



Women's experiences of maternity service reconfiguration during the COVID-19 pandemic: A qualitative investigation

Sergio A. Silverio^{a,b,*}, Kaat De Backer^{a,c}, Abigail Easter^a, Peter von Dadelszen^a,
Laura A. Magee^{a,‡}, Jane Sandall^{a,‡}

^a Department of Women & Children's Health, School of Life Course Sciences, Faculty of Life Sciences & Medicine, King's College London, 10th Floor North Wing, St. Thomas' Hospital, Westminster Bridge Road, Lambeth, London, SE1 7EH, UK.

^b Elizabeth Garrett Anderson Institute for Women's Health, Faculty of Population Health Sciences, School of Life and Medical Sciences, University College London, Medical School Building, 74 Huntley Street, London, Bloomsbury, WC1E 6AU, UK.

^c Kingfisher Mother and Baby Unit, Hellesdon Hospital, Norfolk and Suffolk NHS Foundation Trust, Drayton High Road, Norwich, Norfolk, NR6 5BE, UK.

ARTICLE INFO

Keywords:

Maternity Care
COVID-19
Service Delivery
Women's Experiences
Qualitative Research

ABSTRACT

Objective: To explore women's experiences of maternity service reconfiguration during the first wave of the SARS-CoV-2 (COVID-19) pandemic.

Design: Qualitative interview study.

Setting: South London, United Kingdom.

Participants: Women (N=23) who gave birth between March and August 2020 in one of the ten South London maternity hospitals.

Methods: Semi-structured interviews were conducted (N=23), via video-conferencing software. Transcribed interviews were analysed 'by hand' using Microsoft Word. Template analysis was selected to code, analyse, and interpret data, according to the findings of a recently-published national survey of maternity service reconfiguration across the UK in response to COVID-19.

Findings: Three main themes emerged through analysis: (i) Disruption to In-Person Care and Increased Virtual Care Provision, (ii) Changes to Labour and Birth Preferences and Plans, (iii) Advice for Navigating Maternity Services During a Pandemic.

Key Conclusions: Women reported mixed views on the reduction in scheduled in-person appointments. The increase in remote care, especially via telephone, was not well endorsed by women. Furthermore, women reported an under-reliance on healthcare professionals for support, rather turning to family.

Implications for Practice: We provide insight into the experiences of women who received antenatal, intrapartum, and postnatal care during the first wave of the COVID-19 pandemic. Our findings should inform healthcare policy to build back better maternity care services after the pandemic.

Introduction

In December 2019, the SARS-CoV-2 or COVID-19 outbreak was first reported in Wuhan, China. Within weeks, the virus had spread throughout China, and cases were being reported elsewhere in the world. By 31 January 2020, the UK recorded its first case, and by 26 March 2020 (Lillie et al., 2020), the government legislated national lockdown, through mandated and enforced stay-at-home orders (UK Government, 2021a). In the year since the first reported case, the UK has

recorded over 3,852,801 cases and over 109,165 deaths, with substantial regional variation, and particularly high rates in London (UK Government, 2021b).

At the outset of the pandemic, pregnant women were identified as having a potential, particular clinical vulnerability to the SARS-CoV-2 virus, and public messaging promoted this concept, with shielding (the concept whereby one is recommended to stay at home under all circumstances unless seeking medical care, or, in the case of pregnant women, travelling to hospital to give birth) recommended until 24 July 2020

* Corresponding author at: Research Office 4, Department of Women & Children's Health, School of Life Course Sciences, Faculty of Life Sciences & Medicine, King's College London, 10th Floor North Wing, St. Thomas' Hospital, Westminster Bridge Road, London, SE1 7EH, UK.

E-mail address: Sergio.Silverio@kcl.ac.uk (S.A. Silverio).

‡ LAM & JS share responsibility as joint Senior Authors of this manuscript.

<https://doi.org/10.1016/j.midw.2021.103116>

Received 10 May 2021; Received in revised form 19 July 2021; Accepted 2 August 2021

0266-6138/© 2021 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>)

in the 11th version of the Royal College of Obstetricians and Gynaecologists (RCOG; 2020) guidelines. Therefore, urgent modifications were made to maternity care services. The National Health Service [NHS] and RCOG published and rapidly updated their guidance on all aspects of maternity care, to mitigate the risk of SARS-CoV-2 infection, and in response to government-imposed social distancing and movement restrictions (NHS, 2020a; 2020b; RCOG, 2021).

A recent national survey (conducted between May-July 2020) documented substantial pandemic-responsive changes to UK maternity services (Jardine et al., 2021). Most sites reported a reduction in scheduled antenatal (by 70%) and postnatal (by 56%) appointments, particularly for low-risk women. Almost all sites (86%, particularly in London) reported provision of at least some component of care using remote methods, usually telephone, particularly in early pregnancy and less so near or at term gestational age. Over half of units (59%) at least temporarily suspended support of birth at home or in a midwifery-led unit. Further, most health visitors¹ were re-deployed, meaning responsibility for ongoing postnatal care was delegated to other healthcare professionals or was delivered at reduced capacity (Institute of Health Visiting [iHV], 2020).

Globally, maternity care services changed the way in which they delivered care to reduce risk to mothers, their newborns, and the staff who were providing care (Grünebaum et al., 2020; Jardine et al., 2021; Montagnoli et al., 2021; Szabo et al., 2021; Wu et al., 2021). Whilst this differed the world over, the common factors included increased use of virtual care and reduced in-person or 'face-to-face' care, reduction of choice with regards to desired location of birth, and fewer people allowed at points of care or during birth, meaning women were often separated from their partners or chosen birth companions (Fumagalli et al., 2021; Jardine et al., 2021; Sweet et al., 2021).

Using established qualitative research methodology, we sought to explore the experiences of women in South London, UK, receiving antenatal care both before and during the pandemic, and who subsequently gave birth and received postnatal care during the pandemic. Our findings contribute to ongoing development of healthcare policy and guidelines for the provision of maternity services during subsequent waves of COVID-19 and post-pandemic service re-build, as well as to prepare for future health system shocks.

Methods

Design

Individual interviews were utilised to facilitate understanding of women's experiences of pregnancy and childbirth during the COVID-19 pandemic, between March and August 2020, thus we interviewed all participants (N=23) who showed interest in the study, and who met eligibility criteria in this set period of time. Interviews were semi-structured to ensure common questions were asked of all participants and responses could be analysed across the dataset, whilst still allowing sufficient flexibility in the interview schedule to follow interesting lines of inquiry pertinent to individual participants (McIntosh and Morse, 2015). Appendix 1. Interviews were conducted chronologically, covering women's experiences of antenatal, intrapartum, and postnatal maternity care services, in addition to women's psychosocial experiences of pregnancy, labour, childbirth, and motherhood, and how the COVID-19 pandemic may have affected those experiences.

Ethical approval

Ethical approvals were sought and granted from the King's College London Biomedical & Health Sciences, Dentistry, Medicine and Natural

¹ In the UK, Health Visitors are Nurses or Midwives who undergo additional training in Public Health Nursing. It is therefore common in the UK for Health Visitors to provide postnatal care from soon after birth.

& Mathematical Sciences Research Ethics Sub-Committee, in June 2020 (project reference:- HR-19/20-19486).

Patient and public involvement and engagement

This study was presented at a National Institute for Health Research [NIHR] Applied Research Collaboration [ARC] South London, Patient and Public Involvement and Engagement [PPIE] meeting for maternity and perinatal mental health research (July 2020), which has a focus on co-morbidities, inequalities, and maternal ethnicity; an NIHR ARC South London Work in Progress Meeting (October 2020) focusing on maternity and perinatal mental health research; and at an NIHR ARC South London Public Seminar (February 2021) which focused on COVID-19 rapid response research. We received advice on study design, recruitment strategy, and interpretation of our findings as well as support to share the study details in the local community from both lay and expert stakeholders, including members of the public, those with lived experience, health and social care professionals, researchers, and policy makers.

Setting

The participants in this study received their antenatal care and gave birth in one of ten South London maternity hospitals. South London is recognised as the region of London under the River Thames spanning approximately 250 sq mi, with a population of approximately three million people (Office for National Statistics [ONS], 2019). The area is home to high levels of ethnic diversity (ONS, 2019), and indices suggest high levels of social complexity, including multiple deprivation (Greater London Authority [GLA], 2019). Types of deprivation include barriers to housing and poorer living environments, higher levels of crime, and increased deprivation affecting children and older people; although employment rates remain high (GLA, 2019).

Participants and recruitment

Women were eligible if they had given birth in South London during the study period and had received at least part of their maternity care prior to both the COVID-19 pandemic and the UK 'lockdown' restrictions (from 23 March 2020 until easing began on 13 May 2020).

Recruitment took place on-line, with posts on social media platforms, and by word-of-mouth. We also tried to specifically recruit women from Black, Asian, and Minority Ethnic backgrounds through our established Patient and Public Engagement and Involvement [PPIE] network, so as to achieve a more demographically representative sample of South London itself.

A critical case purposeful sampling technique (Farrugia, 2019) was used to identify newly parous women who had recently given birth in South London, UK. This meant we recruited from one area, aiming to extrapolate our findings to the wider general population (e.g. to other cities where ethnic diversity is high or where there are high levels of social complexity and multiple deprivation). In addition, this approach aids comparison between participants and the exploration of commonalities and differences within a single given context (Farrugia, 2019) – in this case, geographically-bounded to South London.

Data collection

Interested participants e-mailed the research team and were sent a participant information sheet and consent form, to be completed electronically prior to their interview or verbally at the beginning of the interview. Due to UK Government-imposed lockdown and physical distancing restrictions associated with the COVID-19 pandemic, all interviews were conducted by one researcher [SAS], remotely using video-conferencing software. Interviews were recorded and ranged between 30 and 90 minutes ($M_{Time} = 52$ minutes). The audio was transcribed by a professional transcription company using intelligent (or 'standard')

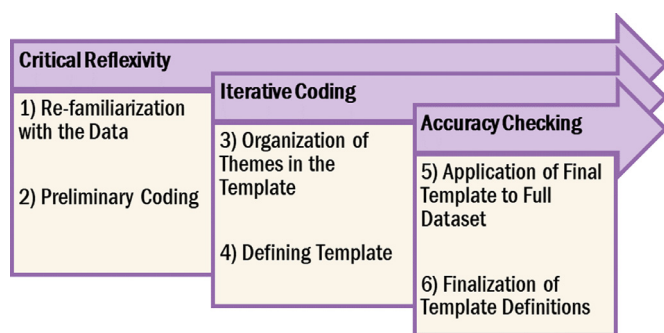


Fig. 1. Template Analysis Process (adapted from Brooks et al., 2015 and King & Brooks, 2017).

transcription, i.e. not following verbatim which would have included every single incidence of “contextual matter such as false sentence starts; filler-words, or those which are emphasised or repeated; grammatically incorrect phrases, and those spoken in a different way (including foreign words and the demarcation of whispers, mumbles, raised- or acted-voices e.g. falsetto), whilst also noting coughing, laughing, crying etc., as well as any interruptions to the interview.” (Silverio et al., 2019; p.44). This decision was taken to match the rapid research approach we had adopted.

Data analysis

Template analysis (King, 2012) was selected to evaluate women’s experiences of pandemic-related maternity care changes according to the findings of a recently-published national survey of maternity service configuration across the UK in response to COVID-19 (Jardine et al., 2021), and conduct our evaluation rapidly enough to inform care during subsequent waves of COVID-19 and post-pandemic. As a qualitative methodology it is philosophically flexible, but has been used in this study with a critical perspective (King and Brooks, 2017; p.15), whereby we are interested in the “realities which exist independent of human activity” meaning contextual factors outwith human control (in this case, the COVID-19 pandemic) “may not directly determine behaviour, they are nonetheless recognized as having important influences in understanding experience”. Template analysis follows a stepped procedure (see Fig. 1), broadly categorised as: (re)familiarisation with the data; preliminary coding; organisation of themes; defining an initial coding template; application of the initial template; finalisation of the template and application to the full dataset (Brooks et al., 2015). Importantly, the initial template can be modified to ensure completeness of analysis, as described below (King, 2012).

An analyst who had not conducted the interviews [KDB] checked every transcript for accuracy against its corresponding audio, which also allowed her to familiarise herself with the data. The analyst who had conducted the interviews [SAS] was able to re-familiarise himself with each transcript in the context of the dataset. Transcripts were analysed ‘by hand’ [SAS] using annotation tools on Microsoft Word, rather than qualitative data analysis [QDA] software, to allow multiple researchers to access the dataset at the same time using shared files, and facilitate more rapid analysis. Rigour is maintained in Template Analysis and in our study by reflexively engaging with data and analytical processes throughout all six analytical steps, as detailed above. Furthermore, as per Brooks et al., (2015), iterative coding from step three onwards allowed for thorough and methodical analyses, whilst accuracy checking employed in the final two stages allowed for certainty and confidence in thematic saturation (i.e. final themes were well supported by data contained within the dataset).

The coding template initially included the following key changes in maternity care services in the UK (as described by Jardine et al., 2021): (i) Disruption to Routine, In-Person Care; (ii) Increased Provision of Virtual Appointments; and (iii) Changes to Labour and Birth Preferences

and Plans. An iterative approach (King and Brooks, 2017) was taken to coding data and extracting key quotations [SAS], involving reading and re-reading transcripts, and ensuring comparisons were being made between all participants’ data to that point. The coding template was tested with the initial transcripts [SAS], modified accordingly, and then re-applied to all data within the dataset. The modified template incorporated a fourth theme of (iv) Advice for Navigating Maternity Services During a Pandemic. Later iterative analytic work noted similarity between the first two themes (i & ii), and so these were merged and renamed into (i) Disruption to In-Person Care and Increased Virtual Care Provision; thus, results are presented as three themes. The cohesion, completeness, and meaningfulness of all data, coding, and analysis was checked and confirmed with regular consultations with the wider study team [KDB, JS, LAM] throughout the data collection and analysis stages.

Results

Participants (N=23) were predominantly white (n=20; 87%); married (n=17; 74%); and employed (n=22; 96%). Just over half were primiparous (n=13; 57%), and they ranged in age at interview from 27 to 44 years ($M_{Age} = 35$ years). Half of infants were female (n=12; 52%), all were singletons (n=23; 100%); and about one-third had a Caesarean section (n=8; 35%; elective: n=4; 17%; emergency: n=4; 17%), as compared with spontaneous (n=13; 57%) or instrumental (n=2; 9%) vaginal births. A quarter of women were induced (n=6; 26%), and almost a third did not receive appropriate one-to-one intrapartum care as recommended by the National Institute for Health and Care Excellence (NICE; 2017) guidance (n=7; 30%). Participants gave birth at five of South London’s ten maternity hospitals: King’s College Hospital (n=8; 35%); Kingston Hospital (n=6; 26%); St. George’s Hospital (n=5; 22%); Croydon University Hospital (n=2; 9%); and University Hospital Lewisham (n=2; 9%). One participant initially received antenatal care at one South London hospital, but transferred, subsequently delivering at another. Full demographic information can be found in Table 1.

Qualitative analysis of the data resulting in three themes is presented below, with the most illustrative quotations presented in text and supplementary quotations found in Table 2. Where appropriate, representative figures have been used to further illustrate participant data (see Figs. 2 & 3). Each quotation is presented with its corresponding participant identifier.

Disruption to in-person care and increased virtual care provision

Lockdown restrictions and subsequent maternity service reconfigurations affected routine appointment schedules and the frequency of those appointments. Antenatal care visits were found to have been either altered frequently or cancelled altogether, with women discussing their perceptions of virtual care appointments as having less value or importance:

“...they showed us in the book [maternity record] at the first appointment, ‘These are all the weeks you should be having these appointment and this is how it should all work’, then it was the polar opposite to that because pretty much every single one of those was cancelled or turned into a telephone call.”
(Participant-021)

In addition, women discussed how reduced frequency of antenatal care appointments made them feel, with provision of virtual care not equated to the in-person care they had either expected or wanted:

“I would say: don’t have any expectations for the midwife care up until the point of labour. At the time you feel cheated out of these appointments. You keep looking at this book that tells you, you should have been seen in all these weeks and you are thinking, I have been seen face-to-face twice. You feel a bit cheated and anxious that they maybe are missing out on something...”

Table 1
Participant demographics

| Participant ID [†] | Age | Ethnicity [‡] | Marital or Partnership Status | Employment Status | Parity | Infant Sex | Labour Companion Present at Birth | Place of Birth | Mode of Birth | Postnatal Admission |
|-----------------------------|-----|--------------------------|-------------------------------|--------------------|--------|------------|-----------------------------------|-------------------------------|---|----------------------------------|
| 001 | 36 | White British | Married | Employed Part-time | 2 | Male | Yes | Labour Ward | SVD | unclear |
| 002 | 34 | White British | Married | Employed | 1 | Male | Yes | Labour Ward | SVD (after IOL) | <1day |
| 003 | 42 | White Other | Married | Self-Employed | 1 | Female | Yes | Labour ward | SVD | 1day |
| 004 | 31 | White British | Married | Employed | 1 | Female | Yes | Labour Ward | SVD | 5days (partner allowed to visit) |
| 005 | 32 | White British | Married | Employed | 1 | Male | Yes | Labour Ward | Instrumental birth (after IOL) | 2.5days |
| 006 | 33 | White British | Married | Self-Employed | 1 | Female | Yes | Labour Ward | Instrumental birth (after IOL) | 4nights/ 5days |
| 007 | 37 | White European | Married | Employed | 1 | Male | Yes | Operating Theatre | Elective Caesarean Section | 4nights |
| 008 | 27 | White British | Married | Employed | 1 | Female | Yes | Midwife-Led birthing unit | SVD | 1night |
| 009 | 30 | Portuguese Mixed | Co-habiting | Employed | 2 | Female | Yes | Operating Theatre | Emergency Caesarean Section | 1night |
| 010 | 44 | Asian – Sri Lankan | Married | Employed | 3 | Female | No | Induction bay, antenatal ward | SVD | 5nights |
| 011 | 32 | White | Engaged | Employed | 1 | Male | Yes | Operating Theatre | Emergency Caesarean Section | 2nights |
| 012 | 44 | White British | Single | Employed | 1 | Male | Yes | Operating Theatre | Emergency Caesarean Section (after IOL) | 2nights |
| 013 | 38 | British Mixed | Co-habiting | Employed | 2 | Male | Yes | Labour Ward | SVD | <1day |
| 014 | 29 | White British | Married | Employed Part-time | 2 | Female | Yes | Operating Theatre | Emergency Caesarean Section | 2nights |
| 016 | 36 | White American | Married | Employed | 2 | Male | Yes | Operating Theatre | Elective Caesarean Section | 1night |
| 017 | 30 | White British | Married | Employed | 2 | Female | Yes | Midwife-led birthing Unit | SVD | <1day |
| 018 | 42 | White British | Married | Employed | 2 | Male | Yes | Operating Theatre | Elective Caesarean Section | 1day |
| 019 | 33 | White British | Married | Employed | 1 | Female | Yes | Operating Theatre | Elective Caesarean Section | 1day |
| 020 | 39 | White British-Italian | Single | Unemployed | 4 | Female | No | Labour Ward | SVD | 1week |
| 021 | 35 | British | Married | Employed Part-time | 2 | Female | No | Labour Ward | SVD (IOL) | 2nights |
| 022 | 31 | White British | Married | Employed | 1 | Female | Yes | Labour ward | SVD (IOL) | 1night |
| 023 | 31 | White British | Married | Employed | 1 | Male | Yes | Labour Ward | SVD | 1night |
| 024 | 35 | White Australian-British | Co-habiting | Employed | 1 | Male | Yes | Home | SVD | 2nights |

[†] Participant 015 is missing, as they withdrew from the study after consenting (and being assigned a participant number), but before taking part in the interview.

[‡] Ethnicity was defined by participants in response to the question: “Could you tell me the ethnicity with which you identify?”

(Participant-022)

Whilst many women understood why appointments were changing so rapidly, concern often arose about the lack of in-person care, in re-

lation to the growth and wellbeing of the baby during pregnancy or of their newborn infant (see Fig. 2):

I was conscious, people were adapting as they went along. There was no rule book about what to do here. It wasn't like right, we're in this protocol; let's get it out of the cupboard and dust it off. People were looking at it and thinking well for this week, on this day, this is the guidance, therefore we'll do this. It might all be different in a week's time. So, I thought, appointment-wise, everyone handled it pretty well.

(Participant-010)

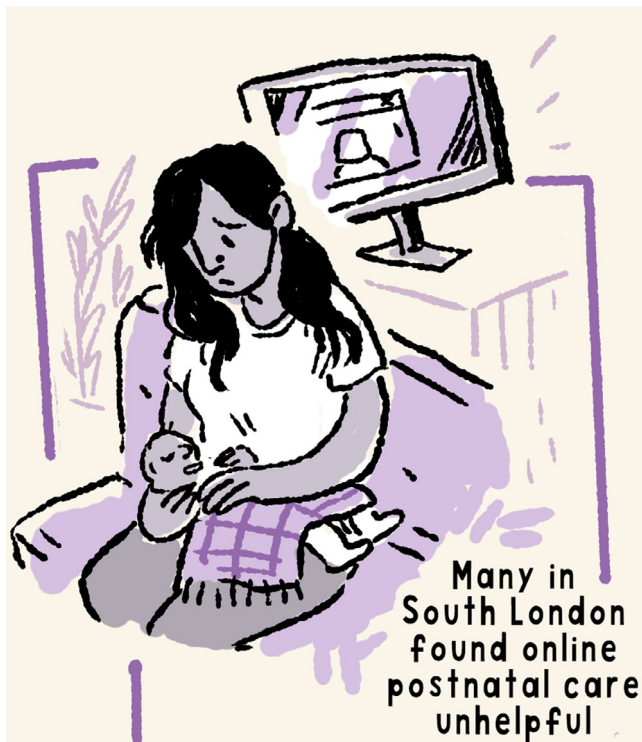


Fig. 2. Artistic depiction of findings – online postnatal care

Many women expressed they had less postnatal care than expected, and often felt mental health care was lacking:

“I did think that, postnatally, there is not much attention that is paid to mental health. Yes, people ask if you are okay but, again, I think a lot of women feel quite bad about saying well actually I’m feeling really low……. And the fact that you are expected to just get on with it… I think some kind of… Even now I am finding it hard to find the words for it, because I feel like I’m asking for a luxury product, but some kind of mental health attention for all women, postnatally, I think would make a huge difference.”

(Participant-010)

“I think in the first few days she started to get very jaundiced… I ended up ringing the postnatal ward at <Hospital> and going, ‘Can I ask you about this?’… And they took the time to give me a very sensible and reassuring answer……. They have their health visitor advice line, which I have used several times when I was worried about stuff……. A few weeks later when she got very dehydrated……. I rang 111 [non-emergency medical helpline provided by the NHS]. They took me through their triage and a thing came up that I hadn’t freaked out about at all, which was there had been a couple of times when she had just been very floppy and I had just thought that was normal and they were like, ‘Whoa!’ and they ended up sending an ambulance round, which took me to baby A&E again.”

(Participant-003)

In relation to the reduction of antenatal and postnatal care, women often mentioned virtual care was sometimes used as an alternative, however, was recognised as not being accessible to all:

“I think I would question the accessibility of that. Not everyone does have a smartphone and so expecting people to be able to receive a video call is not necessarily the most inclusive thing. Although where it is available, it would be nice. I think the weirdest call was the one I had with the consultant at <Hospital> just before giving birth, which felt very impersonal because it was someone I had not met in person and never to hear from again.”

(Participant-003)

However, where accessibility was not an issue, virtual care was often discussed as an inappropriate medium through which to conduct health checks, especially postnatally, during which time both newborns and new mothers required attention:

“I was also referred by my health visitor for a breastfeeding Zoom call. That was ridiculous. I needed to see someone face-to-face because they have to check your position, your latch and whether your baby has tongue tie. Feeding support has to be there face-to-face and it needs to be available.”

(Participant-005)

Whilst not favoured in the postnatal period as much as it had been accepted for certain aspects of antenatal care, virtual care was tolerated as a better alternative to no care at all, which many postnatal women faced:

“So, I’ve had no Health Visitor follow-up. Just to know that your baby’s healthy, I just find it hard that people weren’t physically seeing her, it was all done by phone. As I say, I don’t know what she should weigh, and I’m weighing her myself which might not be accurate, and you’ve just got to hope that she’s doing okay. And yes, you just need to sort of wing it really. So yes, I think the first six weeks were very isolating and very hard, and then I think yes, I don’t know, maybe once the baby starts getting slightly easier to cope with, maybe you just get on with it a bit more; I don’t know.”

(Participant-019)

Changes to labour and birth preferences and plans

Service reconfigurations extended to the intrapartum period, about which pregnant women were often warned by midwives:

“…I was kind of calling my Midwife… on almost a daily basis [laughs] leading up to my labour, just because things were changing and you were hearing things in the news so regularly, and I was concerned that I could go into labour tomorrow and not know what to expect. So yes, it was confirmed that I wouldn’t be able to have my husband with me until established labour, which I think did impact my labour quite dramatically.”

(Participant-023)

Whilst some women were reassured and told sensitively that their birth experience would be different, others did not receive such supportive care:

“It was really abrupt. They definitely said, ‘Your choices are now limited. You are choosing between not the scenarios you wanted, but this is where we are, and you need to get it together.’……. There was a definite ‘This is a crisis, take the choices you have on the table, don’t complain about it’, attitude.”

(Participant-016)

“…my midwife told me my partner couldn’t come in with me, I think I was a bit upset about it because that’s not the kind of experience you

want. You want your support with you. Also the fact that I only could have one birthing partner as well, where I had my partner and my mum with me at that time, so it was really upsetting that my mum couldn't be with me and she told me as well that when it came to visitors as well, I only could have one named visitor.”

(Participant-009)

Sometimes, this extended to the communication between maternity care providers and women during their intrapartum care:

“So anyway, I went into this room and I basically said to the midwife, ‘Look, I’m getting really panicky; I need to go and get some fresh air outside and I need to speak to my husband. I need to go outside.’ And I think she could see that I was getting a bit stressed and getting a bit panicky. And it was a bit odd. She had to go out and ask more of a senior midwife is it all right if she goes out for 20 minutes to the car park. And I was a bit like ‘hang on, I’m not a prisoner’.”

(Participant-004)

Occasionally, the restriction on birth partners meant that non-birthing parents missed the birth of their baby (see Fig. 3):

“...she was born within half an hour of getting proper contractions [laughs]. I was still in the induction bay, basically, and I was like, ‘Oh excuse me, I think I’m having my baby’. [Laughs] Then they just wheeled me round incredibly quickly to a room and she was born within 10 minutes..... so, yes, all that morning he wasn’t there and because they only realised it was an established labour half an hour before she was born, he didn’t get there..... It was a shame really. ”

(Participant-021)



Fig. 3. Artistic depiction of findings – birth partners

However, restrictions were often viewed as arbitrary and, therefore, changes to birth plans, including presence of birth partners, were frequently reported as unnecessarily frustrating:

“I’m not clear that the policy on fathers not being able to be present until you’re four centimetres dilated is a necessary decision.”

(Participant-001)

Advice for navigating maternity services during a pandemic

The final theme of this analysis covered women’s advice for other pregnant and birthing women. Largely, advice centred around replacing the face-to-face support with virtual forms of social support, and a noticeable under-reliance on healthcare professionals for this type of support:

“Trying to talk to people. Nothing can beat face-to-face in terms of being able to go somewhere and talk to someone face-to-face, someone coming into your house and having a cup of tea or you going in someone’s house and having a cup of tea, but if that is not possible trying to talk to people, talking to people on the phone. When I came off the phone from particularly my friends and my mum – anyone who had had a baby, who understood what some of these difficulties felt or looked like – I always felt reassured.”

(Participant-013)

In addition, there was a firm belief amongst women that whilst managing COVID-19 was currently the immediate priority of all healthcare services, pregnant women were never going to be forgotten, and, more so, were always privy to prioritisation amongst healthcare services and professionals:

“The advice my mum kept giving me was: Try and stay relaxed about it. Maternity services are never going to stop. People are going to be giving birth. My mum kept saying to me, ‘Every hospital prioritises pregnant women and maternity services.’ They are never going to compromise on the welfare of you. If they are restricting your visitors, that is only to protect you..... Clearly in my experience maternity services were being prioritised just as much and there was no question of compromising on the level of care. Try and stay relaxed.”

(Participant-018)

And finally, many women recognised the importance of mental health as well as physical health during pregnancy, childbirth, the post-natal period, and during the COVID-19 pandemic:

“...try to keep on top of how you are feeling about things, because there’s a lot of being in pregnancy, when you feel like everyone else knows what is best for you and you don’t feel that your own feelings, your own views, are heard. And sometimes it is hard to even identify how you actually feel about something. And I guess the other thing I would say is don’t be afraid to – and I think this is easier for some people than others – don’t be afraid to ask for things: advocate for yourself.”

(Participant-010)

Table 2
Supplementary quotations.

| Disruption to In-Person Care and Increased Virtual Care Provision | Changes to Labour and Birth Preferences and Plans | Advice for Navigating Maternity Services During a Pandemic. |
|---|---|---|
| <p>I have reached out to the health visitors a couple of times and I found that helpful but perhaps actually there needs to be an ongoing touching base with new mums over the first six months in the absence of face-to-face services. Because I don't think anyone is going to phone me and check on me and actually having somebody phone me every couple of weeks and just say this is 15 minutes – is there anything you want to talk about. Rather than it having to be me phoning because I've got a specific issue or a specific concern. (Participant-001)</p> <p>They advised to keep your appointments on the same day so that you saw the same midwife, so I did do that so that I saw the same person throughout. And it was only then when COVID hit that my appointments got rearranged and, I guess, her schedule got moved around as well. So, I then saw different people. So, it was never a guarantee, but it was kind of 'you should do this if you can because it leads to better outcomes', so they said. (Participant-002)</p> <p>I ended up doing a phone appointment where I was in the waiting room and the doctor was in his room [laughs] which was the weirdest GP appointment I have ever had. (Participant-003)</p> <p>They were trying to do the appointments very quickly, which I understand. I understand it was for the safety of me and them, but there was that sense that if I did have any questions I couldn't really sit there and ponder them. I had to really be thinking do I have any questions because I have to ask them because they are going to try and get me out as soon as possible. That felt a little strange. It all felt very clinical. (Participant-005)</p> <p>I got discharged on the basis of a phone call and me saying I think it is fine. The aftercare – not the hospital, the transition from hospital care over to the GP – is probably where the sticking point for me is. (Participant-006)</p> <p>I guess the fact that the guidelines nationally and also within the hospital felt like they were constantly changing, and possibly adding an extra layer of panic almost, or not fully explaining as to why things have been put in place or haven't been put in place. (Participant-008)</p> <p>...it's just a bit more on you that it maybe would have been otherwise, because all these clinics are not running and the regular appointments are not happening, or at least not face-to-face. Maybe that's what I would say, is that the support is there and really good, but I think generally it is on you to enquire. (Participant-011)</p> <p>I think there was a lot of confusion; the one negative was there was no good communication about what was happening to appointments. You weren't really sure; were they happening on the phone, when were you going to get the call, were you going to get a letter now stating that it was now going to be a phone-call? Which no, there was very little communication. So, I always felt a bit uneasy about that... (Participant-012)</p> <p>I didn't like the fact that I had to travel out with a baby. I was lucky I had a car because I thought to myself, "If I didn't have a car now, I wouldn't get on a bus." Because I remember saying to the Midwife, she said to me "Do you drive?" I said "Yes." She goes, "Oh brilliant, you could park." I said "Well, what happens if I don't drive?" and she goes "Well, you'd have to get a bus." I said, "But with a two week old baby, on a bus, during a lockdown, during a pandemic?" I went "That's not really safe." And the attitude I got was like "Oh well, you just have to do it." It wasn't very concerned, if anything, it was "You're making our job a little bit easier," that was the feeling I got from the conversation, "You're making our job a little bit easier because we don't have to do the home visits, you can come to us in the clinic." (Participant-020)</p> <p>...at 34 weeks I had a telephone appointment and I tried to ask what changes are there in the hospital, because of COVID and talk about the birth plan. She basically said, 'Everything is changing so quickly there is no point in us even talking about that now. Wait until your next appointment.' My next appointment wasn't until 38 weeks and I remember thinking that was really strange because I could technically have had the baby by 38 weeks. It felt like I was being brushed off a bit and that made me quite anxious because it felt like I hadn't had the chance to have that conversation. At 38 weeks I had a face to face appointment and that was supposed to be where we talk about the birth plan, but when she checked for the baby's heart rate, she said it was a bit faster than it should be. She sent me straight to the assessment unit again, so we never had the chance to talk about the birth plan. (Participant-022)</p> | <p>...the two Specialist Midwives and likewise for the PPH or the Midwives and Doctors that were coming in for that, they all had a mask on, which then felt like it was quite difficult to communicate with them and to hear them properly as to what was going on, and I think a few of them had aprons, but that was the level of PPE that they were wearing..... It felt really clinical. It made it feel more like an American soap TV documentary or something. Yes, it didn't feel very - relaxed isn't the right word - but that sort of feeling... It definitely added a layer of "You're a Clinician and I'm a patient," as a step in between. Which obviously is true, but yes, it felt less friendly, I would say. (Participant-008)</p> <p>To be able to have my partner throughout the whole labour experience would have been much easier for me, I'd say, but I feel that's me being selfish [laughs]. Because labour is hard, labour is really hard, and you just don't want to be alone. (Participant-009)</p> <p>I had to stay in hospital and have insulin for two days and then they would do the C-section. But obviously my partner couldn't come and that was horrible because I had to just go in and say, "Okay, see you in two days, then I'll see you for two hours while I have the C-section, then I'll see you in another two days when I go home". As it turned out, I instantly went into labour, so he got to come straight back again and they did an emergency C-section, so it was okay. But the thought of having to go in for a five-day period and seeing him for just that tiny window in the middle was just really strange and difficult. (Participant-014)</p> <p>I'd also at that point spoken to my Midwife and they said that both of us would have our temperatures checked when we arrived. So, I was actually more concerned about my husband catching COVID, because obviously if I had it, they would [laughs] let me in regardless, whereas if he had it, he wouldn't be there for the birth. So, we had been really, really anxious about going out, and I think by my 30-week appointment we hadn't been out for at least a month, we hadn't left the house. (Participant-023)</p> <p>At some point – I can't remember what point – the midwife led unit was shut because it became the COVID wing. That would be where women who had COVID or suspected COVID symptoms were going for delivery. Basically, then we knew I probably wasn't going to get a water birth. It would still be midwife led care so it wouldn't be suddenly you were dealing with the doctors, but the surroundings would be very different. No orchids on the wall, that kind of nice mood lighting. (Participant-024)</p> | <p>Well it is difficult, because every time you go to a healthcare setting then she could pick up all kinds of things, not just coronavirus but colds and all kinds of stuff are passed on in those settings. So it's not that it is always better to see someone face-to-face. I think there is always a balance to be struck between keeping away from germ-laden environments but also the reassurance of seeing someone in person can't be denied. (Participant-003)</p> <p>This would be my advice to any mum. Take every day as it comes and ease up on yourself because it is hard with the pandemic and without the pandemic. It is different hard with different babies, I can tell you now, and it is different hard with different phases in your relationship with other people, your family and your spouse. Every day is different. This is my theory now. (Participant-016)</p> <p>I didn't mean to labour at home for so long, and the reason I did was because the hospital kept saying I wasn't in established labour because my contractions weren't at the right time that indicates that you're in established labour. And it's really hard to know when you're a first-time mum if you are or aren't, and if the hospital's telling you that you aren't, you just go with it. [Sigh] And obviously, by the time I had got there I could have been at risk of having him on the way there, for instance; I mean, I was 9½ centimetres. So, I think that needs... I don't know what the solution is, but reviewing that, because saying "Right," and the only reason I was putting it off was because I didn't want to go in and my husband being turned away, and it was that fear. So, I don't know what the solution is to that, but if there's a better way of advising women when to come into hospital, because I can imagine I'm not the only one that's put it off because of not wanting to go in and then losing their birthing partner, whoever they may be. (Participant-023)</p> |

Discussion

Main findings

The landscape of healthcare service delivery during the COVID-19 pandemic changed rapidly and healthcare Trusts within the NHS adapted their services, and continue to do so, to ensure both their staff and the populations they serve remain safe. Our interviews of women in

South London confirmed disruptions in maternity care, in terms of reduced frequency, reduced face-to-face visits, relocation of care, and/or cancelled antenatal and postnatal care, and the impact that this had on women's experiences.

Virtual care – either by video-call or telephone – was deemed more acceptable antenatally than postnatally, and there was an emphasis on prioritisation of face-to-face care for foetal and newborn health surveillance. However, virtual care was preferred to no care whatsoever –

reported frequently, postnatally and especially in relation to health visitors. There was an emphasis on in-hospital restrictions placed on birthing mothers, from healthcare providers requesting women delay hospital attendance when in labour, to separation of women from their birthing partners until they were in established labour, and frequently, the non-birthing parent missing the birth of their child.

Finally, most women focused on replacing in-person social support with virtual alternatives to ensure they were seeking help and practicing wellbeing throughout their pregnancies and after their baby arrived. However, there was an under-reliance on seeking support from healthcare professionals (Birthingrights, 2021). This under-reliance on healthcare professionals, showed a social shift of emotional burden and advice seeking from trained professionals to family members or friends who had experienced pregnancy and childbirth beforehand. Whilst it may have reduced the workload of healthcare professionals and providers, it largely meant that women sought advice from those with experience, rather than those who were appropriately qualified (Birthingrights, 2021; Fumagalli et al., 2021; Sweet et al., 2021). The potential outcome of this – both positive and potentially negative – is yet to be substantiated, evaluated, or calculated.

Strengths, limitations, and future directions

This study was conceived and conducted as a rapid research response to the COVID-19 pandemic. To our knowledge, this is the first qualitative study of women's experience of maternity service reconfiguration in the UK during the COVID-19 pandemic. Other strengths include the large sample size for a qualitative study, and use of template analysis to relate women's experiences to reported service configuration, and to do so iteratively, rigorously, and at a rapid rate.

Limitations include limited ethnic, relationship, and socio-economic diversity amongst our participants, despite our efforts to recruit a more representative population and targeted advertisement of the study. Our participants represent views of women in South London, an area of the country particularly hard-hit by COVID-19. However, their descriptions of maternity care service changes mirror those described nationally and so may have broader applicability (Jardine et al., 2021). We interviewed women who began receiving antenatal care pre-pandemic and then completed antenatal care and gave birth during the pandemic; it is not known whether their views may reflect re-alignment of expectations formed pre-pandemic and, therefore, may differ from the views of those whose expectations were formed during the pandemic. Future research should compare findings from new data collection with our findings whilst also making efforts to recruit a more ethnically diverse sample (Fernandez Turienzo et al., 2021).

Finally, we interviewed few women with hypertension or diabetes. Therefore, we are unable to comment on the increased use of home blood pressure and glucose monitoring during the pandemic. Such practices were increasing in prevalence pre-pandemic, even by women's independent choice (Tucker et al., 2021). Future research should consider these specific populations of pregnant women, including those with other pregnancy or neonatal complications (e.g. hyperemesis gravidarum, pre-eclampsia, NICU/SCBU admission).

Interpretation

Our analysis details the experiences of women who were pregnant and subsequently gave birth during the COVID-19 pandemic, thus adding experiential evidence to the outcomes of the national survey of service reconfigurations (Jardine et al., 2021). Women were unhappy about the reduction of relational care. While they understood the pandemic mandated certain circumstances to keep everyone safe (Szabo et al., 2021), they questioned whether some of the apparently arbitrary decisions about provision of care really improved safety, as they certainly diminished care quality. It should also be noted that, whilst not elucidated in this study, there is widespread concern (see

Montagnoli et al., 2021) that virtual care can lead to less frequent reporting or detection of unsafe living or relationship conditions (i.e. domestic violence).

Women were reassured that maternity care would always remain a priority of healthcare services, regardless of the pandemic, as babies will continue to be born, and women will continue to require maternity care, regardless of how the service is reconfigured (Grünebaum et al., 2020). Whilst re-aligning women's expectations may have resulted in different views compared with women who booked during the pandemic, there may be lessons to learn about preparing women for uncertainties related to pregnancy complications and external forces which may negatively affect pregnancy experiences (Fumagalli et al., 2021; Sweet et al., 2021; Wu et al., 2021).

Conclusion

Our study provides new insights into the experiences of women who received part of their maternity care as substantially reconfigured during the first wave of the COVID-19 pandemic, as documented by the recent national survey (Jardine et al., 2021). Women variably endorsed the reduction in scheduled antenatal and, in particular, postnatal appointments. While women recognised that modifications in service delivery were necessary to protect themselves and others from SARS-CoV-2 infection, they expressed disappointment at the loss of choice, autonomy, and relational care, particularly with regards to their birth plan and labour. The increase in remote care, especially over the telephone, was viewed with disappointment, particularly for newborn care and infant wellbeing. Women's reliance on personal, rather than professional, relationships, could be due to women not wanting to burden their care providers during the pandemic, or because most women did not receive continuity of carer and, consequently, lacked the relational care required to feel safe in asking for support. Initially, our findings suggest four key recommendations: 1) if virtual care is to become part of routine maternity care, video methods should be employed; 2) staff and women may require training to utilise virtual methods of care and Trusts should be aware of data poverty which exists amongst especially deprived areas across the UK, meaning women do not always have access to the internet in order to access virtual care; 3) due to the nature of maternity care (whereby care cannot be delayed as it can for elective surgeries, for example), policy makers and healthcare providers should carefully consider whether maternity staff should in fact be re-deployed at all during a health crisis, so as not to compromise the health and welfare of pregnant women and their babies; and 4) chosen birth partners should be deemed essential to all aspects of maternity care and should not be excluded. Whilst countries around the world, and the NHS within the UK are looking at post-pandemic service delivery and care, our findings complement ongoing studies of healthcare delivery during the pandemic and can inform plans to build back better maternity services as this pandemic continues, thereafter, and in preparation for future health system shocks.

Funding

This project was funded by the King's College London King's Together Rapid COVID-19 Call, successfully awarded to LAM, SAS, AE, Pvd, and colleagues (grant reference:- 204823/Z/16/Z) as part of a rapid response call for research proposals. The funder had no role in the recruitment, data collection and analysis, or write-up associated with this work. This study was also supported by an NIHR Senior Investigator Award, held by JS (ref:- NIHR200306).

Disclosures of Interest

Sergio A. Silverio, Abigail Easter, & Jane Sandall (King's College London) are currently supported by the National Institute for Health Research Applied Research Collaboration South London [NIHR ARC South

London] at King's College Hospital NHS Foundation Trust. Jane Sandall is also an NIHR Senior Investigator (NIHR200306). Kaat De Backer (Norfolk and Suffolk NHS Foundation Trust) is currently supported by the National Institute for Health Research Applied Research Collaboration East of England [NIHR ARC East of England] at Cambridgeshire and Peterborough NHS Foundation Trust. The views expressed are those of the authors and not necessarily those of the NIHR or the Department of Health and Social Care.

Contribution of Authorship

Conceptualization: [SAS, LAM, Pvd, JS, AE]; Methodology: [SAS]; Software: [SAS; KDB]; Validation: [AE, JS]; Formal Analysis: [SAS, KDB]; Investigation: [SAS]; Resources: [SAS, AE, JS, LAM]; Data Curation: [KDB, SAS]; Writing – Original Draft: [SAS]; Writing – Review & Editing: [LAM, KDB, AE, JS, Pvd, SAS]; Visualization: [SAS]; Supervision: [JS, LAM]; Project Administration: [SAS]; Funding acquisition: [LAM, SAS, AE, Pvd].

Details of Ethical Approval

Ethical approvals were sought and granted from the King's College London Biomedical & Health Sciences, Dentistry, Medicine and Natural & Mathematical Sciences Research Ethics Sub-Committee, in June 2020 (project reference:- HR-19/20-19486).

Data Availability Statement

The data supporting the findings of this study are available upon reasonable request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

Declaration of Competing Interest

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

Acknowledgements

We would like to thank B. Mure & Dr. M. Greenfield for use of the illustrations contained within this manuscript, which were developed at a workshop titled: 'Becoming a Parent in Lockdown', funded by the Economic and Social Research Council and hosted by King's College London (November 2020).

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.midw.2021.103116.

References

- Birthrights, 2021. [Internet]. Coventry: Birthrights; c2020-2021 [cited 2021 March 11]. Coronavirus. Available from: <https://www.birthrights.org.uk/campaigns-research/coronavirus/>.
- Brooks, J, McCluskey, S, Turley, E, King, N., 2015. The utility of template analysis in qualitative psychology research. *Qual. Res. Psychol.* 12 (2), 202–222. doi:10.1080/14780887.2014.955224.
- Farrugia, B., 2019. WASP (write a scientific paper): sampling in qualitative research. *Early Hum. Dev.* 133, 69–71. doi:10.1016/j.earlhumdev.2019.03.016.

- Fernandez Turienzo, C, Newburn, M, Agyepong, A, Buabeng, R, Dignam, A, Abe, C, Bedward, L, Rayment-Jones, H, Silverio, SA, Easter, A, Carson, LE, Howard, LM, Sandall, J, on behalf of the NIHR ARC South London Maternity and Perinatal Mental Health Research and Advisory Teams, 2021. Addressing inequities in maternal health among women living in communities of social disadvantage and ethnic diversity. *BMC Public Health* 21 (176), 1–5. doi:10.1186/s12889-021-10182-4.
- Fumagalli, S, Ormaghi, S, Borrelli, S, Vergani, P, Nespoli, A., 2021. The experiences of childbearing women who tested positive to COVID-19 during the pandemic in northern Italy. *Women Birth* 1–12. doi:10.1016/j.wombi.2021.01.001.
- Greater London Authority, 2019. Indices of Deprivation 2019 Initial Analysis. Greater London Authority, London.
- Grünebaum, A, Dudenhausen, J, McCullough, LB, Chervenak, FA., 2020. Women and children first: the need for ringfencing during the COVID-19 pandemic. *J. Perinatal Med.* 48 (4), 305–306. doi:10.1515/jpm-2020-0149.
- Institute of Health Visiting (UK), 2020. Health visiting during COVID-19: unpacking re-deployment decisions and support for health visitors' wellbeing. *The iHV*, London.
- Jardine, J, Relph, S, Magee, LA, von Dadelzen, P, Morris, E, Ross-Davie, M, Draycott, T, Khalil, A., 2021. Maternity services in the UK during the COVID-19 pandemic: a national survey of modifications to standard care. *BJOG* 128 (5), 880–889. doi:10.1111/1471-0528.16547.
- King, N., 2012. Doing template analysis. In: Symon, G, Cassell, C (Eds.), *Qualitative organizational research: Core methods and current challenges*. SAGE, Los Angeles, pp. 77–101.
- King, N, Brooks, J., 2017. Doing template analysis: A guide to the main components and procedures. In: *Template analysis for business and management students*. SAGE, Los Angeles, pp. 25–46.
- Lillie, PJ, Samson, A, Li, A, Adams, K, Capstick, R, Barlow, GD, Easom, N, Hamilton, E, Moss, PJ, Evans, A, Ivan, M, Incident Team, PHE, Taha, Y, Duncan, CJA, Schmid, ML, 2020. The Airborne HCID Network. Novel coronavirus disease (Covid-19): The first two patients in the UK with person to person transmission. *J. Infect.* 80 (5), 578–606. doi:10.1016/j.jinf.2020.02.020.
- McIntosh, MJ, Morse, JM., 2015. Situating and constructing diversity in semi-structured interviews. *Glob. Qual. Nurs. Res.* 2, 1–12. doi:10.1177/2333393615597674.
- Montagnoli, C, Zanconato, G, Ruggeri, S, Cinelli, G, Tozzi, AE., 2021. Restructuring maternal services during the Covid-19 pandemic: early results of a scoping review for non-infected women. *Midwifery* 94 (102916), 1–6. doi:10.1016/j.midw.2020.102916.
- National Health Service (UK), 2020a. Clinical guide for the temporary reorganisation of intrapartum maternity care during the coronavirus pandemic, 1st ed. The NHS, London.
- National Health Service (UK), 2020b. Supporting pregnant women using maternity services during the coronavirus pandemic: Actions for NHS providers, 1st ed. The NHS, London.
- National Institute for Health and Care Excellence (UK), 2017. Clinical guidance [CG190]. Intrapartum care for healthy women and babies. NICE, London.
- Office for National Statistics, 2019. Ethnic groups by boroughs. Greater London Authority, London.
- Royal College of Obstetricians and Gynaecologists (UK); Royal College of Midwives (UK), 2020. Coronavirus (COVID-19) infection in pregnancy: information for healthcare professionals, 11th ed. The RCOG, London.
- Royal College of Obstetricians and Gynaecologists (UK); Royal College of Midwives (UK), 2021. Coronavirus (COVID-19) infection in pregnancy: information for healthcare professionals, 13th ed. The RCOG, London.
- Silverio, SA, Gauntlett, W, Wallace, H, Brown, JM, 2019. (Re)discovering grounded theory for cross-disciplinary qualitative health research. In: Clift, BC, Gore, J, Bekker, S, Costas Battle, I, Chudzikowski, K, Hatchard, J (Eds.), *Myths, methods, and messiness: Insights for qualitative research analysis*. University of Bath, Bath, pp. 41–59.
- Sweet, L, Bradfield, Z, Vasilevski, V, Wynter, K, Hauck, Y, Kuliukas, L, Homer, CSE, Szabo, RA, Wilson, AN., 2021. Becoming a mother in the 'new' social world in Australia during the first wave of the COVID-19 pandemic. *Midwifery* 98 (102996), 1–7. doi:10.1016/j.midw.2021.102996.
- Szabo, RA, Wilson, AN, Homer, C, Vasilevski, V, Sweet, L, Wynter, K, Hauck, Y, Kuliukas, L, Bradfield, Z., 2021. Covid-19 changes to maternity care: Experiences of Australian doctors. *Aust. N.Z. J. Obstet. Gyn.* 1–8. doi:10.1111/ajog.13307.
- Tucker, KL, Hodgkinson, J, Wilson, HM, Crawford, C, Stevens, R, Lay-Flurrie, S, Dale, M, Astbury, N, Chappell, LC, McManus, RJ., 2021. Current prevalence of self-monitoring of blood pressure during pregnancy: the BUMP Survey. *J. Hypertension* 1–8. doi:10.1097/hjh.0000000000002734.
- UK Government, 2021a. [Internet]. [cited 2021 March 11]. Stay at home: guidance for households with possible or confirmed coronavirus (COVID-19) infection. Public Health England, London Available from: <https://www.gov.uk/government/publications/covid-19-stay-at-home-guidance/stay-at-home-guidance-for-households-with-possible-coronavirus-covid-19-infection>.
- UK Government, 2021b. [Internet]. c2020-2021 [cited 2021 March 2]. Coronavirus (COVID-19) in the UK. Public Health England, London Available from: <https://coronavirus.data.gov.uk/>.
- Wu, D, Fang, D, Wang, R, Deng, D, Liao, S., 2021. Management of pregnancy during the COVID-19 Pandemic. *Glob. Challenges* 5 (2), 1–8. doi:10.1002/gch2.202000052.