile)	Least deprived	258,430	70.1	Baseline	-	Baseline	-
		245,284	67.4	-1.71 (-2.83 to -0.59)	0.003	-1.76 (-2.82 to -0.73)	0.001
		220,760	65.2	-4.39 (-5.52 to -3.27)	<0.001	-4.35 (-5.40 to -3.30)	<0.001
		238,024	64.0	-5.04 (-6.14 to -3.95)	<0.001	-4.69 (-5.72 to -3.66)	<0.001
		231,292	61.0	-7.71 (-8.82 to-6.61)	<0.001	-6.99 (-8.02 to -5.95)	<0.001
		238,452	58.4	-9.58 (-10.70 to -8.45)	<0.001	-7.78 (-8.84 to -6.72)	<0.001
		215,003	55.6	-12.67 (-13.85 to -11.50)	<0.001	-10.13 (-11.24 to -9.02)	<0.001
		229,787	52.4	-15.66 (-16.85 to -14.47)	<0.001	-11.75 (-12.89 to -10.61)	<0.001
		238,225	48.6	-19.49 (-20.68 to -18.29)	<0.001	-14.26 (-15.43 to -13.09)	<0.001
	Most deprived	238,105	45.5	-22.13 (-23.33 to -20.94)	<0.001	-17.58 (-18.77 to -16.38)	<0.001
School Isoa % black or minority ethnicity	<5%	766,450	65.0	Baseline	-	Baseline	-
	5 to <12%	730,032	64.9	0.41 (-0.19 to 1.01)	0.176	0.26 (-0.42 to 0.94)	0.455
	12 to <34%	763,459	60.1	-4.52 (-5.14 to -3.89)	<0.001	-1.60 (-2.46 to -0.73)	<0.001
	34+ %	740,242	43.4	-19.68 (-20.34 to -19.02)	<0.001	-10.24 (-11.57 to -8.90)	<0.001
School Isoa % Jewish	0%	2,375,348	58.9	Baseline	-	Baseline	-
	>0%	624,835	56.6	-2.10 (-2.74 to -1.46)	<0.001	-0.64 (-1.29 to -0.00)	0.050
School Isoa % Muslim	0%	605,476	65.0	Baseline	-	Baseline	-
	1 to 5%	1,489,509	63.2	-1.32 (-1.88 to -0.76)	<0.001	0.19 (-0.44 to 0.82)	0.555
	6+%	905,198	46.1	-16.90 (-17.56 to -16.24)	<0.001	-3.81 (-4.98 to -2.64)	<0.001
Rural/Urban school	Rural	470,432	66.3	Baseline	-	Baseline	-
	Urban	2,529,751	57.0	-7.40 (-7.96 to -6.83)	<0.001	-0.67 (-1.33 to -0.00)	0.050
Pilot/Non-Pilot	Non-pilot	2,785,509	58.1	Baseline	-	Baseline	-
	Pilot	214,674	63.1	3.89 (2.90 to 4.87)	<0.001	2.62 (1.67 to 3.57)	<0.001

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

Figure 2. Adjusted linear regression percent uptake change values with corresponding 95% confidence intervals for population-level predictors for children in school years reception to year 4 in England, 1 September 2017 to 31 January 2018.



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

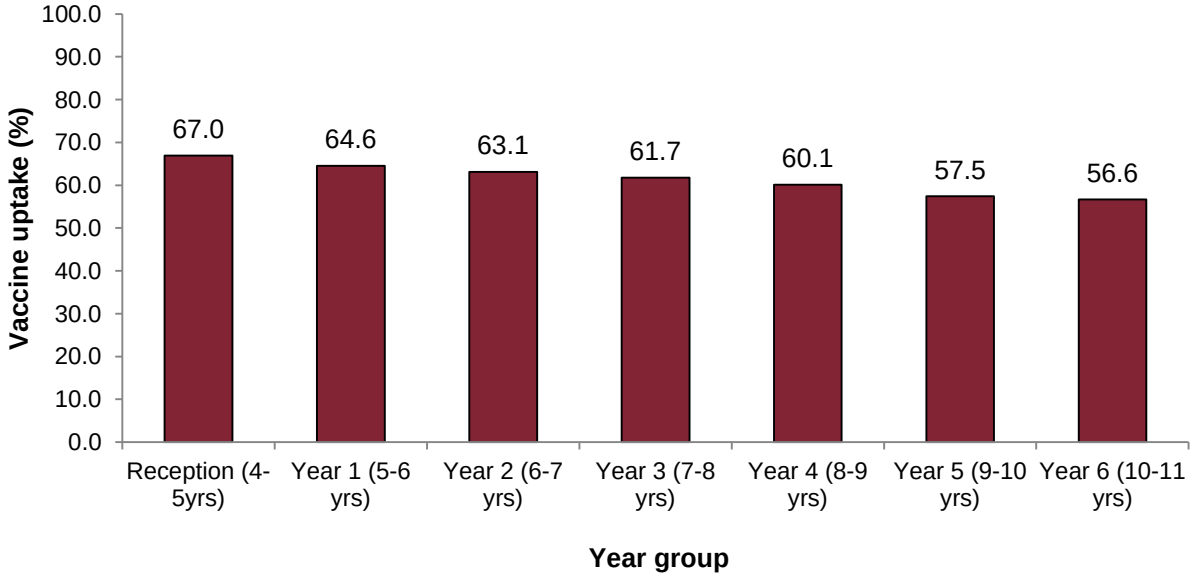
An estimated 186,287 children in school years reception to 6 in England out of 303,842 eligible received the influenza vaccine during the period 1 September 2017 to 31 January 2018 in schools (Table 3). Overall uptake for children in school years reception to 6 vaccinated in schools was 61.3%, ranging from 55.8% in London to 66.4% in Greater Manchester (Table 3). Vaccine uptake in the pilot areas ranged from 67.0% in reception to 56.6% in year 6, with overall decreasing uptake with increasing age (Figure 3, Annex F).

Table 3. Estimated proportion of children in school years reception to 6 by pilot area with the influenza vaccine. England, 1 September 2017 to 31 January 2018.

Pilot area	LAs responding (%)[a]	No. of children eligible for vaccination	No. of children vaccinated with at least 1 dose of influenza vaccine	Vaccine uptake (%)
Cumbria, Northumberland, Tyne and Wear	66.7	27,558	16,401	59.5
Essex	100.0	156,452	99,458	63.6
Greater Manchester	100.0	17,380	11,539	66.4
Leicestershire and Lincolnshire	100.0	80,018	46,368	57.9
London	100.0	22,434	12,521	55.8
Total	**90.9**	**303,842**	**186,287**	**61.3**

[a]Excluding data for the reception cohort for Rutland, Leicestershire and Leicester and all data in Sunderland.

Figure 3. Estimated proportion of children in school years reception to 6 in pilot areas across England vaccinated with at least one dose of influenza vaccine by year group from 1 September 2017 to 21 January 2018[a]



[a]Excluding data for the reception cohort for Rutland, Leicestershire and Leicester and all data in Sunderland.

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

Results from univariate and multivariable analysis are shown in Table 4 based on data for children in school years reception to 6. A decreasing trend in vaccine uptake with increasing deprivation, and with increasing Muslim and ethnic populations was observed. Vaccine uptake decreased in areas with ethnic population of 34 +%, with uptake being 21.08% lower in areas with <5% ethnic populations. London had a 6.06% lower vaccine uptake compared to the North of England while there was no significant difference in vaccine uptake in the Midlands and East compared to the North of England.

After risk adjustment, the largest effects were seen for deprivation and ethnicity (Table 4, Figure 4). Uptake in the most deprived decile was lower than the least deprived decile (baseline group) before and after risk adjustment. Similarly in populations with the highest ethnicity proportion, uptake in that group had a considerably lower vaccine uptake than those with the lowest ethnicity proportion (baseline) before and after risk adjustment.

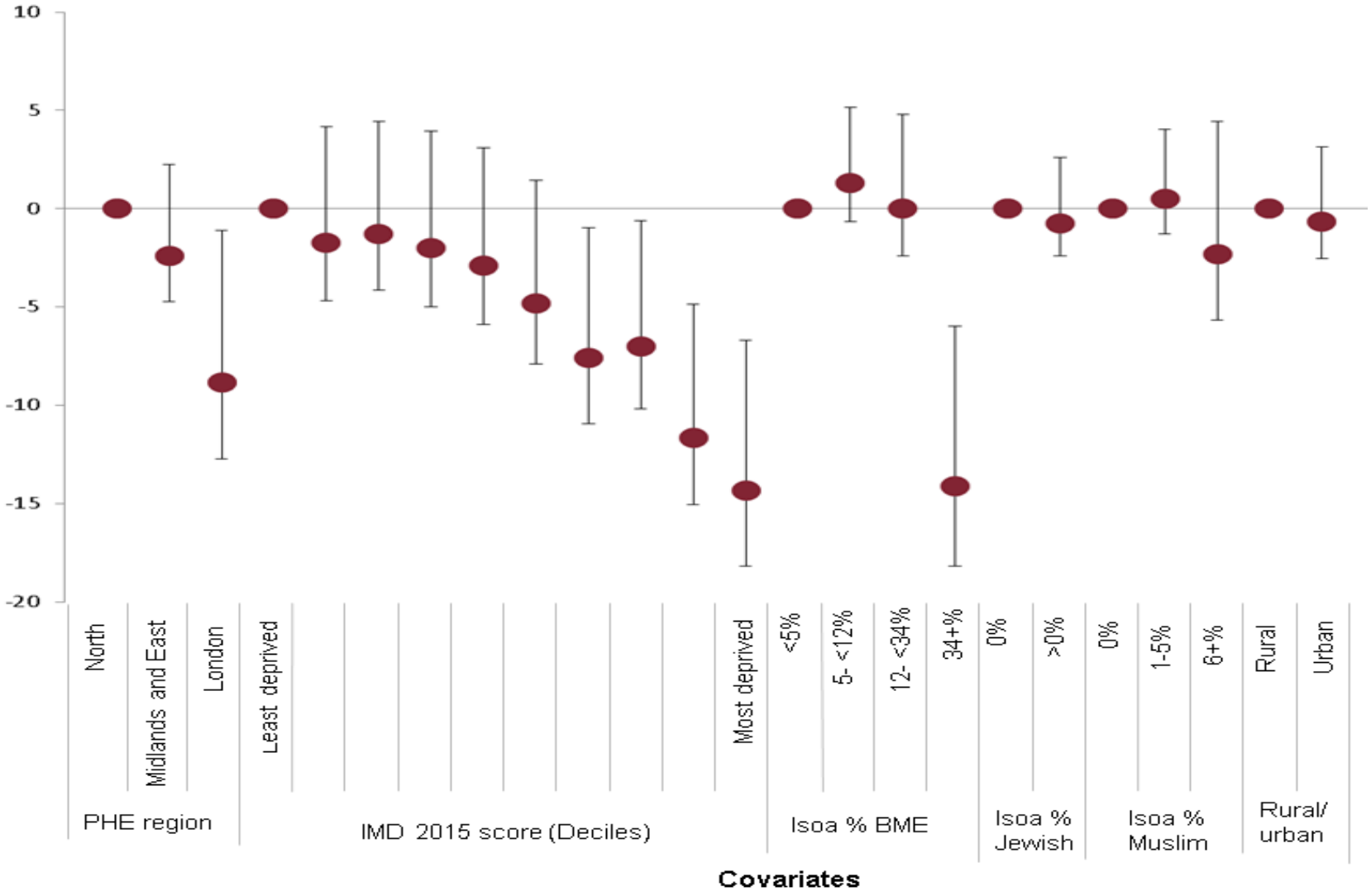
Uptake was associated with region before and after risk adjustment, where uptake was significantly lower in London than the Midlands and East and the North of England. Finally, there was no significant difference in vaccine uptake among religious beliefs after the risk adjustment.

Table 4. Vaccine uptake and unadjusted/adjusted impact on uptake determined through linear regression for children of school years reception to year 6 in pilot areas across England, September 1 2017 to 31 January 2018.

Covariate		Number of children	Crude uptake (%)	Unadjusted		Adjusted (R2= 22.8%)[a]	
				Estimated % uptake change (95% CI)	p-value	Estimated % uptake change (95% CI)	p-value
PHE Region of School	North	31,374	61.4	Baseline	-	Baseline	-
	Midlands and East	202,284	61.9	0.41 (-2.01 to 2.82)	0.741	-2.39 (-4.71 to -0.07)	0.043
	London	15,947	56.3	-6.04 (-10.20 to -1.87)	0.005	-8.85 (-12.73 to -4.97)	<0.001
IMD 2010 Score of school (decile)	Least deprived	24,246	69.1	Baseline	-	Baseline	-
		29,561	66.0	-2.64 (-5.81 to 0.53)	0.103	-1.73 (-4.67 to 1.21)	0.249
		32,727	66.1	-1.96 (-5.05 to 1.13)	0.214	-1.29 (-4.16 to 1.57)	0.375
		26,289	63.7	-2.64 (-5.84 to 0.57)	0.107	-2.01 (-4.98 to 0.97)	0.186
		23,658	63.8	-4.04 (-7.28 to -0.80)	0.014	-2.90 (-5.90 to 0.09)	0.058
		24,509	61.4	-6.54 (-9.91 to -3.16)	<0.001	-4.80 (-7.92 to -1.68)	0.003
		21,131	59.0	-9.12 (-12.67 to -5.57)	<0.001	-7.61 (-10.93 to -4.29)	<0.001
		27,845	56.1	-10.48 (-13.86 to -7.11)	<0.001	-7.00 (-10.20 to -3.80)	<0.001
		24,040	53.7	-14.90 (-18.43 to -11.37)	<0.001	-11.65 (-15.05 to -8.26)	<0.001
	Most deprived	15,599	49.0	-17.99 (-21.93 to -14.06)	<0.001	-14.36 (-18.20 to -10.53)	<0.001
School Isoa % black or minority ethnicity	<5%	68,481	65.2	Baseline	-	Baseline	-
	5 to <12%	78,325	65.5	0.27 (-1.51 to 2.05)	0.766	1.29 (-0.65 to 3.23)	0.193
	12 to <34%	76,738	59.8	-4.83 (-6.68 to -2.98)	<0.001	-0.01 (-2.41 to 2.40)	0.996
	34+ %	26,061	44.5	-21.08 (-23.88 to -18.28)	<0.001	-14.11 (-18.19 to -10.04)	<0.001
School Isoa % Jewish	0%	185,452	61.4	Baseline	-	Baseline	-
	>0%	64,153	61.6	0.28 (-1.58 to 2.13)	0.770	-0.73 (-2.40 to 0.93)	0.389
School Isoa % Muslim	0%	56,366	65.5	Baseline	-	Baseline	-
	1 to 5%	153,635	63.0	-1.41 (-3.14 to 0.31)	0.109	0.50 (-1.27 to 2.27)	0.578
	6+%	39,604	49.7	-14.47 (-16.98 to -11.95)	<0.001	-2.31 (-5.69 to 1.06)	0.179
Rural/Urban school	Rural	47,761	66.4	Baseline	-	Baseline	-
	Urban	201,844	60.3	-5.37 (-7.10 to -3.64)	<0.001	-0.65 (-2.55 to 1.25)	0.504

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

Figure 4. Adjusted linear regression percent uptake change values with corresponding 95% confidence intervals for population-level predictors for children in school years reception to year 6 in pilot areas across England, 1 September 2017 to 31 January 2018.



Consent/refusals/non-responders and contraindications (school year's reception to 4 across England)

Data for consent, refusal and no return information was complete for 82.0% (13,674/16,680) of primary schools reporting data for schools years reception to 4 (Table 5). 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 61.8% ranging from 46.5% to 80.1%; with 28.7% of non-returns and 9.4% were parental refusals.

Table 5. Proportion of primary school children in school years reception to 4 consenting, refusing and not responding to the vaccination in schools that provided consent, refusal and no return data within England, 1 September 2017 to 31 January 2018.

NHS Enlgand Local Team[a,b]	Number of children eligible for influenza vaccine (Denominator)[c]	Consented (%)	Refused (%)	Refused but previously vaccinated (%)	No return (%)
Cumbria and North East	145,973	65.5	5.4	0.3	28.9
Lancashire	89,778	61.5	12.8	0.0	25.7
Greater Manchester	5,561	78.0	22.0	0.0	0.0
Yorkshire and Humber	191,777	71.0	5.1	0.0	23.9
Cheshire and Merseyside	20,596	73.0	8.5	0.0	18.6
North Midlands	119,518	67.3	3.2	0.0	29.5
Central Midlands	235,254	46.5	3.5	0.2	49.8
West Midlands	37,342	69.6	11.7	0.0	18.7
East	210,029	65.0	8.5	0.2	26.3
London	499,304	50.5	15.7	0.3	33.5
South Central	225,918	68.7	8.9	0.1	22.3
South West	80,639	64.7	8.8	0.0	26.5
Wessex	143,471	80.1	10.9	0.0	9.0
South East	285,778	63.8	9.6	0.2	26.4
Total	**2,290,938**	**61.8**	**9.4**	**0.2**	**28.7**

[a] Isles of Scilly are not included due to solely providing a GP delivery model. All 16 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/reasons for non-vaccination were reported by parents and/or guardians prior to or on the day of vaccination. A total of 50.4% (8413/16,680) of schools provided information on contraindications/reasons for non-vaccination. Of these schools, a total of 5.9% (95,956 /1,638,476) of children in school years reception to 4 who were offered vaccines through school delivery models across England from

1 September 2017 to 31 January 2018 were contraindicated to receive the influenza vaccine or provided a reason for non-vaccination. Of the contraindications noted prior to the vaccine delivery day, the most common prior contraindications were 'confirmed egg allergy' (n=633) and immunosuppression of a family member (n=511) representing 1.3% and 1.0% of all contraindications/reasons for non-vaccination respectively. Children contraindicated prior to vaccination to receive LAIV may either have been referred to their general practice for vaccination or received the quadrivalent inactivated influenza vaccine (Fluarix Tetra) on site.

On the day contraindications resulted in 9.9% of all contraindications/reasons for non-vaccination (Table 6). 'Child not well' on the day of the vaccination was the highest percentage (7.0%) of all medical related contraindications/reasons for non-vaccination. The total number or known reasons for influenza vaccine refusal was much lower than other or unknown reasons for the vaccine. Some areas that provided contraindication/ reasons for non-vaccination data solely provided total numbers of contraindication/reasons for non-vaccination, thus resulting in a larger proportion of other and unknowns.

Table 6. Total prior, on day and other contraindications/reasons for non-vaccination of the influenza vaccination for children of school years reception to year 4 across England from 1 September 2017 to 31 January 2018.

Contraindication/Reason for non-vaccination	Number of children contraindicated	% of total contraindications
Known contraindications		
Prior	**2,408**	**4.9**
Confirmed egg allergy	633	1.3
Immunosuppression (family)	511	1.0
Previous allergy to flu vaccine	421	0.9
Severe asthma	338	0.7
Another vaccine given/due	282	0.6
Immunosuppression (personal)	180	0.4
Cardiac disease/Salicylate therapy	43	0.1
On day	**4,869**	**9.9**
On day: Child not well	3,445	7.0
On day: Asthma, wheezing	1,424	2.9
Known reasons for refusal: Vaccine contains porcine gelatine	**5,221**	**10.6**
Other and unknown	**36,633**	**74.6**
Total	**49,131**	**100.0**

Consent/refusals/non-responders and contraindications (school years reception to 6 in pilot areas across England)

Data were returned on 70.4% of primary schools reporting vaccine uptake for schools years reception to 6 (846/1,202) in pilot areas with complete information on consents, refusals, and no returns (Table 7). The overall consent rate was 63.7% ranging from 55.8% to 89.7%. Overall there was a greater no return rate than parent refusal rate. Overall the percentage of no returns (28.8%) was greater than the percentage of parent refusals (7.3%).

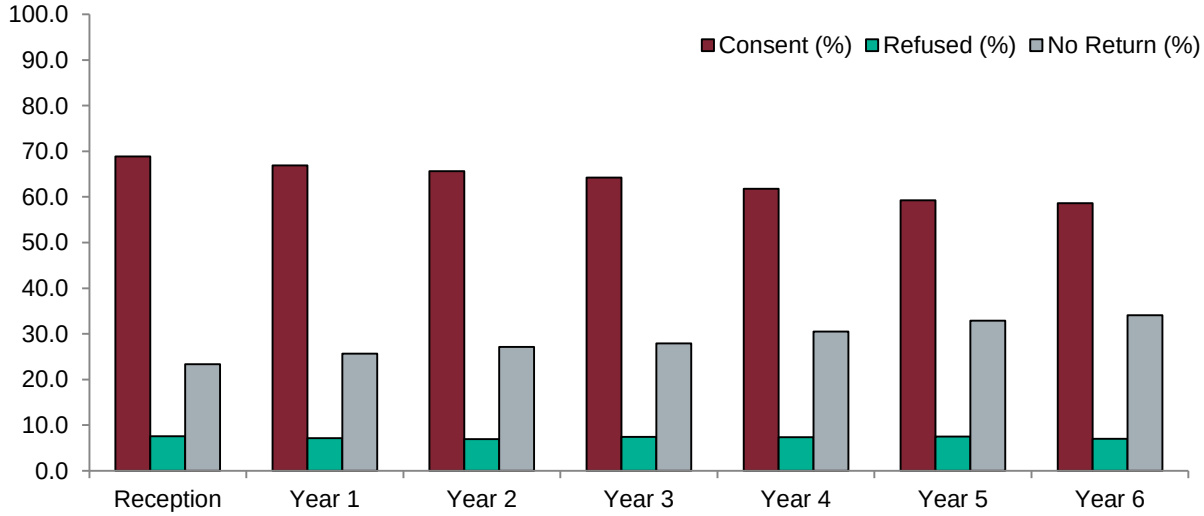
Table 7. Proportion of primary school children in years reception to 6 consenting, refusing, and not responding to vaccination within England, 1 September 2017 to 31 January 2018 in pilot areas.

Area team[a,b]	Number of children eligible for influenza vaccine (Denominator)	Consented (%)	Refused (%)	Refused but previously vaccinated (%)	No return (%)
Cumbria, Northumberland, Tyne and Wear	27,558	62.6	0.0	0.0	37.4
Essex	156,452	64.7	7.8	0.4	27.2
Greater Manchester	802	86.9	13.1	0.0	0.0
Leicestershire and Lincolnshire	1,103	89.7	10.3	0.0	0.0
London	22,434	55.8	12.5	0.0	31.6
Total	**208,349**	**63.7**	**7.3**	**0.3**	**28.8**

a Excluding schools with missing or incomplete consent form data i.e. ((school denominator) ≠ Σ (consents + refusal + no return)).
b Excluding home educated children and children who received vaccines in a mop-up clinic.
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 in school years reception to 6 in pilot areas within England, 1 September 2017 to 31 January 2018.



In pilot areas contraindications/reasons for non-vaccination were reported by parents and/or guardians prior to or on the day of vaccination. A total of 74.7% (898/1,202) of schools provided information on contraindications/reasons for non-vaccination. Of these schools, a total of 3.0% (7,021/236,883) of children in school years reception to 6 who were offered vaccines through school delivery models across England from 1 September 2017 to 31 January 2018 were contraindicated to receive the influenza vaccine or provided a reason for non-vaccination.

Of the contraindications noted prior to the vaccine delivery day, the most common prior contraindications were ‘immunosuppression of a family member’ (n=41), ‘confirmed egg allergy’ (n=37) and severe asthma (n=37), representing 4.5%, 4.0% and 4.0% of all contraindications/reasons for non-vaccination respectively. Children contraindicated prior to vaccination to receive LAIV may either have been referred to their general practice for vaccination or received the quadrivalent inactivated influenza vaccine (Fluarix Tetra) on site.

On the day contraindications resulted in 54.9% of all contraindications/reasons for non-vaccination (Table 8). ‘Child not well’ on the day of the vaccination was the highest percentage (53.4 %) of all medical related contraindications.

The total number or known reasons for influenza vaccine refusal was much lower than other or unknown reasons for the vaccine. Some areas that provided contraindication/ reasons for non-vaccination data solely provided total numbers of contraindication/reasons for non-vaccination, thus resulting in a larger proportion of other and unknowns. Children that were absent or refused the vaccination were also recorded by a subset of the pilot teams of which 1.6% (4921/303,842) children of school

years 1-6 age were reported as being absent and 0.2% (684/303,842) children of school years 1-6 age refused vaccination on the day of the session.

Table 8. Total prior, on day and other contraindications/reasons for non-vaccination of the influenza vaccination for children in school years reception to 6 in pilot areas across England from 1 September 2017 to 31 January 2018.

Contraindication/Reason for non-vaccination		Number of children contraindicated	% of total contraindications
Known contraindications			
Prior		**146**	**13.6**
	Immunosuppression (family)	41	3.8
	Severe asthma	37	3.4
	Confirmed egg allergy	37	3.4
	Immunosuppression (personal)	13	1.2
	Previous allergy to flu vaccine	14	1.3
	Cardiac disease/Salicylate therapy	4	0.4
	Another vaccine given/due	0	0.0
On day		**590**	**54.9**
	On day: Child not well	574	53.4
	On day: Asthma, wheezing	16	1.5
Known reasons for refusal: Vaccine contains porcine gelatine		**117**	**10.9**
Other and unknown		**221**	**20.6**
Total		**1,074**	**100.0**

Discussion

The 2017 to 2018 influenza season saw the successful extension of the national childhood influenza vaccination programme to children in school years reception, 1, 2, 3 and 4 age across England. An overall influenza vaccine uptake of 58.3% was achieved in children in school years reception to year 4, demonstrating the feasibility of rolling out the programme to further year groups nationally.

For children in school years reception to year 4, vaccine uptake at the Local Team level was found to be the lowest in London and highest in Wessex.

For the Pilot areas, vaccine uptake varied by year group, which was also observed during the past 3 influenza seasons[11-13]. Vaccine uptake decreased as the year groups increased in age. Among all pilot areas the lowest vaccine uptake was in London (Havering LA) and the highest vaccine uptake was in Greater Manchester (Bury LA).

The ecological analyses looking at predictors of uptake suggest that low uptake of children in school years reception to year 4 strongly 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 with 6+% or more identifying with the Muslim faith reported significantly lower uptake in children in school years reception to year 4. These results are similar, with some suggestion of improvement over time, to those found in the first year of the pilot vaccination programme in 2013 to 2014[10] and in the past during the past 3 influenza seasons[11-13].

Additionally, a significantly lower vaccine uptake was observed in the Midlands and East, London and the South of England when compared to the North of England, which is similar to last season where vaccine uptake was significantly lower in London and the South of England[13]. When compared to the North of England vaccine uptake was not significantly different in the Midlands and East during the 2016 to 2017 season[13].

Overall, the results indicate that efforts to improve influenza vaccine uptake in children should be targeted to groups of greatest need such as those with highest deprivation and ethnicity. Religious faith is an important area for public health efforts so that the gap between these populations and baseline groups is minimised further.

Ecological analysis based on data from the pilot programme (children in school years reception to year 6) show similar results to the main analysis. The results from this subset of data indicated uptake was significantly and independently associated with deprivation, ethnicity and PHE region. The biggest effects were observed for areas in

the most deprived decile of deprivation or in areas with larger BME population. Geographically, the lowest uptake was reported in London. 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[10], and in the subsequent three seasons[11-13].

Similarly to the 2015 to 2016 and 2016 to 2017 seasons, areas identifying Jewish and Muslim, as well as urban vs rural schools, were not significantly associated with lower uptake in children school years reception-6 in pilot areas[12, 13]. It should be noted that the response rates and the completeness of the datasets provided vary each season.

Consent, refusal and non-response rates for children in school years reception to 4 indicate that consent rates, refusal rates and no return rates varied among the different Local Teams. The overall no return rate has declined since the 2016 to 2017 influenza season[13]. Among the pilot areas, consent, refusal, and non-response rates indicate that decreasing uptake appears to be linked mainly to an increase in no return 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[15, 16].

Further work is required to understand and address these differences. A reduction in the percentage of no returns would increase the overall consent and vaccine uptake. Additionally further work is required regarding the number of schools that chose not to participate in the influenza vaccination programme.

Data on contraindications/reasons for non-vaccination were variable in children schools years reception to 4 and among children in school years reception to 6 in pilot areas. The most common contraindication/reason for non-vaccination was ‘vaccine contains porcine gelatine’ for both children in school years reception to 4 across England and children in school years reception to 6 in pilot areas. The most common contraindication reported on the day of the campaign was ‘child not well’ in both children in school years reception to 4 across England and children in school years reception to year 6 in 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[16]. The programme is being continually strengthened through the further roll out of the programme, which is seeing a further extension in the 2017 to 2018 season[17]. From October 2018 all children in school years reception to 5 in England will be offered LAIV vaccination mainly through a school-based programme. Children aged 2 and 3 years on 31 August 2018 will be offered influenza vaccination through GPs. Additionally, the 5 pilot areas that have been

piloting the primary school vaccination programme over the past 3 seasons will continue to offer LAIV to all primary school-age children in years reception to 6. 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.

Acknowledgements

The Respiratory Diseases Department would like to thank everyone that contributed to this report and specifically acknowledge:

- PHE and NHS staff responsible for planning and delivering the school-based vaccination programme for primary school children and providing the end of season data return to run this report
- ImmForm staff that provided and supported the online survey

Annexes

Annexe A: Year Group definitions

Academic Year Group	Age range 1st Sept. 2017	Birth Date Range	
		Born From	Born To
Reception	Age 4-5	01/09/2012	31/08/2013
1	Age 5-6	01/09/2011	31/08/2012
2	Age 6-7	01/09/2010	31/08/2011
3	Age 7-8	01/09/2009	31/08/2010
4	Age 8-9	01/09/2008	31/08/2009
5	Age 9-10	01/09/2007	31/08/2008
6	Age 10-11	01/09/2006	31/08/2007

Annexe B: End of season data collection variables

Category	Data Type	Description
School URN	Count (integer)	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 (0-6)	Year group cohorts as defined in Annexe A.
Denominator (provisional pre-filled LEA figures)	Count (integer)	The PROVISIONAL denominator is based on the January 2017 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 (integer)	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 (integer)	Difference between the actual and provisional denominators
Parental consent total	Count (integer)	Consent forms/parental attendance on the day
Parental refusal	Count (integer)	Consent forms returned indicating refusal for consent
No. Form Returned total	Count (integer)	The number of non-responders through no form returned/non-attendance
No. Vaccinated with one dose of LAIV since 1 September 2017	Count (integer)	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 2017/Denominator (actual if different)	Percentage uptake
No. vaccinated with one dose of TIV since 1 September 2017	Count (integer)	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 2017/Denominator (actual if different)	Percentage uptake
No. that have received flu vaccine since 1 September 2017	Count (integer)	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 2017/ Denominator (actual if different)	Percentage uptake
Consented but not given	Count (integer)	Total number of children that consent but did not receive the vaccine
Total GP referrals	Count (integer)	Total number of children who were referred to the GP for vaccination
No. Yellow Cards Issued	Count (integer)	Total number of children who were issued a yellow card

Contraindications	Data Type	Description
Total No. of contraindications	Count (integer)	Total number of children with contraindications
Previous allergy to flu vaccine	Count (integer)	Total number of children who have an allergy to flu vaccine
Egg Allergy	Count (integer)	Total number of children who have an egg allergy
Severe asthma	Count (integer)	Total number of children who have severe asthma
Another live vaccine given/due	Count (integer)	Total number of children who have/had another live vaccine due/given
Immunosuppression (personal)	Count (integer)	Total number of children with an immunosuppression
Immunosuppression (family)	Count (integer)	Total number of children who have a family member with an immunosuppression
Cardiac disease/salicylate therapy	Count (integer)	Total number of children with a cardiac disease/ salicylate therapy
On day: child unwell	Count (integer)	Total number of children who were unwell on the day of the vaccination campaign
On day: child absent	Count (integer)	Total number of children who were absent on the day of the vaccination campaign
On day: child refused	Count (integer)	Total number of children who refused the vaccine on the day of the vaccination campaign
On day: allergies	Count (integer)	Total number of children who had allergies on the date of the vaccination campaign
Other	Count (integer)	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 delivery model

NHS England Local Team	Local Authority
Non-responders	
South West	Bristol, City Of
	South Gloucestershire
	Plymouth
East	Norfolk
Cheshire and Merseyside	Cheshire East
	Halton
	Knowsley
	Liverpool
	Sefton
	St. Helens
	Warrington
	Wirral
Wessex	Isle of Wight
Cumbria and North East	Sunderland
Yorkshire and Humber	North Yorkshire
	York
	Wakefield
GP mode of delivery	
South West	Kernow (Cornwall and Isles of Scilly)*

*School level data were submitted for Cornwall LA.

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

NHS England Local Team[a,b]	Local Authority	No. schools with blank data	No. schools where numerator was greater than denominator
North		**21**	**30**
Cumbria and North East	Newcastle upon Tyne	2	-
Greater Manchester	Manchester	-	3
	Tameside	-	1
	Wigan	-	1
Yorkshire and Humber	Doncaster	13	-
	Leeds	-	25
	North Lincolnshire	4	-
	Bassetlaw	2	-
Midlands and East		**333**	**114**
North Midlands	Nottinghamshire	-	4
	Shropshire	-	20
	Staffordshire	33	-
	Stoke-on-Trent	14	-
	Telford and Wrekin	-	3
Central Midlands	Leicestershire	1	2
	Northamptonshire	-	68
West Midlands	Birmingham	-	1
	Dudley	-	2
	Sandwell	5	-
	Walsall	5	-
	Wolverhampton	15	14
East	Cambridgeshire	177	-
	Peterborough	47	-
	Suffolk	36	-
London		**17**	**4**
London	Camden	13	-
	City of London and Hackney	3	-
	Lewisham	-	-
	Southwark	-	4
	Waltham Forest	1	-
	Wandsworth	-	-
South		**244**	**451**
South Central	Buckinghamshire	-	1
	Reading	7	-
	West Berkshire	8	-
	Wokingham	5	-
South West	Devon	118	407
Wessex	Dorset	-	43
South East	East Sussex	31	-
	Kent	67	-
	Medway	3	-
	Surrey	5	-
Total		**615**	**599**

Annexe E: Vaccine uptake (%) for children school ages reception to 4 by NHS England Local Team from 1 September 2017 to 31 January 2018

NHS England Local Team[a,b]	Reception uptake (%)	Year 1 uptake (%)	Year 2 uptake (%)	Year 3 uptake (%)	Year 4 uptake (%)
Cumbria and North East	63.3	62.8	62.6	60.6	59.7
Lancashire	63.0	60.5	58.9	54.8	54.2
Greater Manchester	63.0	60.9	60.8	57.6	56.0
Yorkshire and Humber	63.5	63.3	62.7	59.2	58.7
Cheshire and Merseyside	73.6	69.6	71.4	68.7	66.7
North Midlands	63.6	61.5	61.4	56.0	57.1
Central Midlands	56.7	55.1	54.4	48.5	50.1
West Midlands	59.1	57.4	56.5	52.8	53.6
East	66.1	62.5	62.5	56.1	56.4
London	51.6	49.8	48.7	45.0	44.1
South Central	70.8	68.2	67.8	64.4	62.4
South West	63.8	63.4	61.6	51.2	50.4
Wessex	75.6	72.5	73.1	69.0	64.2
South East	60.5	62.3	61.6	54.3	56.8
Total	**61.3**	**60.0**	**59.4**	**54.7**	**54.5**

[a] A total of 17 LAs that provided vaccinations via a school delivery model did not provide any school level data. The Isles of Scilly provided vaccinations through a GP delivery model and are not included.

[b] Schools that provided merged data for school years reception to 4 are not included.

Annex F: Vaccine uptake (%) for children in school years reception to 6 in pilot areas from 1 September 2017 to 31 January 2018

Pilot area	Reception (%)	Year 1 (%)	Year 2 (%)	Year 3 (%)	Year 4 (%)	Year 5 (%)	Year 6 (%)
Cumbria, Northumberland, Tyne and Wear	61.8	60.8	60.5	59.1	58.3	58.5	57.4
Essex	68.5	67.1	65.6	64.8	61.6	58.9	58.2
Greater Manchester	68.9	69.5	67.1	65.0	67.5	64.4	62.2
Leicestershire and Lincolnshire	N/A	61.7	60.0	58.3	57.8	55.2	54.5
London	61.5	59.1	59.2	55.0	55.3	50.4	49.6
Total	**67.0**	**64.6**	**63.1**	**61.7**	**60.1**	**57.5**	**56.6**

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