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Human Papillomavirus (HPV) Vaccine Coverage in England, 2008/09 to 2013/14

A review of the full six years of the three-dose schedule

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Executive summary

Over 2.3 million girls have received three doses of human papillomavirus (HPV) vaccine in England since the start of the programme in September 2008. In this report we look back at the first six years of the national HPV immunisation programme for adolescent girls in England. In March 2014, based on the latest immunological evidence, the Joint Committee on Vaccination and Immunisation (JCVI) advised a change from a three to a two-dose schedule in the routine programme, which was implemented in September 2014. Therefore, it is timely to reflect on the success of this programme and the lessons that can be learned to strengthen it in future.

In the last three years, coverage of the routine programme for the full three-dose course has been consistently above 86%, with more than 40% of primary care trusts (PCTs) achieving at least 90% coverage. The HPV vaccine is one of a number of vaccines aimed at adolescents that are mainly delivered in schools as part of the national childhood immunisation programme. Mop-up vaccination one year on increases coverage in the routine programme by around 1-2%.

It is imperative that vaccination status is recorded on the local child health information system (CHIS) and GP clinical records in order to ensure girls who are not up to date can be vaccinated before their 18th birthday. In addition HPV vaccination details should also be uploaded on to the NHAIS system (Open Exeter) so that as these young women become eligible for the NHS Cervical Screening programme (currently at the age of 25 in England) their immunisation history is known. Coverage estimates on this system vary widely by area team and are far lower than the PHE Official Statistics for coverage, indicating substantial under-recording of HPV immunisation in NHAIS (coverage was between 4.2 and 86.5% lower by area team on NHAIS for the most recent cohort).

Surveillance data already suggest that the programme is achieving its aims. Reductions in the prevalence of HPV 16/18 infections are consistent with very high vaccine effectiveness among those vaccinated and suggest that herd-protection is also lowering prevalence among those who are not vaccinated. These early findings support confidence in the programme delivering its expected impact on cervical cancer and other HPV-related diseases in due course. It is anticipated that, with the new two-dose schedule, higher coverage of the completed course should be achievable, thus increasing the potential impact of the programme.

Background

The programme

The HPV vaccination programme's primary aim is to reduce the incidence of cervical cancer in women [1]. The objective of the programme between 2008/09 and 2013/14 was to provide three doses of HPV vaccine to females before they reach an age when the risk of HPV infection increases as they become sexually active [1]. The three doses were scheduled within one academic year (dose one and two at least one month apart, dose two and three at least three months apart). The vast majority of areas delivered the programme in schools with only a small number of areas delivering the programme in primary care or using a mixed approach.

The programme started in 2008 following advice from the JCVI recommending that the HPV vaccine should be offered routinely to females aged 12 to 13 years [2]. The committee also recommended a time-limited catch-up vaccination of females aged from 14 to less than 18 years.

In March 2014 the JCVI revised its existing recommendation to change from a three-dose to a two-dose schedule for girls starting their vaccination under 15 years of age [3]. Recent research shows that antibody response to two doses in adolescent girls is as good as a three-dose course in the older age group where efficacy against persistent infection and pre-cancerous lesions has been demonstrated. Immunological follow-up studies to date have supported expecations of long-term protection from HPV vaccines. This change was introduced in September 2014, at the beginning of the academic year [3]. Further advice for health professionals is available from PHE [4] and the Green Book [1].

Although PCTs were abolished in April 2013, the majority of the HPV three-dose programme was delivered before this date so annual data (Official Statistics) for 2013/2014 have been published by PCT, as well as by local authority and NHS England area team [5]. From April 2013 onwards area teams have been responsible for commissioning national immunisation programmes [6]. In this report we have taken the opportunity to review, by PCT and by area team (using data aggregated retrospectively), coverage for the full six years of the three-dose programme (routine and catch-up) since it began in September 2008. Full data and reports for previous years are available online [7, 8].

The disease

HPV is one of the most common sexually transmitted infections. Persistent infection with high-risk HPV types can lead to the development of cervical and other rarer anogenital cancers and some cancers of the head and neck [9-11], while low-risk types cause the majority of genital warts [12, 13]. In England, around 2,500 new cases of invasive cervical cancer were diagnosed in 2012. Cervical cancer is the most common cancer among women who are 15 to 34 years old and unlike the majority of cancers, is primarily a disease of the young with 62% of cases occurring in women who are less than 50 years old [14]. The time span between being infected with a high-risk HPV and the development of cervical cancer is, in most cases, many years [15].

While infection with genital HPV is most common among young adults (aged 18-28) [16], cases of cervical cancer peak in women in their late 30s. Two high-risk types, HPV 16 and HPV 18, are responsible for over 70% of all cervical cancers in Europe [17] and England [18]. Genital warts are the most common viral sexually transmitted infection in England, with over 70,000 cases of new infection reported from genitourinary medicine (GUM) clinics in 2013 [19].

The vaccine

The HPV vaccine used routinely in the national programme when the programme started in 2008 was Cervarix, which protects against HPV types 16 and 18. This was changed to Gardasil in September 2012 [20], which protects against a further two strains of HPV – types 6 and 11 – that cause the vast majority of genital warts [12, 13].

HPV vaccines are highly effective at preventing the infection of susceptible women with the vaccine HPV types and at preventing pre-cancerous lesions and genital warts associated with vaccine HPV types [21-23]. Protection is maintained for at least ten years and follow-up studies are in place to establish the expected longer-term duration of protection. Some other high-risk HPV types are closely related to those contained in the vaccines, and vaccination has been shown to provide some cross-protection against infection and disease by some of these types as well [23-25].

Change from three-dose to two-dose schedule in September 2014

In March 2014 the JCVI advised that based on the latest immunological evidence [26, 27] the efficacy and duration of protection in adolescents vaccinated using a two-dose schedule administered as a prime and boost (separated by a minimum of six months) was likely to be the same as demonstrated with the three-dose schedule used in older women.

The two-dose schedule was implemented throughout the UK from September 2014. In England the first dose is offered to girls in Year 8 (aged 12-13 years) and the second dose recommended 12 months later for operational purposes, as this reduces the number of immunisation sessions required in schools, however some local areas are choosing to schedule the second dose from six months after the first.

Methods

Data sources

HPV vaccine coverage data are collected via ImmForm, the web-based system provided by PHE to record vaccine coverage data for some immunisation programmes and to provide vaccine ordering facilities for the NHS [28].

The ImmForm website provides a manual online data submission function for NHS England area teams and data providers, together with relevant survey information and guidance for the HPV vaccine coverage collection [29]. PHE is responsible for managing the ImmForm website, as well as the data collection, validation, reporting and analysis of the data.

To allow timely monitoring of this new vaccination programme provisional cumulative monthly data were collected from 2008/9 to 2012/13, plus an annual return to provide final data. In 2013/14, to reduce the burden of the collection, reporting of provisional cumulative data was only required quarterly, plus a final annual data return. As most areas deliver the vaccine through a schools-based programme an estimated denominator based on the PCT school-roll (and local authority from 2013/14) for females in Year 8 was calculated from data taken from the Department for Education (formerly the Department for Children, Schools and Families), website [30]. PCTs, and more recently area teams, are notified of their individual school-rolls in advance of each academic year and have an opportunity to modify the figure if appropriate. The corrected denominators for that area are then fixed for each of the 12-monthly collections and held on the ImmForm website as an integral part of the collection form.

Data on HPV immunisations given in schools are collected on tally sheets by immunisation nurses or administrative support staff and passed to the data provider for collation and data entry, ie the number who have received at least one, at least two, or all three doses of vaccine. Data on females vaccinated in GP surgeries is collated by PCTs (later area teams) from information submitted by fax, email or telephone.

An annual survey is also completed on the ImmForm website at the end of the academic year by PCTs/area teams, using the appropriate algorithms developed for either a schools- or GP-based programme to re-calculate denominators and numerators. Defining a consistent denominator for the annual return across all PCTs (and more recently local authorities) is not straightforward because not all eligible females go to a school within the PCT/local authority where they live, not all PCTs/local authorities are running school-based vaccination programmes and not all eligible females go to school – some are educated at home, for example. User guides have been prepared to assist in the collation and submission of relevant PCT and, more

recently, local authority level data [29]. The annual survey also required a breakdown of the number of vaccines given in different settings for the routine cohort (ie school/GP practice/clinic etc). These data are also based on manual records collated centrally by PCT/area teams and their data providers.

From the second year of the HPV programme data on 'mop-up' vaccinations was collected. This is the number of vaccines given to females in the current academic year who either started or completed their HPV vaccine course late, and is used in this report to produce a revised estimate of the previous year's routine cohort coverage one year on.

Although PCTs ceased to exist from 1 April 2013 and NHS England area teams are now responsible for commissioning immunisation programmes for their local communities, vaccine coverage data for the 2012/13 HPV vaccination programme were required at PCT level as these were the organisations that were responsible for the delivery of that academic year's programme. PCT data is also required for comparison with previous years' vaccine coverage for trend analysis and was collected in 2013/14 alongside local authority data.

Each year cumulative monthly (and more recently quarterly) surveys have been published as provisional, estimated data and used for monitoring the programme within each academic year. The annual HPV survey data are considered final and since 2010 have been included in the Public Health Outcomes Framework (PHOF) indicator 3.3, population vaccine coverage (sub-indicator 3.3 xii) [31]. PHOF indicators should relate to local authority resident populations where possible and although initially these geographies had to be estimated from PCT data, from 2013/14 the HPV coverage data has been provided in this format [5].

Vaccine coverage for the two-dose HPV vaccination programme introduced in September 2014 will be monitored via an annual collection only [4]. Monthly data will not provide a useful early indication of coverage as there are local variations in the implemation of the two-dose programme in England. Local authority vaccine coverage data will continue to be collected via ImmForm by area teams with 2014/15 annual data being collected at the beginning of the 2015/16 academic year [4]. This data will be published in December 2015.

Data quality

Each of the 151 PCTs in England submitted annual survey data. Any PCT that provided annual denominators that varied from the estimated monthly denominators or final annual population estimate for the previous year by +/- 5% was contacted via email and asked to verify their data as part of data validation and quality assurance. A similar exercise was conducted querying coverage estimates that varied by +/- 5% from the

previous year. ‘Mop-up’ data is not always complete and when unavailable for a PCT (four PCTs were unable to submit data in 2013/14 but in previous years around 10-15 PCTs were unable to submit data) the data submitted for the previous year were used in the ‘one year on’ coverage estimates.

Definitions

Cohorts

The age cohorts of girls offered vaccine during each year of the programme are described in Box 1, Table 1 and Figure 1. Figure 1 also shows that 17-18 year old girls vaccinated as part of the catch up programme in 2008/09 are now, in 2015, in England, reaching the age at which they become eligible for cervical screening.

Box 1. Explanation of cohorts

Routine cohorts: girls aged 12-13 years who were offered vaccine in school year 8, starting in 2008/09.

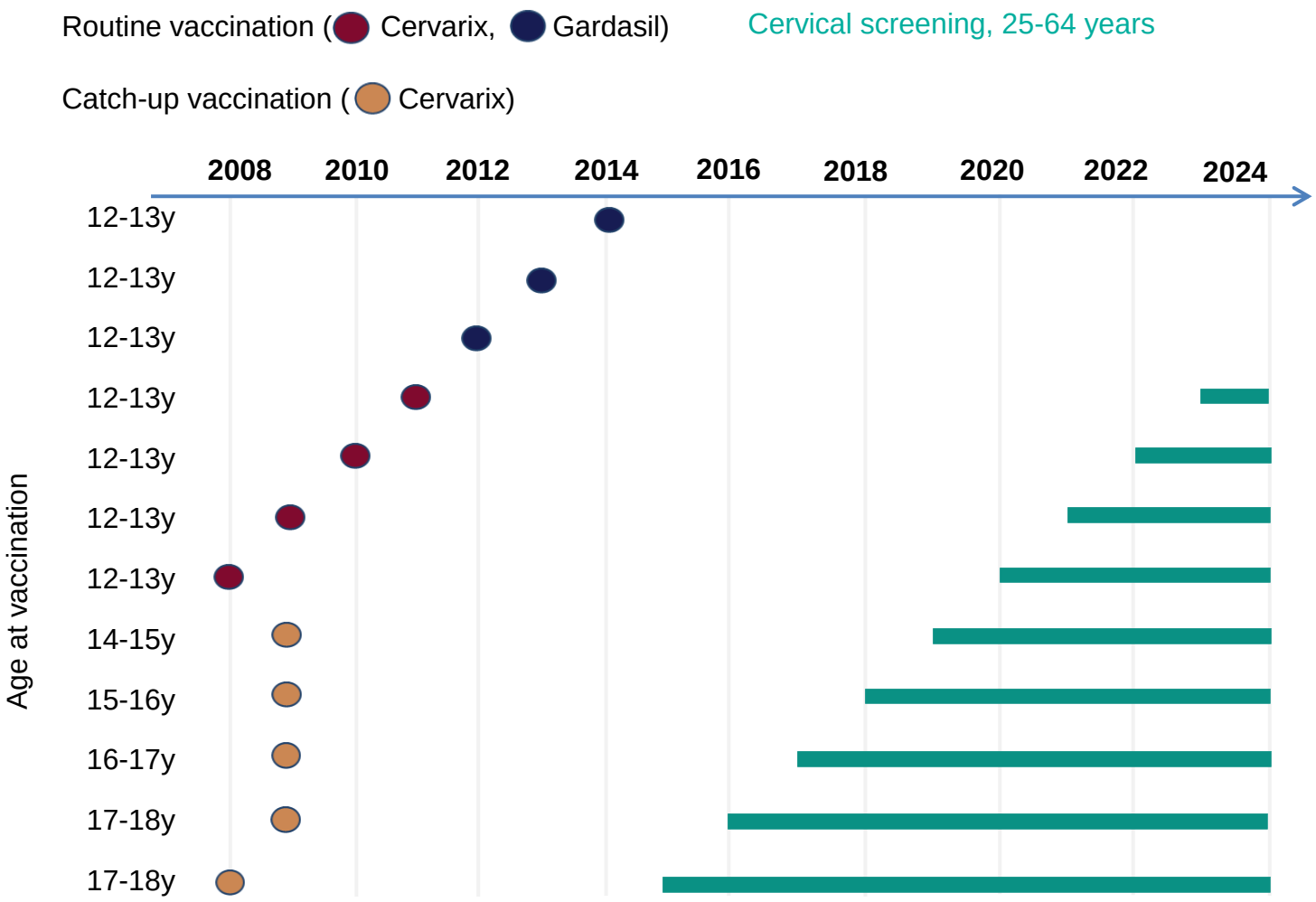
Catch-up cohorts: girls aged 13 to 18 years at the start of the programme in 2008 who were offered vaccine in a catch-up programme run over two years. In 2008/09 vaccine was offered to females aged 17 to 18 years (school year 13, born 1 September 1990 to 31 August 1991) and in 2009/10, females aged 14-18 years in four catch-up cohorts (school years 10-13, born between 1 September 1991 and 31 August 1995) were offered vaccine.

Mop-up vaccination: vaccine given to girls who did not complete a course of vaccine in the year(s) after they were first offered it through either routine vaccination in year 8 or as part of the catch-up programmes – only mop-up data one year on for the routine cohorts is reported in this document.

Table 1. Routine and catch-up cohorts 2008/09 to 2013/14

Cohort number	Girls born between	Year of first data collection	School year	Routine/ catch-up cohort
1	1 September 1995 to 31 August 1996	2008/09	8	Routine
2	1 September 1990 to 31 August 1991	2008/09	Year 13/not in school	Catch-up
3	1 September 1991 to 31 August 1992	2009/10	Year 13/not in school	Catch-up
4	1 September 1992 to 31 August 1993	2009/10	Year 12	Catch-up
5	1 September 1993 to 31 August 1994	2009/10	Year 11	Catch-up
6	1 September 1994 to 31 August 1995	2009/10	Year 10	Catch-up
7	1 September 1996 to 31 August 1997	2009/10	8	Routine
8	1 September 1997 to 31 August 1998	2010/11	8	Routine
9	1 September 1998 to 31 August 1999	2011/12	8	Routine
10	1 September 1999 to 31 August 2000	2012/13	8	Routine
11	1 September 2000 to 31 August 2001	2013/14	8	Routine

Figure 1. HPV vaccination cohorts and scheduled cervical screening in England



Annual survey denominator

Depending on the type of programme run locally, annual denominators for each cohort could be derived from one of three methods:

- **schools-based programme denominator:** the school roll for each of the PCTs/local authorities as of 31 August in the appropriate academic year. This was defined as all females in Year 8 attending school in the PCT/local authority (including those from the PCT or local authority's 'responsible population' and other PCTs/local authorities), PLUS females in the PCT or local authority's 'responsible population' not otherwise offered the vaccine, such as those not on any school roll or those attending a school in another PCT/local authority without a schools-based programme

- **non-schools-based programme denominator:** all females in the appropriate birth cohort as of 31 August from the PCT or local authority's 'responsible population' only, EXCLUDING those on the school roll of neighbouring PCTs/local authorities with schools-based programmes
- **schools/non-schools mixed approach denominator:** all females in the appropriate birth cohort as of 31 August from the PCT or local authority's 'responsible population' only, PLUS females not registered in the PCT/local authority that attend schools targeted for vaccination and EXCLUDING those on the school roll of neighbouring PCTs/local authorities with similar schools-based programmes.

A more detailed description of how the annual denominator is determined is available online [32].

The PCT/local authority 'responsible population' for HPV vaccine coverage data is defined as:

- all females in the appropriate age cohort registered with a GP practice whose practice forms part of the PCT/local authority, regardless of where they are resident, plus
- any females in the appropriate age cohort not registered with a GP, who are resident within the PCT's/local authority's statutory geographical boundary

For the purposes of the data collection, the term 'schools' includes all schools managed by a local authority, including/as well as independent and faith schools, schools managed by voluntary or private agents, grant maintained schools, sixth form colleges, pupil referral units, young offender units and residential units.

Annual survey numerators

For the routine cohorts the numbers of females who received at least one, at least two, or all three doses, up to 31 August of the appropriate academic year were counted. These were used as numerators to calculate vaccine coverage by dose, using the appropriate denominator as defined above.

For mop-up cohorts, the number of females who received at least one, at least two, or all three doses one year on from the year they were offered vaccine routinely were counted.

To minimise the numbers of missed or double counted females, providing a more accurate estimate of HPV vaccine coverage, the numerators were corrected (where possible) by PCTs, and later area teams, to record the number of vaccines given to females included in the denominator irrespective of who delivered them.

A detailed description of how annual numerators should be determined is available online [32].

In practice it is difficult to estimate true coverage, particularly in areas where there is high population mobility or adjacent areas using different population definitions, because of the difficulty of ensuring data for females who moved during the school year were shared appropriately. Where HPV data are recorded accurately on child health information systems (CHIS) and GP systems this is less problematic as up-to-date information can be automatically extracted.

Vaccine delivery setting

A count of total doses (irrespective of whether dose one, two or three) given in each setting (eg school, GP practice, community clinic or other setting) was provided for each routine cohort.

National Health Application and Infrastructure Services, also known as the Open Exeter System

The National Health Application and Infrastructure Services (NHAIS) system is a software suite used by all health authorities in England and Wales for, among other things, the administration of cancer screening call and recall programmes.

There is an expectation that HPV vaccination records for girls are uploaded onto NHAIS from CHIS or the GP record so that as these young women become eligible for the NHS Cervical Screening programme (currently at the age of 25 in England) their immunisation history is known.

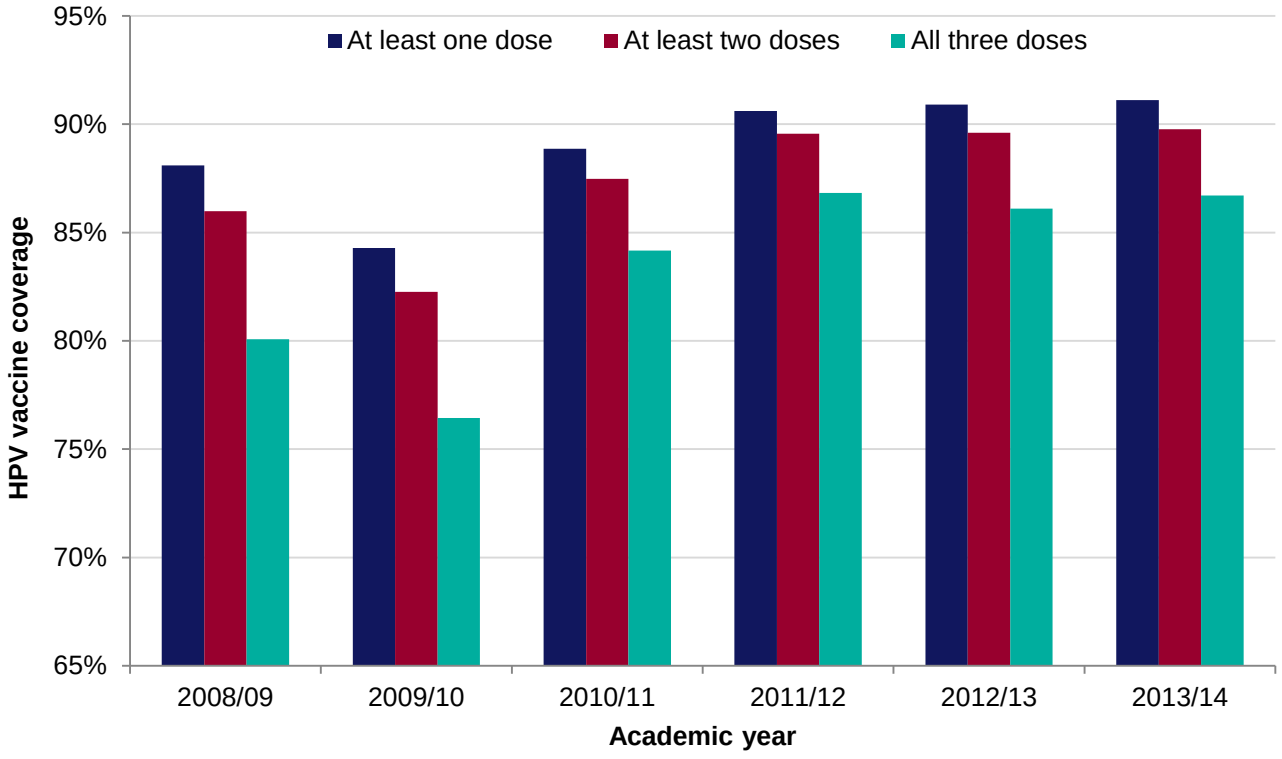
Data were extracted from the NHAIS system on 15 January 2015 for each of the routine HPV cohorts, in order to compare coverage data from this system with PHE Official Statistics coverage data.

Analysis and commentary

Routine cohorts

In 2008/09, the first year of the progamme, coverage of the routine cohort was high with 88.1% of females receiving at least one dose, 86.0% receiving two doses and 80.1% receiving all three doses. Although lower overall coverage in England was observed in 2009/10 than in the first year, 2008/09 (due to various possible factors described in detail in 2009/10 report but particularly due the scale of the HPV programme as PCTs were asked to accelerate the catch-up programme and vaccinate five school year cohorts [33]), coverage subsequently recovered and for the last three years (which includes September 2012 when the vaccine changed from Cervarix to Gardasil) has been consistently >90% for the first dose, >89% for doses one and two, and >86% for all three doses (Figure 2). In 2013/14, 91.1% of girls in school year 8 (cohort 11) received at least one dose of HPV vaccine, 89.9% received at least two doses, and 86.7% received all three doses.

Figure 2. Routine HPV vaccine coverage in Year 8 girls (aged 12-13 years) in England, assessed at the end of academic years 2008/09 to 2013/14



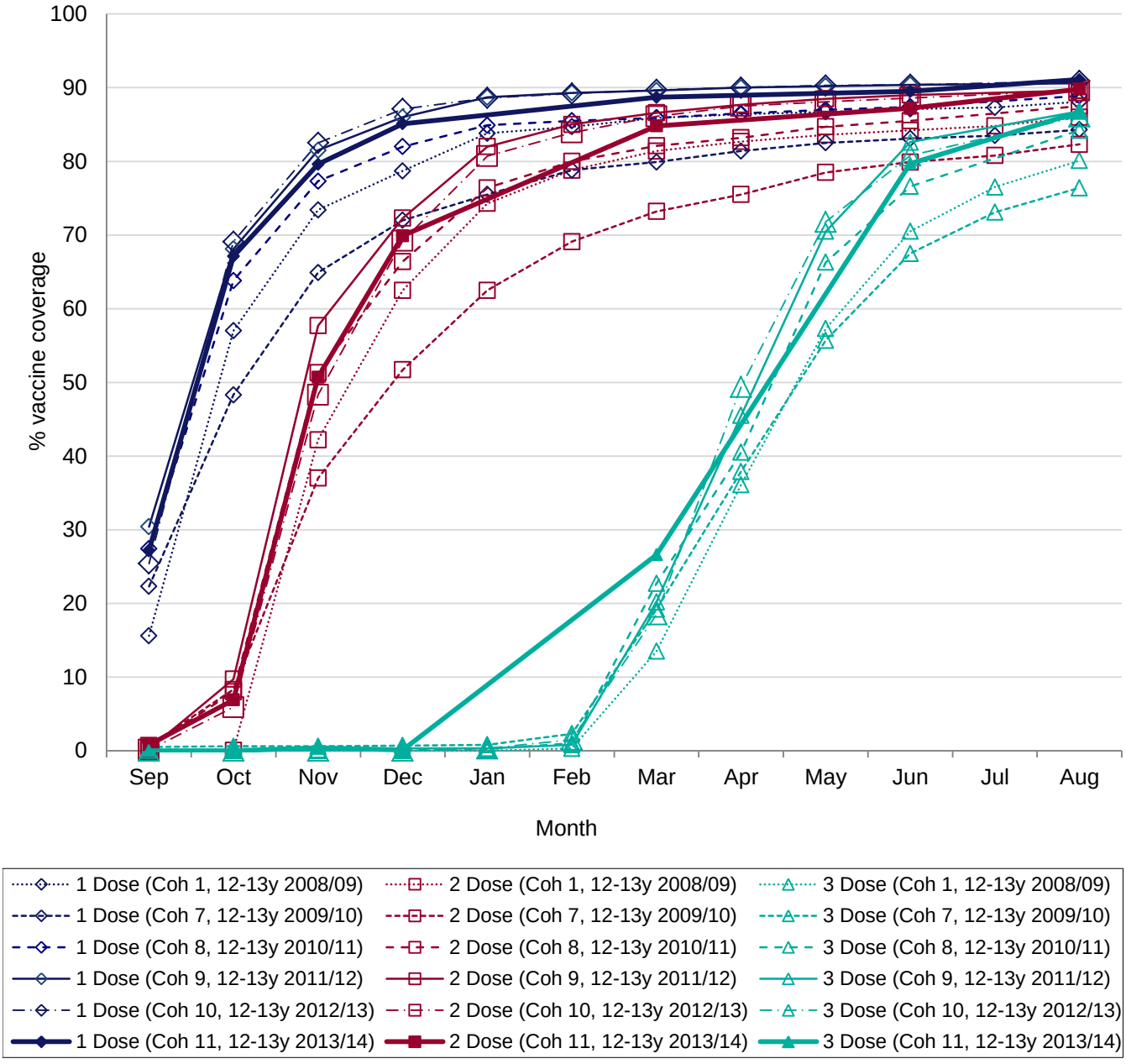
Note: the data in this figure excludes mop-up vaccinations

Monthly data

At least 75% coverage in England was acheived for the first dose by the end of November for the last four years, for the second dose by the end of January for 2010/11 to 2012/13 (January data was not available for 2013/14 due to the change to quarterly data that year), and for the third dose by the end of June for the last four years (Figure 3).

This reflects a general pattern of offering the first dose in the September to December term, the second dose largely between November and February, and the third dose in the summer term. In general the monthly curves have moved slightly earlier each year, enabling the programme to be delivered with time to reschedule vaccination of girls who have missed doses at early sessions.

Figure 3. Provisional monthly HPV vaccine coverage - routine cohort (12-13 year olds) 2008/09 to 2013/14

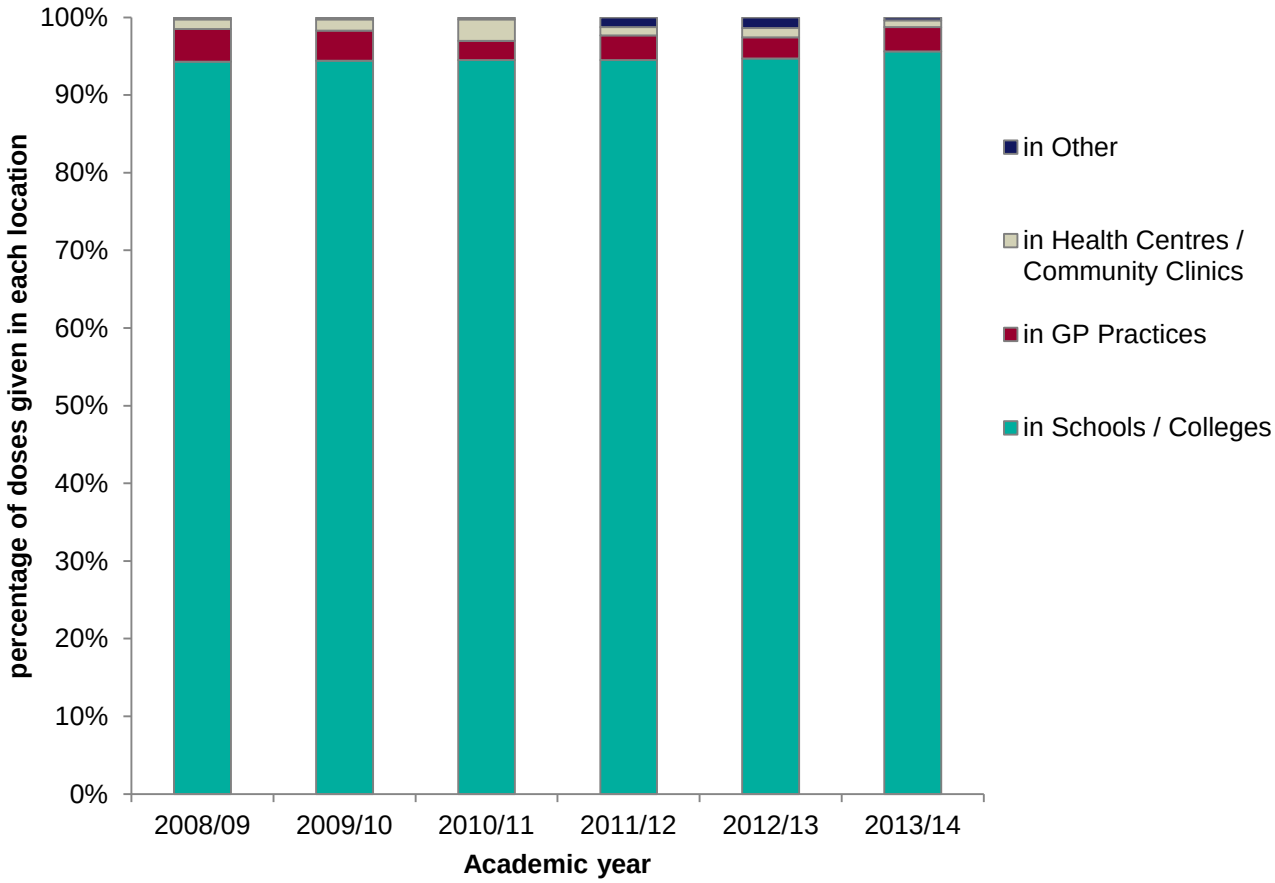


Notes:
1. For 2013/14, data were not available for January, February, April, May, July.
2. For 2010/11 to 2013/14 monthly data were not available for July.
3. For August, annual data have been used for all years.

Setting for routine HPV vaccine delivery

Throughout the six years of the HPV vaccination programme, schools-based programmes were delivered across most of the country. In the first year of the programme, 2008/09, four PCTs (Birmingham East and North, Cornwall and Isles of Scilly, Derbyshire County, and Hounslow) chose to offer the vaccine through GP practices, however, in all subsequent years only Derbyshire County PCT area and Cornwall and Isles of Scilly PCT area used a GP-based programme. These two areas accounted for the majority of doses given in GP practices (71% in 2013/14), though GPs from other areas will have delivered vaccinations to females who missed out on school sessions. Overall between 2008/09 and 2013/14 the majority (95%) of doses for the routine cohort were given in schools (Figure 4). However, as the majority of PCTs excluded from the delivery setting data (for the reasons described in the notes) ran school-based programmes the proportion of doses given in schools was likely to have been higher.

Figure 4. Proportion of routine cohort HPV doses given in different locations, England, 2008/09 to 2013/14



Note: This figure excludes PCTs that did not supply these data (between 0 and 7% of annual PCT records), as well as PCTs for whom the total doses given differed by more than 5% from the equivalent figure recorded in their coverage data (between 0 and 14% of annual PCT records).

Area team and PCT coverage

Coverage of three doses has been calculated retrospectively for area teams from 2008/09 to 2012/13 and is displayed, along with coverage for 2013/14, in Appendix 1. Coverage for each area team over the last four years has generally been stable. At the local level, at least 41% of PCT areas have achieved ≥90% coverage of the third dose of HPV vaccine in the routine cohort and more than 60% of PCT areas have achieved coverage of more than 85% in the last three years (Figure 5).

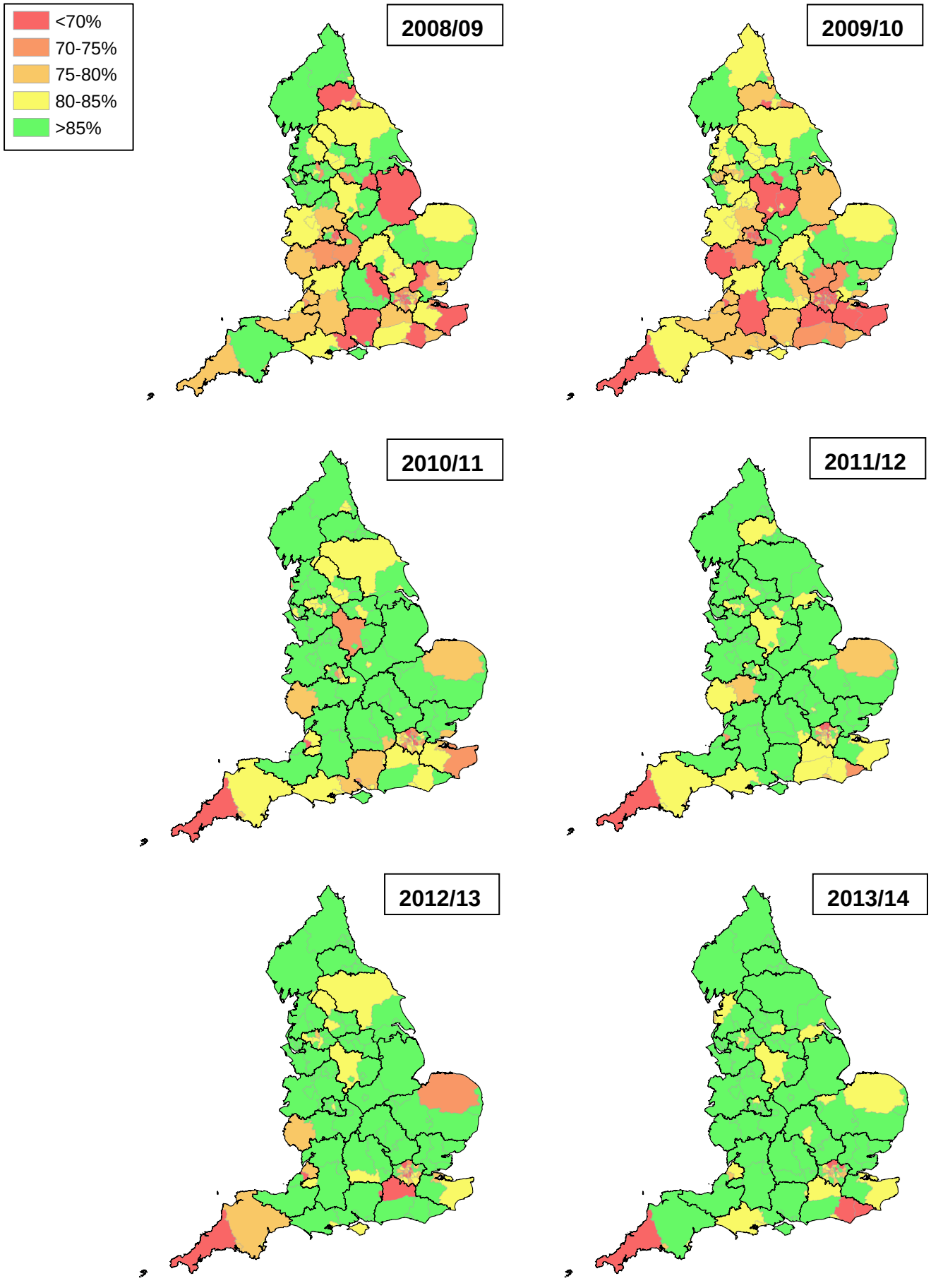
In 2013/14, the most recent routine cohort, coverage of all three doses of HPV vaccine ranged by area team from a high of 93.3% for Leicestershire and Lincolnshire to a low of 73.8% for Devon, Cornwall and Isles of Scilly, with coverage for Surrey and Sussex also below 80% (77.8%) [5].

Although 22/48 (46%) PCT areas with coverage of three doses below 85% were within London Area Team, the lowest coverage estimates were reported from East Sussex Downs and Weald PCT area (48.7%), Hastings and Rother PCT area (57.1%), and Cornwall and Isles of Scilly PCT area (57.3%). For East Sussex Downs and Weald PCT and Hastings and Rother PCT (both now within Surrey and Sussex Area Team) this represented a sizable drop on 2012/13 coverage, which was above 85% for both areas. In contrast, in Cornwall and Isles of Scilly (now within Devon, Cornwall and Isles of Scilly Area Team) (where a GP-based programme operates) coverage has been below 65% for the last five years.

A range of local factors have impacted on coverage in Cornwall and the Isles of Scilly area, including transition of the provider to a new CHIS system and ongoing reporting challenges from a primary care delivery model. The provider in East Sussex Downs and Weald, and in Hastings and Rother areas has indicated that the reported coverage data does not include all immunisations given by GPs to girls who were not available for school sessions [5]. Derbyshire County PCT area (within Derbyshire and Nottinghamshire Area Team), where a GP-based programme is also in operation, has reported coverage just over 82% for the last three years.

Full tables of PCT HPV vaccine coverage for the six years 2008/09 to 2013/14 are available online [5, 7, 8].

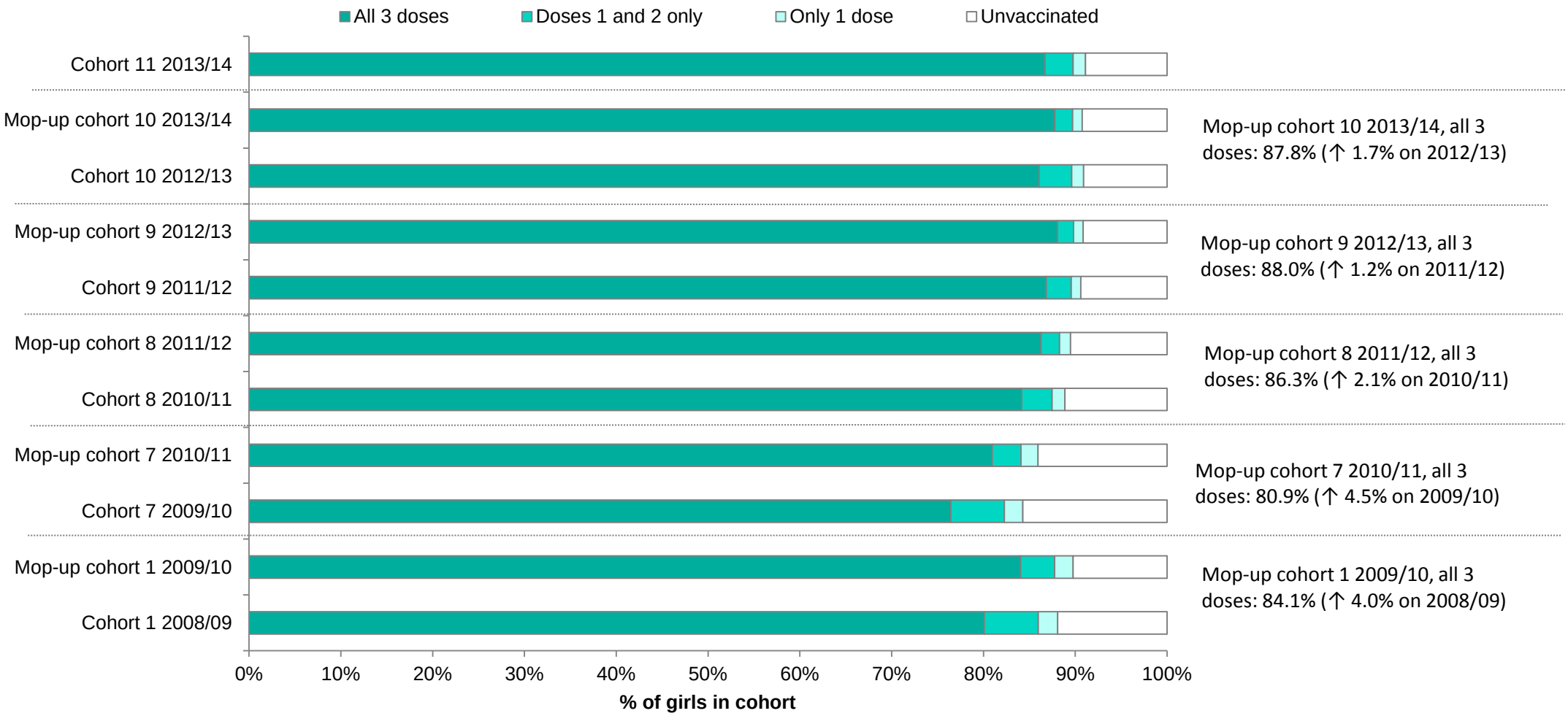
Figure 5. PCT coverage of the third dose of HPV vaccine in the routine cohort (12 to 13 year olds) between 2008/09 and 2013/14, with area team boundaries overlayed (black outlines)



Mop-up vaccination of routine cohorts: updated estimates of vaccine coverage one year on

In the last three years, mop-up vaccination of the routine cohorts the following year increased coverage of three doses by approximately 1 to 2% (Figure 6).

Figure 6. Vaccine coverage one year on (mop-up)



Estimated total number of girls vaccinated with all three doses since the start of the programme

Approximately 2.3 million girls have received three doses of HPV vaccine since the start of the programme in September 2008 (includes routine [>1.5 million, based on mop-up data one year on] and catch-up [almost 0.8 million, based on data from the first year of assessment] cohorts).

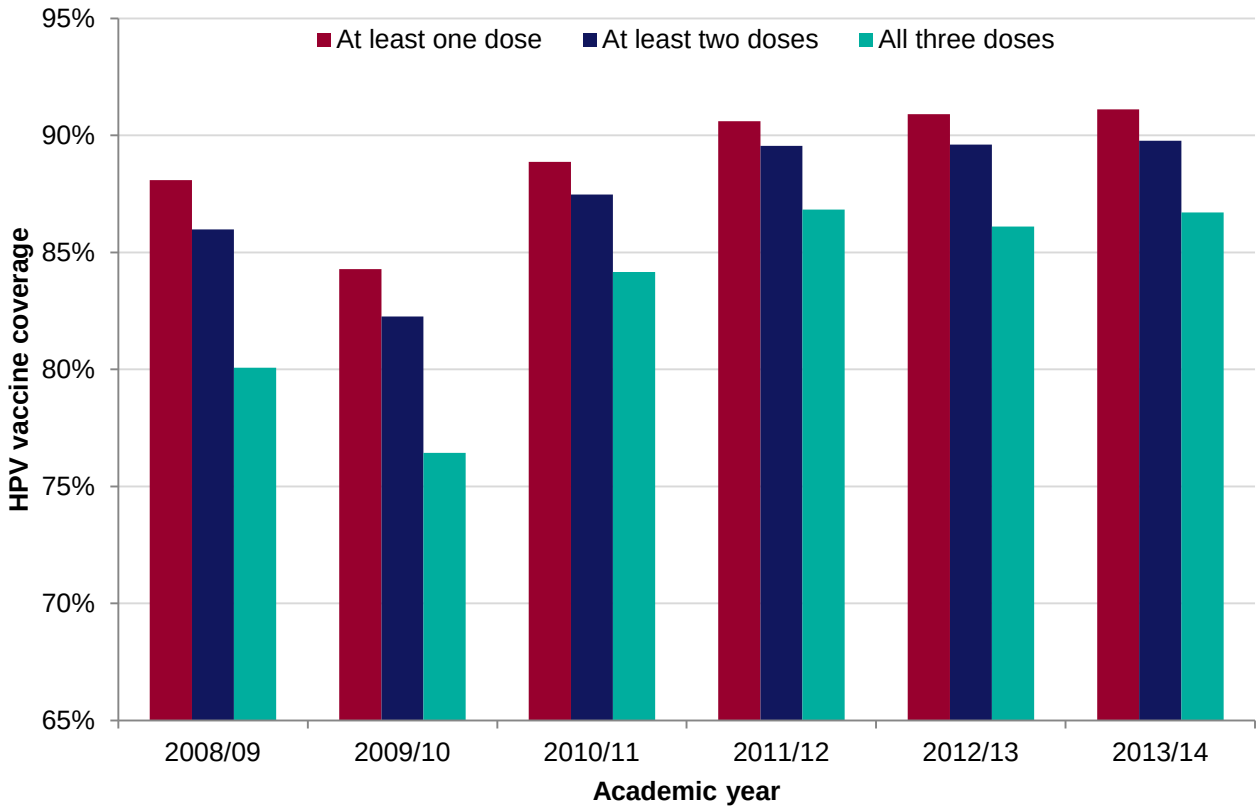
Approximately 3.3 million girls were eligible to receive the vaccine in either routine or catch-up cohorts. Overall three-dose coverage for the routine cohorts (one year on) was 86%, while for the catch-up cohorts it was 49%.

These figures underestimate the total number of girls vaccinated as girls in the routine and catch-up cohorts continue to be offered the vaccine at school or by their GP in subsequent years as they remain eligible until their 18th birthday.

UK HPV vaccine coverage

In the whole of the UK combined, coverage of three doses of HPV vaccine increased overall from 80.9% in the first year of the programme in 2008/09 to 85.9% in 2013/14 (Figure 7, Table 2).

Figure 7. Routine HPV vaccine coverage in girls aged 12-13 years (school year 8 in England and Wales, secondary school S2 in Scotland, school year 9 in Northern Ireland) in the UK, assessed at the end of academic years 2008/09 to 2013/14



Note: the data in this figure excludes mop-up vaccinations

Highest coverage results in 2013/14 were reported by Northern Ireland, followed by England, Scotland and Wales (Table 2).

Table 2. Annual England, Scotland, Wales and Northern Ireland HPV vaccine coverage 2013/14, and UK coverage 2008/09 to 2013/14

	At least one dose	At least two doses	Three doses
UK coverage			
2008/09	88.4%	86.6%	80.9%
2009/10	85.0%	83.1%	77.5%
2010/11	89.0%	87.6%	83.8%
2011/12	90.8%	89.7%	87.0%
2012/13	91.0%	89.7%	85.8%
2013/14	91.3%	89.9%	85.9%
Individual country coverage in 2013/14			
England [5]	91.1%	89.8%	86.7%
Scotland [34]	93.6%	91.7%	81.4%*
Wales [35]	89.6%	87.6%	77.2%**
Northern Ireland [36]	91.5%	90.8%	87.2%

* Data for the first five years of the HPV immunisation programme in Scotland shows that a number of girls in S2 complete their immunisation course after the school year in which they were first offered the vaccine. Vaccine coverage for girls in S2 during school year 2013/14 is expected to increase as girls complete their immunisation course in school year 2014/15. For girls who were in S2 during school year 2012/13, one year later data shows coverage increased to 91.4% for all three doses, 93.4% for two doses and 94.4% for one dose by the end of school year 2013/14.

** Data entry and some vaccination sessions for the third dose may not have been complete when data for Wales were extracted and therefore, coverage for the third dose is also expected to increase.

Recording and transfer of HPV vaccination records on permanent health records

It is imperative that HPV vaccination status is recorded on the local CHIS and GP clinical record in order to ensure girls who are not up to date can be vaccinated before their 18th birthday. In addition the vaccination record should also be uploaded on to the NHAIS system. This is essential so that as these young women become eligible for the NHS Cervical Screening programme (currently at the age of 25) their immunisation history is known.

It is expected that in due course different screening protocols may be introduced for women who were vaccinated as girls but this will be dependent on the vaccination status being recorded in the correct systems. It is imperative that this information is

added to the NHAIS system as soon as possible after vaccination in order that it can be as accurate as possible and, as changes to name and location occur through life, the record will then follow the woman as part of her NHS history.

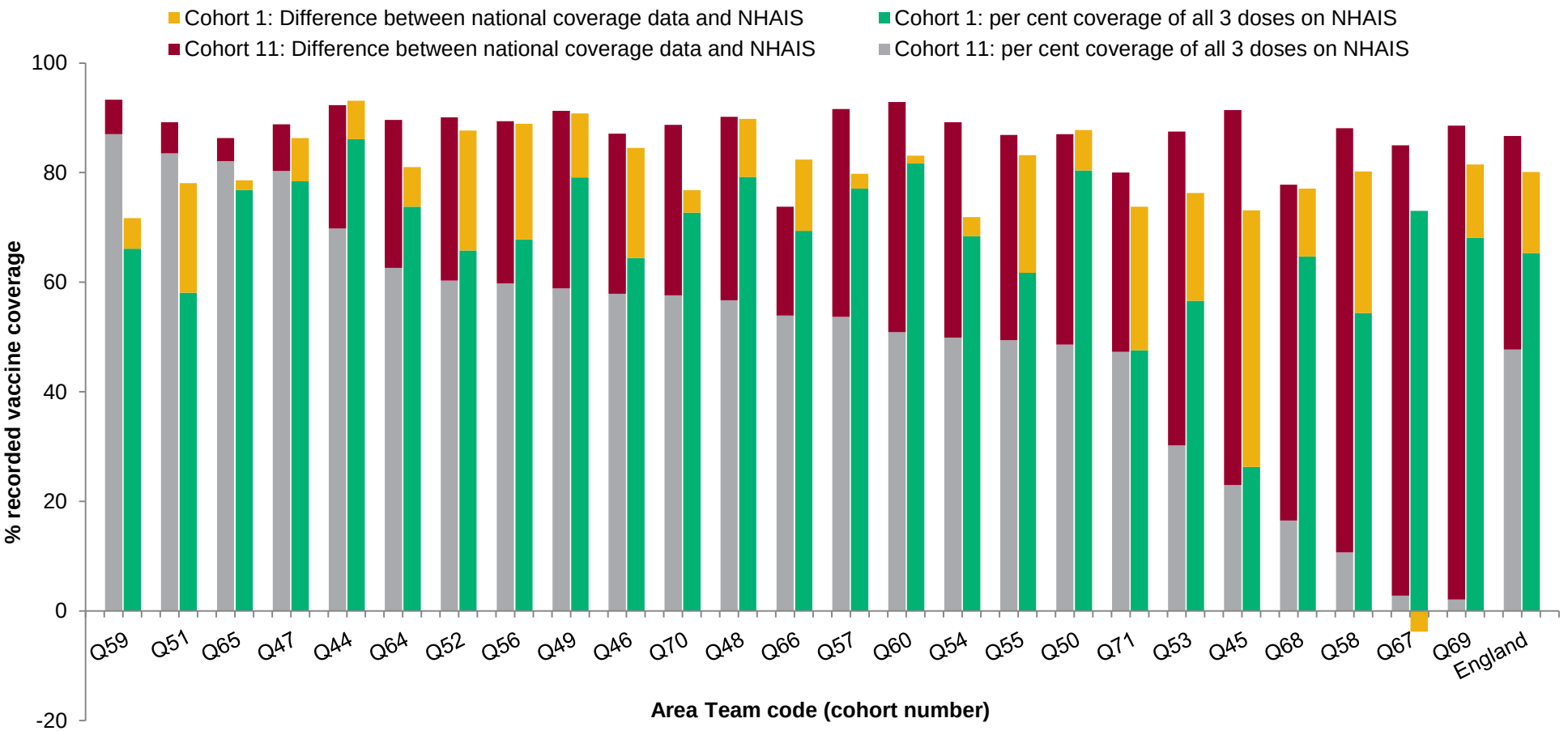
NHAIS data are presented by area team for the latest cohort (cohort 11) and first cohort (cohort 1) in Figure 8 and Appendix 2, with the difference between national published coverage data alongside for comparison. Most (18/25) area teams had third dose coverage below 60% recorded on the NHAIS system for cohort 11.

Within area teams the coverage for individual PCTs often varied widely. The coverage recorded on the NHAIS system for each area team was consistently lower than national coverage data for cohort 11; overall for England the coverage of the third dose on the NHAIS system for cohort 11 was 44.7% compared to 86.7% in the official coverage statistics for 2013/14. In contrast for cohort 1 the difference between the coverage recorded on the NHAIS system (65.3%) and that reported by PHE (80.1%) was smaller.

Results for previous routine cohorts suggest that to a certain extent records may be updated at a later stage, this is particularly evident for area teams with lowest coverage recorded for cohort 11 (Figure 8, Appendix 2).

The coverage for the most recent routine cohort (cohort 11) is the lowest of all the routine cohorts in the NHAIS system nationally. England coverage for cohorts 1 and 7-10 ranged from 50.7% (cohort 7) to 65.3% (cohort 1), but without a clear overall trend. Comparing coverage for different cohorts also suggests that within eg South Yorkshire and Bassetlaw Area Team, recording on the NHAIS system is now more timely and complete than it was for cohort 1.

Figure 8. HPV vaccine coverage of the third dose of HPV vaccine in the routine cohort 11 (12 to 13 year olds) 2013/14 and cohort 1 2008/09, comparison of NHAIS data (extracted 15 January 2015) and national coverage data, by area team* in England. Ordered by area team NHAIS coverage for cohort 11 (greatest to lowest)



Note: Kent and Medway Area Team (Q67) had higher coverage recorded on NHAIS than national data for cohort 1.

*Area teams: Leicestershire and Lincolnshire (Q59), South Yorkshire and Bassetlaw (Q51), Bristol, North Somerset, Somerset and South Gloucestershire (Q65), Lancashire (Q47), Cheshire, Warrington and Wirral (Q44), Bath, Gloucestershire, Swindon and Wiltshire (Q64), West Yorkshire (Q52), East Anglia (Q56), Cumbria, Northumberland, Tyne and Wear (Q49), Greater Manchester (Q46), Wessex (Q70), Merseyside (Q48), Devon, Cornwall and Isles of Scilly (Q66), Essex (Q57), Shropshire and Staffordshire (Q60), Birmingham and the Black Country (Q54), Derbyshire and Nottinghamshire (Q55), North Yorkshire and Humber (Q50), London (Q71), Arden, Herefordshire and Worcestershire (Q53), Durham, Darlington and Tees (Q45), Surrey and Sussex (Q68), Hertfordshire and the South Midlands (Q58), Kent and Medway (Q67), Thames Valley (Q69)

Infection surveillance systems in place to monitor the impact of the HPV vaccination programme

Given the long period (10+ years) between HPV infection and cancer, and the mix of vaccine- and non-vaccine HPV type infections, surveillance of type-specific infections in the population provides a useful early outcome measure.

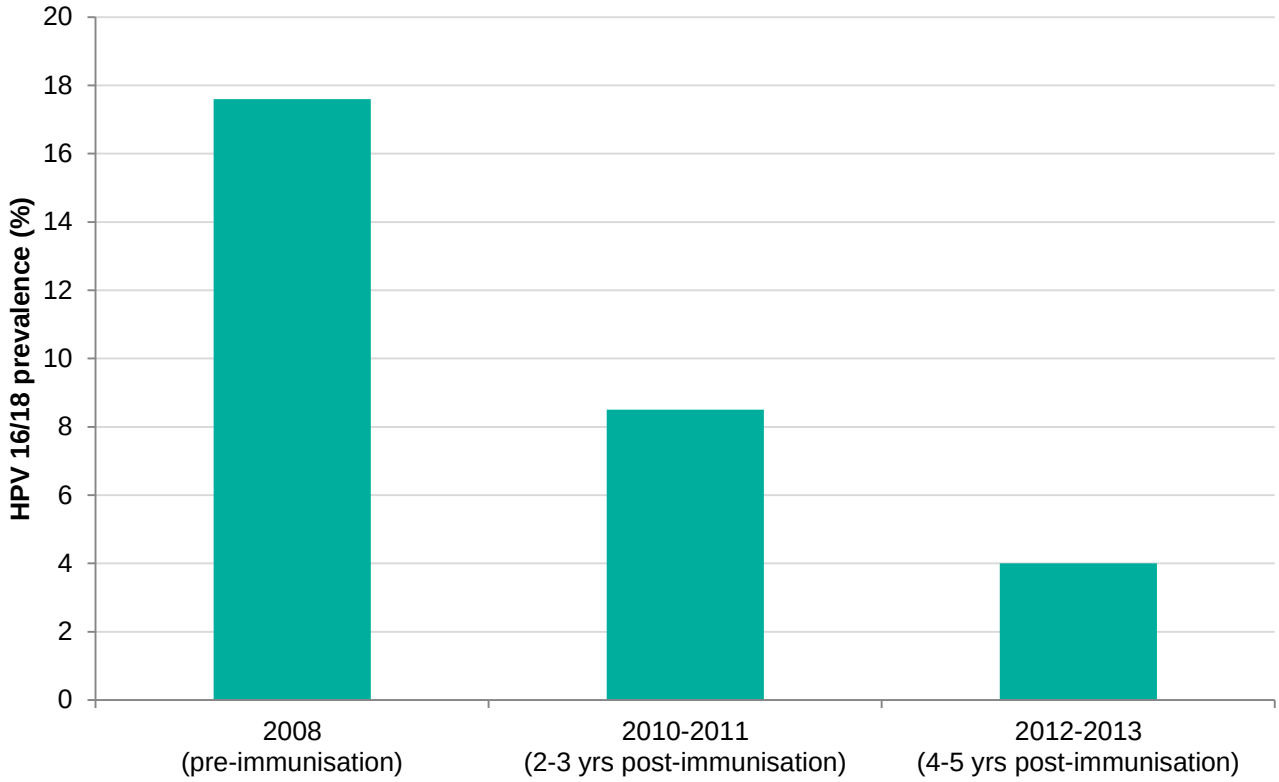
Seroprevalence in young women

Serological surveillance is being used to validate reported coverage and explore changes in serological markers over time. Residual serum specimens collected from females aged 15-19 years in 2010-2011 have been tested for anti-HPV16 and HPV18 immunoglobulin G [37]. The proportion of females with vaccine-induced seropositivity was slightly lower than the reported three-dose coverage for 15 year olds but higher for all other ages, and this difference increased with age (difference -3.1%, 2.7%, 5.9%, 12.5% and 15.8% for 15, 16, 17, 18 and 19 year olds respectively). This serological surveillance has therefore confirmed high coverage of the HPV vaccination programme in young females in England. Discrepancy between reported three-dose coverage and estimated serological-coverage, particularly evident in the older females (offered HPV vaccine at an older age), suggests that three-dose coverage in the catch-up cohorts could be higher than reported, or that partial vaccination (ie one or two doses) has provided high antibody responses in 13-17 year olds, or both. Further analyses by ethnic group and other factors, based on HPV serology testing of residual specimens collected from GUM clinics are planned in the future.

HPV infection prevalence in sexually active young women

Surveillance of HPV infection in sexually-active young women undergoing chlamydia screening has found that HPV16/18 prevalence among sexually-active females aged 16-18 years was 66% lower in 2010-13, ie post-immunisation than it was in 2008, ie pre-immunisation (Figure 9). The three-dose coverage of HPV16/18 vaccine among this age group, estimated from the data in this report, was 67%, suggesting very high vaccine effectiveness in those vaccinated and/or some herd-protection also lowering prevalence among those who have not been vaccinated. These early findings of falls in infection prevalence support confidence in the programme delivering its expected impact on disease in due course.

Figure 9. Prevalence of HPV16/18 in a survey of 16-18 year old sexually active young females in England in 2008 (before the immunisation programme) and in 2010-11 and 2012-13 (after)



Ongoing surveillance will monitor HPV16/18 prevalence over time and aim to identify any substantial variations in protection within the population, and also to determine the impact of the HPV vaccination programme on the frequency of non-vaccine HPV types. As vaccinated females grow older (the oldest participants in the national immunisation programme will be 25 years in 2015 and start to be invited for cervical screening), we expect to start to see the impact on cervical disease (already evident in some countries where cervical screening starts under 25 years) and other HPV-related cancers, however this will take many years to be fully reached.

Discussion

School-based HPV immunisation delivery has successfully achieved high coverage in England and reduced inequalities at area level since the start of the programme in 2008. Coverage in the routine programme of all three doses has been above 75% since the start of the programme, and in the last three years has remained consistently above 86%. It is hoped that with a focus on delivering only two doses it might be possible to achieve higher coverage than the three dose programme, increasing the impact of the programme nationally.

International HPV vaccine coverage

As of April 2013, the World Health Organization (WHO) reported that 21 countries in the WHO European Region (which comprises 53 countries in total) had introduced the HPV vaccine [38]. Of these, seven countries (Denmark, Italy, Luxembourg, Portugal, Spain, Switzerland and the UK) had achieved coverage of 80% or more.

In the US, HPV vaccine has been available for teenage girls since mid-2006, and for boys aged 11 or 12 since 2011 [39]. Receipt of the recommended three doses among girls aged 13 to 17 years increased in 2013, but still remained low from 2012 to 2013 (33.4% in 2012 compared to 37.6% in 2013), and with wide variations in coverage at the state level [40].

In Australia, where a national HPV vaccination programme was introduced for girls in 2007, and extended to boys in 2013 [41], latest published data for females turning 15 years of age in 2012 vaccinated with three doses of HPV vaccine was 70.9% [42].

In addition to the UK, several other countries/jurisdictions have recently switched from three to two dose vaccination schedules for girls aged 9-14 years on the basis of risk-benefit considerations, including Switzerland, The Netherlands, Mexico, and Quebec (Canada) [43].

Ethnicity/deprivation

Ethnicity and deprivation data are not routinely monitored as part of the HPV vaccination programme in England, however some studies have explored these areas and suggest they may be associated with coverage [44]. Sacks *et al* reported coverage of three doses among women aged 13-19 years in 2011 attending sexual health services across England of 72% in those of White ethnicity, 56% in those of Asian ethnicity and 55% in the Black ethnic group [45]. Bowyer *et al* found that among 16 and 17 year old girls attending further education colleges in South East England and

scheduled to receive HPV vaccine as part of a catch-up cohort (either through school, GP or their local pharmacy), participants from black or 'other' ethnic backgrounds were less likely to have received the HPV vaccine than white participants [46]. A further study of girls aged 15 and 16 years from the first two cohorts to be offered routine HPV vaccination took place at 13 schools in London three years post-vaccination [47]. In adjusted analyses, girls from black or 'other' ethnic backgrounds were also less likely to be fully-vaccinated than those from white backgrounds.

Studies in the US have also found lower uptake in those of African American ethnicity than among Caucasians [48].

Hughes *et al* assessed the relationship between HPV immunisation coverage and deprivation (index of multiple deprivation (IMD)) by PCT (N=151) for each school year offered the HPV vaccine between 2008 and 2011 [49]. Coverage at age 12 showed no significant association with IMD at the area-level ($p=0.12$). However, within the catch-up years, there was some suggestion of higher deprivation being associated with lower coverage. This association was not significant for girls offered immunisation under 16 years (in compulsory education) ($p=0.09$), but was more marked and statistically significant for older girls ($p<0.0001$). They concluded that school-based HPV immunisation delivery appears to be successfully reducing inequalities in cervical cancer control at area-level. However, the catch-up cohorts above the age of compulsory education may face increased inequality.

Screening

The NHS Cervical Screening Programme is piloting HPV testing as the primary screening test with a view to switching from cytology in the near future. It is expected that in due course different screening protocols may be introduced for women who were vaccinated as girls. The value of this to women is that they will get a more tailored screening invitation schedule depending on their HPV status. If the vaccination status is not known for the majority of women then they may be unable to take advantage of this tailored approach, and the population will not be able to benefit as a whole from a more focused and efficient screening programme. It is imperative that vaccination status information is recorded on the NHAIS system as soon as possible so that accurate data can follow the woman through the NHS before changes to name and location make linking records more difficult.

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Appendices

Appendix 1. Coverage of the third dose of HPV vaccine in the routine cohort (12 to 13 year olds) between 2008/09 and 2013/14, by Area Team* in England

Area Team (code)	2008/09	2009/10	2010/11	2011/12	2012/13	2013/14
Cheshire, Warrington and Wirral (Q44)	93.1	85.4	92.2	93.0	92.6	92.3
Durham, Darlington and Tees (Q45)	73.1	78.4	88.1	89.3	89.5	91.3
Greater Manchester (Q46)	84.5	83.5	86.2	88.8	87.9	87.1
Lancashire (Q47)	86.3	84.3	88.5	91.4	90.9	88.7
Merseyside (Q48)	89.8	80.3	87.3	93.2	90.6	90.2
Cumbria, Northumberland, Tyne and Wear (Q49)	90.8	85.6	87.1	91.9	91.7	91.3
North Yorkshire and Humber (Q50)	87.8	85.2	83.8	88.2	86.6	87.0
South Yorkshire and Bassetlaw (Q51)	78.1	73.0	91.2	90.1	92.3	89.2
West Yorkshire (Q52)	87.7	84.0	88.5	90.9	89.7	90.1
Arden, Herefordshire and Worcestershire (Q53)	76.3	76.4	85.7	85.4	86.6	87.4
Birmingham and the Black Country (Q54)	71.9	68.8	84.5	86.5	89.4	89.2
Derbyshire and Nottinghamshire (Q55)	83.2	69.1	83.9	87.5	86.3	86.9
East Anglia (Q56)	88.9	85.7	86.6	86.6	86.9	89.4
Essex (Q57)	79.8	80.9	88.1	90.8	91.2	91.6
Hertfordshire and the South Midlands (Q58)	80.2	79.4	87.3	88.8	88.1	88.2
Leicestershire and Lincolnshire (Q59)	71.7	82.8	88.6	93.1	91.7	93.3
Shropshire and Staffordshire (Q60)	83.1	80.0	89.4	92.5	91.9	92.9
Bath, Gloucestershire, Swindon and Wiltshire (Q64)	81.0	77.3	88.1	88.9	88.0	89.6
Bristol, North Somerset, Somerset and South Gloucestershire (Q65)	78.6	73.5	82.7	85.3	82.2	86.4

Devon, Cornwall and Isles of Scilly (Q66)	82.4	72.4	76.0	76.8	73.0	73.8
Kent and Medway (Q67)	69.2	57.5	76.9	84.4	83.2	85.0
Surrey and Sussex (Q68)	77.1	69.9	84.2	82.9	77.0	77.8
Thames Valley (Q69)	81.5	83.3	85.9	88.1	87.8	88.6
Wessex (Q70)	76.8	77.7	78.9	87.4	87.8	88.7
London (Q71)	73.8	66.6	75.6	78.9	78.9	80.0
England	80.1	76.4	84.2	86.8	86.1	86.7

* PCT data has been retrospectively aggregated to area team level for years before 2013/14

Appendix 2. Coverage of the third dose of HPV vaccine in routine cohort 11 and cohort 1, comparison of NHAIS system (data extracted 15 January 2015) and national coverage data, by area team* in England. Ordered by area team NHAIS coverage for cohort 11 (greatest to lowest).

Area Team (code)	Cohort 11 (12 to 13 year olds in 2013/14)			Cohort 1 (12 to 13 year olds in 2008/09)		
	Per cent coverage of all 3 doses – national coverage data	Per cent coverage of all 3 doses on NHAIS	Difference between national published data and NHAIS	Per cent coverage of all 3 doses – national coverage data	Per cent coverage of all 3 doses on NHAIS	Difference between national published data and NHAIS
Leicestershire and Lincolnshire (Q59)	93.3	87.0	6.3	71.7	66.1	5.6
South Yorkshire and Bassetlaw (Q51)	89.2	83.5	5.7	78.1	58.1	20.0
Bristol, North Somerset, Somerset and South Gloucestershire (Q65)	86.4	82.1	4.2	78.6	76.8	1.8
Lancashire (Q47)	88.7	80.3	8.5	86.3	78.4	7.9
Cheshire, Warrington and Wirral (Q44)	92.3	69.8	22.5	93.1	86.1	7.0
Bath, Gloucestershire, Swindon and Wiltshire (Q64)	89.6	62.6	27.0	81	73.8	7.2
West Yorkshire (Q52)	90.1	60.3	29.8	87.7	65.8	21.9
East Anglia (Q56)	89.4	59.8	29.6	88.9	67.8	21.1
Cumbria, Northumberland, Tyne and Wear (Q49)	91.3	58.9	32.4	90.8	79.1	11.7
Greater Manchester (Q46)	87.1	57.9	29.2	84.5	64.4	20.1
Wessex (Q70)	88.7	57.6	31.1	76.8	72.7	4.1
Merseyside (Q48)	90.2	56.7	33.5	89.8	79.2	10.6
Devon, Cornwall and Isles of Scilly (Q66)	73.8	53.9	19.9	82.4	69.4	13.0
Essex (Q57)	91.6	53.7	37.9	79.8	77.1	2.7

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