Public Health 225 (2023) 229–236

Contents lists available at ScienceDirect

Public Health

journal homepage: www.elsevier.com/locate/puhe

Original Research

‘Unable to have a proper conversation over the phone about my concerns’: a multimethods evaluation of the impact of COVID-19 on routine childhood vaccination services in London, UK

Eleanor Buck [a,*], J. Burt [b], K. Karampatsas [c], Y. Hsia [c,d], G. Whyte [e], G. Amirthalingam [f], H. Skirrow [g], K. Le Doare [c,h,i]

[a] St George's Hospital Medical School, St. George's, University of London, London, United Kingdom
[b] Ashford and St Peter's Hospital NHS Foundation Trust, United Kingdom
[c] Centre for Neonatal and Paediatric Infection, Institute of Infection and Immunity, St. George's, University of London, London, United Kingdom
[d] School of Pharmacy, Queen's University Belfast, Belfast, United Kingdom
[e] North Croydon Medical Centre, United Kingdom
[f] Immunisation and Vaccine Preventable Diseases Division, UK Health Security Agency, United Kingdom
[g] School of Public Health, Imperial College London, United Kingdom
[h] MRC/UVRI @LHSTM Uganda Research Unit, Entebbe, Uganda
[i] Pathogen Immunity Group, UK Health Security Agency, Porton Down, United Kingdom

A R T I C L E I N F O

Article history:
Received 20 February 2023
Received in revised form
25 September 2023
Accepted 27 September 2023

Keywords:
COVID-19
Childhood vaccinations
Vaccination services
Public health

A B S T R A C T

Objectives: Investigating the completion rate of 12-month vaccinations and parental perspectives on vaccine services during COVID-19.
Study-design: Service evaluation including parental questionnaire.
Methods: Uptake of 12-month vaccinations in three London general practices during three periods: pre-COVID (1/3/2018–28/2/2019, n = 826), during COVID (1/3/2019–28/2/2020, n = 775) and post-COVID first wave (1/8/2020–31/1/2021, n = 419). Questionnaire of parents whose children were registered at the practices (1/4/2019–1/22/2021, n = 1350).
Results: Comparing pre-COVID and both COVID cohorts, the completion rates of 12-month vaccines were lower. *Haemophilus influenzae* type B/meningococcal group C (Hib/MenC) vaccination uptake was 5.6% lower (89.0% vs 83.4%, P=<0.001), meningococcal group B (MenB) booster uptake was 4.4% lower (87.3% vs 82.9%, $P = 0.006$), pneumococcal conjugate vaccine (PCV) booster uptake was 6% lower (88.0% vs 82.0%, $P < 0.001$) and measles, mumps and rubella (MMR) vaccine uptake was 5.2% lower (89.1% vs 83.9%, $P = 0.003$).
Black/Black-British ethnicity children had increased odds of missing their 12-month vaccinations compared to White ethnicity children (adjusted odds ratio 0.43 [95% confidence interval 0.24–0.79, $P = 0.005$; 0.36 [0.20–0.65], $P < 0.001$; 0.48 [0.27–0.87], $P = 0.01$; 0.40 [0.22–0.73], $P = 0.002$; for Hib/MenC, MenB booster, PCV booster and MMR. Comparing pre-COVID and COVID periods, vaccinations coded as not booked increased for MMR (10%), MenB (7%) and PCV booster (8%).
Parents reported changes to vaccination services during COVID-19, including difficulties booking and attending appointments and lack of vaccination reminders.
Conclusion: A sustained decrease in 12-month childhood vaccination uptake disproportionally affected Black/Black British ethnicity infants during the first wave of the pandemic. Vaccination reminders and availability of healthcare professionals to discuss parental vaccine queries are vital to maintaining uptake.

Introduction

The COVID-19 pandemic has led to a dramatic loss of human lives.[1] While studies have shown the medical impact of COVID-19 on children is milder than compared to adults, the psychosocial

* Corresponding author. St George's University of London, Cranmer Terrace, London SW17 0RE, United Kingdom.
E-mail address: eleanor.buck3@nhs.net (E. Buck).

https://doi.org/10.1016/j.puhe.2023.09.026
0033-3506/

impacts due to the UK lockdown are perhaps greater.[2,3] Globally, routine childhood immunisation services have been significantly disrupted, jeopardising previous gains in child vaccine coverage.[4,5] The reduction of vaccination uptake continued during both the first and second waves of the pandemic, with data indicating vaccination coverage has not recovered to prepandemic levels following the end of restrictions.[6] For example, measles, mumps and rubella (MMR) uptake by 5 years of age in England has fallen to less than 90% in February 2022, putting one in 10 children starting school at risk of measles, according to the UK Health Security Agency (UKHSA).[7] As restrictions have eased, it is important to identify which children require catch-up vaccinations and the barriers parents face in taking their children for routine vaccinations.[8,9] The UKHSA 2021–2022 demonstrated that no region achieved the target 95% coverage of the MMR vaccine, with London at the lowest level of coverage at 79.9%. Further data from January to March 2023 showed the uptake of MMR remained below targets, with 89.9% of children at 24 months having received their first dose of MMR.[10] Coverage for the primary vaccinations given at 8, 12 and 16 weeks old[11] also decreased nationally in 2021–2022, to 91.8% from 92.0% in 2020–2021. Regionally, London had the lowest coverage rate at 86.5%.[12]

By examining vaccine uptake at several London general practices (GPs), lessons can be learned on how to prevent future health system shocks impacting existing vaccine uptake inequalities. Our multimethod study aimed to assess the impact of the COVID-19 pandemic on routine childhood vaccination uptake in Southwest London between 2019 and 2022 and parental perspectives on vaccine services pre/post pandemic.

Methods

Study design and population

This was a service evaluation conducted in five GPs in Southwest London (Fig. 1, A), undertaken using the STROBE checklist.[14] All scheduled childhood immunisations given within the UK are provided by GPs, which are community hubs providing preventative medicine and primary care to all. These five sites responded to open invitations sent to 180 GP surgeries in the National Health Service (NHS) Southwest London Clinical Commissioning Group (CCG) mailing list.

Each GP surgery served unique patient cohorts with varying population sizes and levels of social deprivation; GP1 had 14,603 registered patients in the fifth least deprived decile, GP2 had 5971 patients in the third most deprived decile, GP3 had 15,001 registered patients in the fourth least deprived decile, GP4 had 29,801 registered patients in the least deprived decile, and GP5 had 12,128 registered patients in the fourth most deprived decile.[16]

We extracted data from each GPs electronic medical records (EMRs; EMIS Health software) on routine primary immunisations scheduled within the first year of life according to the UK immunisation schedule (Appendix A).[11] We chose the following dates to reflect a 12-month period before physical distancing measures were implemented (pre-COVID cohort: children born between 1st March 2018 and 28th February 2019), a 12-month period with physical distancing measures in place when children reached the age of one year (COVID cohort: children born between 1st March 2019 and 28th February 2020), and a 6-month period after the discontinuation of the first lockdown in England (post-COVID first wave cohort: children born between 1st August 2020 and 31st January 2021). GP1 did not provide data for the post-COVID first wave cohort. We excluded children who did not survive the first year of life and those not on the standard UK immunisation schedule and were mostly children who had received part of their immunisation schedule abroad following a catch-up schedule.

Two researchers performed data collection. Information collected included sex assigned at birth (male or female), ethnicity (White, Asian or Asian British, Black or Black British, Mixed, Other), postcode, details of vaccinations (vaccine administered and date) and the reason provided if not administered (declined, not booked, not clinically indicated). The primary outcome was the completion rate of 12-month vaccinations, which are *Haemophilus influenzae* type b/meningococcal group C (Hib/MenC) vaccine, meningococcal group B (MenB) booster vaccine, pneumococcal conjugate vaccine (PCV) booster, and the first dose of the MMR vaccine.[11]

To assess the reason for vaccinations not being given, we used codes to indicate declined, where parental declining of the specific vaccination or all vaccinations had been recorded on the EMR, or not booked, where the vaccination had not been given but there was no recorded declination. A decile of deprivation was calculated from each participant's postcode,[17] where one stands for the most deprived area and 10 for the least. The Indices of Deprivation were further classified from deciles to three groups of low/medium/high for analysis. These categories represent the most deprived third of geographic areas in England (high; decile 7–10), middle third (moderate, decile 4–6), and least deprived third (1–3).[18]

An electronic questionnaire held on Microsoft Office Forms (Appendix B) was sent to 1350 parents of children receiving their one-year scheduled immunisations before the 1st April 2022 in four participating GP surgeries (GP2, 3, 4 and 5), to further explore the influences of practice factors (communication, reminders, infection control precautions) and parent motivations on uptake of vaccinations. The questionnaire used a mix of closed and open questions to cover the following topics: participants GP surgery, child's demographic details, vaccinations received, method of invitation to vaccinate, type of appointment reminders (if any), issues with delays/booking/attendance, the impact of COVID on the experience, experience with health professionals, COVID-related safety measures in the GP surgeries, and perspectives of vaccinations in the context of COVID. Where closed questions were used to illicit the presence or absence of an experience, free text boxes were provided for further information as required. Inclusion criteria were defined as patients whose date of birth fell between 1st April 2019 and 1st February 2021. This cohort was chosen to reflect children receiving vaccinations before, during and after the COVID-19 physical distancing measures to mirror the EMR cohorts. Parents were invited via text or email in line with each GPs data protection provisions.[19] Exclusion criteria were date of birth being outside of the specified range and changing GP during the first year of life. Parents were not compensated for taking part in the survey.

Statistical analysis

Categorical variables were expressed as frequencies and percentages, and continuous variables were expressed as the median. Mann–Whitney and Chi-squared tests were used to compare continuous and categorical variables. Only participants with complete information were included in the analysis. Univariate regression analysis was used to explore associations of vaccination completion by sex, ethnicity, index of deprivation and GP. A multivariate model was produced using Akaike's Information Criteria (AIC) for variables selection. P value < 0.05 was considered statistically significant. Statistical analyses were done with RStudio (version 3.6.3).

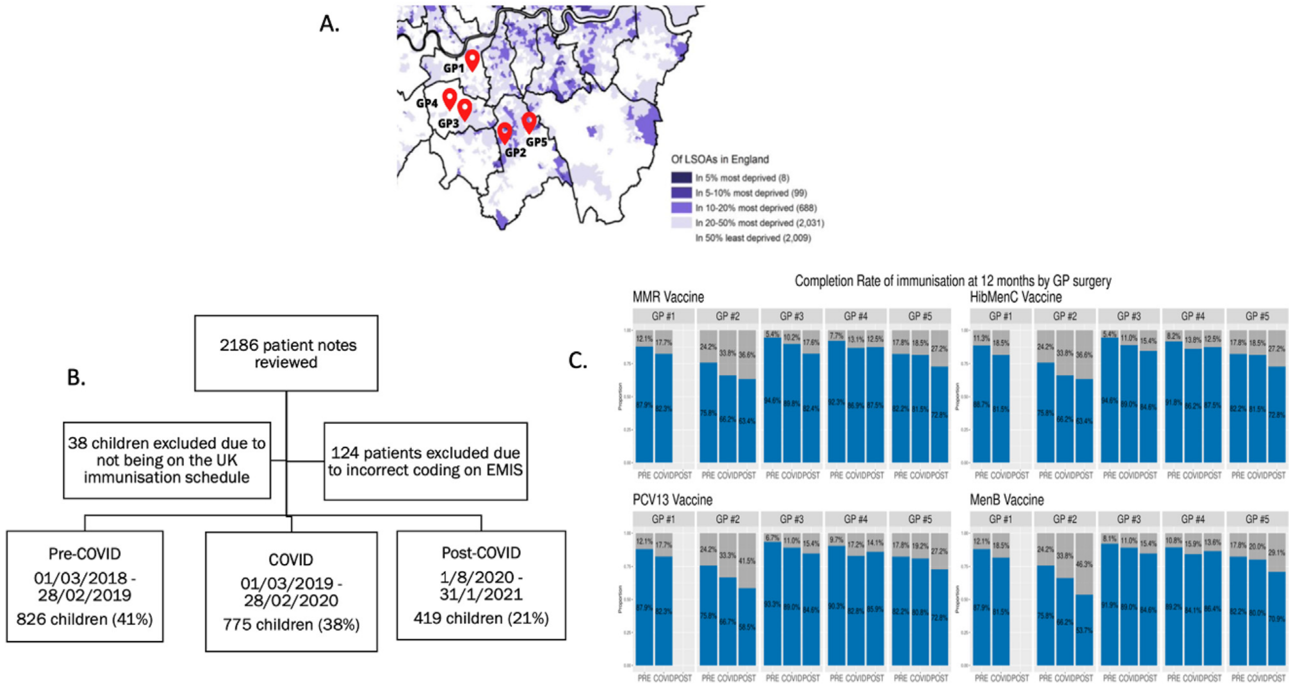

Fig. 1. A – Map showing the locations of GP surgeries overlying the index of multiple deprivation data from 2019.[15] B – Flowchart displaying the formation of the final data set. C – Completion rate of immunisation at 12 months by GP. Calculated using percentage vaccination uptake for pre-COVID, COVID and post-COVID first wave cohorts. Blue bar indicates the percentage of those vaccinated. Grey indicates the percentage of children who have not received the vaccination, coded as either not booked or declined. Blue indicates the percentage of children who have received a vaccination. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

Ethical approval

The data collection from the EMRs was approved by St George's University of London Research Institute Clinical Governance Office. The questionnaire was approved by the United Kingdom Health Security Agency (reference: NR0304).

Results

Participant characteristics

In total, 2186 EMRs were reviewed of children born between 1st March 2018 and 28th February 2020, and 1st August 2020 and 31st January 2021. Of these, 38 children were excluded due to having received vaccinations outside of the UK, hence not being on the standard UK immunisation schedule; 124 children were excluded due to incorrect coding on EMIS, leaving 826 children in the pre-COVID cohort, 775 children in the COVID cohort and 419 children in the post-COVID first wave cohort (Fig. 1, B).

Across all GP surgeries, there was an even split of male and female infants (Table 1). All GP surgeries had a majority of White children, except for GP2, where 30.7% of children were Black/Black British ($P < 0.001$). Within the 5 GP surgeries, the most deprived populations were in GP2 and GP5.

Vaccine uptake

Comparing the pre-COVID and COVID cohorts, the completion rates of HiB/MenC were 5.6% lower (89.0% vs 83.4%, $P = <0.001$), MenB booster was 4.4% lower (87.3% vs 82.9%, $P = 0.006$), PCV booster was 6% lower (88.0% vs 82.0%, $P < 0.001$) and first dose MMR was 5.2% lower (89.1% vs 83.9%, $P = 0.003$). This trend was similar across all GP surgeries, with the biggest decrease observed at GP2 (Fig. 1, C).

Table 1
Demographic characteristics of participants from all three cohorts across GP surgeries.

Characteristics		GP surgeries					
		GP1 [n = 254]	GP2 [n = 175]	GP3 [n = 367]	GP4 [n = 856]	GP5 [n = 368]	*P*-value
Gender (%)	Female	45.7	51.4	46.3	50.6	53.3	0.2
	Male	54.3	48.6	53.7	49.4	46.7	
Ethnicity (%)	Asian or Asian British	2.1	8.6	23.2	10.8	8.3	<0.001
	Black or Black British	8.5	30.7	3.8	0.4	20.6	
	White	56.6	21.4	35.7	46.1	45.1	
	Mixed	4.8	10.7	7.2	5.4	5.1	
	Other	28.0	28.6	30.0	37.3	20.9	
Index of Deprivation (%)	Low (1–3)	17.7	70.1	23.1	5.0	66.7	<0.001
	Moderate (4–6)	50.4	28.7	36.6	15.4	25.7	
	High (7–10)	31.9	1.1	40.2	79.6	7.7	

GP = general practice.

Table 2
Univariate and multivariate logistic regression of variables for MMR first dose, HiB/MenC, MenB booster and PCV booster in the COVID and post-COVID first wave cohorts.[a]

	MMR 1st dose				Hib/MenC				MenB booster				PVC13 booster			
Variables	Univariate regression OR [95% CI]	*P*-value	Multivariate regression Adj OR [95% CI]	*P*-value	Univariate regression OR [95% CI]	*P*-value	Multivariate regression Adj OR [95% CI]	*P*-value	Univariate regression OR	*P*-value	Multivariate regression Adj OR [95% CI]	*P*-value	Univariate regression OR [95% CI]	*P*-value	Multivariate regression Adj OR [95% CI]	*P*-value
Gender (ref female)																
Male	1.22 [0.90–1.65]	0.2			1.22 [0.90–1.64]	0.2				0.2			1.19 [0.89–1.59]	0.2		
Ethnicity (ref White)																
Asian or Asian British	2.60 [1.10–7.66]	0.05	2.58 [1.08–7.62]	0.05	2.85 [1.21–8.37]	0.03	2.83 [1.19–8.33]	0.03		0.1	1.84 [0.88–4.33]	0.1	1.57 [0.78–3.53]	0.2	1.56 [0.77–3.52]	0.2
Black or Black British	0.32 [0.18–0.57]	**<0.001**	0.40 [0.22–0.73]	**0.002**	0.35 [0.20–0.62]	**<0.001**	0.43 [0.24–0.79]	**0.0**05		**<0.001**	0.36 [0.20–0.65]	**<0.001**	0.39 [0.22–0.70]	**0.001**	0.48 [0.27–0.87]	0.01
Mixed	0.51 [0.25–1.11]	0.08	0.54 [0.26–1.18]	0.1	0.72 [0.34–1.67]	0.4	0.77 [0.36–1.78]	0.5		0.5	0.81 [0.38–1.88]	0.6	0.76 [0.36–1.75]	0.5	0.80 [0.38–1.85]	0.6
Other	0.67 [0.43–1.05]	0.07	0.66 [0.42–1.03]	0.07	0.71 [0.46–1.11]	0.1	0.72 [0.46–1.12]	0.1		0.1	0.73 [0.47–1.13]	0.2	0.65 [0.43–0.99]	0.04	0.64 [0.42–0.99]	0.04
IOD (ref high (7–10)																
Moderate (4–6)	0.65 [0.45–0.96]	0.03	0.68 [0.42–1.11]	0.1	0.63 [0.43–0.92]	0.02	0.68 [0.42–1.10]	0.1		0.09	0.85 [0.53–1.36]	0.5	0.67 [0.46–0.96]	0.03	0.73 [0.46–1.16]	0.2
Low (1–3)	0.42 [0.29–0.60]	**<0.001**	0.50 [0.31–0.81]	0.004	0.43 [0.30–0.61]	**<0.001**	0.51 [0.32–0.82]	0.005		**<0.001**	0.55 [0.35–0.87]	0.01	0.46 [0.33–0.65]	**<0.001**	0.54 [0.34–0.84]	0.007
GP surgery (ref 1)																
2	0.40 [0.22–0.73]	**0.003**			0.42 [0.23–0.76]	**0.004**				**<0.001**			0.37 [0.20–0.68]	**0.001**		
3	1.40 [0.77–2.54]	0.3			1.54 [0.84–2.78]	0.3				0.2			1.46 [0.79–2.66]	0.2		
4	1.45 [0.85–2.41]	0.2			1.47 [0.87–2.44]	0.1				0.3			1.12 [0.66–1.84]	0.7		
5	0.75 [0.43–1.28]	0.3			0.78 [0.45–1.34]	0.4				0.2			0.73 [0.42–1.25]	0.3		

CI = confidence interval; GP = general practice; IOD = Index of Deprivation; OR = odds ratio.
[a] decile of deprivation was calculated from each participant's postcode,[17] where one stands for the most deprived area and 10 for the least. IODs were further classified as low (1–3), moderate (4–6), or high (7–10).

Notably, in the post-COVID first wave cohort, there was a further decline in booster vaccination coverage. The HiB/MenC was 8.9% lower (89.0% vs 80.9%, $P < 0.001$), MenB booster was 8.3% lower (87.3% vs 79.0%, $P < 0.001$), PCV booster was 8.3% lower (88.0% vs 79.7%, $P < 0.001$) and first dose MMR was 8.7% lower (89.1% vs 80.4%, $P < 0.001$) when comparing the pre-COVID and post-COVID first wave cohorts.

Comparing the COVID and post-COVID first wave cohorts, there was no significant difference in the uptake of booster vaccinations. HiB/MenC was 2.5% lower (83.4 vs 80.9%, $P = 0.3$), MenB booster was 3.9% lower (82.9% vs 79.0%, $P = 0.2$), PCV booster was 2.3% lower (82.0% vs 79.7%, $P = 0.3$) and first dose MMR was 3.5% lower (83.9% vs 80.4%, $P = 0.1$), suggesting vaccination rates have not recovered to pre-COVID levels.

Comparing the coded reasons, the 12-month vaccinations were not given in the pre-COVID and COVID cohort, and the number coded as not booked increased by 10% (72.2% vs 83.2%) for MMR, 7% for MenB (76.2% vs 83.3%), and 8% for PCV booster (74.8% vs 82.7%). However, there was a 4% decrease (75.8% vs 72.2%) in Hib/MenC vaccinations coded as not booked. However, comparing the COVID and post-COVID first wave cohort, there was a minimal change in the number of vaccinations coded as not booked (83.3% vs 83.0%; 82.7% vs 83.5%; 83.2% vs 84.2%) for MenB3, PCV booster and MMR. Alternatively, there was a 10% increase (72.2% vs 82.5%) in Hib/MenC vaccinations coded as not booked.

Multivariate logistic regression (Table 2 and Supplementary Material) analysed the ethnic, socio-economic and geographical disparities in vaccine uptake.[8] This analysis identified that children of Black/Black British ethnicity were more likely to not receive the vaccinations scheduled to be given at 12 months than children of White ethnicity. The Hib/MenC ($P = 0.005$), MenB booster ($P = < 0.001$), PCV13 booster ($P = 0.01$) and first dose MMR ($P = 0.004$) were all statistically less likely to have been given at 12 months in Black/Black British children than their White counterparts. Additionally, multivariate analysis identified that children living in the most deprived postcodes (indices of deprivation decile 7–10) were more likely to have missed their vaccinations scheduled at 12 months (Hib/MenC [$P = 0.005$], MenB booster [$P = 0.01$], PCV13 booster [$P = 0.007$] and first dose MMR [$P = 0.004$]) compared to those living in the least deprived postcodes (indices of deprivation decile 1–3).

Parental perceptions of vaccine services questionnaire

The questionnaire received 61 responses, 4.5% response rate, across 3 GP surgeries (GP2, GP3 and GP4). Three participants were excluded, all from GP4, due to changing GP surgeries during the first year of life. Demographics, shown in Table 3, differed to the EMR cohorts, with most respondents from GP4 (n = 44, 75.9%).

Our data found the most common methods of invitation to book vaccinations were text message (n = 13, 22.4%) and GP/practice nurse request (n = 10, 17.2%), shown in Table 4. However, 24 respondents (41.4%) did not receive any invitation and 11 (19.05%) were unsure if they had received an invitation. Eighteen respondents (31.0%) did not receive any reminder to book their vaccination appointment and 24 respondents (41.4%) received a text message reminder. Delays to appointments were reported by seven respondents (12.1%), and problems booking affected five respondents (8.6%). Of these five participants, two respondents

Table 3
Descriptive statistics of questionnaire respondent baseline characteristics.

Question	Variable	Frequency (%)
Sex	Female	35 (60.34)
	Male	23 (39.66)
Ethnicity	Asian or Asian British	4 (6.90)
	Black, African, Caribbean, or Black British	3 (5.17)
	Mixed or multiple ethnic groups	8 (13.79)
	Other ethnic group	2 (3.45)
	White	41 (70.69)
8 Weeks Vaccinations	No	1 (1.72)
	Yes	57 (98.28)
12 Weeks Vaccinations	No	1 (1.72)
	Yes	57 (98.28)
16 Weeks Vaccinations	No	1 (1.72)
	Unsure	2 (3.45)
	Yes	55 (94.83)
12 Months Vaccinations	No	4 (6.90)
	Yes	54 (93.10)

Table 4
Descriptive statistics of questionnaire responses regarding vaccination appointment invitation and reminders.

	Variable	Frequency n (%)
Invitation method	Letter	7 (12.07)
	Text	13 (22.41)
	Email	2 (3.45)
	GP or practice nurse asked me to make an appointment	10 (17.24)
	No invitation	24 (41.38)
	Unsure	11 (19.00)
Appointment reminders	No, I did not receive any reminders to book my appointment	18 (31.03)
	No, I had already booked my appointment	9 (15.52)
	Yes, by phone call	1 (1.72)
	Yes, by text	24 (41.38)
	Yes, I was asked by a GP or practice nurse	6 (10.34)

GP = general practice.

gave the reason as not having a convenient day or time available, one respondent reported it took too long to arrange an appointment, one respondent wanted a face-to-face to discuss specific vaccinations and one respondent did not receive the help they required from reception staff when trying to book. Of the two parents who experienced problems with attending their appointments, one parent postponed the appointment and another parent wanted to have a face-to-face appointment to discuss their older child's previous reaction to vaccinations.

Unable to have a proper consultation over the phone regarding my concerns/request for certain vaccines for my child to have… I haven't been able to get a face-to-face appointment with a consultant to discuss which ones I want him to have and ones I don't (response 17, GP4).

Eleven participants reported COVID-19 did impact the vaccination process (19.0 %). Responses included lack of reminders (n = 3), lack of information (n = 1), takes longer to book (n = 1), lower standard of health care (n = 1), poor interactions with staff (n = 4), parental stress (n = 3) and unwell household (n = 1). Two participants detailed that their prior knowledge, due to having older children, mitigated missing vaccinations. These responses were mimicked in further comments regarding the impact of COVID-19 – namely, poor communication from the practice (n = 1), wearing a mask inhibited ability to comfort child (n = 2) and the introduction of COVID-19 measures in surgeries (n = 3).

I had to go alone, which was particularly upsetting for the 1 year vaccinations… Plus, just having to be in a medical setting with an 8 week old baby when the pandemic has just hit is incredibly stressful (response 10, GP4).

Most respondents reported additional safety measures in their GP surgeries (n = 50, 86.21 %). Almost all respondents (n = 56, 96.6 %) reported feeling safe due to the additional measures when attending their appointments. Of the two respondents who were not satisfied, both stated the processes were not clear.

The only difference was social distancing, PPE etc (response 26, GP4).

Discussion

Our study shows the uptake of 12-month immunisations decreased during the COVID-19 pandemic across all five GP surgeries. The most recent data from the Childhood Vaccination Coverage Statistics concluded that in 2021–2022, no vaccines, including the first dose MMR, met the 95 % national target, with an overall decrease in vaccine coverage when compared to 2020–2021.[22,23] This data is worrying when considering the potential for outbreaks of vaccine-preventable diseases, with 34 cases of childhood measles linked to community transmission in London between May and September 2022.[20,21]

In keeping with other findings, infants of Black/Black British ethnicity and from the most deprived areas have been disproportionately impacted.[22,23] Despite the removal of lockdown measures, we have seen a sustained decline in vaccination coverage in the post-COVID first wave cohort, indicating an ongoing issue perhaps unrelated to physical distancing. Previous inequitable healthcare delivery has undermined the trust of the Black Asian Minority Ethnic community in healthcare professionals.[24] Considerations of how to improve immunisation rates in these groups should be incorporated to protect population health, such as those used to promote COVID-19 vaccinations.[25]

Our questionnaire suggested the use of invitations and reminders to schedule vaccination appointments support parents to ensure their child receives the scheduled vaccinations, particularly in times of healthcare disruption. A prepandemic study of 684 GP surgeries in London concluded a majority of GPs have a form of call/recall system in place for immunisations,[26] in line with the National Institute for Health and Care Excellence recommendations.[27] This study reported that the most challenging part of delivering a good call/recall system was a lack of staff time (44 %).[26] The questionnaire free-text responses were particularly useful for providing an individualised perspective of the impact of COVID-19 on GPs and the vaccination services they were able to provide during the pandemic. One theme from the free-text responses was difficulty accessing healthcare professionals to raise questions regarding vaccinations. This reinforces the importance of access to vaccination information online as well as to healthcare professionals to facilitate these discussions. The COVID-19 pandemic created increased pressure on healthcare staff to maintain basic services; therefore, additional tasks such as call/recall systems or answering parental concerns may not be prioritised. Additionally, with consultations moving virtually and an increased demand for GP services, there are fewer opportunities for face-to-face discussions, especially for topics such as vaccine confidence.[28]

Comparison

Data from Europe has also shown a decreased uptake of scheduled vaccinations.[29,30] Dutch national immunisation data showed a prominent decrease in MMR and MenC vaccinations in March 2020,[29] while an Italian survey highlighted that over one-third of respondents did not attend their scheduled vaccinations during March to July 2020.[30] We suggested the pattern of attendance at scheduled immunisations could have reflected the fear of COVID-19 in the UK; however, coverage has not recovered despite the lifting of initial restrictions.[31,32] Data show the National Lockdown in Scotland was associated with an increase in childhood immunisation uptake compared to the decline in England.[33] This research suggests the improvement in Scotland may be due to the increased promotion of vaccinations at local and national levels during this period. Furthermore, there is a long-running downward trend in England's immunisation rates, which has previously been subject to dedicated public health campaigns.[34] Whilst our data show these surgeries did not reach back to pre-COVID rates, this may be an ongoing trend exacerbated, not caused, by COVID. Whilst there has been much discussion regarding the decrease in MMR uptake due to vaccine hesitancy reinforced by COVID,[35] our study and the comparable data suggest the decline in uptake may be due to additional factors, given the rates are similar to other 12-month vaccines such as Hib/MenC.[36]

The questionnaire identified a lack of communication to parents regarding vaccination appointments as a theme (see supplementary findings), from the initial booking of appointments to information about the vaccinations themselves. 90 % of respondents felt vaccinations were important, which is mirrored by another English study, which found 85.7 % felt similarly.[21,23] Effective communication to understand parents' concerns is an important tool in building vaccine confidence. One suggestion is encouraging healthcare practitioners to take any opportunity with a patient in a clinical setting to provide due immunisations.[37]

Clinical relevance

It is essential that children who missed vaccinations are identified and parents are contacted for catch-up immunisations. Data from the UK Health Security Agency identified that more than one in 10 children under the age of 5 years are not fully protected from measles, highlighting the fragility of our vaccination programmes.[7] Public health campaigns to address vaccine confidence are needed, particularly among parents with general vaccination scepticism following COVID-19.[38] Prepandemic research identified the need to promote vaccinations and tackle negative misconceptions of vaccines among some UK parents.[34] Additionally, whilst the UK has robust surveillance with regards to childhood vaccination data, there is a clear need for swift and targeted responses to declines in uptake.[33]

Strengths and limitations

The strengths of this study are the quantity and richness of the data and the ability to analyse small-scale changes. London has traditionally lower vaccination uptake; therefore, a focus on this area is useful for addressing vaccine uptake inequalities. Our data are based in one geographical location, which lent itself toward issues with sample size, influence of outliers, administrative errors and investigator bias. The most significant limitation of our study was the survey response rate and respondent demographics. The response rate to a large-scale survey completed by UKHSA was 0.45% (1485 eligible responses to 328,452 invitations), despite using a parental marketing organisation to supply the invitation email.[39] Additionally, the survey was completed by parents whose children were mainly White and vaccinated, therefore not gathering the perspective of those unvaccinated in underserved communities identified within the audit. Alternative methods, such as semistructured interviews, have been used to gather parental perspectives on vaccinations, which may be a better methodology to target specific population groups.[40]

By excluding participants who did not receive all vaccinations at the same GP, the inclusion criteria may have excluded those less likely to be vaccinated. However, the pandemic was difficult for GP surgeries, so our data collection reflects service pressures. The multimethods approach used enables the reasons, from parental perspectives, on why routine immunisations dropped during the pandemic to be explored.

Conclusion

Our multimethods study in an urban environment has shown a decline in vaccination uptake after the initial wave of the COVID-19 pandemic. There is a clear need to use innovative study methodologies to better understand reduced vaccination uptake and the disproportionate effect on children in underserved communities. For future practice, it is essential for GPs to maintain prompt invitation and reminder messaging even during times of health system disruption to ensure inequalities in access to health services are not exacerbated.

Author statements

Acknowledgements

The authors thank the European Society Paediatric Infectious Diseases Conference 2022 for the poster presentation of pre-COVID and COVID audit data. They thank all the administrative and healthcare staff at Morden Hall Medical Centre, Nelson Medical Practice, North Croydon Medical Centre, Bridge Lane Group Practice and Portland Medical Centre. They also thank Louise Letley and Helen Campbell from the Immunisation and Vaccine Preventable Diseases Division, UK Health Security Agency, for their support in designing the questionnaire.

Ethical approval

The data collection from the EMRs was approved by St George's University of London Research Institute Clinical Governance Office. The questionnaire was approved by the United Kingdom Health Security Agency (NR0304).

Funding

The work was funded by the St George's University of London Institute for Infection & Immunity Research Support Scheme 2021. All researchers are independent from the funders, and all authors had access to the full data set within this study and can therefore take responsibility for the integrity of the data.

Competing interests

All authors have no competing interests to declare.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2023.09.026.

References

1. Wang H, Paulson KR, Pease SA, Watson S, Comfort H, Zheng P, et al. Estimating excess mortality due to the COVID-19 pandemic: a systematic analysis of COVID-19-related mortality, 2020–21. *Lancet* 2022 Apr;**399**(10334):1513–36.
2. [Internet] *COVID-19 - research evidence summaries*. Royal College of Paediatrics and Child Health; 2022. 2022 [cited 2023 Feb 7]. Available from: https://www.rcpch.ac.uk/sites/default/files/generated-pdf/document/COVID-19—research-evidence-summaries.pdf.
3. Harwood R, Yan H, Talawila Da Camara N, Smith C, Ward J, Tudur-Smith C, et al. Which children and young people are at higher risk of severe disease and death after hospitalisation with SARS-CoV-2 infection in children and young people: a systematic review and individual patient meta-analysis. *EClinicalMedicine* 2022 Feb;**44**:101287.
4. Causey K, Fullman N, Sorensen RJD, Galles NC, Zheng P, Aravkin A, et al. Estimating global and regional disruptions to routine childhood vaccine coverage during the COVID-19 pandemic in 2020: a modelling study. *Lancet* 2021 Aug;**398**(10299):522–34.
5. Shet A, Carr K, Danovaro-Holliday MC, Sodha S v, Prosperi C, Wunderlich J, et al. Impact of the SARS-CoV-2 pandemic on routine immunisation services: evidence of disruption and recovery from 170 countries and territories. *Lancet Global Health* 2022 Feb;**10**(2):e186–94.
6. Tessier E, Rai Y, Roy P. *Impact of COVID-19 on routine childhood immunisations: early vaccine coverage data to August 2021 in England*. UK Health Security Agency; 2021. p. 2021.
7. Around 1 in 10 children starting school at risk of measles [Internet]. GOV.UK. 2023 [cited 2023 Feb 7]. Available from: https://www.gov.uk/government/news/around-1-in-10-children-starting-school-at-risk-of-measles.
8. Hoang U, de Lusignan S, Joy M, Sherlock J, Williams J, Bankhead C, et al. National rates and disparities in childhood vaccination and vaccine-preventable disease during the COVID-19 pandemic: English sentinel network retrospective database study. *Arch Dis Child* 2022 Aug;**107**(8):733–9.
9. Tiley KS, White JM, Andrews N, Ramsay M, Edelstein M. Inequalities in childhood vaccination timing and completion in London. *Vaccine* 2018 Oct;**36**(45):6726–35.
10. *Quarterly vaccination coverage statistics for children aged up to 5 years in the UK (COVER programme): January to March 2023*. Official Statistics UKHSA; 2023.
11. uk [Internet] *The complete routine immunisation schedule from February 2022: Gov*. UK Health Security Agency; 2022 [cited 2023 Feb 7]. Available from: https://www.gov.uk/government/publications/the-complete-routine-immunisation-schedule/the-complete-routine-immunisation-schedule-from-february-2022.
12. *Childhood vaccination coverage statistics- England*. 2021 [Internet]. NHS Choices. 2022 [cited 2023 Feb 7]. Available from: https://digital.nhs.uk/data-and-information/publications/statistical/nhs-immunisation-statistics/2021-22#.
14. STROBE Checklists [Internet]. STROBE. [cited 2023 Feb 15]. Available from: https://www.strobe-statement.org/checklists/.
15. Leeser R. *Indices of deprivation 2019 initial analysis — London datastore*. 2022 Jul 27 [cited 2023 Feb 7]; Available from: https://data.london.gov.uk/blog/indices-of-deprivation-2019-initial-analysis/.
16. Public health profiles: Crown copyright 2022 [Internet]. Office for Health Improvement and Disparities. 2022 [cited 2023 Feb 7]. Available from: https://fingertips.phe.org.uk/profile/general-practice.

17. English indices of deprivation 2019: Linked Open Data [Internet]. 2021 [cited 2023 Feb 7]. Available from: https://imd-by-postcode.opendatacommunities.org/imd/2019.
18. *The English indices of deprivation 2019: research report*. Ministry of Housing, Communities & Local Government; 2019.
19. The data protection act 2018. GOV.UK United Kingdom : https://www.gov.uk/data-protection;.
20. Agency UKHS. Laboratory confirmed cases of measles, rubella and mumps in England: July to September 2022. [Internet]. 2023 [cited 2023 Feb 7]. Available from: https://www.gov.uk/government/publications/measles-mumps-and-rubella-lab-confirmed-cases-in-england-2022/laboratory-confirmed-cases-of-measles-rubella-and-mumps-in-england-july-to-september-2022#table1.
21. Agency UKHS. Laboratory confirmed cases of measles, rubella and mumps in England: April to June 2022. [Internet]. 2023 [cited 2023 Feb 7]. Available from: https://www.gov.uk/government/publications/measles-mumps-and-rubella-lab-confirmed-cases-in-england-2022/laboratory-confirmed-cases-of-measles-rubella-and-mumps-in-england-april-to-june-2022#measles.
22. Skirrow H, Barnett S, Bell S, Mounier-Jack S, Kampmann B, Holder B. Women's experiences of accessing vaccines during pregnancy and for their babies during COVID-19. *Eur J Publ Health* 2022 Oct 21:32 (Supplement_3).
23. Bell S, Clarke R, Paterson P, Mounier-Jack S. Parents' and guardians' views and experiences of accessing routine childhood vaccinations during the coronavirus (COVID-19) pandemic: a mixed methods study in England. *PLoS One* 2020 Dec 28;**15**(12):e0244049.
24. Razai MS, Kankam HKN, Majeed A, Esmail A, Williams DR. Mitigating ethnic disparities in covid-19 and beyond. *BMJ* 2021 Jan 14:m4921.
25. Wise J. Covid-19: build on success of vaccination programme in reaching ethnic minority groups, report recommends. *BMJ* 2021 Dec 3:n3003.
26. Beaney T, Heffernan C. Implementing the evidence: are call/recall systems for immunisations feasible in general practice? *Vaccines and Immunology Open Access Journal (VIOAJ)* 2018 Jul 3;**1**(1).
27. Tools and resources: vaccine uptake in the general population: guidance. [Internet]. NICE. 2022 [cited 2023 Feb 7]. Available from: https://www.nice.org.uk/guidance/ng218/resources.
28. Majeed A, Maile EJ, Bindman AB. The primary care response to COVID-19 in England's National Health Service. *J R Soc Med* 2020 Jun 10;**113**(6):208–10.
29. Middeldorp M, van Lier A, van der Maas N, Veldhuijzen I, Freudenburg W, van Sorge NM, et al. Short term impact of the COVID-19 pandemic on incidence of vaccine preventable diseases and participation in routine infant vaccinations in The Netherlands in the period March-September 2020. *Vaccine* 2021 Feb;**39**(7):1039–43.
30. Russo R, Bozzola E, Palma P, Corsello G, Villani A. Pediatric routine vaccinations in the COVID 19 lockdown period: the survey of the Italian Pediatric Society. *Ital J Pediatr* 2021 Dec 24;**47**(1):72.
31. McDonald HI, Tessier E, White JM, Woodruff M, Knowles C, Bates C, et al. Early impact of the coronavirus disease (COVID-19) pandemic and physical distancing measures on routine childhood vaccinations in England, January to April 2020. *Euro Surveill* 2020 May 14;**25**(19).
32. Tessier E, Rai Y, Roy P. Impact of COVID-19 on routine childhood immunisations: early vaccine coverage data to May 2021 in England. [Internet]. 2022 [cited 2023 Feb 7]. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1003605/HPR1321_Cvd-COVER_final.pdf.
33. McQuaid F, Mulholland R, Sangpang Rai Y, Agrawal U, Bedford H, Cameron JC, et al. Uptake of infant and preschool immunisations in Scotland and England during the COVID-19 pandemic: an observational study of routinely collected data. *PLoS Med* 2022 Feb 22;**19**(2):e1003916.
34. Royal Society for Public Health Uk. [Internet]. 2022 [cited 2023 Feb 7]. Available from: https://www.rsph.org.uk/static/uploaded/3b82db00-a7ef-494c-85451e78ce18a779.pdf.
35. Thompson S, Meyer JC, Burnett RJ, Campbell SM. Mitigating vaccine hesitancy and building trust to prevent future measles outbreaks in England. *Vaccines* 2023 Jan 28;**11**(2):288.
36. UKHSA. *Quarterly vaccination coverage statistics for children aged up to 5 years in the UK (COVER programme): July to September*. 2022.
37. *Expert reaction to new NHS Digital/UKHSA childhood vaccination coverage statistics for England*. 2021 [Internet]. 2022 [cited 2023 Feb 7]. Available from: https://www.sciencemediacentre.org/expert-reaction-to-new-nhs-digital-ukhsa-childhood-vaccination-coverage-statistics-for-england-2021-22/.
38. Botha E, van der Merwe D, Burnett RJ, Bester P. Predictors of parents' infant vaccination decisions: a concept derivation. *Health SA Gesondheid* 2021 Sep 30:26.
39. *Childhood vaccines: parental attitudes survey 2022*. UKHSA; 2023.
40. Helps C, Leask J, Barclay L, Carter S. Understanding non-vaccinating parents' views to inform and improve clinical encounters: a qualitative study in an Australian community. *BMJ Open* 2019;**9**(5):e026299.
41. Public Health England. *Changes to the infant pneumococcal conjugate vaccine schedule: information for healthcare practitioners*. London: PHE Publications; 2019. p. 4. Available from: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/849646/PCV_schedule_change_HCP_information.pdf.