



Article

Maternity service reconfigurations for intrapartum and postnatal midwifery staffing shortages: modelling of low-risk births in England

Grollman, Christopher, Daniele, Marina A S, Brigante, Lia, Knight, Gwenan M, Latina, Laura, Morgan, Andrei S and Downe, Soo

Available at <https://clock.uclan.ac.uk/44106/>

Grollman, Christopher, Daniele, Marina A S, Brigante, Lia, Knight, Gwenan M, Latina, Laura, Morgan, Andrei S and Downe, Soo orcid iconORCID: 0000-0003-2848-2550 (2022) Maternity service reconfigurations for intrapartum and postnatal midwifery staffing shortages: modelling of low-risk births in England. BMJ Open .

It is advisable to refer to the publisher's version if you intend to cite from the work.

For more information about UCLan's research in this area go to <http://www.uclan.ac.uk/researchgroups/> and search for <name of research Group>.

For information about Research generally at UCLan please go to <http://www.uclan.ac.uk/research/>

All outputs in CLoK are protected by Intellectual Property Rights law, including Copyright law. Copyright, IPR and Moral Rights for the works on this site are retained by the individual authors and/or other copyright owners. Terms and conditions for use of this material are defined in the [policies](#) page.

BMJ Open Maternity service reconfigurations for intrapartum and postnatal midwifery staffing shortages: modelling of low-risk births in England

Christopher Grollman ¹, Marina A S Daniele ¹, Lia Brigante ^{2,3},
Gwenan M Knight ⁴, Laura Latina ⁵, Andrei S Morgan ^{6,7}, Soo Downe ⁸

To cite: Grollman C, Daniele MAS, Brigante L, *et al.* Maternity service reconfigurations for intrapartum and postnatal midwifery staffing shortages: modelling of low-risk births in England. *BMJ Open* 2022;**12**:e051747. doi:10.1136/bmjopen-2021-051747

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (<http://dx.doi.org/10.1136/bmjopen-2021-051747>).

CG and MASD are joint first authors.

Received 27 March 2021
Accepted 13 July 2022



© Author(s) (or their employer(s)) 2022. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

For numbered affiliations see end of article.

Correspondence to

Dr Marina A S Daniele;
marina.daniele@city.ac.uk

ABSTRACT

Introduction Choice of birth setting is important and it is valuable to know how reconfiguring available settings may affect midwifery staffing needs. COVID-19-related health system pressures have meant restriction of community births. We aimed to model the potential of service reconfigurations to offset midwifery staffing shortages.

Methods We adapted the Birthrate Plus method to develop a tool that models the effects on intrapartum and postnatal midwifery staffing requirements of changing service configurations for low-risk births. We tested our tool on two hypothetical model trusts with different baseline configurations of hospital and community low-risk birth services, representing those most common in England, and applied it to scenarios with midwifery staffing shortages of 15%, 25% and 35%. In scenarios with midwifery staffing shortages above 15%, we modelled restricting community births in line with professional guidance on COVID-19 service reconfiguration. For shortages of 15%, we modelled expanding community births per the target of the Maternity Transformation programme.

Results Expanding community births with 15% shortages required 0.0 and 0.1 whole-time equivalent more midwives in our respective trusts compared with baseline, representing 0% and 0.1% of overall staffing requirements net of shortages. Restricting home births with 25% shortages reduced midwifery staffing need by 0.1 midwives (−0.1% of staffing) and 0.3 midwives (−0.3%). Suspending community births with 35% shortages meant changes of −0.3 midwives (−0.3%) and −0.5 midwives (−0.5%) in the two trusts. Sensitivity analysis showed that our results were robust even under extreme assumptions.

Conclusion Our model found that reconfiguring maternity services in response to shortages has a negligible effect on intrapartum and postnatal midwifery staffing needs. Given this, with lower degrees of shortage, managers can consider increasing community birth options where there is demand. In situations of severe shortage, reconfiguration cannot recoup the shortage and managers must decide how to modify service arrangements.

BACKGROUND

The benefits of midwife-led care for women and birthing people experiencing low-risk

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ Combines appropriate data sources to estimate the effect of maternity service reconfigurations on staffing requirements for low-risk births.
- ⇒ Uncertainty assessment was suboptimal due to limitations of the method.
- ⇒ Only considers low-risk births and does not assess the impact of shortages across the whole service.

pregnancy, labour and birth (henceforth ‘women’) are well-established. Evidence from multiple settings including the UK shows that midwife-led continuity models of care are safe and associated with lower levels of obstetric intervention and higher maternal satisfaction compared with other models of care.¹ There are four types of birth setting in England: labour ward (LW), alongside birth centre located in proximity to a labour ward (ABC), freestanding birth centre (FBC) and home. In all but LWs, care is predominantly midwife-led. For low-risk births, the Birthplace in England study (‘the Birthplace study’) showed that planned birth in ABCs, FBCs or at home, compared with birth in LWs, is associated with fewer maternal complications and interventions and, with the exception of nulliparous women planning home birth, equivalent newborn outcomes.² In this paper, ‘community births’ are births in FBCs and at home and ‘hospital births’ are births in ABCs and LWs. Community births are associated with the lowest levels of unnecessary interventions and may be more convenient and acceptable for some people.³ Transferring low-risk births from community to hospital settings is likely to increase the cost of care due to higher levels of interventions in hospitals.

Choice of birthplace has been embedded in policy in England for decades,⁴ yet LWs



remain by far the most common place to give birth.⁵ ABCs account for 12% of births, FBCs 2% and home births a further 2%.^{5,6} Since 2016, government policy through the National Health Service (NHS) England Maternity Transformation programme has been to enable more people to give birth in settings other than LWs.⁷ Between 2010 and 2016, although the number of ABCs increased, multiple FBCs closed.^{5,8} There is some evidence that if women were fully informed of the outcomes in each setting, more would choose community settings.⁹ However, even where community births are available, midwife shortages may prompt decisions to restrict them.

From the start of the COVID-19 pandemic, the Royal College of Midwives (RCM) and Royal College of Obstetricians & Gynaecologists (RCOG) emphasised the benefits of keeping all birth settings available.¹⁰ A rapid scoping review suggested strategies to keep healthy childbearing women out of hospital, if this is their choice, to minimise SARS-CoV-2 transmission.¹¹ The RCM also argued that preserving community birth services during the pandemic could help address concerns about nosocomial infection and prevent a surge in unassisted childbirth.¹²

In England, healthcare is managed by NHS trusts, which are organisations that provide healthcare services to geographically defined populations. Many trusts experienced increased demand for community birth.^{13–15} Some kept FBCs open and strengthened home birth services and others announced temporary restrictions or suspensions of community birth services. Among 74 UK Heads of Midwifery who responded to a survey in late March 2020, 42 reported that local birth centres (alongside or freestanding) were still open (68%). In cases of closure, requisition was the primary reason, followed by staffing shortages and reconfigurations. Home birth provision continued as normal in 47% of trusts (33), was discontinued in 43% (30) and was scaled up in one trust.¹⁶ It seems that ABCs were less affected by pandemic-related reconfigurations.

Nationally, median midwife shortages were 16% by the end of March, ranging from 2% to 40% shortages.¹⁷ Strain on ambulance services also caused concern over potential delays in transfers from community births,¹⁸ and midwives expressed concerns about SARS-CoV-2 transmission during home care.¹⁷ Advocates for rights in childbirth expressed concerns over the proportionality, transparency and speed of these decisions.^{19,20}

Aggregate regional/national level data suggest that hospital births require more midwives compared with community births, although this does not account for different levels of obstetric risk in each setting.²¹ Evidence suggests that midwife-led care is cost-effective for low-risk births,^{21,22} but it is unclear whether births that are low risk at onset of labour will require fewer or more midwives in different types of setting.

This paper aims to inform choices between reconfiguration options to optimise staff resources in times of shortage. We developed a tool for modelling the effect on midwifery staffing requirements of changing the service

configuration for low-risk births in the NHS in England (where virtually all births occur in the NHS system). We present the results in two hypothetical typical English trusts of moving births into hospital settings, and of expanding community and midwife-led birth services, in three midwifery staffing shortage scenarios.

METHODS

Model overview

The model adapts the Birthrate Plus method²³ to estimate intrapartum and postnatal midwifery staffing need for low-risk births in a trust with a given distribution of births by setting. The model inputs are the number and parity of births, the proportions of actual births in each setting, the setting-specific risks of interventions and obstetric outcomes and the transfer risks from planned community births to LW. We designed two hypothetical typical trusts in which we modelled midwifery staffing requirements at baseline and in three scenarios of staffing reduction and birthplace reconfiguration. We report the difference in staffing requirements between each reconfiguration scenario and its baseline, in absolute terms and as a percentage of the national median midwife numbers per trust. We implemented the model in a LibreOffice Calc Spreadsheet²⁴ (online supplemental file 1).

Midwifery staffing requirements in the Birthrate Plus method

Birthrate Plus is a tool for calculating midwifery workforce requirements, to help providers avoid staffing deficiencies.²³ It can be used at local or trust level to prospectively assess the midwifery staffing needs in a given population, and can also be used at higher geographical levels to estimate health system-wide midwifery training and recruitment needs.

In Birthrate Plus, the basic intrapartum staffing estimate for a hospital birth is based on the duration of labour, and this estimate is increased for births with complications or interventions: each intervention and obstetric outcome has a score and the scores for each are summed to give the total score for a birth. This score maps to a 'need category', which determines a multiplier for intrapartum staffing compared with the least complicated category. In its prospective trust-level implementation, Birthrate Plus assigns a score to each hospital birth recorded in a trust.

Birthrate Plus calculates midwifery staffing need for community births as 17 hours of intrapartum care and 5 hours of postnatal care per birth, with supplements to cover admin time and travel time. Overall staffing needs are based on summing the needs across all individual births. Subtotals are increased by 22% to cover leave and supervision allowances.²³

We took the following approach in our model. We used parity (primiparous/multiparous) as a proxy for duration of labour. We calculated the numbers of overall complications among hospital births based on setting-specific risks of each intervention and obstetric outcome (see below). We multiplied these numbers of complications by their

corresponding scores. The sum of these scores across all hospital births was divided by the number of hospital births to give an average score per hospital birth and associated 'average' need category. The need category also determines the number of hours of postnatal midwifery care per birth, and the number of hours of community-based follow-up. We divided total hours by 37.5 to give the number of standard working weeks and then by 52 to give the annual staffing estimate in whole-time equivalent (WTE) midwives (staffing need equivalent to a number of full-time workers, even if work is conducted by more workers some of whom work part-time).

Our model only considers staffing for intrapartum and postnatal care, whereas the full Birthrate Plus method also covers antenatal care and other aspects of midwifery staffing. Further detail on how we used Birthrate Plus can be found in the methodological appendix (online supplemental file 2; methods for calculating staffing in section 1/online supplemental figure A).

Interventions and obstetric outcomes

The Birthrate Plus method requires estimates of certain interventions and obstetric outcomes. For some of these, setting-specific risks based on planned place of birth are reported in the Birthplace study.² The Birthplace risks relate to planned place of birth, while the model inputs are actual births in each setting. The actual numbers of births are converted to planned numbers for each setting using the transfer risks from the Birthplace study (online supplemental table A).²⁵ The setting-specific risks of interventions and obstetric outcomes are then applied to births planned for each setting. The numbers of interventions and outcomes are then distributed between actual birth settings: for interventions and outcomes that can only occur in labour ward, all that occur among planned non-LW births are added to the total for actual LW births. For interventions and outcomes that can occur in any setting (such as episiotomy), we used expert opinion to estimate the proportion per planned place of birth that occurred among women transferred to the LW and the proportion that occurred in the planned birth setting (online supplemental tables B and C).

We used expert opinion to estimate the risks of those interventions and outcomes not reported in the Birthplace study. We describe our procedure for estimating the numbers of all interventions and obstetric outcomes in more detail in section 2 of the online supplemental methodological appendix.

Applying the model to synthetic trusts: overview

We generated two synthetic trusts with different baseline service configurations. For each synthetic trust, we generated scenarios involving changes in the availability of birth settings for low-risk births only, in which actual community births were reduced or increased. For the baseline and each scenario in each trust, we estimated the number of expected interventions and obstetric outcomes for low-risk births.

Synthetic trusts: population of births

Our two synthetic trusts had 4500 total births per year, the median number in trusts in England providing maternity services,²⁶ of which 2025 (45%) were low-risk at onset of labour and thus eligible for community birth.²⁷ We only modelled low-risk births. We assumed 42.5% of births were to nulliparous women (the national average)²⁸ and distributed births by parity between settings based on the ratios observed in the Birthplace study.² Online supplemental methodological appendix section 3 describes our methods regarding parity in more detail.

Synthetic trusts: birth setting configurations

Our model trusts had different configurations of birth settings. Trust A had home, LW and ABC, reflecting the most common configuration of services in England. Trust B included all four settings. Collectively, these configurations characterised 86 of 134 trusts in England in 2016.⁵ We assigned a proportion of births to each setting as a baseline (see below), and for each trust created scenarios with different levels of staff shortage (−15%, −25% and −35%) and reconfiguration of services reflecting the RCM—RCOG guidance and the Maternity Transformation programme '4–4–20' target.

The RCM—RCOG guidance

RCM and RCOG joint guidance published in April 2020 suggests that trusts could reorganise services during the pandemic in three phases: in phase I, corresponding to midwife shortages of below 20% with ambulance services running as usual, all birth settings are preserved and trusts make contingency plans for further shortages. In phase II, with midwife shortages of 20%–30% and minor delays to ambulance services, the guidance is to restrict home birth services to multipara women and prioritise sustaining ABC services, which may entail closing FBCs. In phase III, with midwife shortages of over 30% and severe delays in ambulance services, the guidance recommends closing all home birth and FBC services and moving births to ABCs. Where ABCs are not available, in phases II and III rooms should be set aside on LW to allow midwife-led care.

The Maternity Transformation programme

In 2016, NHS England established the Maternity Transformation programme to implement the 2016 National Maternity Review and achieve its 'vision for safer and more personalised care across England'.²⁹ This includes a target to expand midwife-led care, including community care. The '4–4–20' target aims to achieve 4% of all births at home, 4% in FBC and 20% in ABC, up from roughly half those levels previously.³⁰ Among the 45% of births that are low-risk and eligible for midwifery-led care, this equates to 8.9% of births at home, 8.9% in FBCs and 44.4% in ABCs.

Rationale for staffing scenarios in our hypothetical trusts

We based our reconfiguration scenarios on the RCM—RCOG guidance, supplemented by the Maternity

**Table 1** Distribution of low-risk births by setting at baseline and in scenarios of staffing reduction in two model trusts.

Setting	Trust A				Trust B			
	Baseline	Phase I	Phase II	Phase III	Baseline	Phase I	Phase II	Phase III
Home birth	4.7%	8.9%	3.9%	0.0%	4.7%	8.9%	3.9%	0.0%
Freestanding birth centre					4.2%	8.9%	0.0%	0.0%
Alongside birth centre	31.0%	44.4%	31.7%	35.7%	25.4%	44.4%	30.4%	34.3%
Labour ward	64.3%	46.7%	64.3%	64.3%	65.7%	37.8%	65.7%	65.7%

Transformation programme goals. In the phase I (–15%) staffing scenario, the RCM—RCOG guidance did not suggest any reconfiguration. We therefore used this lower-shortage scenario as an opportunity to assess the staffing implications of achieving the ‘4–4–20’ target. This broadly reflects the decisions taken in some trusts to encourage community provision during the first months of the pandemic.¹⁶

Trust A

Trust A, with home birth, ABC and labour ward available, had a baseline level of 4.7% home births reflecting the national average for low-risk births.⁶ At baseline, 31% of births were in the ABC, reflecting 14% of all births nationally being in birth centres,⁵ adjusted for a low-risk population. The remaining 64.3% of births were in the LW at baseline (table 1).

In the phase I (–15%) staffing scenario, we modelled the effect on midwifery staffing of expanding community birth services so as to meet the Maternity Transformation programme ‘4–4–20’ target. As there was no FBC, this consisted of 8.9% of births at home and 44.4% of births in the ABC, with 46.7% of births in LW.

In the phase II (–25%) staffing scenario, we moved primipara home births into the ABC, reducing the home birth proportion to 3.9% and increasing the ABC proportion to 31.7%.

In the phase III (–35%) staffing scenario, we closed the home birth service and moved all home births to the alongside birth centre, increasing that proportion to 35.7%. In both phases II and III the LW proportion remained at 64.3%.

Trust B

For the baseline configuration in trust B, where all four settings are available, 4.7% of births were at home as in trust A. We distributed the remaining 95.3% of births between FBC, ABC and LW in the ratio (2:12:86) reported in Walsh *et al*'s mapping of non-home births in England.⁵ As the 86% LW births included the 55% of birth that are high risk, we removed those 55% and adjusted this ratio to 2:12:31. This meant 4.2% of births in FBC, 25.4% in ABC and 65.7% in LW.

In the phase I (–15%) staffing scenario, as with trust A, we modelled the effect on midwifery staffing of expanding community birth services to meet the ‘4–4–20’ target. This meant 8.9% of births at home, 8.9% in FBC and 44.4% of births in ABC, with 37.8% of births in OU.

In the phase II (–25%) staffing scenario, we moved primipara home births and all FBC births into the ABC, reducing the home birth proportion to 3.9% and the FBC proportion to zero and increasing the ABC proportion to 30.4%.

In the phase III (–35%) staffing scenario, we closed the home birth and FBC services and moved all those births to the ABC, increasing that proportion to 34.3%. In both phases II and III, the LW proportion remained at 65.7%.

Generating results

Each phase I/II/III scenario entailed some change in the total number of hospital births (those in ABC and LW) compared with its respective baseline service configuration. For comparing each scenario with its baseline, we subtracted the staffing need in the baseline from that in the scenario, to give the change in the number of WTE midwives needed compared with the baseline configuration. We also report the change as a percentage of the median total number of WTE midwives working in trusts providing maternity services in England, taking account of the shortages prompting the reconfigurations. The median number of WTE midwives per trust across 129 trusts in December 2019 was 155.5.³¹ In our scenarios, we reduced this total staffing by phase-specific levels of shortage (–15%; –25%; –35%), giving denominators of 132.2, 116.6 and 101.1 WTE midwives in phases I–III.

Uncertainty ranges and sensitivity analysis

To determine how sensitive our results were to the input parameters other than service configuration, we recalculated the staffing estimates using the next-highest and next-lowest Birthrate Plus need categories to those modelled in the scenarios. We used the resulting higher and lower values to constitute uncertainty ranges around our modelled results. Our approach is described in more detail in section 4 of the online supplemental methodological appendix.

Patient and public involvement

No patients involved.

RESULTS

In the phase I configurations, with a 15% staffing shortage, we expanded community and ABC births. In trust A, the increase in home births and in ABC births meant a change in staffing need compared with baseline of 0.0

(−4.5 to 12.9) WTE midwives or 0.0% (−3.4% to 9.7%) of the median overall staffing level in trusts in England (table 2). In trust B, the increase in home births, FBC births and ABC births meant an increase in staffing need compared with baseline of 0.1 (−4 to 11.7) WTE midwives or 0.1% (−3% to 8.9%) of overall staffing (table 2).

In the phase II configurations, with a 25% staffing shortage, we moved primipara home births into the ABC. In trust A, the reduction in home births and the increase in ABC births meant a change in staffing need compared with baseline of −0.1 (−4.9 to 13.5) WTE midwives or −0.1% (−4.2% to 11.5%) of overall staffing (table 2). In trust B, the reduction in home births and FBC births and the increase in ABC births meant a change in staffing need compared with baseline of −0.3 (−5.1 to 13.3) WTE midwives or −0.3% (−4.4% to 11.4%) of overall staffing.

In the phase III configurations, with a 35% staffing shortage, we moved all home and FBC births into the ABC. In trust A, the reduction in home and FBC births and the increase in ABC births meant a change in staffing need compared with baseline of −0.3 (−5.3 to 13.8) WTE midwives or −0.3% (−5.2% to 13.7%) of overall staffing (table 2). In trust B, the reduction in home and FBC births and the increase in ABC births meant a change in staffing need compared with baseline of −0.5 (−5.5 to 13.6) WTE midwives or −0.5% (−5.4% to 13.5%) of overall staffing.

DISCUSSION

This theoretical modelling study estimated the effect on midwifery staffing of service reconfigurations suggested in the RCM—RCOG guidance issued in response to COVID-19-related shortages, and of reconfiguration to meet the 4–4–20 target for increasing midwife-led care. The study was based on publicly available data and literature supported, where necessary, by expert opinion. We found that neither the restriction of community births under the RCM—RCOG guidance nor the expansion of community and AMU-based midwife-led care under the 4–4–20 scenario made any appreciable difference to the staffing need for two synthetic median trusts in England.

This study is the first, to our knowledge, to quantify the effect of maternity service reconfigurations on staffing resources during a crisis placing considerable pressure on services. It draws on the widely known Birthrate Plus methodology and we have made the tool available for anyone to use to estimate potential intrapartum and post-natal staffing effects of service reconfigurations for low-risk births.

Our study has some weaknesses. The Birthplace study data were gathered in 2008–2010, since when risks may have changed. Our method of calculating staffing need, involving the discrete cut-offs of the Birthrate Plus need categories, meant that in our sensitivity analysis and estimation of uncertainty we could not calculate orthodox indicators of uncertainty such as confidence intervals. However, given those cut-offs, any less crude approach (such as varying the Birthplace risks by $\pm 10\%$) would

have had less effect on the estimate than the approach we took. This means that our uncertainty ranges are implausibly wide as our approach implied a level of change in obstetric risks far beyond what we would consider for conducting a sensitivity analysis. We are therefore confident that it was an internally valid approach that confirms that the difference in service configurations drove our results and that our modelled estimates were of an accurate order of magnitude.

Our support for the availability of community birth options, within a framework of meaningful informed choice about place of birth, could have biased our approach. To mitigate this risk, where we made assumptions, these were less favourable to the expansion of community births. For example, the way our model estimates numbers of interventions and obstetric outcomes underestimates staffing needs in hospital births: specifically, to estimate the numbers of intravenous infusion and continuous fetal monitoring needed for calculating the Birthrate Plus score we set these equal to the number of epidurals, as the most common of seven interventions/outcomes which would likely require intravenous infusion and continuous fetal monitoring (see online supplemental methodological appendix table D). In practice, there will be instances of both these interventions that do not accompany an epidural, so the Birthrate Plus score of hospital births will be higher.

For several reasons, our findings can only indirectly inform local decisions. Setting-specific utilisation rates and the proportion of births that are low-risk will vary across trusts. We did not consider variables such as distance, or availability of settings in nearby trusts where those locally have been suspended.

Our model only considers staffing needs relating to low-risk births. This is primarily because the Birthplace study only reported setting-specific risks for interventions and obstetric outcomes for births that were low-risk at the onset of labour. However, staffing needs for low-risk births must be considered together with those for high-risk births, and the settings where low-risk births take place may affect midwife availability for high-risk births. In calculating the relative change in midwife staffing need, we used the overall number of midwives as the denominator, which reflects this connection.

Birthrate Plus allows heads and directors of midwifery to calculate staffing hours needed but does not determine where staff ought to be allocated. Our findings suggest that the reconfiguration of births away from the community into hospitals has a negligible effect on overall staffing requirements, far smaller than the effect of substantial staff shortages. Given the effort involved in undertaking such reconfigurations, as well as the potential for redeployment to exacerbate underlying stress, burnout or other ill-health,¹³ reconfiguration may not save any staff resource at all. With modest degrees of shortage and supportive staff, service managers could consider meeting the expanded demand for community births as this would have no appreciable effect on overall

Table 2 Change in midwife staffing needs between baseline and three scenarios of reduced staffing

Service configuration	Trust A					Trust B				
	Median staffing, with shortage, all births* (N WTE midwives)	Staffing need, 2025 low-risk births (N WTE midwives)	Change in staffing need in scenario compared with baseline, N WTE midwives (uncertainty range)	Absolute change in median staffing, with shortage, under scenario, N WTE midwives	Change in median staffing, with shortage, under scenario, % (uncertainty range)	Staffing need, 2025 low-risk births (N WTE midwives)	Change in staffing need in scenario compared with baseline, N WTE midwives (uncertainty range)	Absolute change in median staffing, with shortage, under scenario, N WTE midwives	Change in median staffing, with shortage, under scenario, % (uncertainty range)	
Baseline staffing need for 2025 low-risk births	30.2	30.2				30.2				
Phase I scenario (15% shortage; meet 4–4–20 target)	132.2	30.3	0.0 (–4.5 to 12.9)	0/132.2	0% (–3.4% to 9.7%)	30.3	0.1 (–4 to 11.7)	0.1/132.2	0.1% (–3% to 8.9%)	
Phase II scenario (25% shortage; HB primiparas to ABC)	116.6	30.1	–0.1 (–4.9 to 13.5)	–0.1/116.6	–0.1% (–4.2% to 11.5%)	29.8	–0.3 (–5.1 to 13.3)	–0.3/116.6	–0.3% (–4.4% to 11.4%)	
Phase III scenario (35% shortage; all community births to ABC)	101.1	29.8	–0.3 (–5.3 to 13.8)	–0.3/101.1	–0.3% (–5.2% to 13.7%)	29.6	–0.5 (–5.5 to 13.6)	–0.5/101.1	–0.5% (–5.4% to 13.5%)	

*Median staffing level for England, December 2019, was 155.5 WTE midwives. ABC, alongside birth centre; HB, home birth; WTE, whole-time equivalent.

staffing requirements and might reduce infection transmission risks.¹³

However, in the face of substantial shortages that cannot be ‘recouped’ through staffing efficiency based on reconfiguration, trusts could be left in a position of having to decide where, given the circumstances, they will modify care arrangements. Particularly in the context of an infectious pandemic, virtual antenatal care may provide a way of recouping some community midwifery staffing, by reducing time spent travelling. Maintaining safety, including staffing ratios for in-hospital birth settings, will be the primary concern. In such extreme circumstances, quality may well suffer, including dilution of one-to-one care during labour to allow a reduced number of midwives to attend the same number of births. Service provision may include expansion of ABC capacity in order to maintain midwife-led services despite moving planned community births into hospitals.

Moreover, although staffing shortages were the most important factor in restricting community births, service managers also considered other factors. Although only a minority of transfers from planned community births are for potentially urgent reasons,²⁷ severe delays to ambulance services pose a risk to the safety of community births. In Spring 2020, some trusts responded to restricted availability of ambulances during COVID-19 by contracting with private ambulances or taxis, or by helping families to plan to use their own car where appropriate.¹⁶

Another concern has been that providing care in poorly ventilated home settings without adequate personal protective equipment (PPE) poses an infection risk to midwives.^{20 32} The shortage of PPE in the early phase of the COVID-19 pandemic prompted a response from the department of health and social care, which aimed to have 4-month stockpile of PPE for front-line staff in place by November 2020,³³ which would alleviate some threat of further shortages due to infection.

Future studies based on data from actual trusts could provide validation for our model. Studies could further consider the effects of service reconfigurations on other variables, such as medical staff time, on safety and personalisation outcomes, including stillbirth and adverse neonatal outcomes, maternal physical and mental health outcomes, and on positive birth experience measures. It is worth noting that the absolute changes in midwife staffing need are the same regardless of actual staffing level. The finding that implementing the 4–4–20 target requires no change in overall staffing (0.0 and 0.1 WTE midwives, respectively, in our trusts) has implications for decision-making around service configuration without major shortage, and could form the basis of more detailed work looking at the implications of expanding community births.

CONCLUSION

We constructed a model to estimate intrapartum and postnatal staffing need for low-risk births, and applied it

to two hypothetical typical trusts to model the effects of service configuration on midwifery staffing needs. This study suggests that reconfiguring maternity services in England to reduce or expand community birth options during times of potential staffing shortage has a negligible effect on midwifery staffing demands. Empirical investigation of staffing demands in actually existing service (re)configurations would be valuable to enhance understanding of the topic.

Author affiliations

¹School of Health Sciences, City University of London, London, UK

²Department of Women & Children’s Health, King’s College London, London, UK

³Royal College of Midwives, London, UK

⁴Centre for the Mathematical Modelling of Infectious Diseases, LSHTM, London, UK

⁵Verona, Italy

⁶Equipe EPOPé, U 1153, Université de Paris, CRESS, INSERM, INRA, F-75004, Paris, France

⁷Elizabeth Garrett Anderson Institute for Women’s Health, University College London, London, UK

⁸Research in Childbirth and Health (ReaCH) Group, THRIVE Centre, University of Central Lancashire, Preston, UK

Twitter Marina A S Daniele @marasdan

Acknowledgements The authors are grateful to Birte Harlev-Lam for her valuable comments on the manuscript.

Contributors LB and MD conceived of the study and developed the idea with CG, GK, LL and SD. MD and CG designed the model with input from LB and GK. CG wrote the model with input from MD and ASM. CG and MD wrote the manuscript and all authors made important contributions to interpreting the results and revising the manuscript. CG is the guarantor for the article.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests MD has consulted for and LB works for the Royal College of Midwives. CG, GK, LL, ASM and SD declare no competing interests.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

Ethics approval Ethical approval was not required as the study involved no personal data.

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information. The supplementary materials contain all data used in the study.

Supplemental material This content has been supplied by the author(s). It has not been vetted by BMJ Publishing Group Limited (BMJ) and may not have been peer-reviewed. Any opinions or recommendations discussed are solely those of the author(s) and are not endorsed by BMJ. BMJ disclaims all liability and responsibility arising from any reliance placed on the content. Where the content includes any translated material, BMJ does not warrant the accuracy and reliability of the translations (including but not limited to local regulations, clinical guidelines, terminology, drug names and drug dosages), and is not responsible for any error and/or omissions arising from translation and adaptation or otherwise.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iDs

Christopher Grollman <http://orcid.org/0000-0002-6950-1837>

Marina A S Daniele <http://orcid.org/0000-0002-5666-9489>

Lia Brigante <http://orcid.org/0000-0003-0206-9135>

Gwenan M Knight <http://orcid.org/0000-0002-7263-9896>
 Laura Latina <http://orcid.org/0000-0003-2923-9464>
 Andrei S Morgan <http://orcid.org/0000-0003-4143-1977>
 Soo Downe <http://orcid.org/0000-0003-2848-2550>

REFERENCES

- Sandall J, Soltani H, Gates S, *et al.* Midwife-led continuity models versus other models of care for childbearing women. *Cochrane Database Syst Rev* 2016;4:CD004667.
- Birthplace in England Collaborative Group, Brocklehurst P, Hardy P, *et al.* Perinatal and maternal outcomes by planned place of birth for healthy women with low risk pregnancies: the birthplace in England national prospective cohort study. *BMJ* 2011;343:d7400.
- Coxon K, Chisholm A, Malouf R, *et al.* What influences birth place preferences, choices and decision-making amongst healthy women with straightforward pregnancies in the UK? A qualitative evidence synthesis using a 'best fit' framework approach. *BMC Pregnancy Childbirth* 2017;17:103.
- Department of Health. *Changing Childbirth: Report of the Expert Maternity Group*. London 1993.
- Walsh D, Spiby H, Grigg CP, *et al.* Mapping midwifery and obstetric units in England. *Midwifery* 2018;56:9–16.
- Office for National Statistics. Birth characteristics in England and Wales, 2018. Available: <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/livebirths/bulletins/birth-characteristics-in-england-and-wales/2018> [Accessed 01 May 2020].
- England NHS. Maternity choice and personalisation. Available: <https://www.england.nhs.uk/mat-transformation/mat-pioneers/> [Accessed 09 Jul 2020].
- Rayment J, McCourt C, Scanlon M, *et al.* An analysis of media reporting on the closure of freestanding midwifery units in England. *Women Birth* 2020;33:e79–87.
- Fletcher BR, Rowe R, Hollowell J, *et al.* Exploring women's preferences for birth settings in England: a discrete choice experiment. *PLoS One* 2019;14:e0215098.
- Royal College of Obstetricians & Gynaecologists and Royal College of Midwives. Guidance for provision of midwife-led settings and home birth in the evolving coronavirus (COVID-19) pandemic. Version 1.2, 2020. Available: <https://www.rcm.org.uk/media/4099/2020-05-22-guidance-for-provision-of-midwife-led-settings-and-home-birth-in-the-evolving-coronavirus-COVID-19-pandemic.pdf>
- Royal College of Midwives. Optimising maternity services and maternal and newborn outcomes in a pandemic. In: *A rapid analytic scoping review. Version 4*, 2020.
- Royal College of Midwives. *RCM Clinical Briefing Sheet: "freebirth" or "unassisted childbirth" during the COVID-19 pandemic*.
- Buzzfeed. Home births are on the rise in some parts of the UK as women decide to stay away from hospital, 2020. Available: <https://www.buzzfeed.com/emilyashon/coronavirus-home-births> [Accessed 18 Jun 2020].
- All4Maternity. Where to be born during COVID-19? Positive practice to share, 2020. Available: <https://www.all4maternity.com/where-to-be-born-during-COVID-19-positive-practice-to-share/> [Accessed 16 Jul 2020].
- Rocca-Ihenacho L, Alonso C. Where do women birth during a pandemic? Changing perspectives on safe motherhood during the COVID-19 pandemic. *J Glob Health Sci* 2020;2.
- Brigante L, Morelli A, Jokinen M. Impact of the Covid-19 pandemic on midwifery-led service provision in the UK in 2020-21: findings of three national surveys. *Midwifery* 2022;112:103390.
- Royal College of Midwives. New RCM survey reveals more than half of midwives do not feel safe carrying out home visits, 2020d. Available: <https://www.rcm.org.uk/media-releases/2020/april/new-rcm-survey-reveals-more-than-half-of-midwives-do-not-feel-safe-carrying-out-home-visits/> [Accessed 09 Jul 2020].
- The Guardian. Midwife shortage doubles as NHS staff diverted to tend COVID-19 patients, 2020. Available: <https://www.theguardian.com/society/2020/mar/29/midwife-shortage-doubles-as-nhs-staff-diverted-to-tend-COVID-19-patients> [Accessed 09 Apr 2020].
- Birthrights. Maternity care during and beyond the COVID-19 pandemic. Birthrights evidence, 2020. Available: <https://www.birthrights.org.uk/campaigns-research/coronavirus/>
- Association for the Improvement of Midwifery Services. Coronavirus, 2020. Available: <https://www.aims.org.uk/campaigning/item/coronavirus>
- Ryan P, Revill P, Devane D, *et al.* An assessment of the cost-effectiveness of midwife-led care in the United Kingdom. *Midwifery* 2013;29:368–76.
- Schroeder E, Petrou S, Patel N, *et al.* Cost effectiveness of alternative planned places of birth in woman at low risk of complications: evidence from the birthplace in England national prospective cohort study. *BMJ* 2012;344:e2292.
- Ball JA, Washbrook M, Royal College of Midwives. Working with birthrate Plus®, 2014. Available: <https://www.rcm.org.uk/media/2375/working-with-birthrate-plus.pdf>
- The Document Foundation. LibreOffice Calc version 5.3.0.3, 2016. Available: <https://www.libreoffice.org/discover/calc/>
- Rowe RE, Townend J, Brocklehurst P, *et al.* Duration and urgency of transfer in births planned at home and in freestanding midwifery units in England: secondary analysis of the birthplace national prospective cohort study. *BMC Pregnancy Childbirth* 2013;13:224.
- NHS Digital. NHS Maternity Statistics England, 2018-19. Hospital Episode Statistics – Provider-level analysis 2017-18 to 2018-19, 2019. Available: <https://digital.nhs.uk/data-and-information/publications/statistical/nhs-maternity-statistics/2018-19>
- Sandall J, Murrells T, Dodwell M, *et al.* The efficient use of the maternity workforce and the implications for safety and quality in maternity care: a population-based, cross-sectional study. *Health Serv Res* 2014;2:1–266.
- Office for National Statistics. Births by parents' characteristics, 2018b. Available: <https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/livebirths/datasets/birthsbyparents-characteristics> [Accessed 01 May 2020].
- NHS. Maternity transformation programme. Available: <https://www.england.nhs.uk/mat-transformation/>
- Maternity & Midwifery Forum. The maternity transformation programme: where we are now, 2018. Available: <https://www.maternityandmidwifery.co.uk/maternity-transformation-programme-now/1734/> [Accessed 12 Jul 2020].
- NHS Digital. NHS Workforce Statistics – December 2019, 2020. Available: <https://digital.nhs.uk/data-and-information/publications/statistical/nhs-workforce-statistics/december-2019>
- Royal College of Midwives. New RCM survey reveals more than half of midwives do not feel safe carrying out home visits, 2020. Available: <https://www.rcm.org.uk/media-releases/2020/april/new-rcm-survey-reveals-more-than-half-of-midwives-do-not-feel-safe-carrying-out-home-visits/>
- Department of Health and Social Care. Huge increase in UK personal protective equipment production, 2020. Available: <https://www.gov.uk/government/news/huge-increase-in-uk-personal-protective-equipment-production>