

Original Article

Ethnicity, socio-economic deprivation and postpartum outcomes following caesarean delivery: a multicentre cohort study

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Keywords: postpartum recovery; ethnicity; disparity; socio-economic factors; patient-reported outcome measures

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Summary

Disparities relating to postpartum recovery outcomes in different socio-economic and racial-ethnic groups are underexplored. We conducted a planned analysis of a large prospective caesarean delivery cohort to explore the relationship between ethnicity, socioeconomic status and postpartum recovery. Eligible patients were enrolled and baseline demographic, obstetric and medical history data were collected 18 and 30 h following delivery. Patients completed postpartum quality of life and recovery measures in person on day 1 (EuroQoL EQ-5D-5L, including global health visual analogue scale; Obstetric Quality of Recovery-10 item score; and pain scores) and by telephone between day 28 and day 32 postpartum (EQ-5D-5L and pain scores). Socio-economic group was determined according to the Index of Multiple Deprivation quintile of each patient's usual place of residence. Data from 1000 patients who underwent caesarean delivery were included. There were more patients of Asian, Black and mixed ethnicity in the more deprived quintiles. Patients of White ethnicities had shorter postpartum duration of hospital stay compared with patients of Asian and Black ethnicities (35 (28-56 [18-513]) h vs. 44 (31-71 [19-465]) h vs. 49 (33-75 [23-189]) h, respectively. In adjusted models at day 30, patients of Asian ethnicity had a significantly greater risk of moderate or severe pain (numerical rating scale ≥ 4) at rest and on movement (odds ratio (95%CI) 2.42 (1.24–4.74) and 2.32 (1.40–3.87), respectively). There were no differences in readmission rates or complications between groups. Patients from White ethnic backgrounds experience shorter postpartum duration of stay compared with patients from Asian and Black ethnic groups. Ethnic background impacts pain scores and recovery at day 1 postpartum and following hospital discharge, even after adjusting for socioeconomic group. Further work is required to understand the underlying factors driving differences in pain and recovery, and to develop strategies to reduce disparities in obstetric patients.

Introduction

Disparities in maternal and neonatal outcomes between different ethnic and socio-economic groups have been documented widely [1–4]. The postpartum period is of great clinical importance given that the majority of maternal deaths, defined as death during pregnancy or within 1 year of the end of pregnancy, occur following delivery [5,6]. Health inequalities have been observed in more deprived socio-economic groups, with those living in the most deprived areas more than twice as likely to die as obstetric patients living in the wealthiest areas; 11% of maternal deaths occur in patients from severe and multiple disadvantaged backgrounds [6]. In the UK, maternal postpartum morbidity and mortality are significantly higher in minority ethnic groups, with Black patients four times more likely to die than White patients. Differences in obstetric anaesthesia mode have also been reported, with Black patients more likely to receive general (rather than neuraxial anaesthesia) for caesarean delivery than White patients [7]. Postpartum readmission rates have been reported to be approximately 30% higher in Black patients compared with White patients [8].

There is a paucity of prospective multicentre data exploring the relationship between ethnicity, socioeconomic status and postpartum recovery, particularly from outside the USA. Existing data are limited to retrospective analyses and single-centre studies in insurance-based healthcare settings and lack granularity in postpartum recovery assessment using validated patient-reported outcome measures. Previous studies exploring the impact of socio-economic status on maternal and neonatal outcomes have used income or occupation as the sole metric, which fail to comprehensively reflect all the relevant domains of deprivation [9]. Improved understanding of health inequalities during the postpartum recovery period could help improve patient recovery experience and potentially reduce maternal morbidity and mortality.

We conducted a planned analysis of the Obstetric Quality of Recovery (ObsQoR) after childbirth study, which provides a large and diverse cohort of prospectively collected data during inpatient hospitalisation and at 30 days postpartum [10]. We aimed to investigate the association between patient demographics, ethnicity and socio-economic status with inpatient and outpatient recovery metrics following childbirth. We hypothesised that patients from minority ethnic groups and/or more deprived socioeconomic groups would experience worse inpatient and outpatient recovery following caesarean delivery.

Methods

Following ethical approval, prospective trial registration and written informed consent, we performed this planned analysis, which is reported according to the STROBE checklist [11]. Briefly,

ObsQoR was a multicentre study that prospectively collected data from 107 participating obstetric units within the NHS in the UK during a two-week period in October 2021. Patients were recruited between 18 – 30 h postpartum, and data collection was performed on day 1 and between day 28 and 32 postpartum. Patients aged ≥ 18 y, ≥ 32 weeks gestational age at delivery and who were ASA physical status 1-4 were eligible for inclusion. We did not study patients with an inability to understand the questions asked in English, had suffered a neonatal death and/or were not NHS patients. We also did not study patients in whom ethnicity data were unavailable or if we were unable to link the usual place of residence to a valid lower-layer super output area in England [12]. Further methodological details are reported elsewhere [10].

Patients reported their own ethnicity and the Office of National Statistics categorisation system from the 2011 UK census was used for classification. Ethnicity was considered missing if it was not recorded or coded as 'not stated'. Ethnic origin was collapsed into five groups: Asian or Asian British; Black, Black British, Caribbean or African; mixed or multiple ethnic groups; White; and other. We used the Index of Multiple Deprivation (IMD) as a measure of socio-economic status. The IMD provides an area-level measure of deprivation derived from seven domains of income, education, employment, crime and living environment. Patients were categorised into five socioeconomic groups according to national deciles of IMD rankings of 32,844 lower-layer super output areas in England using publicly available data from 2019 [12].

Inpatient day 1 postpartum outcomes used to assess postpartum recovery included: postpartum duration of stay; numeric pain rating scale (NRS) scores (0-10, 0 no pain and 10 the worst imaginable pain) on movement and at rest; patient-reported quality of life metrics of Obstetric Quality of Recovery-10 item score (ObsQoR-10); EuroQoL EQ-5D-5L; and global health visual analogue scale (GHVAS) (0-100, 0 the worst and 100 the best global health score). We assessed the following at 28-32 days postpartum: rates of readmission; complications (defined as the requirement to have investigations, unanticipated general practitioner visit or re-attendance to hospital); use of analgesic medication in the preceding week; pain scores on movement and at rest; EQ-5D-5L; and GHVAS.

Patients in the ObsQoR study who underwent a scheduled or emergency caesarean delivery were analysed. Data were collected by centres over 3 days of a two-week period. There was no prespecified sample size or power calculation conducted. Data were cleaned and statistical analyses were performed using Excel v. 16.6 (Microsoft Corporation, Redmond, WA, USA.) and STATA v. 14.0 (Statacorp., College Station, TX, USA). The Shapiro–Wilk test was used to assess for normal

distribution of continuous variables. All reported statistical analyses were based on an analysis plan that was developed and approved before conducting the analysis to assess the influence of patient demographics on postpartum recovery. Analysis to assess for statistical differences between the reported ethnic groups was done using Kruskal-Wallis and multiple pairwise comparisons with the Dunn test. We performed a logistic regression analysis for adjusted and unadjusted models for pain on movement and rest at 24 h and 30 days, examining significant pain (NRS pain score ≥ 7) at 24 h, moderate pain (NRS pain score ≥ 4) at 30 days and GHVAS < 70 at both time points to understand the effects of possible confounders. Bonferroni correction was used for statistical significance for multiple comparisons. We assessed for multicollinearity between patient reported ethnicity, indices of deprivation and outcomes in the regression analyses, using variance inflation factors.

Results

Details of patient recruitment are summarised in Figure 1. Characteristics of the 1000 included patients are provided in Table 1. There were no differences in age; BMI; ASA physical status; parity; or gestational age between ethnic groups. Past medical history, with the exception of diabetes mellitus and sickle cell disease, was also between ethnic groups. Differences were seen between the groups related to deprivation, with significantly more Asian, Black and mixed ethnicity patients seen in the more deprived quintiles (Table 1).

Inpatient recovery and pain metrics are shown in Table 2. Overall median (IQR [range]) postpartum duration of stay was 39 (28- 62 [18- 513]) h. White patients had a shorter postpartum duration of stay compared with Asian and Black patients (median difference 9.28 h ($p=0.021$) and 13.85 h ($p=0.009$), respectively). There were no differences seen in patients from mixed or other ethnic groups. Significant differences were reported between ethnic groups for pain scores (at rest and on movement), ObsQoR-10 scores and GHVAS scores (Table 2).

Table 3 summarises the patient-reported outcome and recovery data at 30 days postpartum from 803 patients (response rate of 80%). There were significant differences reported in pain at rest and on movement in addition to differences in median EQ-5D-5L and GHVAS scores between ethnic groups. Analgesia utilisation, including opioid consumption in the week preceding 30 days postpartum, was similar between groups. There were no differences seen in readmission rates or complications between ethnic groups.

The crude and adjusted models for pain at rest and on movement and GHVAS (day 1 and day 30 postpartum) are summarised in Tables 4-6. In day 1 adjusted models, the risk of severe pain (NRS

pain score ≥ 7) at rest was significantly higher in patients who were ASA physical status 3 or 4 (OR (95% CI) 2.73 (1.35–5.54)). In addition, patients who had blood loss of 501–1499 ml had a higher risk of poor GHVAS scores (OR (95%CI) 0.69 (0.53–0.90)). At 30 days, Asian patients had significantly higher odds of moderate/severe pain (NRS pain score ≥ 4) at rest and on movement (OR (95%CI) 2.42 (1.24–4.74) and 2.32 (1.40–3.87), respectively). Patients who described themselves as ‘other’ ethnicity had higher odds of moderate/severe pain on movement (OR (95%CI) 4.21 (1.54–11.55)). No collinearity was found between ethnicity or indices of deprivation (online Supporting Information Appendix S2, Tables S1-S4).

Discussion

This national cohort study of maternal patient-centred outcomes found that patients of White ethnic background experienced a shorter duration of hospitalisation following caesarean delivery compared with patients of Black or Asian ethnicity. There is a clinically significant difference of almost 14 h between patient from White and Black ethnic backgrounds.

Other than socio-economic group, there were few differences in baseline characteristics which might explain this, apart from the incidence of gestational diabetes, other endocrine conditions and sickle cell disease. These differences were small, however, and unlikely to explain overall differences in duration of stay in relation to ethnicity. We also found differences in postpartum pain scores at 30 days, particularly in Asian patients, even after adjusting for demographic, medical, obstetric, neonatal and anaesthetic factors, and socio-economic group. We did not find relevant differences in the rates of readmission or complications between ethnic backgrounds, which have been reported previously in the USA [13]. Other differences across ethnic groups in patient-centred recovery outcome measures on postpartum day 1 and day 30 appear small and are likely to be of limited clinical significance.

Our findings related to pain are consistent with international studies reporting racial and ethnic inequalities in the experience, assessment and treatment of postpartum pain [14–16]. Patients from minority ethnic backgrounds are more likely to receive neuraxial labour analgesia than White patients [7,17,18]. However, we found no significant differences between ethnic groups in the proportion of patients receiving general anaesthesia for caesarean delivery. This is in contrast to previous English data highlighting patients of Black or Black British ethnic backgrounds are 10% more likely to receive a general anaesthetic compared to those of White ethnic backgrounds [7]. These

findings must be considered with caution, given the small number of caesarean deliveries under general anaesthesia in our cohort.

The differences seen in the patient demographics related to their ethnic and socio-economic group highlight that there is a higher prevalence of social deprivation among patients from non-White ethnic groups. The intersection between ethnicity, social determinants of health and socio-economic group are difficult to disentangle. It is known those in patients from lower socioeconomic groups have worse outcomes in both obstetrics and major surgery [6,19,20]. In our cohort, when correcting for socio-economic group, the effect of ethnic background remains, with no collinearity existing between patient reported ethnicity, deprivation level and measured outcomes.

Despite the difference in pain scores reported at 30 days between ethnic groups, no significant differences were shown in the use of outpatient analgesia, including opioid consumption at 30 days postpartum. In a UK single-centre retrospective study examining differences in pain and duration of stay following abdominal hysterectomy, no differences were found in pain or analgesia requirements related to ethnicity, although Asian patients had an increased duration of stay [21]. Differences in perceived health states between ethnic groups have been reported using patient-reported outcome measures [22]. However, since there are no England-based value sets for EQ-5D-5L including in the postpartum period, the differences between socio-economic and ethnic groups with each health state are yet to be elucidated. We have shown that day 1 GHVAS and ObsQoR-10 scores are highest (representing better recovery) in patients of Black ethnicity; despite this, we found that these patients have increased duration of hospital stay. We did not find any differences in readmission or complication rates, despite previous research showing higher maternal mortality and morbidity rates related to ethnic background [2,6]. Qualitative research to explore potential underlying reasons for this finding would be of value.

Ethnic and socio-economic health disparities are complex and reflect multiple levels of inequity ranging from patient characteristics to healthcare policy. In a UK survey, patients from minority ethnic groups reported a poorer maternity care experience compared with White patients [23]. In addition, an association has been shown with the lack of individualised care and maternal outcome related to ethnicity [24]. Postpartum duration of stay is an important objective indicator of quality for inpatient care following caesarean delivery and is independently, but weakly, associated with postpartum pain [25–27]. Patients delivering in the UK have shorter postpartum duration of hospital stay compared to patients delivering in other high income countries, with no international

consensus surrounding optimal time period [28,29]. Traditional postpartum care following caesarean delivery involves the use of standardised protocols to manage patients, without significant patient involvement or a patient-centred care model. Patient input can facilitate individualised peri-operative treatment protocols based on their preferences, needs and expectations. Therefore, to reduce the disparities based on socio-economic group and ethnicity, patient-specific care should be implemented where possible, irrespective of background.

Minimal clinically important difference (MCID) defines the clinical benefit of an intervention as perceived by the patient, as opposed to one determined as statistically significant which may not be clinically significant. Post-caesarean pain scores (assessed using a visual analogue scale) has suggested a MCID of 10/100 to be significant [30]. Similarly, the PROSPECT methodology uses a MCID of 1/10 using a numeric rating scale [31]. However, these have not been validated in obstetrics and are an important area for further research [32]. Further work is needed to evaluate postpartum pain and recovery in patients from different ethnicities with cohorts that are matched for other confounding variables. Pain and recovery profiles can be developed using the best validated patient-reported outcome measures [33]. Objective measures of assessing pain, such as hyperalgesia and mapping, could help determine the extent to which pain persists in the postpartum period. Furthermore, the duration of effect for recovery metrics and pain warrants further consideration as the majority of pregnancy-related morbidity and mortality occur after 6 weeks postpartum [6].

The strengths of our study include prospective data collection from a large cohort and multidimensional patient reported outcomes utilised across multiple centres. The proportion of recruited patients from each ethnic background is representative of the demographic within England, and for this reason patient numbers are not equal among groups [34]. Patients were recruited from 94 obstetric units in 78 of the 130 NHS trusts and from all seven NHS commissioning regions, making this a representative sample. Furthermore, accurate data collection was achieved for relevant factors including mode of anaesthesia, obstetric, medical and neonatal history and inpatient and outpatient recovery metrics.

Our study has several limitations. Since this study required consent, those patients who could comprehend the questions asked in English were not studied. We used an IMD based on maternal home postal code as an aggregated measure to capture the level of socio-economic deprivation but appreciate that home addresses may have changed during the study period. The socio-economic status of people living in a particular area may vary, which could have led to misclassification of

some patients. Deprivation measures covering smaller areas or the use of validated metrics such as household income or highest level of education attainment could further help quantify the effect of socio-economic deprivation on postpartum recovery and self-reported healthcare related quality of life. The time of hospital discharge may not reflect readiness for discharge and social factors associated with delayed discharge such as paediatric review, distance from hospital to dwelling and planned transportation mode back to the community were not captured in this cohort. The study was conducted between waves of the COVID-19 pandemic. The additional risks faced by those patients from minority ethnic groups were exacerbated during the pandemic, with infection, risk of hospitalisation and mortality higher in Asian and Black peripartum patients [35,36] and it is unclear if these differences persist out of this context.

In summary, we have found ethnicity-based health inequalities of inpatient and outpatient patient-centred outcomes in obstetric patients in England. Further work is required to understand the underlying reasons, causation and implementation of public health initiatives surrounding how to address this disparity.

Acknowledgements

This study was prospectively registered at clinicaltrials.gov (NCT04192045). The authors would like to thank the ObsQoR collaborators who collected and submitted patient data, in addition to gratitude to all the patients who participated in this study. This research was funded by a grant from the Obstetric Anaesthetists' Association and supported by UK National Institute for Health Research (NIHR) clinical research network portfolio adoption. The views expressed are those entirely of the authors. The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. Data may be requested by contacting the corresponding author. SRM receives support from the National Institute for Health Research University College London Hospitals Biomedical Research Centre and the NIHR Central London Patient Safety Research Collaboration of which she is Director. KE is Editor of Anaesthesia, and he or his institution has received educational or research funding from Fisher and Paykel Healthcare, Edwards Lifesciences and Cardinal Health. PS has NIH funding from NHLBI (R01HL166253-01A1) and NICHD (U54HD113142-01). No other funding or competing interests declared. This study represents the views of the authors and not of the National Institute for Health Research or the Department of Health and Social Care.

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Table 1. Baseline characteristics of the study population across ethnicity. Values are mean (SD), median (IQR [range]) and number (proportion)

	Patient ethnicity					
	Asian* (n=115)	Black** (n=65)	Mixed or multiple (n=28)	White (n=768)	Other*** (n=24)	p value
Age; y	33 (4.7)	33 (4.7)	32 (5.0)	32 (5.3)	34 (6.1)	0.065
BMI; kg.m ⁻²	27 (23-30 [17-47])	28 (25-32 [19-51])	27 (24-31 [22-50])	27 (23-31) [16-65])	26 (24-32 [21-40])	0.256
Deprivation IMD						<0.001
1 (Most deprived)	42 (36%)	32 (49%)	3 (11%)	137 (18%)	7 (29%)	
2	31 (27%)	21 (32%)	12 (43%)	152 (20%)	10 (42%)	
3	11 (10%)	6 (9%)	5 (18%)	159 (21%)	3 (13%)	
4	19 (17%)	4 (6%)	3 (11%)	169 (22%)	1 (4%)	
5 (Least deprived)	12 (10%)	2 (3%)	5 (18%)	151 (20%)	3 (13%)	
ASA physical status						0.505
1	20 (18%)	14 (22%)	3 (11%)	190 (25%)	5 (21%)	
2	84 (73%)	46 (71%)	24 (86%)	523 (68%)	15 (63%)	
3	10 (9%)	5 (8%)	1 (4%)	49 (6%)	4 (17%)	
4	0	0	0	1 (<1%)	0	
Missing	1 (1%)	0	0	5 (1%)	0	
Parity						0.414
Nulliparous	44 (38%)	18 (28%)	13 (46%)	294 (38%)	10 (42%)	
Multiparous	71 (62%)	47 (72%)	15 (54%)	474 (62%)	14 (58%)	
Gestational age; weeks	38 (1.7)	39 (1.7)	38 (2.2)	39 (1.6)	38 (1.4)	0.099
Previous caesarean delivery	47 (41%)	28 (43%)	11 (39%)	293 (38%)	4 (17%)	0.203
Category of caesarean delivery						0.560
1	13 (11%)	11 (17%)	3 (11%)	66 (9%)	3 (13%)	
2	33 (29%)	23 (35%)	9 (32%)	211 (27%)	7 (29%)	
3	16 (14%)	6 (9%)	4 (14%)	92 (12%)	2 (8%)	
4	53 (46%)	25 (38%)	12 (43%)	399 (52%)	12 (50%)	
Blood loss; ml						0.988
<500	63 (55%)	32 (49%)	16 (57%)	415 (54%)	13 (54%)	
501-1499	47 (41%)	29 (44%)	12 (43%)	319 (42%)	10 (43%)	

>1500	5 (4%)	4 (6%)	0	30 (4%)	1 (4%)	
Missing	0	0	0	4 (1%)	0	
Past medical history[#]						
Respiratory	13 (11%)	6 (9%)	7 (25%)	88 (12%)	2 (8%)	0.304
Cardiac	3 (3%)	3 (5%)	0	24 (3%)	0	0.934
Musculoskeletal	3 (3%)	0	1 (4%)	9 (1%)	2 (8%)	0.146
Gastrointestinal	0	0	0	11 (1%)	0	0.894
Endocrine	18 (16%)	4 (6%)	2 (7%)	37 (5%)	2 (8%)	0.011
Sickle cell disease	0	2 (3%)	1 (4%)	0	0	0.015
Epilepsy	0	0	1 (4%)	10 (1%)	0	0.647
Haemoglobin (pre-operative) g.l ⁻¹	119 (11.4)	118 (11.2)	117 (13.7)	119 (11.5)	119 (13.6)	0.707
Haemoglobin (postoperative) g.l ⁻¹	107 (13.7)	107 (12.0)	101 (10.3)	105 (12.8)	110 (13.2)	0.288
Obstetric history						
Pregnancy-induced hypertension	7 (6%)	4 (6%)	2 (7%)	33 (4%)	0	0.764
Pre-eclampsia	2 (1%)	5 (8%)	2 (7%)	20 (3%)	1 (4%)	0.234
Gestational diabetes	36 (31%)	8 (12%)	6 (2%)	75 (10%)	5 (21%)	<0.001
Venous thromboembolism	0	0	0	2 (<1%)	0	1.000
UTI/Group B streptococcus	4 (3%)	0	4 (14%)	30 (4%)	2 (8%)	0.108
Anaesthetic						
Spinal	90 (78%)	47 (72%)	17 (61%)	588 (77%)	17 (71%)	0.292
Epidural/epidural top up	16 (14%)	11 (17%)	7 (25%)	124 (16%)	4 (17%)	0.688
Combined spinal epidural	4 (3%)	6 (9%)	3 (11%)	32 (4%)	3 (13%)	0.039
General anaesthetic	5 (4%)	1 (2%)	0	32 (4%)	1 (4%)	0.797
Neonatal location post-delivery						0.361
Postnatal ward	103 (90%)	62 (95%)	25 (89%)	676 (88%)	19 (79%)	
Special care baby unit	7 (6%)	2 (3%)	1 (4%)	32 (4%)	1 (4%)	
Neonatal intensive care	3 (3%)	1 (2%)	1 (4%)	37 (5%)	4 (17%)	
Missing	2 (2%)	0	1 (4%)	23 (3%)	0	

IMD, Index of Multiple Deprivation; UTI, urinary tract infection; *includes Asian British or Asian Welsh; **includes Black British, Black Welsh, Caribbean or African; ***includes Arab and all other ethnic groups; #respiratory: asthma/pulmonary embolus; cardiac: hypertension/arrhythmia/

cardiomyopathy/valvular heart disease; musculoskeletal: rheumatoid arthritis/systemic lupus erythematosus/fibromyalgia; gastrointestinal: inflammatory bowel disease/hepatitis; endocrine: diabetes mellitus/thyroid disease.

Table 2. Inpatient quality of recovery metrics. Values are median (IQR [range]).

	Asian* (n=115)	Black** (n=65)	Mixed or multiple (n=28)	White (n=768)	Other*** (n=24)	p value
Duration of stay; h	44 (31-71 [19-465])	49 (33-75 [23-189]) (n=63)	43 (33-71 [24-190])	35 (28-56 [18-513]) (n=767)	49 (33-75 [21-169])	<0.001
Pain at rest (NRS 0-10)	5 (3-6 [0-10]) (n=114)	5 (2-6 [0-10]) (n=63)	5 (2-6 [0-9])	4 (2-6 [0-10]) (n=761)	5 (3-6 [0-10])	0.024
Pain on movement (NRS 0-10)	7 (5-8 [0-10])	7 (5-8 [0-10]) (n=63)	6 (5-8 [0-10])	6 (4-8 [0-10]) (n=758)	6 (5-8 [2-10])	0.045
ObsQoR-10 (range 0-100)	68 (53-80 [26-99]) (n=111)	74 (60-87 [4-100])	68 (61-85 [42-96])	73 (61-84 [17-100]) (n=759)	60 (52-80 [31-98]) (n=23)	0.009
EQ-5D-5L (range 5-25)	12 (9-15 [5-23]) (n=114)	11 (9-15 [5-23]) (n=63)	11 (9-14 [5-18])	11 (9-14 [5-25]) (n=765)	13 (9-15 [5-20])	0.615
EQ-5D GHVAS (range 0-100)	60 (50-75 [10-100])	70 (55-85 [3-100])	60 (53-80 [20-100])	65 (50-80 [0-100])	60 (50-85 [20-100]) (n=23)	0.030

*includes Asian British or Asian Welsh; **includes Black British, Black Welsh, Caribbean or African; ***includes Arab and all other ethnic groups; ObsQoR-10, obstetric quality of recovery – 10 item scale; GHVAS, global health visual analogue scale; NRS, numerical rating scale.

Table 3. Postpartum metrics at 30 days. Values are number (proportion), median (IQR [range])

	Asian* (n=100)	Black** (n=52)	Mixed or multiple (n=22)	White (n=608)	Other*** (n=21)	P value
Readmission to hospital	7 (7%)	2 (4%)	0	34 (6%)	0	0.743
Complications [#]	21 (21%)	11 (21%)	2 (9%)	117 (19%)	2 (10%)	0.611
Pain at rest (NRS 0-10)	1 (0-3 [0-10]) (n=96)	0 (0-3 [0-6]) (n=49)	0 (0-0 [0-4]) (n=21)	0 (0-1 [0-10]) (n=576)	n=18 1.5 (0-2 [0-7])	<0.001
Pain on movement (NRS 0-10)	3 (0-5 [0-10]) (n=96)	2 (0-4 [0-8]) (n=49)	0 (0-2 [0-9]) (n=21)	1 (0-3 [0-10]) (n=576)	n=18 3.5 (2-7 [0-9])	<0.001
EQ-5D-5L (range 5-25)	7 (6-9 [5-21]) (n=100)	6 (5-8 [5-16]) (n=52)	6 (5-7 [5-13]) (n=22)	6 (5-8 [5-19]) (n=607)	n=21 7 (6-9 [5-13])	0.004
EQ-5D GHVAS (range 0-100)	80 (65-85 [15-100]) (n=100)	80 (70-95 [35-100]) (n=52)	80 (75-90 [40-100]) (n=22)	80 (70-90 [0-100]) (n=608)	n=21 80 (60-90 [45-100])	0.039

*includes Asian British or Asian Welsh; **includes Black British, Black Welsh, Caribbean or African; ***includes Arab and all other ethnic groups; EQ-5D-5L EuroQoL 5-dimension, 5-level sum score (lower score represents better recovery); GHVAS, global health visual analogue scale; NRS, numerical rating scale. [#] Complications defined as unanticipated blood tests, imaging investigations, unplanned reattendance to healthcare professionals or readmission within 30 days postpartum.

Table 4. Multivariable logistic regression for severe pain at rest and movement on postpartum day 1. Values are OR (95%CI)

	Pain at rest (≥ 7 vs. < 7)				Pain on movement (≥ 7 vs. < 7)			
	Crude model		Adjusted model		Crude model		Adjusted model	
	OR (95%CI)	p value	OR (95%CI)	p value	OR (95%CI)	p value	OR (95%CI)	p value
Ethnicity								
White	Ref		Ref		Ref		Ref	
Asian*	1.76 (1.10 - 2.81)	0.019	1.70 (1.03 - 2.83)	0.039	1.57 (1.06 - 2.33)	0.026	1.57 (1.06 - 2.33)	0.026
Black**	1.69 (0.91 - 3.11)	0.094	1.60 (0.82 - 3.11)	0.165	1.29 (0.77 - 2.16)	0.332	1.31 (0.78 - 2.19)	0.304
Mixed	1.17 (0.44 - 3.15)	0.752	1.12 (0.41 - 3.08)	0.819	0.59 (0.26 - 1.32)	0.202	0.61 (0.27 - 1.36)	0.225
Other***	1.42 (0.52 - 3.88)	0.494	1.27 (0.45 - 3.64)	0.635	0.75 (0.32 - 1.73)	0.501	0.75 (0.32 - 1.73)	0.499
Age; y	0.97 (0.94 - 1.00)	0.075	0.97 (0.94 - 1.00)	0.049	0.99 (0.96 - 1.01)	0.270	-	-
BMI (kg.m ⁻²)	1.02 (0.99 - 1.04)	0.188	1.00 (0.97 - 1.03)	0.965	0.99 (0.97 - 1.01)	0.371	-	-
Deprivation level								
1	Ref		Ref		Ref		-	-
2	0.85 (0.53 - 1.36)	0.489	0.83 (0.50 - 1.38)	0.480	0.87 (0.60 - 1.27)	0.467	-	-
3	1.01 (0.62 - 1.65)	0.967	1.11 (0.66 - 1.89)	0.688	0.99 (0.66 - 1.47)	0.946	-	-
4	0.43 (0.24 - 0.76)	0.004	0.52 (0.28 - 0.95)	0.034	0.96 (0.65 - 1.41)	0.819	-	-
5	0.90 (0.54 - 1.49)	0.680	1.13 (0.65 - 1.95)	0.658	0.94 (0.63 - 1.40)	0.745	-	-
ASA physical status								
1	Ref		Ref		Ref		-	-
2	1.32 (0.86 - 2.03)	0.200	1.21 (0.77 - 1.90)	0.408	1.05 (0.78 - 1.42)	0.738	-	-
3-4	3.00 (1.60 - 5.65)	0.001	2.73 (1.35 - 5.54)	0.005	0.97 (0.56, -1.68)	0.923	-	-
Parity								
Nulliparous	Ref		-	-	Ref		-	-
Multiparous	1.11 (0.79 - 1.56)	0.566	-	-	1.10 (0.85 - 1.43)	0.451	-	-
Gestational age	0.90 (0.81 - 0.98)	0.023	0.89 (0.80, 0.98)	0.017	0.97 (0.90 - 1.05)	0.482	-	-
Previous caesarean delivery	1.17 (0.84 - 1.64)	0.358	-	-	0.97 (0.75 - 1.26)	0.839	-	-
Category of caesarean delivery								
1	Ref		-	-	Ref		-	-
2	1.08 (0.60 - 1.95)	0.800	-	-	0.96 (0.60 - 1.54)	0.877	-	-
3	0.95 (0.47 - 1.89)	0.879	-	-	0.94 (0.54 - 1.61)	0.810	-	-
4	0.75 (0.43 - 1.89)	0.327	-	-	0.87 (0.56 - 1.35)	0.530	-	-
Spinal	0.70 (0.49 - 1.01)	0.059	0.69 (0.47 - 1.02)	0.063	0.93 (0.69 - 1.25)	0.624	-	-
Epidural/Epidural top up	1.29 (0.85 - 1.97)	0.237	-	-	0.92 (0.66 - 1.30)	0.654	-	-
Combined Spinal Epidural	1.27 (0.62 - 2.59)	0.518	-	-	1.15 (0.64 - 2.06)	0.643	-	-

General anaesthetic	1.50 (0.70 - 3.23)	0.298	-	-	1.87 (0.96 - 3.63)	0.064	1.86 (0.96 - 3.62)	0.068
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*includes Asian British or Asian Welsh; **includes Black British, Black Welsh, Caribbean or African; ***includes Arab and all other ethnic groups.

Table 5. Multivariable logistic regression for moderate pain at rest and movement at postpartum day 30. Values are OR (95%CI)

	Pain at rest (≥ 4 vs. < 4)				Pain on movement (≥ 4 vs. < 4)			
	Crude model		Adjusted model		Crude model		Adjusted model	
	OR (95%CI)	p value	OR (95%CI)	p value	OR (95%CI)	p value	OR (95%CI)	p value
Ethnicity								
White	Ref		Ref		Ref		Ref	
Asian*	1.76 (1.10 - 2.81)	0.019	1.70 (1.03 - 2.83)	0.039	1.57 (1.06 - 2.33)	0.026	1.57 (1.06 - 2.33)	0.026
Black**	1.69 (0.91 - 3.11)	0.094	1.60 (0.82 - 3.11)	0.165	1.29 (0.77 - 2.16)	0.332	1.31 (0.78 - 2.19)	0.304
Mixed	1.17 (0.44 - 3.15)	0.752	1.12 (0.41 - 3.08)	0.819	0.59 (0.26 - 1.32)	0.202	0.61 (0.27 - 1.36)	0.225
Other***	1.42 (0.52 - 3.88)	0.494	1.27 (0.45 - 3.64)	0.635	0.75 (0.32 - 1.73)	0.501	0.75 (0.32 - 1.73)	0.499
Age; y	0.97 (0.94 - 1.00)	0.075	0.97 (0.94 - 1.00)	0.049	0.99 (0.96 - 1.01)	0.270	-	-
BMI (kg.m ⁻²)	1.02 (0.99 - 1.04)	0.188	1.00 (0.97 - 1.03)	0.965	0.99 (0.97 - 1.01)	0.371	-	-
Deprivation level								
1	Ref		Ref		Ref		-	-
2	0.85 (0.53 - 1.36)	0.489	0.83 (0.50 - 1.38)	0.480	0.87 (0.60 - 1.27)	0.467	-	-
3	1.01 (0.62 - 1.65)	0.967	1.11 (0.66 - 1.89)	0.688	0.99 (0.66 - 1.47)	0.946	-	-
4	0.43 (0.24 - 0.76)	0.004	0.52 (0.28 - 0.95)	0.034	0.96 (0.65 - 1.41)	0.819	-	-
5	0.90 (0.54 - 1.49)	0.680	1.13 (0.65 - 1.95)	0.658	0.94 (0.63 - 1.40)	0.745	-	-
ASA physical status								
1	Ref		Ref		Ref		-	-
2	1.32 (0.86 - 2.03)	0.200	1.21 (0.77 - 1.90)	0.408	1.05 (0.78 - 1.42)	0.738	-	-
3-4	3.00 (1.60 - 5.65)	0.001	2.73 (1.35 - 5.54)	0.005	0.97 (0.56, -1.68)	0.923	-	-
Parity								
Nulliparous	Ref		-	-	Ref		-	-
Multiparous	1.11 (0.79 - 1.56)	0.566	-	-	1.10 (0.85 - 1.43)	0.451	-	-
Gestational age	0.90 (0.81 - 0.98)	0.023	0.89 (0.80, 0.98)	0.017	0.97 (0.90 - 1.05)	0.482	-	-
Previous caesarean delivery	1.17 (0.84 - 1.64)	0.358	-	-	0.97 (0.75 - 1.26)	0.839	-	-
Category of caesarean delivery								
1	Ref		-	-	Ref		-	-
2	1.08 (0.60 - 1.95)	0.800	-	-	0.96 (0.60 - 1.54)	0.877	-	-
3	0.95 (0.47 - 1.89)	0.879	-	-	0.94 (0.54 - 1.61)	0.810	-	-
4	0.75 (0.43 - 1.89)	0.327	-	-	0.87 (0.56 - 1.35)	0.530	-	-
Spinal	0.70 (0.49 - 1.01)	0.059	0.69 (0.47 - 1.02)	0.063	0.93 (0.69 - 1.25)	0.624	-	-
Epidural/Epidural top up	1.29 (0.85 - 1.97)	0.237	-	-	0.92 (0.66 - 1.30)	0.654	-	-
Combined Spinal Epidural	1.27 (0.62 - 2.59)	0.518	-	-	1.15 (0.64 - 2.06)	0.643	-	-

General anaesthetic	1.50 (0.70 - 3.23)	0.298	-	-	1.87 (0.96 - 3.63)	0.064	1.86 (0.96 - 3.62)	0.068
Inpatient pain at rest	1.16 (1.05 - 1.28)	0.002	1.00 (0.88 - 1.15)	0.946	1.14 (1.06 - 1.22)	<0.001	0.99 (0.90 - 1.09)	0.881
Inpatient pain on movement	1.22 (1.08 - 1.37)	0.001	1.14 (0.96 - 1.34)	0.128	1.21 (1.11 - 1.31)	<0.001	1.13 (1.01 - 1.27)	0.040
ObsQoR-10 score	0.98 (0.9 - 1.00)	0.009	0.99 (0.97 - 1.01)	0.299	0.98 (0.97 - 0.99)	<0.001	0.99 (0.97 - 1.00)	0.026
Duration of postpartum stay; h	1.01 (1.00 - 1.01)	<0.001	1.01 (1.00 - 1.01)	0.011	1.01 (1.00 - 1.01)	<0.001	1.01 (1.00 - 1.01)	0.009

*includes Asian British or Asian Welsh; ** includes Black British, Black Welsh, Caribbean or African; *** includes Arab and all other ethnic groups; ObsQoR-10, obstetric quality of recovery – 10 item scale.

Table 6. Multivariable logistic regression for global health visual analogue scale (GH VAS) score on postpartum days 1 and 30. Values are OR (95%CI)

	GH VAS (≥70 vs <70) Day 1				GH VAS (≥70 vs <70) Day 30			
	Crude model		Adjusted model		Crude model		Adjusted model	
	OR (95%CI)	p value	OR (95%CI)	p value	OR (95%CI)	p value	OR (95%CI)	p value
Ethnicity								
White	Ref		Ref		Ref		Ref	
Asian*	0.61 (0.41 - 0.92)	0.017	0.61 (0.40 - 0.93)	0.021	0.60 (0.37 - 0.98)	0.043	0.64 (0.37 - 1.10)	0.107
Black**	1.64 (0.98 - 2.76)	0.061	1.72 (1.00 - 2.94)	0.049	0.89 (0.43 - 1.82)	0.744	0.77 (0.35 - 1.67)	0.507
Mixed	0.77 (0.36 - 1.65)	0.501	0.78 (0.36 - 1.69)	0.530	2.11 (0.49 - 9.17)	0.319	2.04 (0.46 - 9.16)	0.351
Other***	0.79 (0.34 - 1.82)	0.580	0.88 (0.37 - 2.09)	0.778	0.42 (0.17 - 1.07)	0.070	0.56 (0.19 - 1.64)	0.288
Age; y	0.99 (0.97 - 1.02)	0.521	-	-	0.95 (0.92 - 0.99)	0.010	0.95 (0.91 - 0.99)	0.013
BMI (kg.m ⁻²)	0.99 (0.97 - 1.01)	0.186	0.98 (0.96 - 1.01)	0.141	0.99 (0.97 - 1.02)	0.640	-	-
Deprivation level								
1	Ref		-	-	Ref		Ref	
2	0.83 (0.57 - 1.20)	0.323	-	-	1.01 (0.59 - 1.72)	0.981	1.10 (0.61 - 1.98)	0.763
3	1.01 (0.68 - 1.49)	0.962	-	-	1.3 (0.71 - 2.39)	0.399	1.15 (0.59 - 2.25)	0.684
4	0.90 (0.61 - 1.32)	0.587	-	-	1.05 (0.6 - 1.83)	0.871	1.07 (0.57 - 2.02)	0.828
5	0.77 (0.51 - 1.14)	0.192	-	-	0.63 (0.3 - 1.08)	0.092	0.67 (0.37 - 1.24)	0.206
ASA physical status								
1	Ref		Ref	-	Ref		Ref	
2	0.76 (0.56 - 1.02)	0.066	0.81 (0.59 - 1.10)	0.180	1.26 (0.83 - 1.92)	0.272	1.49 (0.95 - 2.34)	0.084
3-4	0.81 (0.48 - 1.39)	0.454	0.98 (0.54 - 1.79)	0.957	0.53 (0.26 - 1.06)	0.073	0.67 (0.31 - 1.46)	0.313
Parity								
Nulliparous	Ref		-	-	Ref		-	-
Multiparous	1.10 (0.85 - 1.42)	0.463	-	-	0.81 (0.56 - 1.17)	0.266	-	-
Gestational age	1.08 (1.00 - 1.17)	0.043			1.13 (1.02 - 1.25)	0.021	1.09 (0.97 - 1.23)	0.154
Previous caesarean delivery	1.13 (0.88 - 1.46)	0.333	1.11 (0.85 - 1.46)	0.444	0.81 (0.57 - 1.16)	0.259	-	-
Category of caesarean delivery								
1	Ref		-	-	Ref		-	-
2	0.73 (0.46 - 1.16)	0.180	-	-	0.7 (0.34 - 1.44)	0.331	-	-
3	0.89 (0.52 - 1.52)	0.670	-	-	0.71 (0.31 - 1.62)	0.422	-	-
4	0.92 (0.59 - 1.42)	0.709	-	-	0.71 (0.36 - 1.42)	0.335	-	-
Spinal	1.12 (0.84 - 1.50)	0.434	-	-	1.17 (0.78 - 1.75)	0.462	-	-
Epidural/ Epidural top up	0.75 (0.54 - 1.06))	0.104	-	-	0.91 (0.57 - 1.46)	0.703	-	-
Combined Spinal Epidural	0.82 (0.46 - 1.47)	0.505	-	-	0.92 (0.40 - 2.15)	0.853	-	-

General anaesthetic	1.39 (0.73 - 2.66)	0.312	-	-	0.74 (0.33 - 1.67)	0.473	-	-
Blood loss								
<500 ml	Ref				Ref			
501-1499 ml	0.69 (0.54 - 0.90)	0.005	0.69 (0.53 - 0.90)	0.007	0.90 (0.63 - 1.28)	0.551	-	-
> 1500 ml	0.73 (0.38 - 1.40)	0.343	0.77 (0.39 - 1.51)	0.440	1.57 (0.54 - 4.62)	0.409	-	-
Endocrine disease [#]	0.59 (0.35 - 1.00)	0.051	0.70 (0.40 - 1.22)	0.207	0.68 (0.36 - 1.27)	0.227	-	-
Anaemia ^{##}	1.37 (1.02 - 1.83)	0.036	1.36 (1.00 - 1.84)	0.047	1.36 (0.88 - 2.11)	0.165	1.47 (0.91 - 2.37)	0.115
Inpatient pain at rest	-	-	-	-	0.92 (0.86 - 0.99)	0.029	0.99 (0.90 - 1.09)	0.894
Inpatient pain on movement	-	-	-	-	0.90 (0.83 - 0.98)	0.013	0.99 (0.89 - 1.11)	0.910
ObsQoR-10 score	-	-	-	-	1.03 (1.02 - 1.04)	<0.001	1.03 (1.01 - 1.04)	<0.001
Duration of postpartum stay; hours	-	-	-	-	1.00 (0.99 - 1.00)	0.026	1.00 (1.00 - 1.00)	0.734

*includes Asian British or Asian Welsh; ** includes Black British, Black Welsh, Caribbean or African; *** includes Arab and all other ethnic groups; #, includes diabetes mellitus and thyroid disease; ##, defined as haemoglobin < 110 g.l⁻¹; ObsQoR-10, obstetric quality of recovery – 10 item scale.

Figure legends

Figure 1. Flow diagram of patient recruitment and data analysis.
ONSPD, Office of National Statistics Postcode Directory

Online Supporting Information

Appendix S1. ObsQoR Collaborators

Appendix S2. Variance inflation factors for 24 hour and 30-day outcomes (Tables S1–S4).