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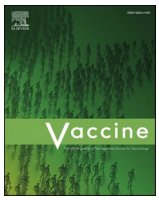

Parents' experiences of accessing childhood vaccination services in England: A qualitative longitudinal cohort study

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ABSTRACT

Background: In England, declining childhood vaccine uptake and related inequalities are causes for concern. Existing evidence suggests challenges accessing services contribute to this decline. This is particularly true for parents facing socioeconomic disadvantage. This study aimed to explore parents' experiences of the vaccination process to generate recommendations for improving the accessibility of childhood vaccination services.

Methods: A longitudinal cohort study was established in May 2023. Sequential interviews were conducted with 22 parents from the birth of their child as they progressed through the vaccination pathway. Data collection comprised life journey interviews and diary keeping. Data were analysed using temporal thematic analysis.

Results: Four vaccination trajectories were observed collectively referred to as the 4S Vaccination Trajectory Framework: supported ($n = 9$), struggled ($n = 10$), stalled ($n = 2$), and shunned ($n = 1$). Three main temporal themes were identified which accounted for the diverging vaccination trajectories: booking systems, the unexpected (e.g., how General Practices managed parents who were late or missed their appointment), and vaccine information provision. For example, many within the 'struggled' trajectory, initiated contact with their General Practice and had considerable difficulty securing appointments due to inflexible booking systems.

Conclusions: To address declining vaccination coverage within England it is vital that vaccine accessibility is improved and that services meet parents' needs. This study deepens our understanding of accessibility issues with the vaccination service and discusses implications for policy and practice.

1. Introduction

Despite repeated calls to action and considerable attention, childhood vaccination uptake has declined for a thirteenth consecutive year in the United Kingdom (UK) [1]. This declining trend was captured by the Cover of Vaccination Evaluated Rapidly (COVER) surveillance scheme, whereby administrative data from the National Health Service (NHS) is provided for uptake by ages one, two, and five years [2]. These data are aggregated by the UK Health Security Agency (UKHSA) and published quarterly by NHS Digital. In response, the British Medical Association has voiced concern and called for long-term investment to strengthen the provision and uptake of vaccination services [3]. Notably, a mixed-methods study revealed that only 46 % of immunisation managers (i.e., those who commission, manage or play a role in service quality improvement or population level health protection) felt confident in their local systems' ability to deliver equitable services and address poor performance [4].

The current UK vaccination programme routinely offers vaccines to protect children against nine serious infectious diseases in their first year: Diphtheria, Tetanus, Poliomyelitis, Pertussis, *Haemophilus Influenzae* b, Hepatitis B, Meningococcal B, Pneumococcal, and Rotavirus [5]. Infant vaccinations offered as part of the routine programme are provided free of charge via registration with a General Practice (GenPr) – a community-based primary care facility. Achieving timeliness of vaccination at the routine scheduled appointments at 2, 3, and 4 months of age is a priority to ensure infants are protected as early as possible. Coverage of the primary vaccine course is routinely assessed and reported at 12 and 24 months with uptake at 24 months higher than at 12 months suggesting considerable delay completing the primary vaccine course for a proportion of children [1].

Identifying the reasons for sub optimal vaccine uptake is essential to inform the development of appropriate interventions to increase

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coverage. A national survey ($n = 1792$) found that of the 10 % of parents who did not take their children for vaccination when due, only 2 % were due to vaccine refusal [6]. This emphasises the need to examine the accessibility of vaccination services rather than solely focus on parental attitudes. In other words, how the ramifications of '*day-to-day socio-material circumstances*' can shape decisions and experiences of vaccination services [7], which is '*often overlooked*' [8]. Unsurprisingly, timely access to vaccines can be more challenging for those experiencing socioeconomic disadvantage in relation to factors such as income, education, and living standards [9–14].

To inform this study a scoping systematic review explored the methodological approach and findings of research on the accessibility of childhood vaccination services within the UK [15]. The review applied Saurman's six distinct but interconnected dimensions of accessibility to categorise the factors identified by the review: location; supply and demand; consumer perception; financial and incidental cost; organization; and communication and information provision [16]. A total of 45 studies were included in the review, 7 of which were intervention studies.

The review concluded that with a few notable exceptions, accessibility was poorly defined, and information provision was over-represented as a cause of low vaccine uptake compared to other areas of interest. Studies frequently referred to 'low access' without clarification (e.g., difficulty registering with the GenPr, booking a vaccine appointment, or attending the clinic) or did not mention accessibility at all despite findings pointing to it. Notably, many of the factors identified in the review did not 'neatly' fit into the selected accessibility framework. Predominantly, it under-represented factors which affected parents' ability to engage with vaccination services. Thus, an alternative conceptual framework was selected to guide this study which captured the dual role of service provision and parental profile.

While accessibility issues have been explored in UK Gypsy, Roma, Traveller, Charedi, and migrant communities which face unique access challenges, there has been little focus on the role of accessibility and socio-economic constraint in a general population sample [17–20]. Therefore, this project aimed to explore parents' experiences of accessing childhood vaccination services from birth to age one within a socio-economically diverse cohort. In utilising a vaccination journey approach, it was possible to identify factors which drive different vaccine outcomes. These findings will inform the development of interventions and service level improvements to increase the accessibility of childhood vaccination services.

2. Methods

2.1. Research question

What are the driving forces and lived experiences associated with different vaccination outcomes during infancy (i.e., the first three routine vaccination appointments)?

2.2. Study design

The dataset utilised within this analysis was obtained from an ongoing qualitative longitudinal cohort study. This qualitative longitudinal study follows a group of parents from the birth of their child as they progress through the vaccination pathway. We present the findings from the first two waves of data collection when each child was approximately two (Jul 23-Feb 24) and four months old (Oct 23-May24). Qualitative longitudinal methods are credited with capturing complex social processes, revealing not only how a journey unfolds, but also how it is driven, managed, and experienced [21]. Across a sample this can reveal how and why life course trajectories (in this instance vaccination 'journeys' or 'outcomes') converge and diverge, enabling a focus on theoretical and substantive ideas.

2.3. Setting

Initially, the research setting for this investigation was Manchester, but was later expanded to include Greater Manchester as per a recruitment failsafe built into the original protocol. Manchester was selected as it was the highest ranked local authority for deprivation where vaccine uptake at 12 months is consistently below 90 % [22,23].

2.4. Patient and public involvement

A two-series, face-to-face workshop for socioeconomically disadvantaged parents living in Manchester was conducted to consult and co-design elements of the study in partnership with a local community centre.

Workshop participants included 10 parents (8 mothers, 2 fathers) with children under 5. The same group of parents were invited to take part in both workshops. Parents self-identified as white British ($n = 2$), Asian ($n = 2$), Black African ($n = 1$), Eritrean ($n = 1$) and Arab ($n = 1$); preferred not to say ($n = 3$). Parents ranged in age, number of children, educational attainment, and co-habiting status. Participants were not invited to participate in the main study as they did not meet the inclusion criteria specified below.

The workshops generated feedback on key study materials and processes (i.e., the recruitment flyer, diary keeping guidance, compensation/engagement plan) and hosted a general discussion on the study topic (i.e., accessibility of childhood vaccination services) to inform the interview topic guide.

2.5. Sample size and eligibility

Qualitative longitudinal research involves recruiting a relatively small cohort which yields case-rich, processual data [21]. The volume of data generated from qualitative longitudinal research depends on both the sample size, and the number of waves of data collection [21]. For instance, a sample of 20 would result in 40 interviews and vast amounts of diary data after two waves of data collection. The cohort eligibility criteria are detailed in Table 1. Priority was given to 'lower-income' households. Income was self-reported and guiding household income figures were provided (equivalised for family size) when participants were unsure how to classify themselves (see supplemental file 1).

2.6. Recruitment

Participants were recruited via NHS maternity services and community outreach. Midwives from three hospitals with antenatal services signposted potential participants to the study by handing out a study flyer with contact details during appointments. Community outreach was predominantly achieved via displaying study posters and flyers across 24 children centres, but alternative avenues were also utilised (e.g., community Facebook groups and local charities). Both maternity and community outreach sites also disseminated the flyer via their online social media platforms. To build rapport with recruitment sites and potential participants the principal investigator (GC) distributed study flyers in-person.

Table 1
Cohort eligibility criteria.

Inclusion criteria	Exclusion criteria
Parents who were 7–9 months pregnant OR had a baby under 4-weeks of age	Parents with a baby expected to be admitted to the neonatal unit after birth were not eligible for participation *(on ethical grounds)*
Live within Greater Manchester	
Able to speak English	
18 years or older *(on ethical grounds)*	

2.7. Ethical considerations

Parents who registered an interest in the study were emailed copies of the study and data archiving information sheet and given the opportunity to discuss these with GC. Participants were enrolled into the study when they returned signed consent forms. Parents were reminded of their right to withdraw at any stage of the study without repercussions and verbal consent was obtained at the start of each wave of fieldwork. Participants were issued with a voucher at the end of each interview as compensation for their time. Ethical approval was provided by the NHS (no. 22/PR/1465) and LSHTM (no.28158).

2.8. Data collection

The data collection toolkit comprised of life journey interviews (see supplemental file 2) and diary keeping (see supplemental file 3). Interview topic guides were developed using Levesque's accessibility framework [24]. This conceptualises accessibility as the interface between individual (e.g., where they live, economic resources, and social status) and system level factors (e.g., outreach systems, location of facilities, costs) at different points of the patient pathway from perception of needs through to healthcare utilisation and consequences. Table 2 describes the data collection methods in further depth, while Fig. 1 specifies the timeline of data collection in relation to the vaccination schedule. Data were collected about the vaccines offered in the routine and selective vaccination programmes. The analysis presented in this article focuses on data regarding routine vaccines due to the unique nature and challenges of the selective vaccination programme.

2.9. Data analysis

The aim of qualitative longitudinal analysis is to explore peoples' journeys over time and key triggers or drivers of various outcomes. The themes, therefore, are identified from observable patterns in the journeys taken and their associated drivers across the cohort. Thus, a processual element is embedded within the analysis, termed temporal thematic analysis [21]. Unlike traditional thematic analysis, where the unit of analysis is *per participant interview*, the unit of analysis is *per participant journey*. Before patterns in journeys and triggers can be identified, these must be first recognised at the case-level ready for cross-case comparison. Thus, qualitative longitudinal analysis is a multi-stage process which involves progressing from a case-led to a cross-case diachronic analysis. An overview of this analytical process is presented in Table 3.

Table 2
Data collection toolkit.

Method	Brief description/rational	Implementation
Life journey interviewing	A narrative style of interviewing which encourages participants to reflect on how processes have unfolded and potential causes leading to certain life events [21].	Topic guides followed a cartographic strategy. Interviews begin with a basic account of the vaccination journey since the last interaction. This is followed with an exploration of the 'back story', a sense of 'plot' which infers how and why the journey has followed a given trajectory.
Diaries	Diaries capture and timestamp key events, with brief reflections from the participant. This provides continuity between fieldwork waves and provides the basis for further discussion during interviews [21].	The diary method used was 'snapshot diaries'. This captured critical incidences as they occurred. Parents were given a list of key events they should document (e.g., recall reminder from GenPr). Participants sent short WhatsApp/email messages to the researcher with a brief description of the event. Parents were encouraged to send diary entries in a range of formats: text, audio-clips, and photographs.

2.10. Positionality statement

We strive to avoid '*obvious, conscious, or systematic bias*' and to be as '*neutral as possible*' across the research process [27,p.4]. By consulting the literature, first in the form of a literature review and subsequently a systematic scoping review, GC was able to challenge her pre-existing bias regarding potential causes of low vaccine uptake. As someone with an academic background in Health Psychology GC entered the topic with an expectation that the primary focus would be on vaccine hesitancy and planned to utilise frameworks which championed decision-making. After reviewing the literature, GC was struck by the potential contribution of accessibility issues, which to date had predominantly been explored in ethnic, religious, and migrant populations. This was further explored during workshops with lower-income parents prior to commencement of the study. Guided by the literature, conversations with parents, and a carefully selected theoretical framework which took a more holistic approach to service use GC was able to avert her initial assumptions from biasing the direction of the study.

3. Results

3.1. Study participants

Of the 23 participants recruited, 22 provided data for the study. The cohort is predominantly female, but diverse in terms of reported income level, ethnicity, migrant status, family composition, socioeconomic status, and job status. An overview of participant characteristics is provided in Table 4. Two participants provided only one interview (one in wave one only; one in wave two only). Hence, a total of 42 interviews were conducted (21 per data collection wave). Interviews lasted an average of 50 min. All but three participants made diary entries; 75 diary entries were made with 92 picture submissions, an average of three entries and four picture submissions per participant.

Given the study design we would not expect to capture observable differences between the vaccination outcomes or key drivers between higher- and lower-income parents. Although it is worth highlighting the representation of those facing substantial financial hardship within the cohort to the extent this affected mental health, breastfeeding being a financial choice, or reliance on the assistance of charities and foodbanks. Vaccination was seen by many as 'just something you do' irrespective of logistical, emotional, or financial burden across the cohort.

3.2. Vaccination trajectories

Four vaccination trajectories were identified collectively referred to as the 4S Vaccination Trajectory Framework: supported ($n = 9$), struggled ($n = 10$), stalled ($n = 2$), and shunned ($n = 1$). These trajectories are defined in Table 5. Three main temporal themes were identified which accounted for the diverging vaccination trajectories: 'booking systems', 'the unexpected' (e.g., how GenPrs handled parents who were late or missed their appointment), and 'information provision'. An overview of the primary themes associated with each participant over time is available in supplemental file 4. While presented separately, temporal themes can be experienced in tandem creating an ever more complex vaccination journey.

Here we present two temporal themes ('booking systems' and 'the unexpected'), we will report the third ('information provision') separately. The rationale for this is twofold. Firstly, unlike the preceding temporal themes which have already reached saturation, there is opportunity to observe how information provision (or lack thereof) from the service and the interference of competing sources of information (e.

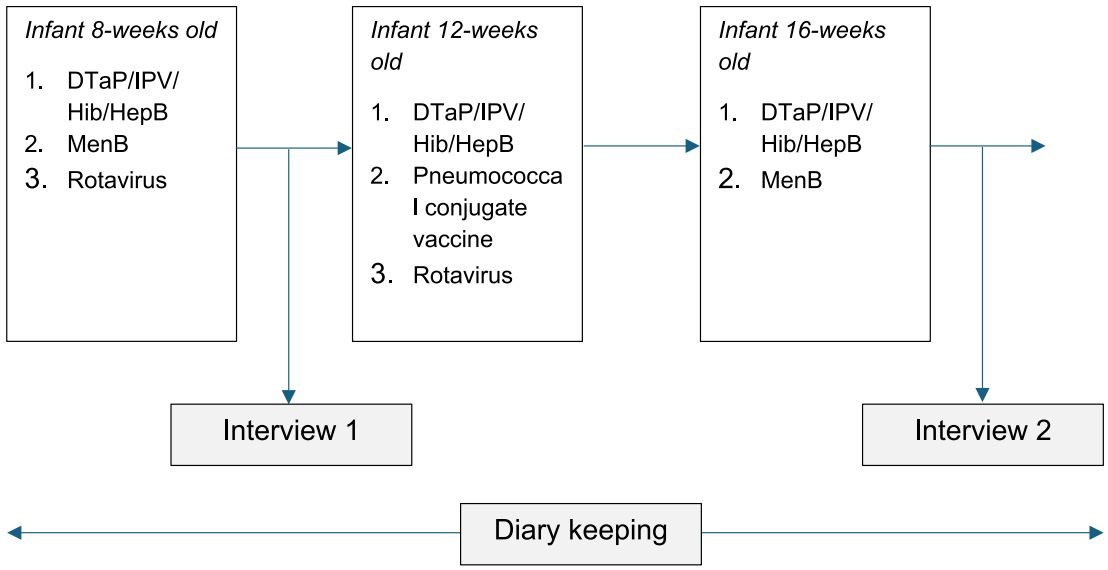

Fig. 1. Data collection timeline (per participant).
Note,
1) Following enrolment into the study parents were asked to start making diary entries.
2) Interviews were scheduled once the parent had either: (a) made a diary entry specifying that a vaccine appointment has been attended/declined; (b) 4-weeks post the vaccinations being due. This was to avoid influencing parental vaccination decisions during the period which is considered 'on time' [25,26].

g., social media) affect vaccine uptake at the subsequent wave of data collection (at age one). Secondly, information provision is a distinct area of investigation which historically has received significant attention [15]. The results, therefore, would benefit from being situated within an alternative literature base and potentially enlisting additional guiding theoretical frameworks to those utilised within this analysis. Given its strong relationship with information provision the 'shunned' trajectory will predominately be explored as part of this distinct analysis.

3.3. Booking systems

Booking systems were identified as a core temporal theme accounting for the divergence between different vaccine trajectories. Two factors were identified as key trigger points for determining which vaccination trajectory a parent may experience: 'who made the first point of contact' and 'the presence or absence of strict slot release booking systems'. Many within the 'struggled' trajectory, initiated contact with their GenPr prior to receiving appointment letters and had difficulty making appointments due to limitations on when they could be booked. Duplicative vaccination letters, vaccine appointments available on only one day of the week, and appointment changes or errors were identified as further booking system characteristics which slowed or undermined parents' journey to vaccination.

i. When is the first vaccination appointment broached and by who? How does this act as a trigger point?

For most, registering their baby with the GenPr was not a notable part of their vaccination journey, for others it was either a satisfying or challenging experience. Some parents cited frustration with GenPr registration due to faulty online registration systems resulting in an in-person visit; inability to register with a new GenPr after moving house to avoid losing mental health support thus requiring expensive taxi journeys to attend vaccination appointments; or being unaware of the need for GenPr registration as separate from birth registration. Simultaneously, others reported satisfaction with midwives, GenPrs, local Sure Start Centres issuing reminders about early GenPr registration to ensure timely vaccination. Proactivity of the system was well perceived (e.g., receiving new patient forms by post with paid return postage, receiving calls from the GenPr to register over the phone, and being issued a temporary GenPr to receive vaccinations after moving house).

For most parents the first major event was the initial contact regarding GenPr vaccination appointments. All parents within the 'supported' trajectory had unsolicited contact from their GenPr via a phone call, text, or letter which either issued an appointment or requested them to arrange one. Parents were divided regarding preferences for being issued with an appointment or calling to arrange one. Some liked being able to book an appointment to suit their schedule. Others preferred the GenPr to issue appointments to avoid the responsibility of remembering to book and very long phone wait times (reported as up to 40–60 min).

> *"…because I have other kids, and obviously that means that I've got other stuff on, it's much more convenient for me to pick the times myself, even if that means I have to put in the effort to call them…"* [Ruth, wave 1 interview].
>
> *"…as a mother of two, we sometimes forget things. So when you have your appointment and your time, most likely it'll be convenient unless it's during the school run. And I think they try to avoid those times anyway, they're midday most of the time. So for me, I mean, it would be better because then what if I forgot to book an appointment, then they'd be waiting for me to book an appointment."* [Ifra, wave 1 interview].
>
> *"I do quite like that [being issued an appointment], mainly because for my practice anyway, it takes about half an hour to get through to them on the phone. So I much prefer them to just give me a time, and worst-case scenario, I just have to call them anyway and change it."* [Holly, wave 2 interview].

In any case, the GenPr being the first to contact the parent regarding vaccination was a defining factor in the process being considered 'easy'. Parents in this trajectory were confident that their GenPr would support them in booking subsequent appointments and ensuring their child was up to date with their vaccinations.

> *'The whole process has been very easy as the GPs have come to me and I haven't really had to think about it.'* [Eloise, wave 1 diary entry].

Parents in the 'supported' trajectory were willing to wait for the GenPr to approach them close to the vaccination due date often at six-to-seven-weeks, but in one case this was the day before vaccination. Most of

Table 3
Data analysis approach.

Stage	Brief description	Purpose
Stage 1: ongoing data management and reduction	***Trajectory summary chart*:** an Excel (one for the cohort, updated after each interview) which logs the vaccine outcome alongside the main causes. Participants are listed per row, with a column per vaccination appointment.	To log the various journeys emerging within the cohort and potential temporal themes to explore in greater depth as the analysis progresses.
	Pen portraits: a document (per case, updated after each interview) which summarises core circumstances, experiences, and developments.	So that cases can be reviewed without revisiting the mass of primary data (for personalising wave 2 interviews).
Stage 2: case-led analysis	***Case histories:*** a document (per case, can be updated after each interview or upon cessation of data collection) which not only summarises the participant's account, but identifies/codes key themes/concepts within a participant's journey. This is written as a third-person account by the researcher, embedded with key quotations from the participant.	To identify triggers/drivers at the case-level in preparation for cross-case analysis. This utilises the same concepts and skills of traditional thematic analysis but is applied at the case-level.
	***Analytical log*:** an Excel (one for the cohort, updated alongside case history production) which logs emerging codes.	This is used in conjunction with the trajectory summary chart to select exploratory themes.
Stage 3: cross-case diachronic analysis	***Framework grid analysis:*** an Excel (one for the cohort, upon completion of stage 2) where each row represents a participant, with three columns for each vaccination event (8-weeks, 12-weeks, 16-weeks); each theme has its own tab. Data is extracted from the case histories and inserted into the matrix.	To enable analysis of exploratory themes. This analytical tool enables through-time, cross-case readings of the data.
	***Analytical memos*:** exploratory themes are analysed per vaccination trajectory type for shared and distinct temporal themes.	These are written up in the form of analytical memos which form the basis of the results section.

Note, this analytical approach was developed based on qualitative longitudinal analysis guidance produced by Neale [21].

Table 4
Summary of participant characteristics.

Characteristic domain	Cohort prevalence
Income level	Lower ($n = 11$); Higher ($n = 11$)
Gender	Female ($n = 21$); Male ($n = 1$)
Ethnicity[1]	White British ($n = 10$); British Indian ($n = 1$); Asian British ($n = 1$); Indian ($n = 1$); Pakistani ($n = 1$); Egyptian ($n = 1$); Asian with Afghan/Pakistani descent ($n = 1$); Portuguese ($n = 1$); Spanish ($n = 1$); Arab ($n = 1$); Arab/Amazigh ($n = 1$); West African ($n = 1$); Black African ($n = 1$)
Migrant status[2]	No ($n = 13$); Yes ($n = 7$); unknown ($n = 2$)
Number of children	2 ($n = 12$); 1 ($n = 8$); 3 ($n = 2$)
The National Statistics Socio-economic classification (NS-SEC)[3] based on pre-maternity leave job title*	*Lower SES* ($n = 7$, 32 %)
	• Unclassified (full time student) ($n = 1$); • Grade 8 (never worked and long-term unemployed) ($n = 1$); • Grade 7 (routine occupations) ($n = 3$); • Grade 6 (semi-routine occupations) ($n = 2$); • Grade 5 (lower supervisory and technical occupations) ($n = 0$)
	Intermediate SES ($n = 5$, 23 %)
	• Grade 4 (small employers and own account workers) ($n = 2$); • Grade 3 (Intermediate occupations) ($n = 3$).
	Higher SES ($n = 10$, 45 %)
	• Grade 2 (lower managerial, administrative and professional occupations) ($n = 6$); • Grade 1 (higher managerial, administrative and professional occupations) ($n = 4$).
Job status	Maternity leave/pay ($n = 16$); Unemployed ($n = 6$)

[1] Ethnicity refers to the participant within the cohort, their partner/child may have a different ethnicity. Ethnicity was self-defined.
[2] Reported migrant status (yes/no) was distributed across the lower- and higher-income group.
[3] NS-SEC is a tool which categorises jobs based on socio-economic positioning; here the simplified NS-SEC tool has been used [28].

those within the 'struggled' trajectory had assumed that they should receive information regarding the 8-week vaccination appointment earlier and as a result thought that they had been 'forgotten'. Consequently, many of these parents reached out to their GenPr.

> *18.08.23 As we didn't receive an vaccination appointment letter yet and baby is week 6,I am worried that he was forgotten and that we receive a letter later than 8 weeks.*
> *21.08.23 I received a phone call today from gp in reply to my enquiry about my son first immunisation appointment…unfortunately i had bad experience, i didn't get an appointment, i called gp and asked them to book my son's 8 weeks vaccination appointment. It's only then that i was booked an appointment…I am disappointed that had to call gp and book the appointment myself rather than getting one automatically.*
> *25.08.23 I received a letter of vaccination by post Friday…The letter indicates the time frame of the vaccination but said it's left to gp to book it. I had to call gp to make process go faster…I am disappointed…*
> [Safa, wave 1 diary entries].

This was considered a disappointing experience undermining their confidence in the system and resulted in feeling a personal responsibility to ensure their child received the vaccines. Many "*persevered*" because of the perceived "*importance*" of vaccination [Evie, wave 1 interview].

> *"There is a big responsibility on the patient now, more than before."* [Safa, wave 1 diary entries].
> *"No. They won't contact me. I don't think they will. The GP contacting me? No, no way. [Laughs] No, no they won't. I need to chase them up… Vaccination service, I don't think they take it seriously."* [Bahia, wave 1 interview].

Booking challenges were a more notable problem with the first set of vaccinations as some GenPrs used the 8-week appointment as an opportunity to book in the next appointment. However, many parents had to go through the same booking process for each set of vaccinations. One identified reason for this was GenPr appointment booking systems which did not facilitate scheduling this far in advance.

ii. How does the timeliness of vaccination appointment release act as a trigger point?

Table 5
The 4S Vaccination Trajectory Framework.

Vaccine trajectory	Typology	In a quotation
Supported	GenPrs assume a proactive role in ensuring vaccination takes place (on time). Resultantly, parents feel that vaccination is a smooth and easy process. Parents may express a desire for more information but ultimately are satisfied with the service provided on the grounds it is straightforward and hassle-free.	*'The whole process has been very easy as the GPs have come to me and I haven't really had to think about it.'* [Eloise, wave 1 diary entry]
Struggled	Parents assume a driving role in ensuring their child receives their vaccinations (on time). This may be characterized by parents reaching out to their GenPr to obtain a vaccine appointment without invitation, persistently trying to secure vaccination appointments in instances of limited availability, or advocating that their child receives their vaccinations on time when offered appointments which deviate from the schedule.	*"…if I didn't care that much about getting them, I definitely wouldn't have persevered."* [Evie, wave 1 interview]
Stalled	Parents face challenges securing appropriate appointments which results in vaccination taking place after a notable delay (four weeks or more). This may be due to limited appointment availability or being unaware of temporary GenPr registration[1] options when away from home which could have facilitated timely vaccination.	*"I thought was a big gap, but yeah. They told me it is the first appointment day available, so what I can do? But in my mind it was a big gap."* [Paula, wave 2 interview]
Shunned	Information provision from the NHS does not meet parents needs resulting in vaccination deferral or refusal. Concerns or queries may arise in response to information from the NHS website, friends, or social media. In some cases, parents may actively seek information from their GenPr but are signposted to online resources which are insufficient in answering their questions or concerns. Often, there is no follow-up from the GenPr when parents decide to delay or refuse vaccination.	*"I feel like the questions that we asked weren't revolutionary… You'd have thought they might be prepped for it…we would've definitely taken what she said on board, and I think that would have helped us make this important decision"* [Nathen, wave 1 interview]

[1] Temporary registration is when you can receive care at a second GenPr to your usual facility while you are away from home [29].

Another notable trigger for the 'struggled' trajectory was when appointments had not been released by the time a parent called to book, resulting in further follow-up interactions and frustration. Similar to the prior sub-theme, this was exacerbated by a lack of transparency about the process resulting in confusion about when appointments should be booked.

> "*…they said, 'Oh, someone will send it to you. Someone will send it to you,' and then I didn't actually get contacted about this appointment until two weeks before…and a time we couldn't do, and so we had to rearrange it anyway…I was just pushed away, pushed away, pushed away…If it hadn't been time specific, then I think I'd have just – I wouldn't have been so forthright with it. But, the fact we knew it was eight weeks kept me thinking, 'I need to contact them. I need to contact them. I'll phone them.' And, if they'd given me a timescale and said, 'At six weeks, we'll contact you with the appointment,' I'd have said, 'OK,' but I was never given a timescale. I was just worried that, actually, we were just going to slip through the net, and we weren't going to get called, so I need to keep phoning to get this organised.*" [Jane, wave 1 interview].

The substantial administrative burden this can place on parents is highlighted in the emblematic case presented in Table 6 and associated quotes.

> "*I suspect there's a lot of people who haven't been able to get appointments because they've just given up or it's too confusing.*" [Evie, wave 1 interview].

> *"…if I didn't care that much about getting them, I definitely wouldn't have persevered.*" [Evie, wave 1 interview].

This was also an issue for parents who were travelling and needed specific dates for timely vaccination, prior to or post-holiday. Parents were told to call closer to the time but were then informed that their request could not be facilitated. One mother confronted the receptionist and applied a lot of pressure to secure a vaccine appointment for her baby.

> *"I said, "Well I need it this week." She said, "That's impossible." [Laughs] I said, "It has to be this week because I'm going away next week and we're going to be there for almost three weeks, and he has to have the vaccines before we go… She was like not happy – you can tell on the face she was not happy me pushing her to get the appointment…I said to her, 'I have one hour until I have got my appointment with the doctor. I am going nowhere, you have one hour to find me that appointment.' She was not happy. I think it's my culture as well, I'm very direct."* [Silvia, wave 2 interview]

iii. What features of the booking system act as points of resistance which slows, confuses, or undermines confidence in a parents' journey to vaccination?

a. Multiple invitation letters

Across the trajectories parents received a second appointment letter when the vaccination was either already booked or received. For those who quickly realised this duplication it was a minor inconvenience, but for others this was confusing and undermined their confidence in the system or caused concern about how to cancel the unnecessary appointment.

Table 6
Emblematic case of the 'slot release' issue [Evie, based on wave 1 interview and diary data].

Baby's age	Record of events
Baby born	Evie received a letter which instructed her to register and call the GenPr to arrange a vaccination appointment.
2 weeks	Evie calls her GenPr and is told that she will have to call back at the end of September because the slots aren't open yet.
6 weeks	She rings back at the end of September and is told that the slots are still not open. She is informed that they open the Thursday before the Tuesday baby clinic. So, to call on Thursday. Evie receives a text reminder to book in the vaccines.
7 weeks	Evie called on Thursday to book in vaccinations for the following week but is told that there are no slots available for next week and to try again for the following week.
8 weeks	Anxious to not miss the appointments Evie calls on Wednesday but is reminded that the slots do not become available until Thursday. Evie sends a complaint letter to the practice regarding their booking systems. The assistant practice manager responds to Evie's email and offers to book in her baby's appointment.
9 weeks	Evie's has successfully secured an appointment and her baby gets vaccinated.

"*The letter thing is confusing. I really did have to stop and be like, "Hang on a second, I'm sure this isn't right." And obviously it's not a massive vote of confidence but then I do think there is that element that a lot of people are like, "Oh well, is just the NHS a bit like that now*." [Hailey, wave 2 interview]

b. One-day a week clinic

Many felt frustrated with the lack of flexibility with appointments which for some clashed with other responsibilities. In contrast, availability of multiple slots on different days and times was highly valued by parents.

"*I mean, the surgery didn't actually seem to have that much flexibility because on one of the days I couldn't do, she was like, 'Well, we only do them on a Thursday.' And I was like, 'Well, that is very inconvenient if you can't make it on a Thursday.' So that was really, really annoying…*" [Emily, wave 2 interview].

"*I think my appointment was about three o'clock, which for some people would clash with pick-up time, but she goes to after-school club, but we can afford after-school club. You know, some people wouldn't be able to and that sort of thing.*" [Evie, wave 1 interview]

c. Appointment changes or errors

Appointment changes were not inherently a problem. Several parents were contacted with requests to make changes to the timing of their vaccinations (sometimes due to nurse shortages) or needed to amend the date due to the baby having a fever. In these cases, this was not an issue due to the diligence of the GenPr (often the receptionist). For others, amendments or errors did cause delay, confrontation, or undermined confidence. One mother, following a minor illness, was not offered a replacement appointment until significantly later (22 rather than 16 weeks old) resulting in a 'stalled' vaccine trajectory. Another mother turned up to find that her appointment had been 'lost' despite having a record of it in her Red Book. The mother felt belittled by the receptionist and that she had to be assertive to get the vaccine for her baby diverting from a 'stalled' to a 'struggled' vaccine trajectory.

"…she kind of said, 'Oh there's no appointment.' And I was kind of like, 'Oh well we have booked this appointment, I'm sure it's the case.' And there wasn't really a solution, there wasn't really – she didn't really drive the conversation at all, it was just kind of, 'There's no appointment'… Maybe I was a little bit forward but I said, within the first few minutes of the conversation, 'I want my baby to have these injections today because we are prepared for them and this was the appointment that was definitely made.'…Now I came away from the situation feeling quite guilty thinking I've maybe been a bit abrupt there. But in the same respect I wanted – I want to advocate for my child…" [Jane, wave 2 interview].

In a minority of cases GenPr receptionists nearly booked appointments too early, which was challenged by the parents. This undermined their confidence in the system and made them feel medically responsible for their baby's care.

"*…they said, 'Oh no, we could book her in for next week,' and I said, 'Well, next week, she'll only be three weeks old,' and the receptionist said, 'OK, how about the following week?' and I was like, 'She'll be four weeks old.' So it didn't fill me with massive confidence that they knew what they were doing*." [Evie, wave 1 interview].

One parent was surprised to be able to cancel the vaccinations without resistance from the receptionist and was expecting a follow-up conversation with the GenPr representing a missed opportunity to address their concerns. In contrast, some parents seeking to move the vaccine appointment felt that their GenPr receptionist was too forceful.

"*She was like, "No, come tomorrow." I was like, "Is it forced? I'm telling you I can't, I can't take care of the baby the same day so I'm not doing the vaccination the same day." [Laughs] It wasn't the doctor, it was a nurse or receptionist. They are quite rude. So, when I spoke with the doctor she was really nice, she understood, she was like, "Yeah no problem, do it next week*." [Bahia, wave 1 interview].

3.4. The unexpected

The second temporal theme accounting for diverging trajectories was how GenPrs managed parents who were late, forgot, or could not attend their vaccination appointments. First this section explores the lived experiences of parents navigating appointment attendance, followed by scenarios in which this did not go to plan and how this was managed by their GenPr.

i. The lived experience of appointment attendance: a logistical event.

Many referred to attending vaccination appointments as a logistical ordeal. At times parents would turn up feeling flustered and somewhat overwhelmed. Parents felt that given the unpredictability of babies clinics with more flexible timings would be preferable. Most parents reported waiting for at least ten minutes, although they did not mind, they hoped that this courtesy would extend both ways.

"*I think because you don't always know you're doing a good job. You can go in and think, "Oh god today has been an absolute faff to get out the door. I've had to do two dress changes, change five nappies…It's a bit of a whirlwind I suppose I'm trying to say…*" [Jane, wave 2 interview].

"*And I would hope that if you were running late, that they would allow you the same principle, but, yeah*." [Emilia, wave 1 interview].

Most parents reported reliably receiving reminders without which many felt that they would have got the date or time wrong. For those who did not, this required good organization skills or additional calls to the GenPr to check the appointment time.

ii. A dichotomy of experiences: how GenPrs handle parents who are late, forget, or cannot attend their appointments as a trigger point.

As a result of the logistics required, many parents were late, forgot their appointment, or in one instance attended a day early. One parent reported taking a taxi to avoid being late after struggling to get their baby ready in time. For some, while this was a briefly panicked and embarrassing event, it was quickly resolved by the GenPr with kindness. This enabled them to maintain a positive vaccination trajectory (i.e., 'supported').

"And then the third one, totally my fault, I forgot to go. Can you believe it? I was absolutely horrified…I just completely forgot to go and it was one of those things where I think it was 9:30 on a Monday and it was 9:30 on the Tuesday…they were really lovely about it, because I felt so bad, wasting their time…they got me back in quickly, I think the next week and they didn't make me feel bad about it at all. Because I didn't mean it; it just completely had gone out of my brain. And that was brilliant…" [Holly, wave 2 interview].

Other GenPrs handled appointment tardiness or absence with a punitive approach. One mother received a letter warning her that if she missed another appointment that she would be removed from the practice list. Although the letter stated this was her second missed appointment, she could not recall the first. As a result, she reported that she would try to avoid booking appointments. She felt it was a disproportionate reaction for a vaccination appointment. Such situations can result in significant conflict which not only damages a parent's vaccination trajectory, but also causes long lasting damage to a patient's

relationship with their GenPr; see Table 7 for an emblematic case.

Another mother could not attend the vaccination appointments as she was staying with her parents. She was diagnosed with postnatal depression and cited that staying with family with a newborn was a part of her culture. As a result, the 12- and 16-week vaccines were received after a 4-week delay at 16 and 20 weeks of age (i.e., a 'stalled' trajectory). She was unaware that she could have received appointments at another GenPr local to her parents with a temporary registration. This would have been her preference and allowed her to stay for longer with her parents before returning home.

4. Discussion

To our knowledge, this is the first published study to prospectively follow parents' journey through the vaccination programme in real time and identify core triggers for different vaccine outcomes. It is unfortunate that most parents within the cohort did not experience a favourable 'supported' vaccination trajectory. While longitudinal qualitative cohort studies cannot address questions regarding prevalence, the pervasive experience of accessibility challenges by these parents is concerning and warrants further investigation using appropriate quantitative or mixed methods approaches. Our approach, however, is well situated to provide rich explanatory accounts of the potential causes of these trajectories which can be used to inform interventions to improve vaccine accessibility.

Implications for policy and practice are presented in the form of recommendations. Most of these do not require more resources and could even result in resource gains through reducing administrative (e.g., reducing the number of parental calls) and financial (e.g., addressing multiple vaccination letters) burden. Despite efforts to ensure that recommendations are resource sensitive, the findings and implications of this study are deeply affected by ongoing staffing and resourcing pressures faced by GenPrs [30,31]. Quality improvement, even with opportunities for resource gains, requires time investment which is likely to prove challenging when GenPrs are pre-occupied tackling vaccination backlogs [31] and dealing with increasing pressures on the NHS. Hence, mobilisation of these recommendations will require strong leadership at practice level and national support to become institutionalised.

Currently, GenPrs are incentivised under the Quality and Outcomes Framework (QOF) to achieve vaccination targets for childhood immunizations [32]. Recent changes (November 2024) aim to address inequalities and improve vaccination coverage by introducing fairer payment systems. This included the removal of financial penalties for practices with coverage below 80 % and the introduction of a sliding scale of rewards with a lower starting threshold. These reforms seek to incentivise higher performance without penalising practices operating in deprived areas. Our recommendations aim to help GenPrs achieve higher vaccination coverage, at minimal cost, while delivering quality

Table 7
Emblematic case of a parent who was late to an appointment.

Kafia is a lower-income British Pakistani mum with two children. At the first interview, she had a collection of vaccine flyers to hand, proudly citing that she had read them all. She could easily recall that her child had received the first set of vaccinations at 8-weeks and 2 days old. When asked how she felt about the NHS generally she become emotional but cited that they were tears of gratitude.

> *"They were amazing, yes. They don't let you to feel lonely, especially if we don't have our family here...[gets teary]...No, it's OK. I just feel like how much patience they have for people and how much they care about us...I didn't struggle at all."*

During the second interview, Kafia described how the baby dirtied her nappy just as she was about to leave for the 12-week vaccination appointment. Despite arriving only four minutes late, she was told by the receptionist that she had missed her appointment. She was instructed to go home, and that the appointment would now be in four weeks. Kafia felt that four-weeks was too long and was worried about the risk this posed to her baby.

> *"Anything can happened. Because in our country we have seen child get some kind of god forbid disabilities, any health conditions and I was so scared that she's doing this to me. And you know here, if something happens to our child they will say, "It's parents' ignorance. They have ignored it and they have not taken it seriously." That's why I said no it should be on time."*

Eventually the lead doctor came out and challenged Kafia for making excuses for being late and being rude to staff. After 20-minutes of back and forth the doctor agreed to vaccinate Kafia's baby if she waited. Kafia waited for one hour before she was seen. In that time, she observed a patient being late for a (non-vaccination) appointment and was upset that they did not face the same repercussions.

> *"I said, "Last time when I came here I waited so long for my daughter to have the vaccine and now you cannot give me five minutes." She said, "We are busy, we have to look after other patients so they are human, they can get delayed, some patients have got serious problems or unexpected discussions so they can delay." I said, "I'm also human, so things can happen to me too and to my baby as well"...She said, "You cannot make excuses, you have to understand I'm the lead doctor here…You cannot be rude to my staff." I said, "I'm not rude, I'm not rude I'm just telling you that I'm not satisfied with the system you have here..."*

> *"...And surprisingly, after me a patient came there, she tried to log in on the screen, she couldn't. She spoke to the receptionist that she had an appointment, she said, "You are eight minutes late." The receptionist told her, "You are eight minutes late, go upstairs for your appointment." Then I wanted to go to her and say, "Look she is eight minutes late and you are sending her upstairs for her appointment and you just told me off to go home." And I didn't go and I ignored her. But I heard her..."*

This experience damaged Kafia's relationship with her GenPr. She no longer felt welcome, wanted to change GenPr, and could not get past the memories of her prior experience when returning for the 16-week immunizations.

services to families and meeting QOF targets.

4.1. Temporal theme 1: booking systems

Registration as a cause of delay, particularly for those without a permanent residence has been previously reported [9,17,20,33]. However, the finding that parents often initiate contact with their GenPr regarding vaccination, due to a lack of transparency regarding the appointment timeline or when appointments should be issued (which for many is later than anticipated) is novel. This is significant due to the burden placed on parents, the resultant dissatisfaction and undermined trust in the system, and the additional resources this demands in terms of receptionist time. A positive vaccination journey should not be dependent on parents being willing to wait to be contacted near the vaccination due date.

Recommendation 1: Parents should be aware of when and how vaccination appointments are issued – this is particularly important for the 8-week vaccinations. This information should be signposted when they register with the GenPr and could be added to the newborn bloodspot screening results letter (in the UK this is sent to parents by the Child Health Information System (CHIS) usually by six weeks of age). Alternatively, appointment letters could be issued earlier to avoid parents pre-empting being 'missed'. This would require booking systems to be able to book appointments earlier in advance of the vaccine due date.

Letters instructing parents to ring the GenPr to arrange appointments received mixed reviews. Some preferred being able to pick the date and time of the appointment, while others were frustrated by long waiting times on the phone. For some, the administrative burden was substantial and were vaccination not so important for them they would not have persisted. This sheds further light on the mechanisms behind statements such as 'complicated booking systems' and 'unable to get an appointment' in previous research [20,33–35].

Recommendation 2: While some parents cited a preference to be issued an appointment (instead of being instructed to call the GenPr to schedule one), we acknowledge that getting parents to book can reduce 'did not attend' (DNA) rates and vaccine waiting lists. Instead, GenPrs should focus on improving their vaccination booking systems to reduce the administrative burden faced by parents. For example, reduce call waiting times or create a separate online form for parents to fill in to request vaccine appointments. These online forms would also enable parents to log their availability, serving as a mutually beneficial system for both parents (in terms of appointment suitability) and GenPrs (by limiting DNA rates). A minority of GenPrs within the sample were reported to use the end of a current vaccine appointment as an opportunity to book in the next set of vaccinations. This was a highly successful method valued by parents reducing administrative burden for all. This, however, is dependent on appointments being 'released' at least four weeks in advance.

Having contacted the GenPr, appointments not yet being released and or being unavailable were a further cause of poor accessibility. This 'no booking in advance', week-by-week appointment release system, and lack of appointments were also reported by Bell et al. during the Covid-19 pandemic, but it appears the issue has persisted [9].

Recommendation 3: Vaccination appointment slots should be released at least four weeks in advance of their due date. This would make booking easier for parents and facilitate the implementation of Recommendations 1 and 2.

In addition to appointment availability, appointment flexibility was also frustrating for parents with many GenPrs only running vaccine clinics one day a week. Problems with getting convenient appointments has been frequently reported [20,35–40].

Recommendation 4: Offer multiple days and am/pm vaccination slots (where possible).

Appointment changes or errors were not always a problem but did result in delay or notable effort in instances where appointments were lost or not rescheduled promptly following illness. Receptionists further undermined confidence in the system or missed opportunities to improve uptake by trying to book vaccination appointments too early or cancelling appointments without referring parents to discuss this with a trained healthcare worker.

Recommendation 5: Through the provision of appropriate training, ensure that GenPr receptionists are aware of: the importance of vaccine timeliness and offer vaccine appointments as close to the due date as possible; that vaccine appointments cannot be brought forward; when parents seek to cancel vaccination appointments having a system in place which includes offering a consultation with a healthcare worker (this requires the availability of clinical staff who are trained and confident in vaccine-related risk communication).

This study also identified a common issue of parents receiving more than one appointment letter for the same vaccinations. This can cause confusion, reduce trust in the system and wastes time and resource.

Recommendation 6: Improved communication between GenPrs and relevant services (within the UK this is CHIS) to establish who is commissioned for call and recall within the region. Where call recall can be outsourced, services (e.g., CHIS) should do some engagement work with GenPrs to promote their services and the range of options available to GenPrs in terms of letter formats and appointment options.

4.2. Temporal theme 2: how GenPrs handle the unexpected

Parents found attending vaccination appointments a logistical challenge, whether this was as a first-time parent, or a parent with older children. Flexible clinics and mutual respect were important to parents in the cohort. It was not uncommon for parents to be late or forget appointments. Some in the cohort were treated compassionately, while others faced vaccination delays or confrontation to receive the vaccination on time. While two studies have reported the phenomenon of parents forgetting appointments [35,41], the consequence of forgetting an appointment or the impact on vaccination was not known and is a unique contribution of this study.

Recommendation 7: Where possible parents who turn up late should still have their babies vaccinated (or offer for them to wait). If the appointment needs to be re-arranged this should be offered as soon as possible. There should not be a punitive approach, or risk of being discharged from the practice for missing a vaccine appointment. Practices should explore the possibility of flexible appointments (i.e., arrive between 8:00 and 9:00, if you arrive at the same time as someone else in your slot there may be a short wait) or drop-in clinics where possible.

Those who are away from home can also avoid significant vaccination delays with temporary GenPr registration, similar to interventions believed beneficial for traveller communities [20,33].

Recommendation 8: Improve awareness and provision of temporary registration systems to support vaccination delivery.

4.3. The bigger picture: looking across drivers, simultaneously, over time

Across all the temporal themes we can see that those within the 'struggled' trajectory were often highly motivated to receive the vaccine either going through significant administrative burden or even confrontation to get their child vaccinated. Combative and adversarial events were evident within the booking system and when parents were late to appointments. While 'tensions' have been reported in relation to rushed appointments [34], the confrontation identified within this study appears novel. Although it is worth noting that the 'anticipation of conflict' has been reported as off-putting in Gypsy, Roma, Traveller communities [7].

While these themes are presented in isolation, it is important to recognise that these temporal themes and sub-themes can be experienced simultaneously creating greater complexity in the vaccination journey. For example, in Jane's journey, she contacted the GenPr first but was 'pushed away' due to the slot release system; her second appointment was cancelled at short notice; and her third appointment

was lost resulting in a 'pushy' interaction with the receptionist to get seen. While for most people there was typically one main driver determining their vaccine trajectory, features of the system can confuse, slow, or undermine (e.g., multiple letters, one-day clinics) making the picture increasingly multi-faceted.

Furthermore, these experiences occur 'over time' at different points of the vaccination programme. Namely, people's experiences and thoughts can change from one interaction to the next. This phenomenon was first observed by Henderson et al. albeit specific to vaccine beliefs rather than the wider vaccination experience [39]. To our knowledge, this is the first paper to explore this phenomenon and does so using an appropriate qualitative longitudinal cohort study design. The third wave of data collection (when each child is approximately one year old) will further add to our understanding of the vaccination trajectories identified by this analysis, including the lived experiences which shapes them.

4.4. Notable absences

Locality of parents and of services was not a primary finding of this study despite being a commonly reported accessibility issue. This contradicts previous research in which participants cite a need for a wider choice of clinics and venues [7,20,35]. This may be a more prevalent issue in rural areas [7], or this may reflect an issue for those in exceptional circumstances, such as the two opposing cases observed within the cohort (e.g., being unable to change GenPr after moving house as this would result in the loss of mental health support resulting in the use of taxis to attend vaccination appointments). In contrast with previous studies, parents' motivation was superior to any inconvenience resulting from time constraints or apprehension of the physical aspect of vaccination [20,42,43]. This included the inconvenience of looking after other children [9]. Similarly, long waiting times [20,39] did not deter the parents in this cohort. These absences may reflect the evolving nature of accessibility issues or simply that they were not observed within the cohort given the small sample size.

4.5. Strengths and Limitations

The theory-driven qualitative longitudinal cohort study design is a strength of this research, enabling the exploration of key drivers and trigger points for different vaccine trajectories as they occur in real time. This study does not claim to have captured all the potential drivers of different vaccine outcomes, but this does not invalidate or diminish the drivers which have been identified within this cohort. This approach has deepened our understanding of vaccine decline with in-depth understanding of previously unidentified accessibility issues.

The selected accessibility framework provided a valuable and comprehensive approach to exploring accessibility constraints faced by parents within the cohort and may be a valuable tool for future research. Compared to other available frameworks, such as the one utilised for the scoping review [16], Levesque's framework [24] demonstrated a better real-life 'fit' with its ability to capture not only access 'topics' but the interaction between parental resource, features of the service, and the passing of time.

Another strength is the time and community engagement which went into securing a socioeconomically diverse cohort. While socioeconomic drivers of low and untimely vaccine uptake warrant further exploration with a larger sample, we believe that addressing the accessibility challenges identified within this study (which are likely to disproportionately affect those with fewer socioeconomic resources) would still represent important steps in improving vaccine equity.

The cohort predominantly comprises of mothers; however, this may not inherently be a limitation of the study as women within the cohort often reported being the decision-makers regarding vaccination (even if this was discussed with their partner). This is also reported in other empirical studies [33,44]. The role fathers play in vaccination decision-making and attendance is another potential area of focus for future research.

While several approaches were taken to mitigate against observation effects (e.g., the interviewer emphasising they respect parents' autonomy to make vaccination decisions and sympathising with vaccination concerns, or not reaching out for interviews until 4-weeks post vaccination due dates to avoid acting as reminders or prompts) we are unable to assess the impact of study involvement on vaccination outcomes. Interestingly, for a minority of participants study involvement made them more questioning of why they vaccinate their children with an expressed desire to be better informed, but ultimately, they did not feel this shaped their vaccine behaviour.

5. Conclusion

To address declining vaccination coverage within England it is vital that vaccine accessibility is improved and that services meet parents' needs. This could be achieved by reforming the timeliness and process of vaccine booking systems and establishing flexible vaccination clinics. This study deepens our understanding of accessibility issues with the vaccination service and reminds us to treat parents with understanding and kindness. For instance, progressing our understanding from 'complicated' booking systems to booking systems which are often too slow to contact parents proactively, issues a 'you call us' request when waiting times to get through to reception are long, and do not have appointment slots available when parents call to book. Our recommendations will enable vaccination commissioners and providers to make specific, informed decisions to improve the accessibility of their services.

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Ethics declarations

Ethics approval was granted by the NHS (no. 22/PR/1465) and LSHTM (no.28158). Participants were informed of the purpose of the study, their right to confidentiality, and that any data would be appropriately handled. Written consent was obtained during enrolment to the study and verbal consent was obtained during each subsequent wave of data collection.

CRediT authorship contribution statement

Georgia Chisnall: Writing – review & editing, Writing – original draft, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Louise Letley:** Writing – review & editing, Validation, Supervision, Methodology, Conceptualization. **Sandra Mounier-Jack:** Writing – review & editing, Validation, Supervision, Methodology, Conceptualization. **Helen Bedford:** Writing – review & editing, Validation, Supervision. **Tracey Chantler:** Writing – review & editing, Validation, Supervision, Methodology, Conceptualization.

Declaration of competing interest

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2025.126921.

Data availability

Plans are in place to archive anonymised copies of transcripts and analysis materials which will be available from the corresponding author on reasonable request.

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