Safe midwifery staffing for maternity settings

Appendix D: Evidence tables for evidence review 1

A report for the National Institute for Health and Care Excellence
Prepared by Bazian Ltd.
Version: 2

Contents

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List of abbreviations

AMU	Alongside midwifery unit
AR	Actual rate
AUC	Area under curve
CEFM	Continuous Electronic Fetal Monitoring
CI	Confidence interval
CTG	Cardiotocography
DOH	Department of Health
DwBI	Delivery with bodily integrity
FMU	Free standing midwifery unit
FTE	Full time equivalent
GP	General practitioner
HES	Hospital Episode Statistics
IMD	Index of Multiple Deprivation
ICD	International Classification of Diseases
IPPV	Invasive positive pressure ventilation
IQR	Interquartile range
IVD	instrumental vaginal delivery
LW:MW	Labouring women: midwives
LOS	Length of stay
MIMAS	Manchester Information and Associated Services
NHS	National Health Service
NICE	National Institute for Heath and Clinical Excellence
NICU	Neonatal Intensive Care Unit
NIHR	National Institute for Health Research
NNU	Neonatal unit
O&G	Obstetrics and gynaecology
OR	Odds ratio
OU	Obstetric unit
ONS	Office for National Statistics
OPCS	Office of Population Censuses and Surveys Classification of Interventions and Procedures
RCT	Randomised controlled trial
PCT	Primary Care Trust
Q	Quintile
RCOG	Royal College of Obstetrics and Gynaecology
SCBU	Special Care Baby Unit
SD	Standard deviation
SE	Standard error
SHA	Strategic health authority
SNNM	Birth weight standardised neonatal mortality
SSBR	Birth weight standardised stillbirth rate
SVD	Spontaneous vaginal delivery

Sandall et al. (in press) Academic in confidence	
Study details	Sandall J, Murrells T, Dodwell M et al. The efficient use of the maternity workforce and the implications for safety & quality in maternity care. (in press) **Study aim** To understand the relationship between organisational factors, maternity workforce staffing and skill mix, cost and indicators of safe and high quality care. **Study type** Correlational study **Source of funding** The National Institute for Health Research Health Services and Delivery Research programme. **Time period** 2010 to 2011 **Country** England **Quality score** **Internal validity** ++ **External validity** ++ **Overall score** ++
Population and setting	**Setting** NHS trusts in England in 2010-11. **Stage of care** Not stated. Analysis was at the trust level, so would include midwives deployed at all stages of care. Outcomes were largely in the intrapartum period, along with some neonatal outcomes. **Number of trusts/hospitals/units** 143 NHS trusts. Data was obtained from the Hospital Episode Statistics database (HES), which contains data for all 143 trusts in England. Data for 134 NHS trusts and 2 PCTs were analysed in regression models. Trusts or PCTs which only provided midwifery services were excluded due to differences in costs and patterns of care, as were trusts with atypical or inconsistent data or data which was overly influential on the analyses.

	Number of women/births 665,969 delivery records (all records in HES database for the study period). Data from trusts with <80% of women coded for any outcome were excluded. Missing outcome or postcode data left 650,678 deliveries for analysis for the five final outcome indicators in multilevel modelling. (Some analyses were restricted to non-caesarean section deliveries and therefore included smaller numbers than these 5 indicators). **Skill mix/type/duties of midwives** Not reported. **Key characteristics of trusts/hospitals/units assessed** *Type of units in each trust:* 42% of trusts had obstetric units (OU) only 31.5% had OU plus AMU 12.6% had OU plus freestanding midwifery units (FMU) 14.0% had OU and AMU and FMU 29.4% were university trusts *Mean characteristics in 2011 (SD; range):* Maternities: 4620 (1990; 1214 to 10,678) FTE midwives/100 maternities: 3.08 (0.50; 1.11 to 4.71) FTE doctors/100 maternities: 0.82 (0.22; 0.21 to 1.65) FTE support workers/100 maternities: 0.90 (0.35; 0.05 to 2.88) FTE all staff/100 maternities: 4.80 (0.77; 2.43 to 8.66) Doctor/midwife ratio: 0.27 (0.07; 0.07 to 0.50) Support worker/midwife ratio: 0.30 (0.11; 0.02 to 0.85) **Key characteristics of participants assessed** *Age:* 5.0% aged ≤19 year; 67% aged between 20 and 34 years; 14.2% 35 to 39 years; 3.4% 40 and over; 10.4% unknown *Parity:* 42.9% nulliparous, 31.8% one previous birth, 25.3% more than one previous birth *Clinical risk:* 54.7% at higher clinical risk of complications based on NICE intrapartum guidelines; 45.3% at lower risk *Ethnicity:* 65.3% white British, 8.6% any other white ethnicity, 3.5% African, 4.0% Pakistani, 3.1% Indian, with other categories less common *Deprivation:* 27.7% were from the most deprived areas (quintile [Q] 1), 22.3% from Q2, 18.3% from Q3, 15.8% from Q4, and 15.1% from the least deprived (Q5) *Rural/urban classification:* 85.5% from denser urban areas **Data sources** The Hospital Episodes Statistics (HES) database (inpatient records 2000/01 to 2010/11; outpatient records 2003/4 to 2010/11; A&E records 2007/8 to 2010/11), Office for National Statistics (ONS)-HES linked mortality statistics (including neonatal deaths) 000/01 to 2010/11, and the NHS National Workforce Dataset 2010.

Factors assessed	**Midwife staffing** FTE midwives/100 maternities, FTE doctor/FTE midwife ratio, and FTE midwife/FTE support worker ratio (all assessed at trust level). Midwife types/grades included not specified, would include all midwives working for the trust. **Other staffing factors** FTE all staff, obstetric medical staff (all levels), and maternity support staff/100 maternities (assessed at trust level) **Maternal and neonatal factors** Maternal age, parity, clinical risk at the end of pregnancy, ethnicity. Clinical risk was assessed based on the presence or absence of medical conditions or situations listed in NICE intrapartum care guidelines as increasing risk for the woman or baby during or shortly after labour, as well as additional conditions that might also increase risk. Women were classed as being at higher risk (having conditions listed by NICE as increasing risk or requiring individual assessment) or lower risk (none of the conditions increasing risk of requiring individual assessment), based on ICD-10 codes, OPCS or HES Data Dictionary items recorded in each woman's HES records for the past 10 years. **Environmental factors** Individual level characteristics: area socio-economic deprivation (Index of Multiple Deprivation), geographic location (urban/rural), region Trust level characteristics: trust size/number of deliveries, teaching status (university trusts), maternity configuration (i.e. OU, AMU, FMU provision) **Management factors** None **Organisational factors** None **Control variables/adjustment** All of the variables described above were included in the model as independent variables. No additional variables were adjusted for.
Comparison	Higher versus lower levels of midwife staffing (midwives/100 maternities) or other factors in the trust, compared using regression
Outcomes and analysis	Quality indicators used in maternity care were reviewed and 10 outcome indicators (some composite) were selected. **Maternal/neonatal outcomes** *Healthy mother and baby outcomes:* Healthy mother (composite of: delivery with bodily integrity, return home in ≤2 days, and no instrumental delivery, maternal sepsis, anaesthetic complication, or readmission within 28 days) Healthy baby (composite of: baby's weight 2.5 to 4.5 kg, gestational age

37 to 42 weeks, and live baby)
Healthy mother and baby (composite of the above)
Mode of birth outcomes:
Delivery with bodily integrity (DwBI, composite of: no uterine damage, $2^{nd}/3^{rd}/4^{th}$ degree tear, stitches, episiotomy, or caesarean)
Normal birth (composite of: no induction, instrumental delivery, caesarean, episiotomy or general or regional anaesthetic)
Spontaneous vaginal delivery
Intact perineum
Caesarean outcomes:
Elective caesarean
Emergency caesareans
All caesareans

Process of care outcomes
None

Reported feedback
None

Other outcomes
None

Analysis
Analysis was at the trust level. Multilevel logistic regression models were used, with mothers nested within trusts, and fitted to 10 dichotomous outcome indicators. Results were reported as residual variance (σ^2), relative chi squared (which was categorised as minor: 1 to <100, moderate: 100 to <1000, strong: 1000 to <10000, or dominant: 10,000). Relationships between continuous predictors and outcomes were classified as positive monotonic (consistently increasing in a linear or non-linear way), negative monotonic (consistently decreasing in a linear or non-linear way), non-monotonic (direction of effect not consistent e.g. increases initially and then decreases). Independent variables were added in blocks, with maternal level variables added first, then socio-demographics, trust level variables, and then staffing variables. Staffing variables were added into two models: the first (set 1) included FTE/100 maternities for midwives, doctors, and support staff, and the second (set 2) used FTE/100 maternities for all staff and the ratio measures (doctors: midwives, support workers:midwives), these tested the effect of substitution of these staff for each other. The intercept was allowed to vary between trusts to account for clustering. Funnel plots were used to plot proportion with outcomes (Y-axis; unadjusted or adjusted for set 1 staffing variables) against deliveries (X-axis). These were used to assess the effect of the independent variables on variation in the outcome rates across trusts. Sensitivity analyses assessed the interactions between parity and clinical risk and the 3 types of FTE staff variables/100 maternities, as well as the effect in the 50 trusts with only one OU, and the effect of splitting clinical risk into 3 categories instead of 2 (lower risk, individual assessment and

	higher risk).
Results	**Maternal/neonatal outcomes** *Mean (SD; range) results by trust:* Healthy mother 28.0% (5.4%; 13.6% to 48.5%) Healthy baby 85.2% (3.0%; 76.9% to 90.3%) Healthy mother and healthy baby 24.9% (4.9%; 12.0% to 44.7%) Delivery with bodily integrity 32.6% (5.9%; 19.6% to 52.8%) Normal birth 40.8% (5.4%; 26.0% to 58.9%) Spontaneous vaginal delivery 62.7% (4.5%; 46.6% 73.8%) Intact perineum 43.6% (6.8%; 25.7% to 66.2%) Elective caesarean 10.0% (1.7%; 5.6% to 16.6%) Emergency caesarean 14.6% (2.5%; 9.0% to 24.9%) All caesareans 24.6% (3.5%; 15.2 to 36.1%) *Descriptive unadjusted analysis* Looking at the distribution of the unadjusted figures, higher levels of midwifery staffing were associated with a higher chance of DwBI (lowest quintile [Q1] of staffing [1.1 to 2.65 per 100 maternities] 29.6% vs. highest quintile [Q5, 3.40 to 4.71 per 100 maternities] 33.7%) and intact perineum (Q1 39.9% vs. Q5 44.5%) and having a birth where the mother was healthy (Q1 25.5% vs. Q5 28.5%; statistical comparisons not reported). Patterns of variation were less clear for other outcomes (Q1 vs. Q5 for: healthy baby 85.8% vs. 85.2%; healthy mother and baby 22.6% vs. 25.4%; normal birth 39.0% vs. 40.8%; spontaneous vaginal delivery 61.8% to 63.5%; elective caesarean 9.8% in Q1 and Q5; emergency caesarean 15.5% vs. 14.0%; all caesareans 25.3% vs. 23.7%). A doctor:midwife ratio of 0.22 to 0.25 (Q2) generally seemed to be associated with the most beneficial pattern of outcomes. Overall, a large amount of the variation in the 10 outcome indicators observed at the level of the individual was attributable to mothers' age, parity and level of clinical risk, with less variation by socio-demographic, trust level and staffing variables (statistical comparisons not reported). *Multilevel models* In multilevel models, about 1 to 2% of variation in the outcomes was attributable to differences between trusts, and 98 to 99% due to variation between mothers within trusts. <u>Overall magnitude of effects</u> Based on the relative chi squared values obtained for the different variables, the effect of maternal characteristics were stronger than other variables. The effect of staffing variables was small by comparison (e.g. for the healthy mother outcomes maternal clinical risk had a chi squared value of 15,841 while the largest chi squared for staffing variables was 3). The magnitude of effect (i.e. relative chi squared) of FTE midwives/100 maternities (with largest effect reported in brackets) was 0 for healthy baby (26,718 for clinical risk), spontaneous vaginal delivery (49,583 for clinical risk), elective caesarean (20,858 for clinical risk), emergency

caesarean (18,388 for clinical risk), and all caesareans (54,882 for clinical risk); 2 for healthy mother (15,841 for clinical risk), healthy mother and baby (23,436 for clinical risk), and normal birth (63,030 for clinical risk); 4 for delivery with bodily integrity (17,470 for clinical risk), and 5 for intact perineum (13,310 for parity).

The magnitude of effect of doctor to midwife ratio was 0 for healthy mother, delivery with bodily integrity, normal birth, spontaneous vaginal delivery, and intact perineum; 1 for healthy baby, healthy mother and baby, and emergency caesarean; and 2 for elective caesarean and all caesareans.

The magnitude of effect of support worker to midwife ratio was 0 for delivery with bodily integrity, normal birth, intact perineum, and emergency caesarean; 1 for healthy baby, spontaneous vaginal delivery, elective caesarean, and all caesareans; and 2 for healthy mother and healthy mother and baby.

Overall predictive ability

The multivariable models had fair (area under curve [AUC] 0.70 to 0.80) to good (AUC 0.80 to 0.90) predictive ability. The model for elective caesarean had the best predictive ability (AUC 0.814) and the model for emergency caesarean the least (AUC 0.698).

The addition of socio-demographic, trust level and staffing variables only led to marginal improvement in the models' ability to predict outcomes, with the greatest improvement seen for the outcome of intact perineum (AUC increased from 0.722 to 0.732). Adding staffing variables made little difference to the AUCs of the model, with the largest impact on delivery with bodily integrity (from 0.732 to 0.733).

Healthy mother and baby outcomes (113 trusts; 431,391 deliveries; significant associations in bold)

Midwife staffing variables (and other staffing variables) were not statistically related to any of the healthy mother and baby outcomes. Results for midwife variables are below:

- FTE midwives/100 maternities: healthy mother OR 1.088, 95% CI 0.963 to 1.230, p=0.1759; healthy baby OR 1.029, 95% CI 0.912 to 1.161, p=0.6456; healthy mother and baby OR 1.093, 95% CI 0.967 to 1.234, p=0.1536
- Doctor-midwife ratio: healthy mother OR 1.316, 95% CI 0.608 to 2.846, p=0.4860; healthy baby OR 1.363, 95% CI 0.638 to 2.914, p=0.4239; healthy mother and baby OR 1.437, 95% CI 0.669 to 3.088, p=0.3526
- Support worker-midwife ratio: healthy mother OR 0.716, 95% CI 0.452 to 1.135, p=0.1552; healthy baby OR 0.758, 95% CI 0.482 to 1.191, p=0.2296; healthy mother and baby OR 0.693, 95% CI 0.439 to 1.094, p=0.1152

On multilevel models there was some indication of a negative effect of support worker per 100 maternities on healthy mother (OR 0.892, 95% CI 0.776 to 1.026, p=0.11), and healthy mother and baby outcome (OR 0.897, 95% CI 0.781 to 1.031, p=0.13), and of support worker: midwife ratio for healthy mother and baby outcome (OR 0.693, 95% CI 0.439 to 1.094, p=0.12).

Overall, the largest associations were with maternal clinical risk and parity. Higher clinical risk was associated with reduced likelihood of healthy mother and baby outcomes (dominant monotonic negative relationship). Higher parity was associated with an increased likelihood of a healthy mother (dominant monotonic positive relationship) and healthy mother and baby (strong monotonic positive relationship). Higher mother's age was associated with a reduced likelihood of healthy mother (strong monotonic negative relationship).

Mode of birth outcomes (119 to 143 trusts; 467,022 to 584,435 deliveries; significant associations in bold)

Increased midwife staffing was significantly associated with increased likelihood of delivery with bodily integrity and increased likelihood of intact perineum. All other associations with midwife staffing variables were non-significant.

- FTE midwives/100 maternities: **Delivery with bodily integrity** (DwBI) **OR 1.110, 95% CI 1.005 to 1.227, p=0.0399**; normal birth OR 1.062, 95% CI 0.968 to 1.166, p=0.2048; spontaneous vaginal delivery (SVD) OR 1.025, 95% CI 0.948 to 1.109, p=0.5362; **intact perineum OR 1.132, 95% CI 1.010 to 1.268, p=0.0324**
- Doctor-midwife ratio: DwBI OR 1.149, 95% CI 0.606 to 2.180, p=0.6702; normal birth OR 0.849, 95% CI 0.448 to 1.608, p=0.6150; spontaneous vaginal delivery (SVD) OR 1.018, 95% 0.615 to 1.685, p=0.9441; intact perineum OR 1.001, 95% CI 0.482 to 2.078, p=0.9981
- Support worker-midwife ratio: DwBI OR 0.884, 95% CI 0.610 to 1.280, p=0.5137; normal birth OR 1.031, 95% CI 0.729 to 1.457, p=0.8649; SVD OR 0.876, 95% CI 0.655 to 1.171, p=0.3706; intact perineum OR 0.911, 95% CI 0.597 to 1.389, p=0.6640

Overall, the largest associations were with maternal clinical risk, parity, and maternal age. Higher clinical risk was associated with reduced likelihood of DwBI, normal birth and SVD (dominant monotonic negative relationship). Higher parity was associated with increased likelihood of DwBI and intact perineum (dominant monotonic positive relationship), and of normal birth and SVD (strong monotonic positive relationship). Increased maternal age was associated with reduced likelihood of DwBI and SVD ((strong monotonic negative relationship).

On multilevel models higher levels of overall staffing were associated with increased the likelihood of DwBI (OR 1.079, 95% CI 1.016 to 1.147) and intact perineum (OR 1.092, 95% CI 1.019 to 1.170).

	Caesarean outcomes (143 trusts; 584,435 deliveries; significant associations in bold) There were no significant associations between midwife staffing and outcomes. • FTE midwives/100 maternities: elective caesarean OR 1.032, 95% CI 0.936 to 1.137, p=0.5303; emergency caesarean OR 0.978, 95% CI 0.897 to 1.066, p=0.6085; all caesareans OR 1.000, 95% CI 0.919 to 1.087, p=0.9962 • Doctor-midwife ratio: elective caesarean OR 0.652, 95% CI 0.349 to 1.220, p=0.1809; emergency caesarean OR 0.760, 95% 0.437 to 1.322, p=0.3314; all caesareans OR 0.650, 95% CI 0.380 to 1.114, p=0.1172 • Support worker-midwife ratio: elective caesarean OR 1.209, 95% CI 0.842 to 1.734, p=0.3035; emergency caesarean OR 1.082, 95% CI 0.786 to 1.489, p=0.6296; all caesareans OR 1.182, 95% CI 0.866 to 1.613, p=0.2914 Overall, the largest associations were with maternal clinical risk, parity, and maternal age. Higher clinical risk was associated with increased likelihood of elective, emergency, and any caesarean (dominant monotonic positive relationship). Higher parity was associated with reduced likelihood of emergency and any caesarean (dominant monotonic negative relationship). Increased maternal age was associated with increased likelihood of any caesarean (strong monotonic positive relationship), this appeared to be due to emergency caesarean which showed an effect in this (positive) direction, while elective caesareans showed an effect in the opposite (negative) direction. On multilevel models there was a non-significant trend for higher numbers of doctors per 100 maternities to be associated with increased rate of all caesareans (OR 0.857, 95% CI 0.709 to 1.036, p=0.1110) Sensitivity analyses It was not possible to fit interaction models for some of the sensitivity analyses looking at midwife staffing (midwives x parity for healthy mother and baby outcomes; normal birth outcome). In the analyses looking at the interactions with midwife staffing there was significant interaction: • with clinical risk for all of the healthy mother and baby outcomes. Midwife staffing level had a more positive effect on the outcomes of mothers at lower clinical risk and their babies (OR for outcome in lower risk vs. higher risk, p for interaction: healthy mother OR 1.12 vs. 1.06, p=0.001; healthy baby OR 1.09 vs. OR 1.02, p=0.009; healthy mother and baby OR 1.12 vs. 1.06, p=0.007) • with parity for intact perineum, the positive effect was greatest for women with 4 or more previous babies (OR 1.25 vs. OR 1.11 to 1.18 for lower parities; p for interaction =0.007) • with clinical risk for all caesareans; increased midwife staffing reduced likelihood of caesarean more in women of lower clinical risk (OR 0.96 vs. OR 1.00, p=0.027)

There were no other significant interactions between midwife staffing and clinical risk and parity for other mode of birth or caesarean outcome.

In sensitivity analyses of the healthy baby outcome excluding preterm births and antepartum stillbirths, midwife staffing levels were associated with a greater effect on healthy baby outcome although this did not quite reach significance (main analysis OR 1.029, 95% CI 0.912 to 1.161, p=0.65; sensitivity analysis OR 1.172, 95% CI 0.991 to 1.387, p=0.063). The size of this effect based on chi squared was still much smaller (3) than the effect of clinical risk (10,681) and parity (2,126).

In the analyses looking at the interactions between doctor staffing levels, parity and clinical risk, higher doctor staffing was associated with:

- more benefit for nulliparous women, with reducing benefit for higher parities for healthy mother and baby outcomes (OR for increased doctor staffing/100 maternities for nulliparous vs. parity of ≥4: healthy mother OR 1.14 vs. 0.95, p=0.041; healthy baby OR 1.25 vs. OR 1.07, p=0.005; healthy mother and baby OR 1.20 vs. 0.99, p=0.014)
- more benefit for nulliparous women for delivery with bodily integrity (DwBI) and intact perineum, and the opposite for other outcomes (DwBI: OR 1.13 vs. 1.07, p=0.014; normal birth: OR 0.88 vs. 1.30, p<0.001; spontaneous vaginal delivery: OR 0.98 vs. 1.27, p=0.002; intact perineum: OR 1.09 vs. 0.99, p=0.007)
- less benefit for nulliparous women for the outcome of elective C-section (OR 1.00 vs. 0.78, p=0.001)
- less benefit for higher risk women for healthy mother outcome (OR 1.14 for lower risk vs. 1.00 for higher risk, p=0.001)
- more benefit for higher risk women for spontaneous vaginal delivery (OR 0.94 vs. 1.06, p<0.001)
- more benefit for higher risk women for elective C-section (OR 1.43 vs. 0.84, p<0.001) and all C-section (OR 0.96 vs. 0.83, p<0.001).

Other interactions were not significant.

There were also significant interactions between level of support worker staffing and parity for some outcomes; higher support worker staffing levels were associated with:

- greater benefit for women with higher parity for intact perineum (OR 1.00 for nulliparous vs. 1.15 for parity of ≥4, p<0.001)
- worse healthy mother and baby, mode of delivery outcome, and emergency and all C-section outcomes for higher clinical risk women (lower risk vs. higher risk: healthy mother OR 0.92 vs. 0.85, p<0.001; healthy baby OR 1.04 vs. 0.95, p=0.018; healthy mother and baby OR 0.93 vs. OR 0.86, p<0.001; delivery with bodily integrity OR 1.04 vs. OR 0.96, p<0.001; normal birth OR 1.06 vs. OR 0.96, p<0.001; spontaneous vaginal delivery OR 0.98 vs. OR 0.95, p=0.044; intact perineum OR 1.04 vs. OR 0.99, p=0.017; emergency C-section OR 0.95 vs. 1.01, p=0.033; all C-section OR 0.98 vs. OR 1.06, p=0.001)

Other interactions were not significant.

Influence of local geography and demography on outcomes

Of all SHAs London had the lowest rates of: healthy mother (23.1%), healthy mother and baby (20.5%), delivery with bodily integrity (27.4%), and spontaneous vaginal delivery (58.5%) and highest rates of emergency caesareans (17.3%) and caesareans overall (28.1%) (statistical comparisons not provided).

Maternal and neonatal outcomes by SHA compared with South West SHA:

- Healthy mother: ORs ranged from 1.288 (Yorkshire and Humber, p=0.0361, only significant difference) to 0.891 (London, p=0.2544)
- Healthy baby outcome: ORs ranged from 1.301 (London, p=0.0088) to 0.915 (North East, p=0.4511)
- Healthy mother and baby outcome: ORs ranged from 1.253 (East Midlands, p=0.0480) to 0.907 (London, p=0.3329)
- Delivery with bodily integrity: ORs ranged from 1.108 (East Midlands, p=0.3366) to 0.835 (London, p=0.0479, only significant difference)
- Normal birth: ORs ranged from 1.266 (East Midlands, p=0.0136) to 0.967 (London, p=0.7045)
- Spontaneous vaginal delivery: ORs ranged from 1.096 (North West, p=0.1576) to 0.905 (London, p=0.1642)
- Intact perineum: ORs ranged from 1.105 (North East, p=0.4085) to 0.832 (South East Coast, p=0.1003)
- Elective caesarean: ORs ranged from 1.097 (London, p=0.2960) to 0.865 (East Midlands, p=0.1638)
- Emergency caesarean: ORs ranged from 1.127 (East of England, p=0.1322) to 0.914 (North West, p=0.2083)
- All caesarean: ORs ranged from 1.119 (London, p=0.143) to 0.875 (East Midlands, p=0.135)

Maternal and neonatal outcomes by rural urban classification compared with Hamlet and Isolated Dwelling - less sparse:

- Healthy mother outcome: ORs ranged from 1.115 (Town and Fringe - less sparse, p=0.0008) to 0.864 (Urban ≥10k - sparse, p=0.1296)
- Healthy baby outcome: ORs ranged from 1.104 (Village - less sparse, p=0.0146) to 0.797 (Urban ≥10k - sparse, p=0.0478)
- Healthy mother and baby outcome: ORs ranged from 1.120 (Town and Fringe - less sparse, p=0.0008) to 0.838 (Urban ≥10k - sparse, p=0.0791)
- Delivery with bodily integrity: ORs ranged from 1.185 (Village - sparse, p=0.0050) to 0.951 (Hamlet and isolated dwelling - sparse, p=0.5352)
- Normal birth: ORs ranged from 1.221 (Village - sparse, p=0.0024) to 0.921 (Urban ≥10k - sparse, p=0.3263)
- Spontaneous vaginal delivery: ORs ranged from 1.244 (Village - sparse, p=0.0004) to 0.970 (Urban ≥10k - sparse, p=0.6986)
- Intact perineum: ORs ranged from 1.167 (Village - sparse, p=0.0207) to 0.952 (Hamlet and isolated dwelling - sparse, p=0.5826)

	• Elective caesarean: ORs ranged from 1.066 (Hamlet and isolated dwelling - sparse, p=0.5885) to 0.865 (Village - sparse, p=0.1256) • Emergency caesarean: ORs ranged from 1.039 (Hamlet and isolated dwelling - sparse, p=0.7182) to 0.928 (Village - sparse, p=0.3703) • All caesarean: ORs ranged from 1.061 (Hamlet and isolated dwelling - sparse, p=0.495) to 0.879 (Village - sparse, p=0.060) Maternal and neonatal outcomes by Index of Multiple Deprivation, most deprived (Q1) compared with least deprived (Q5): • Healthy mother: OR 1.382 (p<0.0001) • Healthy baby outcome: OR 0.854 (p<0.0001) • Healthy mother and baby outcome: OR 1.323 (p<0.0001) • Delivery with bodily integrity: OR 1.457 (p<0.0001) • Normal birth: OR 1.125 (p<0.0001) • Spontaneous vaginal delivery: OR 1.100 (p<0.0001) • Intact perineum: OR 1.546 (p<0.0001) • Emergency caesarean: OR 1.113 (p<0.0001) • Elective caesarean: OR 0.816 (p<0.0001) • Overall caesarean: OR 0.971 (p=0.019). Maternal and neonatal outcomes by trust configuration compared with trusts with OUs or FMUs: • Healthy mother outcome: ORs ranged from 1.006 (OU alone, p=0.9336) to 0.950 (OU/AMU, p=0.5252) • Healthy baby outcome: ORs ranged from 0.961 (OU alone, p=0.5756) to 0.846 (OU/AMU/FMU, p=0.0855) • Healthy mother and baby outcome: ORs ranged from 0.999 (OU alone, p=0.9871) to 0.926 (OU/AMU, p=0.3437) • Delivery with bodily integrity: ORs ranged from 1.050 (OU/AMU/FMU, p=0.5645) to 0.978 (OU/AMU, p=0.7531) • Normal birth: ORs ranged from 0.927 (OU/AMU, p=0.2578) to 0.885 (OU alone, p=0.0362) • Spontaneous vaginal delivery: ORs ranged from 0.988 (OU/AMU/FMU, p=0.852) to 0.971 (OU alone, p=0.560) • Intact perineum: ORs ranged from 1.072 (OU/AMU/FMU, p=0.4697) to 0.964 (OU/AMU, p=0.6490) • Elective caesarean: ORs ranged from 1.039 (OU alone, p=0.5431) to 0.965 (OU/AMU, p=0.6111) • Emergency caesarean: ORs ranged from 0.973 (OU/AMU/FMU, p=0.7036) to 0.941 (OU/AMU, p=0.3260) • All caesarean: ORs ranged from 0.994 (OU alone, p=0.912) to 0.940 (OU/AMU, p=0.301) Larger trusts were associated with reduced likelihood of delivery with bodily integrity (OR 0.975, 95% CI 0.952 to 0.999, p=0.0411) and an intact perineum (OR 0.971, 95% CI 0.945 to 0.998, p=0.0335), and just missed significance for the healthy mother outcome (OR 0.972, 95% CI 0.944 to 1.001, p=0.060).

Compared to a university trust, women in a non-university trust were slightly more likely to have a healthy baby (OR 1.134, 95% CI 1.016 to 1.265, p=0.0253) and to have a spontaneous vaginal delivery (OR 1.090, 95% CI 1.012 to 1.175, p=0.024).

Maternal characteristics

Maternal and neonatal outcomes by ethnicity compared with "any other ethnic group":

- Healthy mother outcome: ORs ranged from 1.776 (mixed White and Black Caribbean, p<0.0001) to 0.605 (Indian, p<0.0001)
- Healthy baby outcome: ORs ranged from 1.189 (Chinese, p=0.0121) to 0.835 (any other Black/African/Caribbean background, p=0.0007)
- Healthy mother and baby outcome: ORs ranged from 1.657 (Caribbean, p<0.0001) to 0.597 (Indian, p<0.0001)
- Delivery with bodily integrity: ORs ranged from 1.799 (Caribbean, p<0.0001) to 0.594 (Indian, p<0.0001)
- Normal birth: ORs ranged from 1.249 (Caribbean, p<0.0001) to 0.731 (Irish, p<0.0001)
- Spontaneous vaginal delivery: ORs ranged from 1.304 (mixed White and Black Caribbean, p<0.0001) to 0.830 (Indian, p<0.0001)
- Intact perineum: ORs ranged from 2.242 (Caribbean, p<0.0001) to 0.563 (Chinese, p<0.0001)
- Elective caesarean: ORs ranged from 1.223 (Irish, p=0.0024) to 0.692 (mixed White and Black Caribbean, p<0.0001)
- Emergency caesarean: ORs ranged from 1.453 (African, p<0.0001) to 0.841 (any other White background, p<0.0001)
- All caesarean: ORs ranged from 1.265 (African, p<0.0001) to 0.826 (Chinese, p<0.0001)

Maternal clinical risk

Clinical risk had a dominant significant effect for all outcomes except intact perineum (chi squared range from 945 for intact perineum to 54,882 for all caesareans). Increasing clinical risk was associated with reduced chances of positive outcomes (healthy mother and baby outcomes and mode of birth outcomes) and increased chance of caesarean outcomes.

Parity

Parity had a strong or dominant significant effect for all outcomes except healthy baby (chi squared range from 615 for healthy baby to 14,185 for delivery with bodily integrity, 3 effects dominant: healthy mother, intact perineum, and delivery with bodily integrity). Increasing parity was associated with increased chances of positive outcomes (mode of birth outcomes, healthy mother, and healthy mother and baby) and reduced chances of emergency and all caesarean, while the relationship was not linear (monotonic) across all parities for healthy baby (least likely for nulliparous women and most likely for women with 1 previous baby) and elective caesarean (least likely for nulliparous women and most likely for

	women with 2 children). Maternal age Maternal age group had moderate to strong significant effects for all outcomes except healthy baby (range 14 for healthy baby to 1,746 for spontaneous vaginal delivery, 4 strong effects: healthy mother, delivery with bodily integrity, spontaneous vaginal delivery, and all caesareans). Increasing age was associated with reduced chances of most positive outcomes (healthy mother and baby and mode of delivery outcomes) and elective caesareans, and increased likelihood of emergency and all caesareans. The relationship was not linear (monotonic) across all ages for healthy baby (increasing likelihood up to age 40 to 45, but lowest for women aged 45 and over) and intact perineum (most likely for age 19 and under and reducing likelihood to age 39, then increasing slightly from age 40). The only other factors showing relative chi squared values over 10 were maternal ethnicity (range 6 for healthy baby to 158 for intact perineum) and deprivation of the area of residence (range 2 for all caesarean to 337 for intact perineum. **Process of care outcomes** None **Reported feedback** None **Other outcomes** None
Notes/comments	**Author conclusions** "Staffing levels have positive and negative effects on some outcomes, and deployment of doctors and midwives where they have most beneficial impact is important. Managers may wish to exercise caution in increasing more support workers in higher risk settings. There also appears to be limited opportunities for role substitution. The findings support current policy of women at low clinical risk giving birth in midwife led settings." "Levels of midwifery staffing were associated with only two of the ten indicators, delivery with bodily integrity and intact perineum." "Certain multiplicative effects revealed themselves and showed that the effect of staffing upon outcomes sometimes varied according to mother's parity and clinical risk. However there is potential here for reverse causation where units with higher proportions of high risk women staff up accordingly." "Much of the variation in outcomes which was measured at trust level was explained by clinical risk and parity." "…it is very hard to say what a 'staffing' ratio or model is, when the most cost-effective care is continuity of midwifery care antenatally/ intrapartum/ postnatally where midwives provide care for women either in

	the community or in an acute trust facility, which could be an obstetric or midwife-led setting. Thus staffing measures that focus on ratios on a ward will miss this, especially when the care takes place over 6 months both in and out of hospital." **Author limitations** The study relied on HES data, and missing or poorly recorded data could cause bias. The analyses could not include risk factors such as smoking status or BMI, or look at bank and agency staff usage, due to lack of good quality data. The analyses were not able to include organisational variables such as organisational climate or models of care, and these and other omitted variables may contribute to outcomes. It is not possible to say how much of the variation could be due to these unmeasured characteristics or variation within trusts in quality of care or difference models of care. The staffing data came from a census undertaken annually in September, and this may hide any variation over time. The outcomes analysed were aggregated over the year and this also may miss fluctuations during periods where the system is under strain. Unadjusted results should be interpreted with caution due to the effect of confounding factors. There is potential for reverse causation in the interaction analyses, as units with higher proportions of high risk women may staff themselves accordingly, and therefore differently to those with primarily lower risk women. Any extrapolation of the findings to staffing levels outside of those seen in this sample should be done with a high degree of caution. Analyses of medical staff could not be disaggregated to look at obstetric care over the pregnancy and during delivery, and gynaecology care. This may bias estimated effects of medical care. **Review team limitations** The use of composite outcomes limits ability to identify effects on individual outcomes. **Other comments** Dataset was large, used nationally collected data, and covered England as a whole, and was relatively complete, therefore selection bias unlikely.
Rowe et al. 2014	
Study details	Rowe RE, Townend J, Brocklehurst P et al. Service configuration, unit characteristics and variation in intervention rates in a national sample of obstetric units in England: an exploratory analysis. BMJ Open, 2014;4:e005551. **Study aim** To explore whether service configuration and obstetric unit characteristics explain variation in obstetric unit intervention rates in 'low risk' women with a full term pregnancy planning vaginal birth

	Study type Correlational study **Source of funding** National Institute for Health Research (NIHR) Health Services and Delivery Research programme. No competing interests reported. **Time period/length of follow up** April 2009 to March 2010 (period of births in obstetric units; full period of data collection described as April 2008 to April 2010) **Country** UK (England) **Quality score** **Internal validity** + **External validity** ++ **Overall score** +
Population and setting	**Setting** Obstetric units **Stage of care** Not stated. Outcomes assessed were in the intrapartum period. **Number of hospitals/units** 36 obstetric units (random sample stratified by size [<2,600; 2,600-4,850; >4,850 births/year] and geographical location [northern or southern England]) **Number of women/births** 32,257 planned vaginal births in obstetric units by women with a term pregnancy (37 to 42 +0 weeks gestation) considered 'low risk' (i.e. not known to have any medical or obstetric risk factors listed in national intrapartum care guidelines in England/Wales). Women were excluded if they had a caesarean section before labour, presented in preterm labour (<37 weeks' gestation), had multiple pregnancy, received no antenatal care or had a stillbirth before the start of care in labour. **Skill mix/type/duties of midwives** Not reported **Key characteristics of hospitals/units assessed** 9 of 36 obstetric units had an alongside midwifery unit (AMU) in the same

	hospital. Number of births in the obstetric units (excluding those in any AMU): Median 2,919 (IQR 2,361 to 3,849; minimum 1,380, maximum 6,490) (data based on 35 obstetric units) Number of delivery beds in the obstetric units: Median 10 (IQR 8 to 12; minimum 5, maximum 19) (data based on 36 obstetric units) Percentage of midwifery 'under' staffing (see factors for definition): Median 29.6 (IQR 20.5 to 41.8; minimum 4.4, maximum 83.6) (data based on 30 obstetric units) Percentage of planned non-obstetric unit births (% of births in the NHS trust planned to take place at home, in an free standing midwifery unit [FMU] or AMU): Median 3.0 (IQR 2.3 to 7.9; minimum 0.4, maximum 37.2) (data based on 30 obstetric units) Percentage of planned 'out of hospital' births (% of births in the NHS trust planned to take place at home or in an FMU): Median 2.4 (IQR 1.4 to 4.1; minimum 0.4, maximum 10.2) (data based on 30 obstetric units) **Key characteristics of participants assessed** Not reported **Data sources** Data on births collected by midwives attending the birth. Data on unit and configuration of care from: Birthplace national prospective cohort collected between April 2008 and April 2010 (its sources included mapping surveys 2007-2010; monthly logs recording number of births planned in each unit; data on openings and closures of maternity units collected from all participating NHS trusts; staffing and activity logs completed twice/day by midwives); and Office for National Statistics for data on number of births per year in each hospital for 2009/2010.
Factors assessed	**Midwife staffing** Midwife 'under' staffing ('under' staffing defined as the percentage of shifts where there was less than 1 midwife on duty per woman on the delivery or labour suite). Staffing data were available for 30 of the 36 obstetric units. **Other staffing factors** Not investigated

	Maternal and neonatal factors Not investigated **Environmental factors** Size of the obstetric unit: number of births per year in each hospital (where there was an AMU in the same hospital as the obstetric unit, this data included births in both settings); annual number of births in each obstetric unit (by estimating the annual number of births in each AMU and subtracting this from the total number of births in the hospital). One AMU had insufficient data to estimate births in the associated obstetric unit. Proportion of births in each NHS trust planned outside an obstetric unit (e.g. AMU, FMU, or at home) and 'out of hospital' (e.g. in an FMU or at home). Number of delivery beds ('bed spaces') in each obstetric unit (using data from 2010 mapping survey, 2007 data was used where 2010 was not available) Presence of an AMU in each hospital (defined as if the associated AMU was open for the whole of the period when cohort study data for the obstetric unit were being collected). One AMU was excluded from analysis for being open for only part of the study period. **Management factors** Not investigated **Organisational factors** Not investigated **Control variables/adjustment** Adjustments were made for maternal age, ethnicity, English language fluency, marital status, Index of Multiple Deprivation (IMD) quintile, and BMI; gestational age; and presence of 1 or more of: prolonged rupture of membranes >18 hours, meconium-stained liquor, proteinuria 1+ or more, hypertension, abnormal vaginal bleeding, non-cephalic presentation, abnormal fetal heart rate.
Comparison	More versus less understaffing of the delivery suite/labour ward (% shifts where midwife: woman ratio <1:1) compared using regression
Outcomes and analysis	**Maternal/neonatal outcomes** Adjusted rates of intrapartum caesarean section (caesareans carried out before labour were excluded, this would exclude elective C-sections) **Process of care outcomes** Instrumental delivery (forceps or ventouse) Rates of two composite measures of low medical intervention: straightforward birth (defined as birth without forceps or ventouse, intrapartum caesarean section, third or fourth degree perineal trauma or

	blood transfusion); and normal vaginal birth (defined as birth without induction of labour, epidural or spinal analgesia, general anaesthetic, forceps or ventouse, caesarean section or episiotomy) **Reported feedback** Not investigated **Other outcomes** Secondary outcomes: rates of augmentation, rates of epidural use **Analysis** Adjusted unit level event rates were calculated using an indirect standardisation procedure. Each unit's rate was standardised by dividing the observed rate for births planned to take place in the unit by its expected outcome rate, and multiplying by the average rate across the units (weighted by duration of participation and probability of selection for the cohort). Expected outcome rates were calculated based on a multiple logistic regression model based on maternal/fetal demographic and clinical characteristics (age, ethnicity, English language fluency, marital status, Index of Multiple Deprivation quintile, body mass index, gestational age and presence of any of 7 specified complicating conditions at the start of care in labour. Simple linear regression used to investigate whether unit characteristics were associated with variations in outcomes. All analyses were stratified by parity and significance considered p<0.05.
Results	**Maternal/neonatal outcomes** <u>Adjusted rates of intrapartum caesarean section</u> There was a significant association between midwife 'under' staffing and intrapartum caesarean section rate in planned obstetric units for nulliparous women (R2 17.6%, coefficient -0.10, p=0.03) but not multiparous women (R2 12.6%, coefficient -0.05, p=0.11). Other factors significantly associated with rates of intrapartum caesarean section (R2, coefficient, p): • Size of the unit: significant for multiparous women (10.6%, -0.07, 0.01) and borderline significant for nulliparous women (5.8, -0.08, 0.05) • Presence of an AMU: significant for nulliparous women (22.8%, 4.99, 0.03) but not multiparous women (23.1%, 3.23, 0.06) • Presence of planned non-obstetric unit births: for nulliparous (31.8%, 0.31, 0.02) and multiparous women (43.2%, 0.23, 0.01) No significant associations were found for number of delivery beds, and percentage of planned out of hospital births for both nulliparous and multiparous women. **Process of care outcomes**

	Instrumental delivery (forceps or ventouse) There was no significant association between instrumental delivery and percentage of midwife under staffing for nulliparous (R2 0.2%, coefficient 0.02, p=0.80) or multiparous women (R2 5.6%, coefficient -0.04, p=0.07). There was also no significant associations found between instrumental delivery and any of the other factors (size of the unit, number of delivery beds, percentage, presence of an AMU, percentage of planned non-obstetric unit births and percentage of planned out of hospital births) for nulliparous or multiparous women Straightforward birth There was a significant association between percentage of midwife under staffing and straightforward birth for multiparous women (R2 15.1%, coefficient 0.08, p=0.01) but not for nulliparous women (R2 3.5%, coefficient 0.06, p=0.31). Other significant associations found for straightforward birth were (R2, coefficient, p): • Presence of an AMU: significant for multiparous (14.8%, -3.14, 0.04) but not for nulliparous women (1.4%, -1.40, 0.55) • Percentage of planned non-obstetric unit births: significant for multiparous (26.3%, -0.22, 0.01) but not nulliparous women (8.2%, -0.17, 0.06) • Size of the unit: borderline significant for multiparous (8.8%, 0.08, 0.05) but not for nulliparous women (0.1%, -0.01, 0.88) No significant associations were found for number of delivery beds and percentage of planned out of hospital births for nulliparous or multiparous women. Normal vaginal birth There was no significant association found between percentage of midwife under staffing and normal vaginal births for nulliparous (R2 0.1%, coefficient -0.01, p=0.89) or multiparous women (R2% 1.7%, coefficient 0.05, p=0.48) Other significant associations found for normal vaginal birth were (R2%, coefficient, p): • Presence of an AMU: significant for multiparous (21.1, -6.35, 0.02) but not for nulliparous women (10.1, -5.16, 0.08) • Percentage of planned non-obstetric unit births: significant for multiparous (17.4, -0.25, 0.01) but not for nulliparous women (6.1, -0.20, 0.08)

	No significant associations were found for size of the unit, number of delivery beds, and percentage of planned out of hospital births for nulliparous or multiparous women. Secondary outcomes <u>Rates of epidural</u> There was no significant association found between percentage of midwife under staffing and rates of epidural for nulliparous (R2 0.9%, coefficient 0.05, p=0.59) or multiparous women (R2 0.0%, coefficient 0.00, p=0.94). No significant associations were found for any of the other factors (size of the unit, number of delivery beds, presence of an AMU, percentage of planned non-obstetric unit births, percentage of planned out of hospital births) for nulliparous or multiparous women. <u>Rates of augmentation</u> Percentage of midwife under staffing was borderline significantly associated with rates of augmentation for multiparous women (R2 11.1%, coefficient -0.09, p=0.05) but not significant for nulliparous women (R2 5.6%, coefficient -0.10, p=0.16). Other significant associations found for rates of augmentation were (R2, coefficient, p): • Percentage of planned out of hospital births: significant for nulliparous (13.7%, -0.73, 0.02) but not for multiparous women (1.3%, -0.13, 0.43). • Presence of an AMU: borderline significant for nulliparous (14.0%, 5.59, 0.05) but not for multiparous women (9.6%, 2.73, 0.07) No significant associations were found for size of the unit, number of delivery beds and percentage of planned out of hospital births for both nulliparous and multiparous women.
Notes/comments	**Author conclusions** "Trusts with greater provision of non-obstetric unit intrapartum care may have higher intervention rates in planned 'low risk' obstetric unit births but at a trust level this is likely to be more than offset by lower intervention rates in planned obstetric unit births." **Author limitations** Exploratory association study using an ecological design; inter-relationships between potential explanatory variables were not explored; limited availability of data on the characteristics of maternity units in England – unable to take account of the dependency levels of women on the delivery ward when calculating midwifery staffing indicator; small number of obstetric units in the sample. **Review team limitations**

	All maternal outcome data was collected by a separate cohort study (Birthplace national prospective cohort study). Data were collected by attending midwives, but no validity check is reported. Individual regression analyses were carried out for the factors of interest (e.g. midwife under staffing, presence of an AMU in the hospital etc.) and these were not combined in a multivariate analysis to determine which remained significant predictors of outcome. **Other comments** Reported to be a nationally representative sample of obstetric units. Obstetric unit intervention rates were evaluated only in planned obstetric unit births, so rates are unaffected by women with complications transferring into the obstetric unit during labour from non-obstetric unit settings. The authors observe that intervention rates in planned 'low-risk' OU births tend to be higher in OUs situated in trusts where a higher proportion of women planned birth in a non-OU setting (home, FMU or AMU). They suggest a number of possible explanations for this centring on the theory that in NHS trusts where the OU is known to have a high intervention rate, 'low risk' women may preferentially opt for a non-OU setting. Where a higher proportion of 'low risk' women plan birth in a non-OU setting, planned birth in the OU could be considered to be 'higher risk' and therefore given a more 'medicalised' approach. There is also the possibility for selection bias where women opting for a non-OU birth might be those most keen to have a 'normal birth' without medical intervention, resulting in the planned OU group being less 'intervention averse'.
Cerbinskaite et al. 2011	
Study details	Cerbinskaite A, Malone S, McDermott et al. Emergency caesarean section: influences on the decision to delivery interval. Journal of Pregnancy, 2011. Article ID 640379; pages 1-6. **Study aim** To measure the impact of workload and midwifery staffing levels on the length of time taken to transfer a women to the operating theatre and deliver her baby by grade 1 or 2 caesarean section. Secondary aims were to investigate particular factors (time of day, form of anaesthesia, time spent in operating theatre prior preparing for surgery, speed of surgery) that contribute to delay of delivery. **Study type** Cohort study (with cross sectional analysis of exposure and outcome) **Source of funding** Not reported

	Time period/length of follow up 12 months (2006) **Country** UK (England) **Quality score** **Internal validity** - **External validity** + **Overall score** -
Population and setting	**Setting** Delivery suite of a tertiary referral hospital northern England **Stage of care** Intrapartum **Number of hospitals/units** 1 obstetric unit **Number of women/births** 333 grade 1 and 2 emergency caesareans were analysed. 5,581 women who gave birth during the study year (755 emergency caesareans, 414 elective caesareans). Of 755 emergency caesareans 122 were grade 1, 211 were grade 2 and 422 were grade 3. (Grade 1 performed for immediate threat to the life of the women or fetus; Grade 2 performed when there is maternal or fetal compromise which is not immediately life threatening; Grade 3 performed when there is no maternal or fetal concern but early delivery is required; and Grade 4 is elective caesarean.) Of 5,167 women who gave birth excluding elective caesareans 2,620 gave birth between during the day (between 08.31 and 20.30hrs) and 2,547 gave birth overnight (between 20.31 and 08.30hrs). **Skill mix/type/duties of midwives** Not reported **Key characteristics of hospitals/units assessed** Daytime staffing (between 08.31 and 20.30 hrs): junior doctors daytime delivery suite shifts with on-site cover provided by 1 Obstetric Registrar, 1 Obstetric Senior House Officer, 1 Anaesthetic Registrar, 1 Consultant

	Obstetrician and 1 Consultant Anaesthetist). Night-time staffing (between 20.31 and 08.30hrs): junior doctors night time delivery suite shifts with on-site cover provided by 2 Obstetric Registrars, 1 Obstetric Senior House Officer, 1 Anaesthetic Registrar, plus on-call cover from 1 Consultant Obstetrician and 1 Consultant Anaesthetist. 2 obstetric operating theatres were available throughout the day/night staffed by an anaesthetic nurse or an operating department assistant or practitioner. **Key characteristics of participants assessed** Not reported **Data sources** An audit proforma was completed by the Obstetrician performing the grade 1 or 2 caesarean, in conjunction with the attending midwife. Forms were collated by the research team within 72 hours of the operation and any missing data was added at this time.
Factors assessed	**Midwife staffing** Ratio of the number of qualified midwives present on the delivery suite at the time of caesarean (not further defined) in relation to the number of labouring women (LW:MW ratio) **Other staffing factors** Not investigated **Maternal and neonatal factors** Total number of labouring women present on the delivery suite at the time of the caesarean, grade of C-section (analysis stratified for this factor), type of anaesthetic used **Environmental factors** Time of day **Management factors** Not investigated **Organisational factors** Not investigated **Control variables/adjustment** None
Comparison	More than 1:1 ratio of labouring women: midwives (i.e. more women than midwives) vs. less than 1:1 ratio labouring women: midwives (i.e. more midwives than women) on the delivery suite
Outcomes and analysis	**Maternal/neonatal outcomes** Not investigated

	Process of care outcomes Decision to delivery interval Transfer times to theatre Time interval between arrival in theatre and commencement of the caesarean and delivery of the baby **Reported feedback** Not investigated **Other outcomes** Not investigated **Analysis** Chi squared analyses used to compare categorical variables and analysis of variance used to compare groups of continuous variables, with two tailed t-tests used to make more detailed comparisons. Values of p below 0.05 were taken as statistical significance.
Results	**Process of care outcomes** Mean decision to caesarean delivery interval (SD): Grade 1: 23 minutes (11) Grade 2: 32 minutes (13) Mean arrival in theatre to start of operation (SD): Grade 1: 19.1 (9.6) Grade 2: 20.4 (8.6) (p=0.201 for difference) Babies born within 30 minutes of operation being requested (NICE recommend that for confirmed or suspected fetal compromise delivery should ideally be performed within 30 minutes): Grade 1: 82.0% Grade 2: 45.0% Babies being born within 75 minutes of operation being requested (previous studies have demonstrated maternal and perinatal outcomes deteriorate when the interval exceeds 75 minutes): Grade 1: 99.2% Grade 2: 98.1% Decision to delivery interval in relation to LW:MW ratio: Grade 1: decision to delivery intervals were less than 30 minutes in 77/82 (93.9%) caesareans when the ratio was 1:1 or more, but only 22/40 (55.0%) when the ratio was less than 1:1 (p<0.001). Grade 2: decision to delivery intervals were less than 30 minutes in 90/168 (53.6%) caesareans when the ratio was 1:1 or more, but only 5/43 (11.6%) when the ratio was less than 1:1 (p<0.001). Transfer times to theatre in relation to the LW:MW ratio: Grade 1: transfer to theatre times were within 15 minutes for 81/82 (98.8%) caesareans when the ratio was 1:1 or more, but only 34/40 (85.0%)

	when the ratio fell below 1:1 (p<0.001). Grade 2: transfer to theatre times were within 15 minutes for 155/168 (92.3%) caesareans when the ratio was 1:1 or more, but only 29/43 (67.4%) when the ratio fell below 1:1 (p<0.001). Time interval between arrival in theatre and commencement of the caesarean and delivery of the baby: LW:MW ratio was reported to have "no discernible bearing" (figures and p value not reported). Decision to delivery interval in relation to the number of women in active labour: Grade 1: the 30 minute cut off was rarely breached until the number of labouring women on the delivery unit exceeded 8; above 8, the 30 minute time limit was frequently exceeded (figures and p value not reported). Grade 2: as the number of women increased, the decision to deliver interval also increased (figures and p value not reported). Decision to perform caesarean during daytime vs. overnight: Grade 1: the decision to perform a grade 1 caesarean was as likely to be made during the daytime (59/2,620) as overnight (63/2547) (p=0.104). Individually measured indications for grade 1 caesareans (low pH on fetal blood sampling, failure to progress in the first or second stages of labour, failed instrumental vaginal delivery including forceps, ventouse or both) did not differ between the 2 timeframes. Grade 2: significantly less grade 2 caesareans were performed during the day (97/2,620) than overnight (114/2,547) (p=0.015). The greatest factor for this difference was a rise in number of procedures performed in response to a pathological cardiotocographic abnormality (CTG) overnight without recourse to fetal blood sampling (37 daytime incidences vs. 62 overnight, p<0.001), and a rise in procedures performed for non-progressive second stage of labour (11 daytime vs. 20 overnight, p=0.01). There was no significant association between the time of day at which the decision was made and decision to delivery interval (figures and p value not reported). Choice of anaesthesia was significantly associated with decision to delivery interval for grade 1 caesareans: 19.7mins (SD 8.5) under general anaesthesia vs. 27.0mins (SD 8.2) under spinal blockade (p<0.001) (under epidural top-up 26.0mins [SD 18.7]; no pairwise comparison performed) Choice of anaesthesia was not associated with decision to delivery interval for grade 2 caesareans: 30.1mins (SD 19.4) under general anaesthesia, 34.7mins (SD 12.0) under spinal blockade, and 29.2mins [SD 15.4] under epidural top-up (p=0.681) Time of day at which the decision was made influenced the choice of anaesthesia for grade 1 caesarean, with general anaesthesia most common in the day (31/59 [52.5%] vs. 22/63 [34.9%], p=0.005) and spinal blockade

	most common at night (17/59 [28.8%] vs. 29/63 [46.0%], p=0.009). Time of day had no influence on choice of anaesthesia for grade 2 (p>0.07). The effect of type of anaesthesia on decision to delivery was influenced by time from arrival in theatre to start of the operation for grade 1 caesareans: it was shortest with general anaesthesia, mean 14.4 minutes (SD 6.0) vs. 24.6 minutes with spinal blockade (SD 9.6, p<0.001), vs. 20.0 minutes with epidural top up (SD 11.4, p=0.032). Anaesthetic had no influence on time from arrival to start for grade 2: 18.2 minutes (SD 14.9) with general, 21.1 minutes (SD 6.5) with spinal block, and 19.9 minutes (SD 10.3) with epidural top up (p=0.335).
Notes/comments	**Author conclusions** "Midwifery staffing levels and the form of anaesthesia employed influence on decision to delivery intervals for the most urgent caesarean sections. " **Author limitations** Findings may not be applicable to smaller obstetric units, stand alone midwifery led units or alongside midwifery led units which deal with different case mix and which may face different organisational challenges than the tertiary level hospital studied here. Maternal or fetal outcomes were not assessed. Observational study design rather than interventional. **Review team limitations** Figures and significance values not reported for some outcomes. The analysis was relatively simplistic (chi squared comparison of the outcomes for LW:MW ratios <1:1 versus >1:1), and did not adjust for potential confounders. Limited information is available on the demographics of the area or the treated population, hospital characteristics or numbers of midwives. Only one hospital was included in the study, which may limit generalisability of the findings. The number of C-sections being analysed was small (333 grade 1 and 2 C-sections) which may limit reliability of the results. There were fewer grade 1 C-sections (122) than grade 2 (211), therefore results for grade 1 C sections may not be as robust and have less power. For each woman, midwife staffing levels (the woman's "exposure") were assessed at the point of delivery (the time of the outcome), rendering the analyses essentially cross sectional.
Gerova et al. 2010	
Study details	Gerova V, Griffiths P, Jones S et al. The association between midwifery staffing and outcomes in maternity services in England: observational study using routinely collected data. Preliminary report and feasibility assessment. Kings College London, 2010.

	Study aim To assess the feasibility of using routinely available data to measure the impact of midwifery staffing upon birth outcomes in maternity services at trust level in England. **Study type** Correlational study **Source of funding** Department of Health England **Time period/length of follow up** April 2008 – March 2009 **Country** UK (England) **Quality score** **Internal validity** + **External validity** ++ **Overall score** +
Population and setting	**Setting** Hospital trusts **Stage of care** Not stated. Outcome assessed was in the postpartum period. **Number of hospitals/units** 144 out of 150 trusts which provide maternity care in England **Number of women/births** 615,042 women **Skill mix/type/duties of midwives** Not reported **Key characteristics of hospitals/units assessed** Staff groups full time equivalent (FTE): birth ratio Mean (SD; range; number of trusts data is from) Midwife consultant: birth ratio: 1,642.5 (1,322.7; 89 to 6,803; n=124) Midwife: birth ratio: 31.5 (7.9; 9 to 81; n=140) Consultant obstetrician and gynaecologist (O&G): birth ratio: 430.5 (131.0; 79 to 971; n=140)

	Associate Specialist and Staff Grade O&G: birth ratio: 1956.0 (1512.0; 190 to 8553; n=113) O&G registrar: birth ratio: 324.7 (163.7; 56 to 1133; n=140) O&G senior house officer: birth ratio: 1776.9 (1338.3; 273 to 7887; n=115) O&G junior house office: birth ratio: 1901.2 (1245.0; 311 to 5912; n=105) Registered nurse: birth ratio: 257.6 (521.5; 26 to 5070; n=133) Nursery nurse: birth ratio: 1598.9 (1291.5; 266 to 5992; n=63) Healthcare assistant: birth ratio: 144.2 (125.7; 18 to 1030; n=141) **Key characteristics of participants assessed** Mean maternal age: 29 years (age group 26-30 years made up the largest group [28.4%] followed by 31-35 years [25.6%]) Ethnicity: 69.7% white, 8.2% Asian or Asian British, 5.5% Black or Black British, 0.6% Mixed, 6.3% other, 9.9% unknown. Charlson comorbidities: No comorbidity: 96.4% Deprivation: Lived in least deprived areas: 15.8% Lived in most deprived areas: 27.2% Delivery method: Normal deliveries without complications: 57.1% Normal deliveries with complications: 14.3% Assisted delivery without complications: 3.4% Assisted delivery with complications: 1.9% Caesarean section without complications: 8.8% Caesarean section with complications: 14.5% Births with midwife (rather than obstetrician) as the responsible clinician: 19% Length of stay (LOS): Percentage of women with a prenatal LOS of 1-4 days: 36.6% Percentage of women with a postnatal LOS of 1-4 days: 76.5% Percentage of women with admissions in the previous 12 months: 9.6% **Data sources** Data on staff variables from The 2008 Maternity Matters Benchmarking dataset Data on patients from the Admitted Patients HES data for England from Dr Foster for April 2008 to March 2009.
Factors assessed	**Midwife staffing** Midwife consultant FTE: birth ratio Midwife FTE: birth ratio

	(Ratios used in the analyses were standardised, i.e. converted to z scores) **Other staffing factors** Consultant obstetrician and gynaecologist (O&G) FTE: birth ratio; Associate Specialist and Staff Grade O&G FTE: birth ratio; O&G registrar FTE: birth ratio; O&G senior house officer FTE: birth ratio; number of O&G junior house office FTE: birth ratio; Registered nurse FTE: birth ratio; nursery nurse FTE: birth ratio; healthcare assistant FTE: birth ratio **Maternal and neonatal factors** Not investigated **Environmental factors** Not investigated **Management factors** Not investigated **Organisational factors** Not investigated **Control variables/adjustment** Age of the mother; ethnicity; Carstairs deprivation index; Charlson comorbidity index; delivery method (normal delivery with and without complications, assisted delivery with and without complications, caesarean with and without complications [no information reported for elective and emergency]); professional delivering (midwife vs. consultant obstetrician + other); number of admissions in the previous 12 months (0,1,2,3); pre- and postnatal length of stay (0 days, 1-4, 5-16, >17 days).
Comparison	Higher versus lower midwife: birth ratios compared using Poisson regression
Outcomes and analysis	**Maternal/neonatal outcomes** 28 day readmission, defined as the number of women readmitted to any hospital within 28 days after discharge from the postnatal ward **Process of care outcomes** Not investigated **Reported feedback** Not investigated **Other outcomes** Not investigated **Analysis** A logistic regression model at patient level and Poisson regression at trust level. Expected readmissions were estimated from the patient level model and used as an offset in the trust level model.

Results	**Maternal/neonatal outcomes** Number of maternal readmissions to any hospital within 28 days after discharge from the postnatal ward: Actual readmissions at 28 days: mean 33.6 (SD 21.3; range 0 to 137) Expected readmissions at 28 days: mean 33.4 (SD 16.9; range 0.01 to 92.0) Relative risk of being readmitted in each trust: mean 1.02 (SD 0.51; range 0 to 3.48) (actual number of readmissions at 28 days divided by number of expected readmissions, obtained from the logistic regression model) <u>Association between staffing and readmission (adjusted)</u> There was a significant association between all staffing variables and readmissions (p<0.001 for all): Higher midwife FTE: birth ratio was associated with a lower probability of readmission: Beta -4.810 (SE 0.032), 95% Wald CI -4.873 to -4.746 Higher consultant midwife FTE: midwife FTE ratio was associated with a lower probability of readmission: Beta -4.348 (SE 0.031) 95% Wald CI -4.408 to -4.289 Higher consultant O&G FTE: midwife FTE ratio was associated with a lower probability of readmission: Beta -3.563 (SE 0.021) 95% Wald CI -3.605 to -3.522 Higher registered nurses FTE: midwives FTE ratio was associated with a higher probability of readmission: Beta 3.133 (SE 0.009) 95% Wald CI 3.115 to 3.151 The following maternal variables were associated with significantly increased risk of maternal readmission (beta [SE] p) • presence of ≥1 maternal comorbidities vs. no comorbidity: 0.168 [0.068], p=0.014 • ≥1 maternal admission in the past 12 months: 1 admission 0.499 [0.044]; 2 admissions 0.741 [0.083]; 3 admissions 0.995 [0.108] (p<0.001 for all) • Black or Black British vs. White ethnicity: 0.238 [0.056], p<0.001 • Longer pre-birth length of stay: 1-4 days 0.114 [0.03]; 5-16 days 0.452 [0.100]; 17+ days' 0.746 [0.223] (p≤0.001 for all) • Longer post-birth length of stay: 1-4 days 0.231 [0.047]; and 5-16 days' stay 0.437 [0.067] (p<0.001 for both) • Having a more complicated delivery: normal delivery with complications 0.360 [0.041]; assisted delivery with complications 0.444 [0.094]; caesarean 0.472 [0.050]; caesarean with complications 0.518 [0.041] (p<0.001 for all) Delivery by a consultant increased probability of readmission compared to delivery by a midwife: 0.98 [0.042], p=0.02
Notes/comments	**Author conclusions**

	"Higher numbers of full time equivalent (FTE) midwives per birth was associated with a lower probability of readmission. A higher ratio of consultant obstetrician FTE to midwives FTE was also associated with a lower probability of readmission, as was a higher ratio of consultant midwives FTE to midwives. A higher ratio of registered nurses FTE to midwives FTE was associated with a higher probability of readmission. The relationships demonstrated with our simple model are certainly plausible with better outcomes consistently associated with higher levels of more experienced and more highly qualified staff". **Author limitations** The authors report that due to limitations in data availability, only one outcome measure was examined. Risk adjustment was reported to be limited in this model, and further risk adjustment might alter the relationships. The data available had information on the level of healthcare assistants FTE in maternity services, but did not differentiate between maternity support workers and maternity care assistants. In any case, healthcare assistants were excluded from the model because of colinearity with other staff groups. It was unclear whether readmissions could be a direct consequence of the original procedure/interventions, or to do with the level of aftercare, or the patient's actions. Future methods should include multilevel logistic regression model at trust and patient level and should strive to incorporate additional variables such as midwifery and other maternity staff workforce characteristics, midwifery grades, skill mix, job relevant training, supervision and turnover. Additional maternal characteristics such as previous mode of birth, parity, multiple births, gestational age, and co-morbidities such as diabetes, hypertension, renal disease, cardiac disease and obesity should be considered **Review team limitations** Only 27 trusts had data on all staff groups assessed, it was not clear whether some trusts did not employ all of the staff groups or whether data was missing. The authors report considerable variation in staffing configurations between trusts. The study would not be able to separate obstetric from gynaecologic work of consultants, therefore the FTE ratio may effectively higher than it would be if only time spent on obstetrics was considered. As this study assessed outcomes at the trust level, it would not be able to identify the effect of variations in staffing at a more local level (e.g. at

	unit level). The analysis was part of a feasibility assessment, it did adjust for some potential confounders (maternal age, ethnicity, deprivation, comorbidity, delivery method, professional delivering, number of admissions in the previous year, pre and post-birth length of stay), but there were others which could not be adjusted for (e.g. parity, multiple pregnancies or births, gestational age, or previous delivery type). **Other comments** FTE: birth ratio defined as number of births per health professional FTE. Data were available on FTE at trust level (i.e. the total number of births per year in each trust is divided to the total FTE for each professional group).
Joyce et al. 2004	
Study details	Joyce R, Webb R, and Peacock J L. Associations between perinatal interventions and hospital stillbirth rates and neonatal mortality. Archives of Diseases in Childhood, Fetal and Neonatal Edition. 2004; 89:F51-F56. **Study aim** To examine the effect of obstetric, paediatric and special care baby unit factors (including staffing and department organisation) upon stillbirth rates and neonatal mortality **Study type** Correlational study **Source of funding** None reported **Time period/length of follow up** 1994 to 1996 **Country** UK (England) **Quality score** **Internal validity** + **External validity** ++ **Overall score** +
Population and setting	**Setting** All maternity units in hospitals in the Thames Region **Stage of care** Not specified. Outcomes assessed were in the intrapartum or neonatal period.

	Number of hospitals/units 64 hospital maternity units (one additional hospital was excluded due to absent data) **Number of women/births** 540,834 births (3,150 stillbirths and 537,684 live births, including 2088 neonatal deaths), including a mean 2.9% of babies at each hospital from multiple births. Number of women not reported. **Skill mix/type/duties of midwives** Not described **Key characteristics of hospitals/units assessed** Data are mean (SD; range): Births in hospital/year: 2,877 (807.7; 872 to 4,214) Midwives/1000 deliveries/year: 29.6 (6.62, 18.3 to 47.0) Consultant O&G sessions on labour ward/week: 2.5 (2.45; 0 to 10) Number consultant O&G staff/1000 deliveries: 1.4 (0.63; 0.7 to 4.7) Number junior O&G staff/1000 deliveries: 4.3 (2.34; 0.5 to 18.3) Number consultant paediatricians/1000 births: 1.2 (0.53; 0.34 to 3.26) Number junior paediatricians/1000 births: 2.9 (1.03; 0.9 to 6.5) Consultant anaesthetist sessions on labour ward/week: 4.1 (1.78; 1 to 10) Number of delivery beds/ 1000 deliveries: 3.6 (0.80; 2.4 to 6.6) NICU beds/1000 deliveries: 1.3 (1.13; 0 to 6.8) SBCU beds (including NICU)/1000 deliveries: 6.1 (2.10; 2.6 to 17.0) **Key characteristics of participants assessed** Data are mean at each hospital (SD; range): % of births to nulliparous women: 41.0 (4.17; 32.4 to 58.6) % of births to teenage mothers: 5.0 (1.77; 2.0 to 10.0) % of births to women >40 years: 2.2 (0.75; 1.0 to 4.7)

	% of births to fathers of manual or "other'' class: 50.4 (10.69; 27.0 to 72.3) Townsend deprivation score of babies born: 1.0 (2.34; -2.2 to 7.1) **Data sources** Four national: Office for National Statistics (ONS) birth and death registrations; the 1991 Census; Royal College of Obstetricians and Gynaecologists (RCOG) hospital recognition returns; and DOH data on hospital staffing levels. One regional: Thames risk management survey
Factors assessed	**Midwife staffing** Midwives /1000 deliveries/year **Other staffing factors** Number of consultant obstetric and gynaecological (O&G) staff and sessions on the labour ward, number of junior O&G staff, number of consultant and junior paediatricians, number of consultant anaesthetist sessions on labour ward **Maternal and neonatal factors** Births per year; mean birth weight; spontaneous vaginal deliveries, caesareans and instrumental deliveries per 100 births; vaginal births, emergency and elective caesareans per 100 breeches; inductions per 100 deliveries; epidurals per 100 deliveries; general anaesthetics per 100 caesareans; % teenage mothers, % mothers >40 years, % nulliparous, % multiple births **Environmental factors** Deprivation of birth district (mean Townsend score), social class of fathers (manual or 'other'), delivery bed rate, neonatal intensive care unit (NICU) rate, special care baby unit (SCBU)+NICU rate (indicator of unit level), dedicated maternity theatre, a 24-hour epidural service **Management factors** Not assessed **Organisational factors** Whether the unit has a risk manager, the grade of the risk manager, and frequency of perinatal meetings **Control factors/adjustment** Factors were grouped into four types: those related to facilities, staffing, interventions, and parental data, and analysed independently. All outcomes were standardised by birthweight, but no other factors were adjusted for.
Comparison	Higher versus lower midwife staffing ratios (midwives/1000

	deliveries/year) compared using regression
Outcomes and analysis	**Maternal/neonatal outcomes** Stillbirth and neonatal mortality rates, crude and standardised per 500g birthweight band **Process of care outcomes** None **Reported feedback** None **Other outcomes** None **Analysis** Factors were all assessed in simple linear regression or t-test analyses as appropriate, followed by multivariate regression models
Results	**Maternal/neonatal outcomes** Crude stillbirth rate 5.69 (SD 2.01; range 1.93 to 12.42) Standardised stillbirth rate 5.84 (SD 1.25; range 3.40 to 8.53) Crude neonatal mortality 3.54 (SD 2.29; range 1.11 to 11.73) Standardised neonatal mortality 3.48 (SD 0.83; range 1.90 to 5.39) Birthweight accounted for over 70% of the overall variability in crude stillbirth and neonatal mortality rates: 1. Mean birthweight: R2 0.708, p<0.001 % births <1.5kg: R2 0.752, p<0.001 % births <2.5kg: R2 0.719, p<0.001 In univariate linear regression analyses midwife staffing levels (midwives per 1000 deliveries) were not significantly associated with any outcome: Standardised stillbirth rate (SSBR): beta 0.012, R2 0.004, p=0.65 Standardised neonatal mortality (SNNM): beta -0.012, R2 0.010, p=0.50 Various other factors were significantly associated with SSBR in univariate analysis. In the four types of category examined these were (beta, R2, p): <u>Facilities</u> NICU beds per 1000 births (-0.378, 0.123, 0.006) and SCBU and NICU beds per 1000 births (-0.153, 0.07, 0.04) <u>Staffing</u> Consultant O&Gs per 1000 deliveries (-0.681, 0.13, 0.006) <u>Interventions</u>

	Spontaneous vaginal deliveries per 100 births (0.088, 0.148, 0.002), caesareans per 100 deliveries (-0.091, 0.083, 0.026), forceps per 100 births (-0.176, 0.074, 0.035), instrumental deliveries per 100 births (-0.153, 0.114, 0.008), general anaesthetics per 100 caesareans (0.032, 0.161, 0.002), epidurals per 100 deliveries (-0.036, 0.167, 0.001), and epidurals for labour per 100 deliveries (-0.042, 0.130, 0.005) Parental % nulliparous (married) women (-0.079, 0.069, 0.037), % teenage mothers (0.183, 0.067, 0.038), % fathers of manual or "other" class (0.039, 0.108, 0.008), % babies from multiple births (-0.485, 0.173, 0.001) The above facilities components explained 90% of the total variation in SSBR, interventional factors 78%, and parental factors 88%. On the final multiple regression model two factors were significantly associated with SSBR: Intervention score (beta -0.21, SE 0.07, R2 0.27, p=0.003), and number of consultant O&Gs per 1000 births (beta -0.55, SE 0.23, p=0.019) An increase of one IQR (2.47 units) in the intervention score was associated with a 0.52 reduction in SSBR, and with one IQR increase in number of consultants per 1000 births was associated with a 0.26 reduction. Mean Townsend score was the only factor significantly associated with SNNM on univariate analysis (beta 0.106, R2 0.090, p=0.016) Organisational factors of having a dedicated maternity theatre, 24 hour epidural service, risk manager, grade of risk manager, or frequency of perinatal meetings, were not associated with SSBR or SNNM.
Notes/comments	**Author conclusions** "Birthweight adjusted stillbirth rates were significantly lower in units that took a more interventionalist approach and in those with higher levels of consultant obstetric staffing. There were no apparent associations between neonatal death rates and the hospital factors measured". **Author limitations** Hospital level analysis was the only feasible approach, as RCTs would not be ethical or feasible, and individual level observational studies would be confounded. There was no data available on neonatal nurse staffing levels, which may have been associated with mortality. **Review team limitations** Midwife numbers data was only available rounded to the nearest 10. ONS, Census, and DOH staffing data were almost 100% complete. Not all hospitals provided all data, with RCOG data available for 95% of hospitals

	for at least one year (range 66% to 86% for each year assessed). Returns were 94% complete. The Thames risk management survey had an 84% response rate, though all returned surveys were fully complete. These response rates are relatively high, but missing data may reduce accuracy of analyses. Multiple comparisons were carried out and it was unclear whether this had been taken into account (p value for significance was 0.05). The data being analysed was from 1994-1996 and may not be representative of current UK practice. Although a range of factors were assessed for association with outcomes there were relatively few maternal characteristics adjusted for (parity [% nulliparous], age [% teenagers and % >40], and multiple births). **Other comments** Study was large and included a large number of hospitals, over a few years, with a range of clinical risk, case mix, and organisational variety.
Tucker et al. 2003	
Study details	Tucker J, Parry G, Penney G et al. Is midwife workload associated with quality of process of care (continuous electronic fetal monitoring [CEFM]) and neonatal outcome indicators? A prospective study in consultant-led labour wards in Scotland. Paediatric and Perinatal Epidemiology. 2003; 17; 369-377. **Study aim** To assess the association between midwife workload and CEFM and neonatal outcome. **Study type** Cohort study **Source of funding** None reported **Time period/length of follow up** 4 weeks in September 2000 **Country** UK (Scotland) **Quality score** **Internal validity** + **External validity** +

	Overall score +
Population and setting	**Setting** All consultant-led labour wards in Scotland (midwife led units not included) **Stage of care** Not specified. Outcomes assessed were in the intrapartum and neonatal periods. **Number of hospitals/units** 23 consultant-led labour wards **Number of women/births** 3,489 consecutive live births (representing 85% of births registered in Scotland for the 4-week study period); 1,561 consecutively delivered women were available for CEFM case review during the 2 of the study weeks **Skill mix/type/duties of midwives** Log recorded midwives as core labour midwives, midwives in rotation into labour ward, caseload carrying midwives, and bank/agency midwives. However, numbers of each not reported or analysed. **Key characteristics of hospitals/units assessed** 5 units had <1000 births annually, 7 units 1000-1999, 5 units 2000-2999, and 6 units 3000-6999. Occupancy, the proportion of observations when there were no women on the labour ward (95% CI): 31% (28 to 33) for units with <1000 births annually; 9% (9.0 to 9.7) for units 1000-1999; 2.8% (2.7 to 3) for units 2000-2999, and 0.14% (0.12 to 0.17) for units with 3000-6999 births annually. The proportion of observations for shortfall staffing where there was less than 1 midwife to 1 woman for all deliveries [as derived from the Framework for Maternity Services in Scotland] was: 21% for units with <1000 births annually; 10% for units 1000-1999; 13% for units 2000-2999; and 18% for units with 3000-6999 births annually. Overall proportion of observations with shortfall: 15%, with significant difference between units ($p<0.001$) The median midwife staffing ratio (IQR), observed/required was: 1.0 (1.0 to 2.0) for units with <1000 births annually; 1.3 (1.0 to 2.0) for units 1000-1999; 1.5 (1.1 to 2.0) for units 2000-2999; and 1.3 (1.0 to 1.8) for units with 3000-6999 births annually. The overall proportion of observations The proportion of observations for shortfall staffing where the midwife: woman ratio did not meet the requirement for case mix (as derived from Birthrate Plus: 1:1 for normal labour; 2.3:1 for high dependency group A

	[caesarean, instrumental delivery, intensive monitoring, general anaesthetic, baby with Apgar<5]; 1.5:1 for high dependency group B [induced or augmented labour, intravenous therapy, epidural, labour lasting >8 hours, perineal trauma requiring suture]; and 0.25:1 for transfer or others [early, not established labour; delivered awaiting transfer; spontaneous rupture of membranes not in labour]) was: 21% for units with <1000 births annually; 32% for units 1000-1999; 33% for units 2000-2999; and 46% for units with 3000-6999 births annually. Overall proportion of observations with shortfall: 35%, with significant difference between units (p<0.001) The median midwife staffing ratio (IQR), observed/required for case mix was: 1.7 (1.0 to 4.0) for units with <1000 births annually; 1.3 (0.9 to 2.4) for units 1000-1999; 1.3 (0.9 to 2.2) for units 2000-2999; and 1.0 (0.8 to 1.6) for units with 3000-6999 births annually. **Key characteristics of participants assessed** Of the 1,561 cases for whom CEFM was analysed, 1,168 (75%) had CEFM. Of those who had CEFM, use was considered appropriate in 79% of cases (924) and inappropriate in the remaining 224, defined as women with no recorded risk characteristics having CEFM (45% [224/544] of women with no risk characteristics). Of the 393 who did not have CEFM, this was considered appropriate in 76% (300) and inappropriate in the remaining 93, defined as women with at least one recorded risk factor not having CEFM (9% [93/1017] with risk characteristics). No other participant characteristics reported. **Data sources** Workload data recorded by shift leaders 4 times daily using a log based on RCOG National Sentinel Caesarean Section Audit of England and Wales, and revised following pilot studies. Midwives were trained to record workload and CEFM data, and there was a helpline for queries. Telephone calls were used to check that logs were completed accurately and on time, and were checked for completeness and internal consistency when submitted weekly. CEFM was collected as part of a national audit in 2 of the study weeks, plus another 2 weeks. National routine data on maternal comorbidity (ICD-10) births and neonatal outcomes was obtained from Information and Statistics Division of NHS Scotland.
Factors assessed	**Midwife staffing** Ratio of observed midwives to 'required' number of midwives accounting for case mix (ratios <1 indicate fewer midwives than required) based on Birthrate Plus.

	Other staffing factors None reported **Maternal and neonatal factors** Fetal heart rate anomaly at admission or in labour, pre-eclampsia, suspected abruption, previous caesarean, no liquor, preterm labour, meconium stained liquor, oyctocin to induce or accelerate labour, and epidural were associated with outcomes and adjusted for. Birthweight was tested as a confounder but did not show association. **Environmental factors** Unit occupancy (% beds empty) was assessed for potential association with outcomes along with midwife staffing, but it was unclear if it was adjusted for in the staffing analyses and vice versa. **Management factors** None reported **Organisational factors** None reported **Control variables/adjustment** Confounding variables were fitted as risk factors in the regression. The full list of potential confounders tested was not reported, but the ones showing links with outcomes are reported above.
Comparison	Higher versus lower midwife staffing ratios (midwives:women) compared using regression
Outcomes and analysis	**Maternal/neonatal outcomes** Apgar score <7 at 5 minutes, admission to neonatal unit (NNU) >48 hours, any neonatal resuscitation (bag and mask with no drugs, bag and mask with drugs, intubation for invasive positive pressure ventilation (IPPV) with or without drugs, or drugs only), resuscitations other than those with bag and mask only **Process of care outcomes** Adjusted rates of CEFM, appropriate or inappropriate CEFM (either use when not indicated by risk factor or no use when indicated), time to senior medical response (4th year specialist registrar or above) for a serious fetal heart trace abnormality **Reported feedback** None **Other outcomes** None

	Analysis A random effects model was used to take into account clustering. For testing effect of staffing on CEFM, unit workload at the time of admission was used; for time to medical response outcome workload at time of first recording the serious heart trace abnormality was used, and for neonatal outcomes the workload immediately at or before time of birth was used.
Results	**Maternal/neonatal outcomes** After adjusting for confounding variables, there was a trend for slight reductions in odds of neonatal outcomes with increasing midwife staffing ratio, but only one of these reached significance (resuscitations, not including bag and mask only resuscitations). OR (95% CI) for every 1 point increase in the midwife staffing ratio and the stated outcomes: Apgar <7 at 5 minutes 0.98 (0.94 to 1.04) (AR 67/3,404, 1.9%) Any resuscitation (including 'lowest level' i.e. bag and mask with no drugs) 0.98 (0.96 to 1.00)(AR 411/3,404, 12%; 228/411, 55% with bag and mask only) Resuscitations excluding bag and mask only 0.97 (0.94 to 0.99)(AR 183/3,404, 5%) >48h admission to the NNU 0.97 (0.95 to 1.00)(AR not reported) Unit occupancy was not significantly related to any of these outcomes. **Process of care outcomes** After adjusting for confounding variables, there was no significant association between midwife staffing ratios (or unit occupancy) and overall use, appropriate or inappropriate use of CEFM, or lag time for senior medical response. OR (95% CI) for every 1 point increase in the midwife staffing ratio and the stated outcomes: Having CEFM 1.00 (0.77 to 1.29) Having inappropriate CEFM 1.44 (0.85 to 2.45) Having appropriate CEFM for high risk cases 0.90 (0.63 to 1.30) Having appropriate CEFM for low risk cases 1.12 (0.85 to 1.47)

	Difference in lag time for senior medical response for a 1 point increase in ratio -7.8 minutes (-52.4 to 36.8)
Notes/comments	**Author conclusions** "There were no associations between occupancy or staffing ratios and adjusted CEFM process, Apgar <7 at 5 minutes, or admission to NNU for >48 hours. However, there was association between increasing staffing ratios and lower odds of adjusted neonatal resuscitation (excluding bag and mask only). The direction of effect of increasing workload suggests detriment to outcome indicators, although the size of effect may be small". **Author limitations** Study recruitment was slightly lower than required to reach the planned level of power. The actual study size gave power to detect an OR for CEFM use of 1.33, smaller effects may not be detected. No information on maternal preferences for CEFM were collected, and this may impact use. **Review team limitations** The time period observed was relatively short (4 weeks) and may not be representative of a longer time period. The discussion mentioned medical staff availability in the labour ward being available for 95% of daytime periods, but this factor did not appear to be taken into account in the analyses **Other comments** The main analyses utilised Birthrate Plus to determine required number of midwives accounting for the case mix/dependency. The relationship between achieving an unadjusted ratio of 1 midwife: 1 woman for all categories (as derived from Framework for Maternity Services in Scotland) and outcomes was only assessed for one outcome (having CEFM). The relationship between another set of requirements accounting for administrative tasks (derived from Towards Safer Childbirth) but not case mix (with midwife: woman requirement being 1.15 for normal and high dependency categories, and 0.25 midwives per woman for transfer and others) was not assessed. The study targeted recruitment to have about 80% power to detect difference in neonatal resuscitations of 3% (12% vs. 15%; n=4,204 needed) and a difference of 1.2% in Apgar<7 (1% vs. 2.2%; n=3,756 needed) at p=0.05. Actual livebirths were slightly lower (n=3,489) meaning that power was lower than planned (n=3,756). Case ascertainment for CEFM was judged complete based on the number of cases returned for the 4 week period as a proportion of per total annual deliveries per unit. Workload logs were complete for 15/23 units (all units returned logs); only

	23/2576 (0.9%) time point records had some missing midwife or woman data fields (1-8 records per unit). 99% of CEFM processes had complete data, and 3,083/3,489 (88%) neonates provided outcome data (elective caesarean, midwife birthing unit births, and multiple pregnancies excluded)
Joyce et al. 2002	
Study details	Joyce R, Webb R and Peacock J. Predictors of obstetric intervention rates: case-mix, staffing levels and organisational factors of hospital of birth. Journal of Obstetrics and Gynaecology. 2002; 22 (6): 618-625. **Study aim** To determine if case mix, staffing levels, or organisational factors are associated with obstetric intervention rates **Study type** Correlational study **Source of funding** None reported **Time period/length of follow up** 1994-1996 **Country** UK (England) **Quality score** **Internal validity** + **External validity** ++ **Overall score** +
Population and setting	**Setting** All Thames region maternity units, all in hospitals (no midwife led units) **Stage of care** Not stated. Outcomes assessed were in the intrapartum period. **Number of hospitals/units** 64 hospital maternity units **Number of women/births** 540,834 births **Skill mix/type/duties of midwives** Not described

	Key characteristics of hospitals/units assessed Data are mean (SD; range) Births in hospital/year: 2,877 (807.7; 872 to 4,214) Midwives/1000 deliveries/year: 29.6 (6.62, 18.3 to 47.0) Consultant O&G sessions on labour ward/week: 2.5 (1.86; 0 to 10) Number consultant O&G staff/1000 deliveries/year: 1.4 (0.63; 0.7 to 4.7) Number junior O&G staff/1000 deliveries/year: 4.3 (2.33; 0.5 to 18.3) Consultant anaesthetist sessions on labour ward/week: 4.1 (1.78; 1 to 10) Number of beds/ 1000 deliveries/year: 3.6 (0.80; 2.4 to 6.6) 92.5% had a dedicated maternity theatre NICU beds/1000 deliveries/year: 1.3 (1.13; 0 to 6.8) SBCU beds (including NICU)/1000 deliveries/year: 6.1 (2.10; 2.6 to 17.1) **Data sources** Four national data sources: Office of National Statistics (ONS) birth registrations; Manchester Information and Associated Services (MIMAS) Census data; Royal College of Obstetricians and Gynaecologists (RCOG) Hospital Recognition data returns; and the DOH. Anonymised individual data were obtained for all live and stillbirths for all hospitals in North and South Thames for 1994–96.
Factors assessed	**Midwife staffing** Midwives /1000 deliveries/year **Other staffing factors** Number of consultant obstetric and gynaecological (O&G) staff and sessions on the labour ward, number of junior O&G staff **Maternal and neonatal factors** Births per year, instrumental vaginal delivery (IVD) rate, induction rate, epidural rate, mean birth weight, low birth weight (<1500g), % teenage mothers, % mothers >40 years, % nulliparous, % multiple births **Environmental factors** Deprivation of birth district (mean Townsend score), social class of fathers (manual or 'other'), delivery bed rate, neonatal intensive care unit (NICU) rate, special care baby unit (SCBU)+NICU rate (indicator of unit level), dedicated maternity theatre **Management factors**

	Not assessed **Organisational factors** Not assessed **Control variables/adjustment** All factors described above were assessed as independent variables in the regression analysis, no additional factors controlled for
Comparison	Higher versus lower midwife staffing ratios (midwives:women) compared using regression
Outcomes and analysis	**Maternal/neonatal outcomes** IVD (included forceps or vacuum extraction), overall caesarean section (caesarean) rate, epidural rate for labour (not overall epidural rate as this included epidurals for caesareans) **Process of care outcomes** None **Reported feedback** None **Other outcomes** None **Analysis** Factors were all assessed in simple linear regression or t-test analyses as appropriate, followed by multivariate regression models
Results	**Maternal/neonatal outcomes** Mean caesarean rate 18.0 per 100 deliveries (SD 3.84; range 8.0 to 33.4) Mean IVD rate per 100 births 11.1 (SD 2.68; range 5.0 to 19.1) Mean labour epidural rate per 100 labour deliveries 20.3 (SD 10.53; range 2.6 to 55.5) In univariate linear regression analyses midwife staffing levels were not significantly associated with caesarean or IVD rates, but showed a significant inverse association with epidural rates: Caesarean: beta -0.117 (SE 0.086), R2 0.038, p=0.181 IVD: beta -0.087 (SE 0.052), R2 0.055, p=0.105 Epidural rate: beta -0.532 (SE 0.264), R2 0.081, p=0.049 Various other factors were associated with these outcomes in univariate analysis. These were: <u>Interventional factors</u> *Associated with caesarean:* Epidural rate: beta 0.142 (SE 0.033), R2 0.250, p<0.001

	Epidural labour rate: beta 0.147 (SE 0.045), R2 0.159, p=0.002 IVD rate: beta 0.407 (SE 0.180), R2 0.081, p=0.028 *Associated with IVD rates:* Epidural rate: beta 0.155 (SE 0.016), R2 0.610, p<0.001 Epidural labour rate: beta 0.195 (SE 0.022), R2 0.574, p<0.001 Caesarean rate: beta 0.199, (SE 0.088), R2 0.081, p=0.028 *Associated with epidural rates:* IVD rate: beta 3.942 (SE 0.418), R2 0.610, p<0.001 Caesarean rate: beta 1.762 (SE 0.404), R2 0.250, p<0.001 <u>Maternal factors</u> <u>*Associated with caesarean:*</u> Percentage mothers >40 years: beta 2.08 (SE 0.627), R2 0.159, p=0.002 Percentage multiple births: beta 1.55 (SE 0.430), R2 0.185, p=0.001 Percentage nulliparous: beta -0.32 (SE 0.148), R2 0.076, p=0.033 *Associated with IVD rates:* Percentage mothers >40 years: beta 1.895 (SE 0.408), R2 0.271 p<0.001 Percentage teenage mothers: beta -0.968 (SE 0.158) R2 0.393, p<0.001 *Associated with epidural rates:* Percentage mothers >40: beta 12.87 (SE 1.737), R2 0.490, p<0.001 Percentage teenage mothers: beta -4.66 (SE 0.828), R2 0.357, p<0.001 <u>Neonatal factors</u> Low birth weight was associated with caesarean: Mean birthweight: beta -0.014 (SE 0.006), R2 0.071, p=0.040 Births <1500g: beta 1.31 (SE 0.429), R2 0.138, p=0.004 <u>Demographic factors</u> Mean Townsend score was not associated with any outcome: Caesarean rate: beta 0.337 (SE 0.211), R2 0.042, p=0.116 IVD rate: beta -0.167 (SE 0.149), R2 0.021, p=0.269 Epidural labour rate: beta 0.395 (SE 0.765), R2 0.005, p=0.607 Father's professional class manual or 'other' was associated with IVD and epidural rates: Caesarean rate: beta -0.08 (SE 0.048), R2 0.049, p=0.088 IVD rate: beta -0.193 (SE 0.024), R2 0.539, p<0.001 Epidural labour rate: beta -0.96 (SE 0.120), R2 0.530, p<0·001 Unit structure Units size was associated with caesarean: Delivery bed rate: beta 1.379 (SE 0.606), R2 0.082, p=0.026 NICU rate: beta 1.073 (SE 0.424), R2 0.100, p=0.014 SCBU +NICU rate: 0.542 (SE 0.229), R2 0.088, p=0.022 Births per year was not associated: beta 0.0002 (SE 0.001), R2 0.001, p=0.819 There were no significant associations between unit size and IVD and epidural rates.

	The presence of a dedicated maternity theatre was not associated with any outcomes: Caesarean: t test for mean rate with a theatre 17.89 vs. 4.16 without (p=0.177) IVD rate: 10.90 with vs. 9.66 without (p=0.530) Epidural rate: 20.82 with vs. 11.16 (p=0.180) Other staffing factors: *Associated with caesarean:* Consultant O&G rate: beta 1.968 (SE 0.786), R2 0.105, p=0.013 Junior O&G rate: beta 0.862 (SE 0.188), R2 0.273, p<0.001 No significant associations with consultant O&G or consultant anaesthetic sessions on labour ward *Associated with epidural:* Consultant anaesthetic sessions labour: beta 2.013 (SE 0.993), R2 0.067, p=0.047 Junior O&G rate: beta 1.539 (SE 0.765), R2 0.069, p=0.049 No significant associations with consultant O&G rates or consultant O&G sessions on labour ward No significant associations between IVD rates and any staffing variable Midwife staffing was not one of the factors that remained associated in the final multivariate regression models for these outcomes. These were: Caesarean (beta, SE): labour epidural rate (0.126, 0.039), delivery bed rate (1.356, 0.504), and junior O&G rate (0.671, 0.178); R2 0.435, p<0.001 IVD: labour epidural rate (0.123, 0.028), % manual or 'other' social class (-0.105, 0.029), R2 0.644, p<0.001 Epidural rate: % manual or 'other' social class (-0.49, 0.094), % mothers 40+ years (6.30, 1.310); R2 0.637, p<0.001
Notes/comments	**Author conclusions** "In contrast to recent media speculation, no association of caesarean section rates with midwifery staffing levels was found after adjustment for confounders. The only association with staffing was with levels of junior obstetric staffing, which could be a reflection of less experienced management of labour. Caesarean section rates were also associated positively with the levels of delivery beds, which could be a reflection of the closer monitoring of labour that may result from increased bed availability. Both caesarean section and instrumental vaginal delivery rates were associated with epidural rates, which was expected from the literature. Variations in epidural rates were mainly associated with variations in demographic case-mix, due possibly to patient demand. Demographic case-mix was also associated with instrumental vaginal deliveries but not the caesarean section rate".

	Author limitations Hospital level analysis was the only feasible approach, as RCTs would not be ethical or feasible, and individual level observational studies would be confounded. Midwife numbers data was only available rounded to the nearest 10. **Review team limitations** Not all hospitals provided all data, with RCOG data available for 95% of hospitals for at least one year (range 66% to 86% for each year assessed). Missing data may reduce accuracy of analyses. Multiple comparisons were carried out and it was unclear whether this had been taken into account (p value for significance was 0.05). The data being analysed was from 1994-1996 and may not be representative of current UK practice. A variety of factors were assessed for impact on outcomes, but relatively few maternal characteristics (parity [% nulliparity], age [% teenagers and % >40], and multiple births). **Other comments** Study was large and included a large number of hospitals, over a few years, with a range of clinical risk, case mix, and organisational variety.
The North Staffordshire Changing Childbirth Research Team (NSCCRT), 2000	
Study details	The North Staffordshire Changing Childbirth Research Team. A randomised study of midwifery caseload care and traditional 'shared-care'. Midwifery, 2000; 16:295-302. **Study aim** To compare caseload midwifery with traditional shared care on the level of "knowledge of carer at delivery" achieved and the effect that this has on maternal and neonatal health outcomes. **Study type** Cluster randomised controlled trial, with randomisation by geographic location (n=6). Randomisation was by one of the principal investigators, who was presented with 3 pairs of geographical location and randomised one of each to caseload care and the other to traditional shared care. The trial was not blinded, with both women and professionals aware of care group allocation. **Source of funding** The North Staffordshire Health Authority

	Time period/length of follow up Data was collected up until the first 1500 deliveries, then for a further 6 months (dates not given) **Country** UK (North Staffordshire, England) **Quality score** **Internal validity** + **External validity** + **Overall score** +
Population and setting	**Setting** Primary care, 6 geographic regions, including an even mix of urban, rural, and mixed urban and rural areas, and their associated district general hospitals (not further described) **Stage of care** Not specified. Caseload midwives would be involved in all stages of care. Outcomes assessed were intrapartum and neonatal periods. **Number of hospitals/units** A total 35 GP practices in the 6 geographic regions. The number of hospital maternity units involved in care is not described. **Number of women/births** 1,505 women/deliveries (770 in caseload areas and 735 in shared care areas) 17 deliveries in the caseload areas, and 14 in the shared care areas, were in a "multiple and breech" category (total number of babies not reported) **Skill mix/type/duties of midwives** <u>Caseload care</u> 26 midwives (21 whole-time equivalent), including both senior (usually more than 5 years' experience) and junior midwives (usually at least 2 years' experience) who were recruited from the community and from hospitals in North Staffordshire. Midwives were attached to 1-3 general practices and assigned 35-40 women at study start, for whom they provided the majority of care, in collaboration with medical colleagues. The number of midwives working in each of the 3 regions allocated to caseload care was 7, 9 and 10. Within these groups, midwives worked in groups of 2 or 3 to achieve high continuity of care, with all antenatal sessions including the woman's "named midwife" and her partner midwife.

	Traditional shared care Number of midwives not reported. Nine midwives were reported as working in the shared care areas prior to the study. Three midwives withdrew before the study, but it was not clear which area they came from, and it not reported whether any additional midwives were recruited for the shared care areas. They continued to follow what was reported as the "current UK 'shared care' model", with a caseload of 100-150 women, with 10% of women expected to be delivered by her "named midwife". A project steering group negotiated the boundaries of care and assessed skill requirements in both groups of midwives at weekly meetings. An individualised skill enhancement programme was carried out at the start of the project to ensure confidence and competence of midwives in new roles. It was unclear whether this training was only offered to caseload midwives, although this is implied by the fact that the caseload approach was new and the comparator was the traditional approach to care. Each midwife kept a monthly audit sheet documenting continuity of care. **Key characteristics of hospitals/units assessed** 26 midwives in caseload care with a caseload of 35-40 women each 16 midwives in shared care with the shared care of 100-150 women each (no other information on primary or secondary care characteristics) **Key characteristics of participants assessed** Women in caseload areas (n=770): mean age 27.8; 32.4% primiparous; 22.8% current smokers; 63.8% married; 96.6% of white ethnicity; area of residence 38.4% rural, 27.3% urban, 34.3% mixed Women in shared care areas (n=735): mean age 27.7; 34% primiparous; 24.2% current smokers; 65.5% married; 96.8% of white ethnicity; area of residence 31.5% rural, 32.5% urban, 36% mixed No significant difference in maternal characteristics between groups **Data sources** Health outcome data for each individual woman was obtained from the hospital information system (CCL computer), supplemented by review of case records for missing data, or if there was intrauterine or neonatal death.
Intervention	Caseload care, with a caseload of 35-40 women per midwife
Comparator	Traditional shared care with a caseload of 100-150 women, the extent of overlap between midwives' caseloads or ratio of midwives to women was not reported.
Outcomes and analysis	**Maternal/neonatal outcomes** Normal vaginal delivery rate (primary outcome) Perineal injury, use of syntocinon, epidural analgesia, and neonatal outcomes (all secondary)

	Process of care outcomes Attendance in labour by a known midwife (primary outcome), as completed on the "results sheet" by delivering midwife. **Reported feedback** None **Other outcomes** None **Analysis** Based on independent observations for each woman, the categorical outcomes were analysed using chi squared tests. Only women completing the study were included (1% assumed migration). The data was combined for the three pairs allocated to caseload care and to shared care.
Results	**Maternal/neonatal outcomes** *Modes of delivery:* no significant differences (p=0.15; note p value is for chi squared test across all modes of delivery) Normal vaginal delivery rate: caseload 70% (542/770) vs. and shared care 69% (509/735) Instrumental (ventouse/forceps): 10% (74/770) vs. 11.5% (84/735) Emergency caesarean: 8% (62/770) vs. 10.5% (76/735) Elective caesarean: 10% (75/770) vs. 7% (52/735) Multiple & breech delivery: 2% (17/770) vs. 2% (14/735) Duration of labour: (p=0.001; note p value is for chi squared test across all duration of labour) Less than 8 hours: caseload 58.5% (451/770) vs. and shared care 68.4% (503/735) 8 to 12 hours: caseload 36.35% (280/770) vs. and shared care 27% (198/735) More than 12 hours: caseload 5.2% (39/770) vs. and shared care 4.6% (34/735) Epidural analgesia: significantly less common with caseload (10.4%; 80/770) than shared care (15%; 110/735) (p=0.01) Induction of labour: no significant difference between caseload (17.4%; 134/770) and shared care (18%; 133/735) (p=0.78) Syntocinon augmentation of labour: significantly less common with caseload (46%; 351/770) than shared care (53%; 387/735) (p=0.01) Intact perineum: no significant difference between caseload (48%; 370/770) and shared care (49%; 361/735) (p=0.72) Perineal laceration: no significant difference between caseload (24.6%; 197/770) and shared care (24.5%; 180/735) (p=0.67) Perineal tear: no significant difference between caseload (32.2%; 248/770)

	and shared care (30%; 221/735) (p=0.40) Episiotomy: no significant difference between caseload (23.5%; 181/770) and shared care (24%; 175/735) (p=0.94) Gestation length: no significant difference (p=0.16; note p value is for chi squared test across all gestations) <24 weeks: caseload 0.6% (5/770) vs. shared care 0.5% (4/735) 24 to 34weeks: 3.2% (25/770) vs. 3.2 (24/735) 34 to 40 weeks: 72.2% (557/770) vs. 69% (506/735) >40weeks: 24% (183/770) vs. 27.3% (201/735) No significant difference for any neonatal outcomes: Stillbirth and neonatal death: caseload 0.7% (6/770) vs. shared care 1.5% (11/735) (p=0.28) Advanced resuscitation: caseload 1.2% (10/770) vs. shared care 0.8% (6/735) (p=0.51) Neonatal unit admission: caseload 5.8% (45/770) vs. shared care 4.6% (34/735) (p=0.34) Birthweight <2.5kg: caseload 6.7% (52/770) vs. shared care 6.9% (51/735) (p=0.96) **Process of care outcomes** Attendance in labour by a known midwife or midwifery partner: significantly more common with caseload care (94.7%; 696/770) than with shared care (6.7%; 52/735) (p<0.001)
Notes/comments	**Author conclusions** "Caseload midwifery results in high levels of 'known carer at delivery' which appears to be associated with a reduction in augmentation and epidural rates but which were not associated with an increase in normal vaginal delivery rate." **Author limitations** The small number of only 6 areas randomised. A RCT where the unit of randomisation was the individual mother or GP was not possible due to the logistics of running caseload and shared care simultaneously in the same place. Insufficient power to reliably detect differences in neonatal outcomes Focus on delivery outcomes only (though maternal and professional feedback, and economic evaluation were to be reported separately) **Review team limitations** This RCT is primarily an assessment of continuity of care and whether caseload care improves the proportion of women who are attended in labour by a midwife who is known to them, and whether this improves

	other intrapartum outcomes compared to shared care, rather than an assessment of different staffing levels. The caseload midwives had care of 35 to 40 women (with care of any individual woman shared between only 2-3 midwives), compared to the shared care midwives who were involved in the shared care of 100 to 150 women (where women have less continuity of midwives involved in their care). While the division of care among the team of midwives differs, whether the staffing level (i.e. overall ratio of midwives: women) in each group differed was not reported. If staffing levels did differ between the groups, any effect of this could be confounded by the effect of the differences in division of care between midwives. The paper was published in 2000 and therefore the RCT much have been carried out prior to this. The study may be less representative of current UK practice than the more recent studies.