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A pilot intervention to improve uptake and equality of childhood influenza vaccination in an area of Wales, through the introduction of a mixed delivery model including nursery school immunisation sessions



Caroline Harris^{a,*}, Simon Cottrell^a, Malorie Perry^{a,b}, Rhian Meaden^c, Rhianydd Davey^c, Megan Elliott^d, Rebecca Cushen^d, Gareth Jones^c, Hawys Youlden^a, Nicola Meredith^a, Rosemary Jones^a, Sara Thomas^c, Ashley Akbari^b, Ronan A. Lyons^b, Christopher Johnson^a

^a Vaccine Preventable Disease Programme and Communicable Disease Surveillance Centre, Public Health Wales, 2 Capital Quarter, Tyndall Street, Cardiff CF10 4BZ, Wales, UK

^b Population Data Science, Swansea University Medical School, Faculty of Medicine, Health & Life Science, Swansea University, Swansea, Wales, UK

^c Cwm Taf Morgannwg University Health Board, Keir Hardie University Health Park, Aberdare Road, Merthyr Tydfil CF48 1BZ, UK

^d Cwm Taf Morgannwg Public Health Team, Glanrhyd Hospital, Tondur Road, Bridgend CF31 4LN, UK

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ABSTRACT

The schools-based influenza vaccination programme has seen consistently high uptake in Wales, however coverage in pre-school two and three-year olds is lower. One health board area (Cwm Taf University Health Board (UHB)) developed an intervention to offer live attenuated influenza vaccine (LAIV) for three-year olds attending nursery schools alongside the existing general practice (GP) programme.

During the pilot, sessions were delivered by health visitors, working with school nurses. The mixed delivery model led to vaccination data being recorded in two separate data systems. To evaluate the impact of the pilot on overall vaccine uptake, data linkage was carried out within the Secure Anonymised Information Linkage (SAIL) Databank. Overall influenza vaccine uptake was calculated for each health board in Wales for two and three-year olds for the 2015–16, 2016–17, and 2017–18 influenza programmes. Uptake in two-year olds in Cwm Taf UHB and also uptake in three-year olds in other health boards in Wales were the comparison groups.

Uptake of influenza vaccine in the 2015–16 (pre-intervention) period was 41.0% for three-year olds in Cwm Taf UHB. Following the intervention, coverage increased to 70.7% and 71.5% for 2016–17 and 2017–18 respectively. The same increases in uptake were not seen in two-year olds in Cwm Taf UHB or in three-year olds in non-intervention health boards. In Cwm Taf UHB resident three-year olds in 2015–16 there was an inequality gap in the uptake of 17.4 percentage points between the most and least deprived areas. Uptake increased across all deprivation quintiles in 2016–17 and 2017–18; and the inequality gap decreased to 10.3 and 13.4 percentage points respectively.

Influenza vaccination uptake and equality of uptake in three-year olds can be improved by adopting a mixed delivery model across nursery school based immunisation sessions with the additional option of influenza vaccination at GPs.

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* Corresponding author.

E-mail addresses: Caroline.Harris2@wales.nhs.uk (C. Harris), Simon.Cottrell@wales.nhs.uk (S. Cottrell), Malorie.Perry@wales.nhs.uk (M. Perry), Rhian.Meaden@wales.nhs.uk (R. Meaden), Rhianydd.Davey@wales.nhs.uk (R. Davey), Megan.Elliott@wales.nhs.uk (M. Elliott), Rebecca.Cushen@wales.nhs.uk (R. Cushen), Gareth.Jones97@wales.nhs.uk (G. Jones), Hawys.Youlden2@wales.nhs.uk (H. Youlden), Nicola.Meredith@wales.nhs.uk (N. Meredith), Rosemary.Jones2@wales.nhs.uk (R. Jones), Sara.Thomas4@wales.nhs.uk (S. Thomas), A.Akbari@swansea.ac.uk (A. Akbari), R.A.Lyons@Swansea.ac.uk (R.A. Lyons), Christopher.Johnson2@wales.nhs.uk (C. Johnson).

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1. Introduction

Influenza causes a significant annual burden of disease, winter mortality and morbidity, and is a key contributor to health service winter pressures [1,2,3,4,5].

Wales is a country within the United Kingdom (UK) with devolved responsibility for health policy and legislature, where healthcare is freely provided by the Welsh National Health Service (NHS Wales). There are seven health boards and three trusts in Wales responsible for delivering most healthcare services, with

General Practices (GPs) contracted by local health boards to provide primary community care [6].

The annual influenza vaccination programme in Wales currently offers free vaccination to: all adults aged 50 years and older, all those aged 6 months to 49 years with a clinical condition that places them at higher risk, pregnant women, health and social care workers, care home residents, carers, prisoners, individuals with severe mental illnesses or learning disabilities, children aged 2–3 years and school-aged children [7].

Cwm Taf University Health Board (UHB) in Wales covered a population of approximately 450,000 across two local authority areas in 2016; there were approximately 3600 three-year olds [8]. The health board contains some areas ranked amongst the most socioeconomically deprived in Wales [9]. From 1st April 2019, the health board was renamed to Cwm Taf Morgannwg University Health Board as healthcare services for another local authority (Bridgend) were also transferred across.

Following recommendation from the Joint Committee on Vaccination and Immunisation (JCVI) in 2012 to extend the seasonal influenza vaccination programme to all children aged 2 to 16 years old, phased roll out of the extended programme commenced in August 2013, with children aged 2–3 and 11–12 years old being offered the free Live Attenuated Influenza Vaccine (LAIV) nasal spray. The childhood vaccination programme aims to directly avert childhood influenza cases and indirectly lower the burden of morbidity and mortality in the population through reduced influenza transmission in the community. The majority of vaccines in two and three-year olds are delivered through GPs [10]. Influenza vaccinations for older, school-aged children are usually delivered by school nursing services at school-based immunisation sessions. Since the implementation of the childhood programme across the UK countries, the programme has been shown to be impactful in reducing influenza related illness and influenza-related burden on healthcare services [11,12,13,14,15,16]. As of 2016, the start year of this evaluation, all children aged 2–7 years old were eligible to receive influenza vaccination (approximately 22,000 children in the Cwm Taf University Health Board area) [8,17].

Although vaccination coverage achieved through the schools-based childhood influenza vaccination programme for children aged 4–11 years in Wales has consistently been high (approximately 70% or higher), coverage in two and three year olds is lower, ranging from 38% in 2013–14 to 56% in 2020–21 [8].

Previously in Wales, modifying delivery models for routine scheduled vaccinations against tetanus, diphtheria and polio (Td/IPV) in school-aged teenagers resulted in a substantial improvement in uptake [18]. This involved the majority of Td/IPV vaccination delivery moving from GP to school-based vaccination sessions. Similar findings from England highlight the benefits of school-based programmes in optimising vaccination uptake in children [19].

For the 2016–17 influenza season, a pilot was developed in Cwm Taf University Health Board to introduce LAIV immunisation sessions in nursery settings of local authority schools. This evaluation aimed to establish a definitive reconciled patient dataset, through data linkage, containing all vaccination records, irrespective of the delivery model; and to use it to evaluate whether the nursery school based delivery of LAIV led to improved and more equitable uptake in three-year olds in the health board during 2016–17 and 2017–18, using 2015–16 as a baseline year.

2. Methods

2.1. The pilot

The pilot intended to offer the majority of LAIV delivery for resident three-year olds through local education authority (LEA) nurs-

ery school-based vaccination sessions, with GPs offering vaccinations to those who did not attend school nurseries, could not attend nursery vaccination sessions, or who attended nurseries that were private or outside the health board area. Those contraindicated LAIV would also have been offered alternative vaccination by their GP.

The pilot was a partnership between School Nursing and Health Visiting services in Cwm Taf University Health Board. During the pilot, one-hour-long vaccination sessions were arranged with local authority nursery schools by school nurse administration teams, with nursery schools being able to select a time slot that they felt would be most appropriate for parents. The timing of the sessions was influenced by parents needing to attend, so sessions were at the start and end of the school day. Vaccination invitation letters and consent forms were then sent to parents by school nursing teams, informing them of the immunisation session date and time for their child's nursery and highlighting the requirement for a parent/guardian to be present. Health Visitors were subsequently allocated to sessions, and attended to administer the vaccine to children of consenting parents, whilst the parents were present. Paper records of vaccinations were made and returned to the Child Health administrative team for digital recording of vaccination status.

2.2. Analyses

Evaluation of this intervention was carried out across two programme delivery years (2016–17 and 2017–18), with the 2015–16 programme delivery acting as a pre-implementation baseline. The impact of the intervention on overall uptake in two-year olds in Cwm Taf University Health Board was estimated in comparison to other Welsh health boards. The impact on equality of uptake across levels of socioeconomic deprivation within the health board was also evaluated.

Vaccination data for children aged 2–3 years are usually recorded within the GP record with aggregated data automatically extracted to inform national vaccination monitoring. For nursery school immunisation sessions, vaccinations were recorded in the Child Health Information System (CHIS). In Wales, the CHIS and GP data systems are separate, with no automatic flow of data between them. Although it is recommended manual notifications are sent between systems for vaccinations administered, there is no central reconciliation of data in place and the completeness of influenza vaccination data for three-year olds in each system is unknown. Provisional data collected by the school nursing service suggested that the pilot had led to improved uptake, however it was not possible to fully quantify the improvement in uptake without undertaking data linkage [10].

All analyses were carried out in the Secure Anonymised Information Linkage (SAIL) [20] Databank. Individuals were included in the analysis if they were aged two or three-years old on the 31st August and living and still resident in the health board as at the 30th April of the following year for each programme year evaluation period. All children aged three-years were included in analyses as the intervention group, as it was not possible to identify which individual children attended school-based nurseries and the majority of children at this age would be expected to be routinely attending a school-based nursery. Children aged two-years were included in analyses as a comparison group, as they would not be expected to attend local education authority school-based nurseries and were not able to access the nursery school immunisation sessions.

Children at two and three-years of age were identified for each evaluation period from the National Community Child Health Database (NCCHD), which holds Child Health Information System records for children alive and resident in Wales. Vaccination infor-

mation was also taken from the National Community Child Health Database and then supplemented with GP data from Welsh Longitudinal General Practice (WLGP) data. Influenza vaccinations were identified in WLGP data using Read version 2 codes [21] (Appendix A). The WLGP data includes data from approximately 80% of GP practices in Wales who submit data to SAIL Databank.

Data linkage of the National Community Child Health Database and Welsh Longitudinal General Practice data sources was undertaken using SAIL methodology to create a reconciled master dataset containing all two and three-year olds, their vaccination status and vaccination dates. Vaccinations must have been received between 1st September and 30th April for each influenza vaccination period to be included in analyses.

Individuals were allocated to a local health board based on the location of the general practice at which an individual was registered, and assigned to small area geographies of residence (Lower-layer Super Output Area, LSOA) version 2011 based on their address as recorded in the Welsh Demographic Service Dataset (WDSD).

The Welsh Index of Multiple Deprivation (WIMD) [9] version 2014 is an official measure of relative deprivation for the 1909 LSOAs in Wales and ranks each LSOA from most to least deprived. For this analysis, deprivation quintiles at a health board level were created based on the Welsh Index of Multiple Deprivation ranking, with quintile 1 being the most deprived and quintile 5 being the least deprived. Vaccination uptake and 95% confidence intervals were calculated for the population in individual quintiles of deprivation from 2015–16 to 2017–18, for three year olds (intervention age-group) and two year olds (comparison age-group).

Overall influenza vaccine uptake and 95% confidence intervals were calculated for each health board in Wales for two and three-year olds across the 2015–16, 2016–17, and 2017–18 influenza seasons. Comparisons were made between: uptake in two and three year olds in Cwm Taf University Health Board across the three seasons and uptake in three-year olds in each health board in Wales across the three seasons. Odds ratios of Cwm Taf University Health Board GP registered individuals being vaccinated compared to individuals in other health board areas were also calculated (adjusted for sex and Welsh Index of Multiple Deprivation quintile).

All analysis was carried out in R version 3.5.3.

3. Results

Uptake of influenza vaccine in the 2015–16 (pre-intervention) vaccination period was similar for two and three year olds in Cwm Taf University Health Board; 44.7% (95% CI: 43.0 to 46.3) and 41.0% (95% CI: 39.4 to 42.6) respectively. At the end of each intervention vaccination period, coverage was significantly higher in three-year olds (70.7% (95% CI: 69.2 to 72.2) and 71.5% (95% CI: 70.0 to 72.9) for 2016–17 and 2017–18 respectively) than in two-year olds (38.3% (95% CI: 36.7 to 39.9) and 48.1 (95% CI 46.5 to 49.7) for 2016–17 and 2017–18 respectively) (Table 1).

In 2015–16, uptake of influenza vaccine in three-year olds ranged by health board area from 33.0% to 47.0%. During 2016–17,

Table 1
Uptake of influenza vaccination in two and three-year olds in Cwm Taf University Health Board; 2015–16 to 2017–18 and odds ratios.

	3 year olds			2 year olds			Crude OR (95% CI)	Adjusted OR (95% CI)
	Population (n)	Vaccinated (n)	Uptake (%) (95% CI)	Population (n)	Vaccinated (n)	Uptake (%) (95% CI)		
2015–16	3606	1478	41.0 (39.4–42.6)	3514	1571	44.6 (43.0–46.3)	0.86 (0.78–0.94)	0.86 (0.78–0.95)
2016–17	3559	2516	70.7 (69.2–72.2)	3473	1330	38.3 (36.7–39.9)	3.89 (3.52–4.29)	3.96 (3.58–4.39)
2017–18	3514	2511	71.5 (70.0–73.0)	3625	1743	48.1 (46.5–49.7)	2.70 (2.45–2.98)	2.83 (2.56–3.14)

Table 2
Uptake of influenza vaccination in three year olds, by health board; 2015–16 – 2017–18.

Local Health Board	Uptake 2015–16 (%) (95% CI)	Uptake 2016–17 (%) (95% CI)	Uptake 2017–18 (%) (95% CI)
HB1	33.0 (31.8–34.2)	41.9 (40.6–43.2)	44.4 (43.2–45.8)
HB2 (Cwm Taf UHB)	41.0 (39.4–42.6)	70.7 (69.2–72.2)	71.5 (70.0–73.0)
HB3	47.0 (45.9–48.1)	46.7 (45.6–47.9)	48.9 (47.7–50.0)
HB4	43.9 (42.6–45.1)	46.4 (45.1–47.6)	46.6 (45.4–47.9)
HB5	39.8 (38.6–41.0)	36.6 (35.5–37.8)	39.4 (38.3–40.6)
HB6	39.7 (36.9–42.5)	36.1 (33.4–38.9)	46.2 (43.4–49.0)
HB7	41.4 (39.9–42.9)	37.2 (35.7–38.7)	42.0 (40.5–43.6)

uptake of influenza vaccine in three-year olds ranged from 36.1% to 46.7% in non-intervention health board areas, compared to 70.7% in Cwm Taf University Health Board. During 2017–18, uptake of influenza vaccine in three-year olds ranged from 39.4% to 48.9% in non-intervention health board areas, compared to 71.5 % in Cwm Taf University Health Board (Table 2).

In the 2015–16 vaccination period, influenza vaccine uptake in three-year olds in Cwm Taf University Health Board was lowest in quintile 1 (most deprived) (32.6%, 95% CI: 29.3 to 36.2) and highest in quintile 5 (least deprived) (50.0%, 95% CI: 46.1 to 53.9), this represents an inequality gap in uptake of 17.4 percentage points between the most deprived and least deprived areas. In the first intervention year (2016–17), uptake of influenza vaccine in three-year olds increased in all deprivation quintiles in Cwm Taf University Health Board. Uptake in three-year olds remained lowest in quintile 1 (most deprived) (66.8%, 95% CI: 63.2 to 70.2) and was highest in quintile 4 (second least deprived) (77.1%, 95% CI: 73.8 to 80.1); however, the inequality gap in uptake narrowed to 10.3 percentage points. In 2017–18, uptake in three-year olds was lowest in quintile 1 (most deprived) (65.32%, 95% CI: 61.6 to 68.8) and was highest in quintile 5 (least deprived) (78.8%, 95% CI: 75.4 to 81.7). The inequality gap was again narrower than was seen in 2015–16, at 13.4% points (Figs. 1a and 1b).

In comparison, in two-year olds, the inequality gap in uptake between the most and least deprived quintiles widened over the same time period. Additionally, although uptake increased in two-year olds in some deprivation quintiles, it remained substantially lower than uptake in three-year olds in the same quintile.

4. Discussion

This evaluation reconciled data from two systems to provide robust quantification of the impact of a service delivery intervention on uptake and equality of childhood influenza vaccine in one area of Wales.

Prior to the delivery of LAIV in nursery schools in Cwm Taf University Health Board, the two and three-year old influenza vaccination programme was delivered solely through general practices, and uptake was low for both age groups. This intervention demonstrates that uptake can be increased by providing a mixed-model of delivery in nursery schools and general practice.

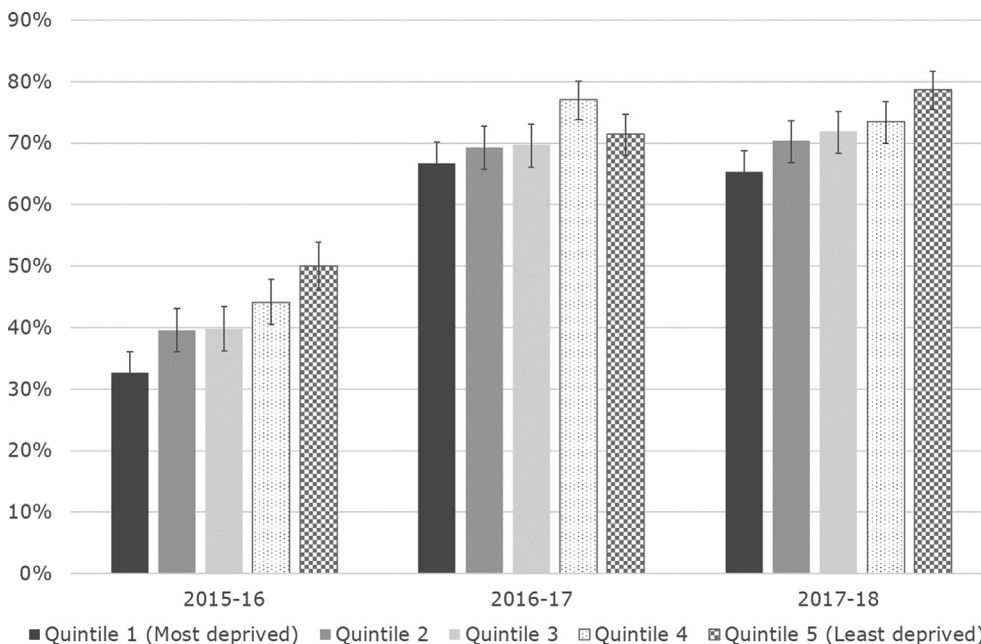


Fig. 1a. Percentage of three-year old children receiving influenza vaccination, by quintile of deprivation in Cwm Taf University Health Board, 2015-16 – 2017-18^a. ^aQuintile 1 is the most deprived, quintile 5 is the least deprived.

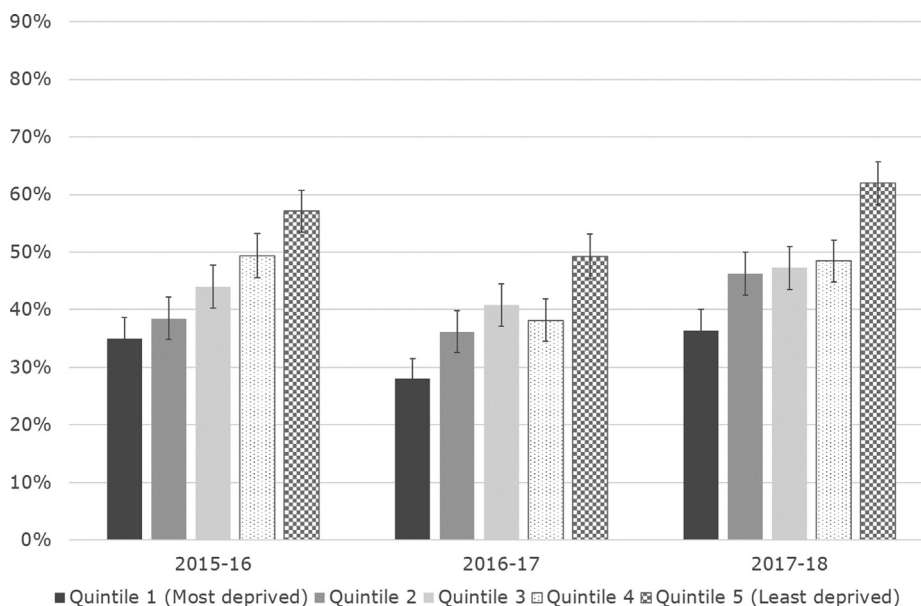


Fig. 1b. Percentage of two-year old children receiving influenza vaccination, by quintile of deprivation in Cwm Taf University Health Board, 2015-16 – 2017-18^a. ^aQuintile 1 is the most deprived, quintile 5 is the least deprived.

High influenza vaccine uptake in children has been shown to decrease burden of influenza-related disease across populations [11,12,13,14,15,16].

In the 2015–16 vaccination period, inequality in uptake of influenza vaccination was seen across deprivation quintiles in Cwm Taf University Health Board. Although the inequality gap remained following the intervention, uptake of influenza vaccination in three-year olds significantly increased across all deprivation quintiles, and the absolute inequality gap narrowed. Previous studies have highlighted inequalities in vaccination uptake in children [22,23,24] and this intervention has provided evidence of reducing the inequality gap across deprivation quintiles. Further work could

be undertaken to describe the inequality gap in terms of ethnicity [25,26].

The immunisation sessions delivered by health visitors at school nurseries will have put additional pressure on those services. However, in turn this will have relieved pressure in general practices, which may have been able to reduce the number of children’s influenza vaccination clinics. Clear, timely and robust communication between both modes of delivery were imperative in minimising risks from a mixed model, so that each service understood who was responsible for vaccinating which children and where. Health visitors saw the programme as a means to increasing influenza vaccine uptake in this cohort of children and an

opportunity to develop relationships with schools and school nurses, as well as additional contact with parents. Parents/guardians were required to provide consent for vaccination and to attend the nursery immunisation sessions, and feedback from parents was mainly positive, whilst acceptance of this delivery model is demonstrated by the higher levels of uptake. Feedback from headteachers was positive and they felt that the sessions were well organised and carried out efficiently.

It was not possible to estimate how equitable access to this intervention was across the health board, but a significant impact was seen when calculating uptake for all health board resident three-year olds. It is important to note that this intervention aimed to introduce a mixed delivery model rather than a wholesale move from GP delivery to nursery school delivery, which would potentially exclude children who do not attend school-based nursery settings, those who were not in attendance at nursery at the date of the vaccination session, and those who attend a school-based nursery outside of the health board area. Failure to provide a mixed delivery model may create or exacerbate vaccination inequities. In this context, it was important that children unintentionally excluded from nursery vaccination sessions were afforded the opportunity to attend GPs for vaccination, however it was not possible to estimate how many three-year old children accessed vaccination in GPs.

Following the intervention period studied in this paper, LAIV was routinely offered in nursery schools in Cwm Taf University Health Board in subsequent years.

Socioeconomic inequalities in LAIV uptake were not calculated for other health board regions as part of this analysis; therefore it is not known how similar Cwm Taf University Health Board is to other health board regions in terms of an inequality gap. However, the reduction in the inequality gap in three-year olds compared to two-year olds within the Cwm Taf suggested that the mixed delivery model gave more equitable outcomes.

Only 80% of GPs in Wales submit data to SAIL Databank, therefore additional vaccinations given in practices that do not submit data to SAIL and were not recorded in the Child Health Information System were unknown. This may have underestimated coverage across all health board areas.

Although socioeconomic inequalities in uptake of childhood vaccinations have been noted in Wales before [27], evidence on interventions to improve vaccination uptake and address inequalities is scarce. This is a non-randomised evaluation based on routinely collected data. However, even given its limitations, it provide clear evidence that this intervention has led to a significant increase in vaccination uptake and a reduction in socioeconomic inequality of uptake, which is unlikely to be due to other external factors. The intervention has potential for similar vaccine uptake improvements in other areas where children at this age attend nurseries, however there may be other service delivery factors to take into account when reproducing the intervention in other health boards or regions.

5. Conclusions

Uptake of influenza vaccine in two and three-year olds in Wales is significantly lower than in school-aged children, and interventions to improve uptake are needed. These findings from one health board area suggest that total influenza vaccination uptake can be increased and inequality of uptake by socioeconomic deprivation reduced by primarily offering delivery of LAIV at nursery school-based immunisation sessions with the additional option of influenza vaccination at GP surgeries as a mixed model. This was delivered in a manner that is acceptable to the services involved and also to the parents or guardians of three-year olds.

CRedit authorship contribution statement

Caroline Harris: Formal analysis, Writing – original draft, Writing – review & editing. **Simon Cottrell:** Conceptualization, Supervision, Writing – original draft, Writing – review & editing. **Malorie Perry:** Supervision, Writing – review & editing. **Rhian Meaden:** Writing – review & editing. **Rhianydd Davey:** Writing – review & editing. **Megan Elliott:** Writing – review & editing. **Rebecca Cushen:** Writing – review & editing. **Gareth Jones:** Writing – review & editing. **Hawys Youlden:** Writing – review & editing. **Nicola Meredith:** Writing – review & editing. **Rosemary Jones:** Writing – review & editing. **Sara Thomas:** Conceptualization, Writing – review & editing. **Ashley Akbari:** Data curation, Writing – review & editing. **Ronan A. Lyons:** Writing – review & editing. **Christopher Johnson:** Writing – review & editing.

Data availability

The authors do not have permission to share data.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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This study makes use of anonymised data held in the SAIL Databank. This work uses data provided by patients and collected by the NHS as part of their care and support and the Understanding Patient Data initiative. We would also like to acknowledge all data providers who make anonymised data available for research. All research conducted has been completed under the permission and approval of the SAIL independent Information Governance Review Panel (IGRP) project number 0804.

Data statement

The data used in this study is available from the Secure Anonymised Information Linkage (SAIL) Databank at Swansea University, Swansea, UK, which is part of the national e-health records research infrastructure for Wales. All proposals to use SAIL data are subject to review by an independent Information Governance Review Panel (IGRP). Before any data can be accessed, approval must be given by the IGRP. The IGRP gives careful consideration to each project to ensure proper and appropriate use of SAIL data. When access has been approved, it is gained through a privacy protecting safe haven and remote access system referred to as the SAIL Gateway. SAIL has established an application process to be followed by anyone who would like to access data via SAIL at: <https://www.saildatabank.com/application-process>.

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Appendix A

Influenza vaccination system codes.

Read codes v2: 65E, n47, ZV048.

National Community Child Health Database (NCCHD): 57, 57CO, 58, 58CO, 76, 94B1, 94B2, 94BA, 94K1, 94K2, 94KA, 94S1, 94S2, 94SA, 57I, 57R, 57A.

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