Adverse pregnancy outcomes attributable to socioeconomic and ethnic inequalities in England: a national cohort study

Jennifer Jardine, Kate Walker, Ipek Gurol-Urganci, Kirstin Webster, Patrick Muller, Jane Hawdon, Asma Khalil*, Tina Harris*, Jan van der Meulen*, on behalf of the National Maternity and Perinatal Audit Project Team†*

Summary

Background Socioeconomic deprivation and minority ethnic background are risk factors for adverse pregnancy outcomes. We aimed to quantify the magnitude of these socioeconomic and ethnic inequalities at the population level in England.

Methods In this cohort study, we used data compiled by the National Maternity and Perinatal Audit, based on birth records from maternity information systems used by 132 National Health Service hospitals in England, linked to administrative hospital data. We included women who gave birth to a singleton baby with a recorded gestation between 24 and 42 completed weeks. Terminations of pregnancy were excluded. We analysed data on stillbirth, preterm birth (<37 weeks of gestation), and fetal growth restriction (FGR; liveborn with birthweight <3rd centile by the UK definition) in England, and compared these outcomes by socioeconomic deprivation quintile and ethnic group. We calculated attributable fractions for the entire population and specific groups compared with least deprived groups or White women, both unadjusted and with adjustment for smoking, body-mass index (BMI), and other maternal risk factors.

Findings We identified 1 233 184 women with a singleton birth between April 1, 2015, and March 31, 2017, of whom 1 155 981 women were eligible and included in the analysis. 4505 (0·4%) of 1 155 981 births were stillbirths. Of 1 151 476 livebirths, 69 175 (6·0%) were preterm births and 22 679 (2·0%) were births with FGR. Risk of stillbirth was 0·3% in the least socioeconomically deprived group and 0·5% in the most deprived group (p<0·0001), risk of a preterm birth was 4·9% in the least deprived group and 7·2% in the most deprived group (p<0·0001), and risk of FGR was 1·2% in the least deprived group and 2·2% in the most deprived group (p<0·0001). Population attributable fractions indicated that 23·6% (95% CI 16·7–29·8) of stillbirths, 18·5% (16·9–20·2) of preterm births, and 31·1% (28·3–33·8) of births with FGR could be attributed to socioeconomic inequality, and these fractions were substantially reduced when adjusted for ethnic group, smoking, and BMI (11·6% for stillbirths, 11·9% for preterm births, and 16·4% for births with FGR). Risk of stillbirth ranged from 0·3% in White women to 0·7% in Black women (p<0·0001); risk of preterm birth was 6·0% in White women, 6·5% in South Asian women, and 6·6% in Black women (p<0·0001); and risk of FGR ranged from 1·4% in White women to 3·5% in South Asian women (p<0·0001). 11·7% of stillbirths (95% CI 9·8–13·5), 1·2% of preterm births (0·8–1·6), and 16·9% of FGR (16·1–17·8) could be attributed to ethnic inequality. Adjustment for socioeconomic deprivation, smoking, and BMI only had a small effect on these ethnic group attributable fractions (13·0% for stillbirths, 2·6% for preterm births, and 19·2% for births with FGR). Group-specific attributable fractions were especially high in the most socioeconomically deprived South Asian women and Black women for stillbirth (53·5% in South Asian women and 63·7% in Black women) and FGR (71·7% in South Asian women and 55·0% in Black women).

Interpretation Our results indicate that socioeconomic and ethnic inequalities were responsible for a substantial proportion of stillbirths, preterm births, and births with FGR in England. The largest inequalities were seen in Black and South Asian women in the most socioeconomically deprived quintile. Prevention should target the entire population as well as specific minority ethnic groups at high risk of adverse pregnancy outcomes, to address risk factors and wider determinants of health.

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Introduction

In many high-income countries, women from more deprived socioeconomic backgrounds and minority ethnic groups experience poorer outcomes in pregnancy and birth than do women from less deprived socioeconomic backgrounds and White women, with higher rates of stillbirth, preterm births, fetal growth restriction (FGR), and neonatal and infant mortality.[1–3] These outcomes have long-term ramifications for children and families, health-care systems, and economies.[4,5]

Reduction of inequalities in pregnancy outcomes by socioeconomic status and ethnicity is a key objective of health policies in many countries.[6] For example, the National Health Service (NHS) in England set a target to reduce the overall rates of stillbirth and neonatal mortality by 50% and preterm birth by 25% between 2019

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*Joint senior authors

†Members of the National Maternity and Perinatal Audit Project Team are listed at the end of the paper

Royal College of Obstetricians and Gynaecologists, London, UK (J Jardine MBBS, I Gurol-Urganci PhD, K Webster MSc, P Muller PhD)**; Department of Health Services Research, London School of Hygiene & Tropical Medicine, London, UK** (J Jardine, K Walker PhD, I Gurol-Urganci, P Muller, Prof J van der Meulen PhD)**; Royal Free London NHS Foundation Trust, London, UK** (J Hawdon PhD)**; Fetal Medicine Unit, St George's Hospital, London, UK** (Prof A Khalil MD)**; Vascular Biology Research Centre, Molecular and Clinical Sciences Research Institute, St George's University of London, London, UK** (Prof A Khalil)**; Centre for Reproduction Research, Faculty of Health and Life Sciences, De Montfort University, Leicester, UK** (T Harris PhD)

Correspondence to: Dr Jennifer Jardine, Royal College of Obstetricians and Gynaecologists, London SE1 1SZ, UK **jennifer.jardine@lshtm.ac.uk**

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Research in context

Evidence before this study

Socioeconomic deprivation and a minority ethnic background are associated with adverse perinatal outcomes. However, there is a paucity of evidence on the strength of these risk factors and on the scale of their effect at population level. We searched MEDLINE from database inception to Jan 1, 2021, for reviews of studies done in the UK using the following search terms: ("inequality", "disparity", "socioeconomic", "ethnicity", or "race") and ("stillbirth", "preterm", or "fetal growth restriction"). A 2012 systematic literature review of the relation between socioeconomic deprivation and adverse pregnancy outcomes reported that risks of adverse pregnancy outcomes in women in the most deprived group were between 1·5 times (for stillbirth) and 1·8 times (for low birthweight) higher than in women in the most affluent group. A 2019 review on inequalities and stillbirth reported that research investigating inequalities and stillbirth was underdeveloped, and therefore estimation of the potential stillbirth reduction if inequalities were reduced is not possible.

Added value of this study

This study of more than 1 million births in the English National Health Service found that a substantial proportion of stillbirths, preterm births, and fetal growth restriction would not have occurred if all women had the same risk as women in the least deprived socioeconomic group and women from White ethnic groups. The largest increases in the risk of stillbirth and fetal growth restriction occurred in Black and South Asian women. These results show that initiatives to reduce adverse birth outcomes focusing on individual women's choices and behaviour and on antenatal care will have limited effects.

Implications of all the available evidence

Concerted action is needed to reduce socioeconomic and ethnic inequalities in pregnancy outcomes. This action must involve midwives and obstetricians, public health professionals, and politicians, and target the entire population as well as Black and South Asian women in deprived socioeconomic groups. Prevention should address wider determinants of health and specific risk factors including maternal smoking and obesity.

Figure 1: Study design

and 2025. However, efforts to improve pregnancy outcomes and to mitigate inequalities are impeded by a paucity of information about how these inequalities are related to women's societal circumstances and pre-existing health and which groups are most strongly affected. Research into inequalities in pregnancy outcomes is underdeveloped in the UK, as in many other high-income countries.[7] Clear measures are needed to communicate the size of these inequalities in pregnancy outcomes to clinicians, to women and their families, and to public health professionals and policy makers.[8,9]

We aimed to quantify socioeconomic and ethnic inequalities in stillbirth, preterm birth, and FGR in England, taking account of health at the onset of pregnancy and complications that arise during pregnancy.

Methods

Study design and data sources

In this national cohort study, we used a dataset compiled by the National Maternity and Perinatal Audit that was based on records of each birth from maternity information systems used by NHS maternity services in England to record care throughout pregnancy and birth.[10] These records were linked to the Hospital Episode Statistics, an administrative database with records of all hospital episodes in the English NHS. The resulting dataset captured approximately 94% of all births that occurred in England during the study period.[10] This study used data collected to evaluate service provision and performance and therefore was exempt from ethical review by the NHS Health Research Authority. The use of personal data without patients' consent was approved by the NHS Health Research Authority (16/CAG/0058).

Participants

We included all women who gave birth to a singleton baby with a recorded gestation between 24 and 42 completed weeks, if information was available on whether the baby was born alive or stillborn. Terminations of pregnancy were excluded.

Outcomes

We collected and assessed data on stillbirth, preterm birth, and FGR. Stillbirth was defined as any recorded birth of a stillborn baby of at least 24 completed weeks of gestation. Preterm birth was defined as the recorded birth of a liveborn baby between 24 and 37 completed weeks of gestation. FGR was defined as the birth of a liveborn baby of at least 24 completed weeks with a

	n (%)
All	1155981
Socioeconomic deprivation quintile	
Total with available data (n)	1087776
Least deprived	158401 (14·6%)
Less deprived	178676 (16·4%)
Median deprived	203698 (18·7%)
More deprived	246266 (22·6%)
Most deprived	300735 (27·6%)
Maternal ethnic group	
Total with available data (n)	1061417
White	818982 (77·2%)
South Asian	126262 (11·9%)
Black	52361 (4·9%)
Other stated	44251 (4·2%)
Mixed	19561 (1·8%)
Maternal characteristics at start of pregnancy	
Age	
Total with available data (n)	1142227
<20 years	37394 (3·3%)
20–34 years	857074 (75·0%)
35–39 years	201336 (17·6%)
≥40 years	46423 (4·1%)
Parity	
Total with available data (n)	1148742
0	485555 (42·3%)
1	414993 (36·1%)
2	150518 (13·1%)
3 or more	97676 (8·5%)
Previous caesarean section	
Total with available data (n)	1131546
Yes	163267 (14·4%)
No	968279 (85·6%)
Smoking status	
Total with available data (n)	950233
Non-smoker	821549 (86·5%)
Smoker	128684 (13·5%)
BMI (kg/m²)	
Total with available data (n)	966324
Underweight (<18·5)	28200 (2·9%)
Ideal weight (18·5–24·9)	457385 (47·3%)
Overweight (25·0–29·9)	274338 (28·4%)
Grade I obese (30·0–34·9)	126644 (13·1%)
Grade II obese (35·0–39·9)	52496 (5·4%)
Grade II obese (≥40·0)	27261 (2·8%)
Presence of conditions considered high risk by NICE	
Total with available data (n)	925996
Pre-existing medical conditions	140980 (15·2%)
Previous birth complication	67946 (7·3%)
Conditions in current pregnancy	248781 (26·9%)

(Table 1 continues in next column)

	n (%)
(Continued from previous column)	
Pregnancy outcomes	
Overall	
Liveborn	1151476 (99·6%)
Stillborn	4505 (0·4%)
Term babies	
Liveborn	1082301 (99·8%)
Stillborn	1683 (0·2%)
Gestational age	
Preterm (<37 completed weeks)	71997 (6·2%)
Term	1083984 (93·8%)
Among liveborn babies	
Preterm (<37 completed weeks)	69175 (6·0%)
Term	1082301 (94·0%)
Birthweight centile among liveborn babies	
Total with available data (n)	1146909
<3rd	22679 (2·0%)
3rd to 9th	66049 (5·8%)
10th to 89th	955177 (83·3%)
≥90th	103004 (9·0%)

Percentages are presented for women with available data only. BMI=Body-mass index. NICE=National Institute for Health and Care Excellence.

Table 1: **Patient characteristics and outcomes**

birthweight below the 3rd centile for gestational age according to UK-WHO growth charts.[11]

We used the Index of Multiple Deprivation (IMD) as a measure of socioeconomic status (appendix p 3). The IMD provides an area-level measure of deprivation derived from information about income, education, employment, crime, and the living environment. We categorised women into five socioeconomic groups according to national quintiles of IMD rankings of 32844 Lower Super Output Areas in England with typically 1500 inhabitants.[12]

See Online for appendix

We coded maternal ethnicity using the Office for National Statistics categorisation system from the 2001 UK census.[13] Ethnicity data was considered missing if it was coded as not stated (appendix p 3). Ethnic origin was collapsed into five groups: White, South Asian, Black, Mixed, and Other (including Chinese). Coding of all included variables is described in the appendix (pp 2–3).

Statistical analysis

We compared outcomes between quintiles of deprivation and ethnic groups by use of χ^2. We used the data for each outcome for women in the least deprived quintile or from a White ethnic background as the reference rate, which were then applied to the women in the entire population or in a specific group to estimate the expected number of women with an adverse pregnancy outcome. Attributable fractions were defined as the difference in the observed and expected number of women with an

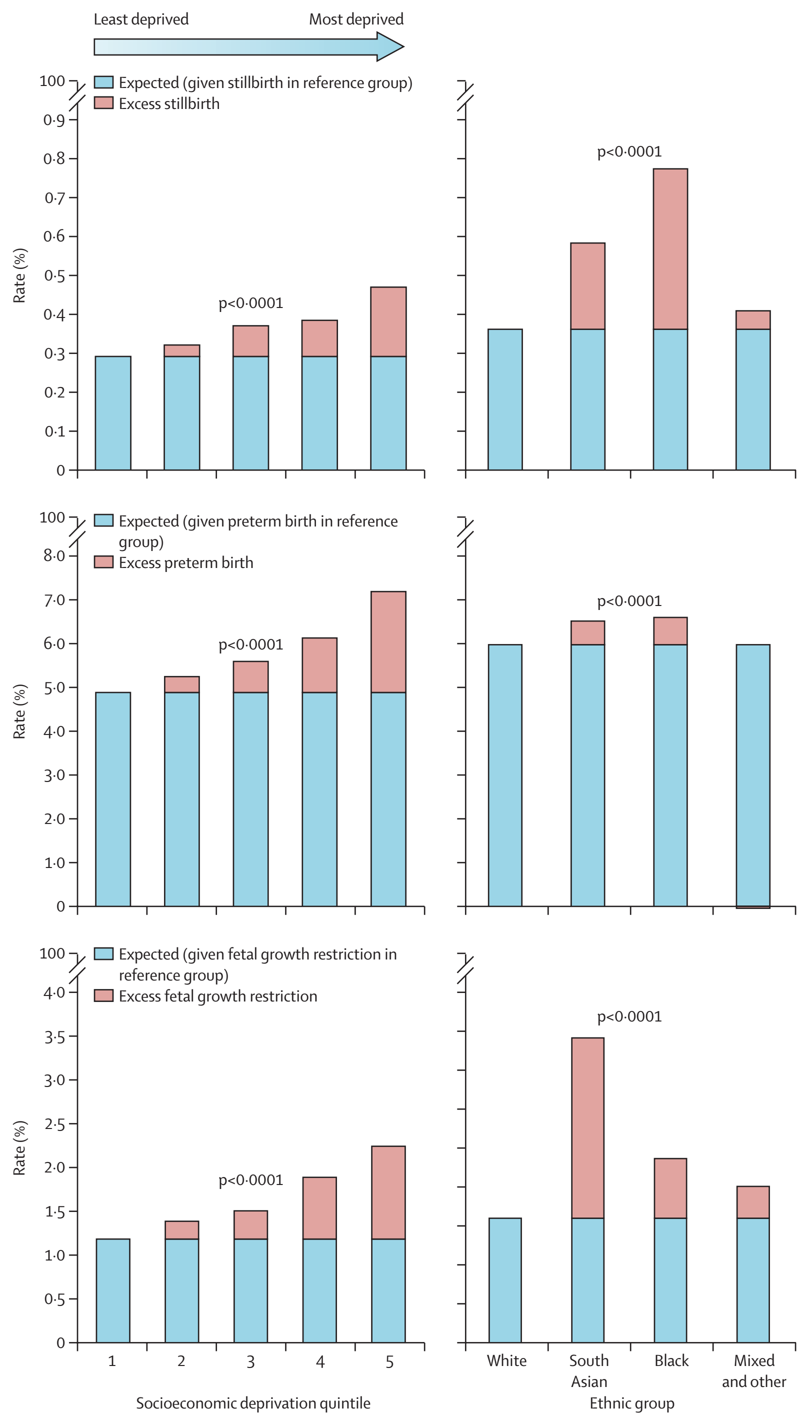

Figure 2: **Stillbirth, preterm birth, and fetal growth restriction rates by socioeconomic deprivation quintile and ethnic group**

(A) Stillbirths. (B) Preterm birth. (C) Birth with fetal growth restriction (less than 3rd centile birthweight). p values calculated using χ^2.

adverse pregnancy outcome, divided by the observed number. The attributable fraction described the proportion of adverse outcome that would not have occurred were the rates of the outcome the same as in the women in the reference group. The attributable fraction compares the reference group either with the entire population, producing a population attributable fraction, or with a specific group, producing a group-specific attributable fraction, also known as attributable fraction in the exposed.[9]

We used logistic regression models to estimate expected numbers of women with adverse pregnancy outcomes, adjusting for ethnicity or deprivation, maternal smoking, and body-mass index (BMI) at the onset of pregnancy. We also adjusted for other maternal risk factors, including maternal age, maternal parity, previous caesarean section, pre-existing medical conditions, previous obstetric complications, and complications in the current pregnancy defined according to the National Institute for Health and Care Excellence (appendix p 3).[14] An interaction term between parity and previous caesarean birth was included in all models in which both these terms were included. A full description of the models and a graphical representation of their goodness of fit is included in the appendix (pp 7–9, 12–13).

We calculated the adjusted attributable fractions again using the expected numbers of adverse outcomes predicted by the logistic regression models. We calculated 95% CIs for the attributable fractions after use of logarithmic transformation to normalise the distribution and stabilise the variance.[15]

Unadjusted attributable fractions were calculated including only women with complete information about socioeconomic deprivation or ethnicity. All regression analyses were restricted to women who had complete information about the outcome under consideration (100% of women for stillbirth and preterm birth and 99·6% for FGR). When estimating adjusted results, we imputed missing maternal risk factors, including socioeconomic deprivation and ethnicity, using chained equations to create ten data sets. We pooled the results for each data set using Rubin's rules.[16]

To examine the robustness of our results to different population definitions, we did sensitivity analyses of stillbirth and FGR only including babies born at term (at or after 37 weeks of gestation). To examine the robustness of results to different outcome definitions, we did sensitivity analyses with preterm birth defined as a birth before 34 weeks of gestation and babies born small defined as those born with a birthweight below the tenth centile (small for gestational age). Our final sensitivity analysis was a complete-case analysis (in other words, excluding records with missing values for maternal risk factors rather than imputing missing data).

All analyses were done with Stata version 14.1, StataCorp, College Station, TX, USA.

Role of the funding source

The funder of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report.

Results

We identified 1233184 women who gave birth in England between April 1, 2015, and March 31, 2017. 46362 records did not include birth outcome, or the outcome was termination. 18767 were not reported as singleton births, 18698 were multiple births, and 69 records did not include information about multiplicity. Gestation length was not reported in 11432 women, and gestation was less than 24 completed weeks in 643 women. 1155981 eligible women were included in the analysis (figure 1), of whom 4505 had a stillbirth (0·4%). Of the 1151476 women who had a livebirth, 69175 (6·0%) had a preterm birth and 22679 (2·0%) had a birth with FGR (table 1).

1087776 women had complete information about their socioeconomic status. Risk of stillbirth increased with socioeconomic deprivation, from 0·29% in the least socio-economically deprived group to 0·47% in the most deprived group (figure 2, appendix p 4; p<0·0001). The population attributable fraction for socioeconomic status was 23·6% (95% CI 16·7–29·8) unadjusted; 19·0% when adjusted for ethnic group; and 11·6% when adjusted for ethnic group, smoking, and BMI (table 2). The population attributable fraction was similar at 12·4% (95% CI 3·5–20·4) with further adjustment for other maternal risk factors.

Risk of a preterm birth in liveborn babies increased with socioeconomic deprivation, from 4·9% in the least deprived group to 7·2% in the most deprived group (figure 2, appendix p 4; p<0·0001). The population attributable fraction for preterm birth was 18·5% (95% CI 16·9–20·2) unadjusted; 18·4% when adjusted for ethnic group; and 11·9% when adjusted for ethnic group, smoking, and BMI (table 2). Additional adjustment for other risk factors reduced the population attributable fraction to 10·1% (8·0–12·1).

The risk of FGR was 1·2% in the least deprived group and 2·2% in the most deprived group (figure 2; p<0·0001). The attributable fraction was 31·1% (95% CI 28·3–33·8) unadjusted; 25·3% when adjusted for ethnic group; and 16·4% when adjusted for ethnic group, smoking, and BMI. Additional adjustment for other risk factors had little effect on the population attributable fraction (16·5%, CI 12·7–20·2).

1061417 women had complete information about their ethnic group. Risk of stillbirth varied according to maternal ethnicity, and ranged from 0·34% in White women to 0·70% in Black women (appendix p 4; p<0·0001). The population attributable fraction for ethnicity was 11·7% (95% CI 9·8–13·5) unadjusted. Adjustment for socioeconomic deprivation, smoking, BMI, and other maternal risk factors had little effect and the population attributable fraction was 12·6% (10·4–14·7) with full adjustment.

Variation in the risk of preterm birth according to ethnicity was small, and ranged from 6·0% in White women to 6·5% in South Asian women and 6·6% in Black women (appendix p 4; p<0·0001). The corresponding population attributable fraction was 1·2% (95% CI 0·8–1·6) unadjusted and 1·2% (0·7–1·7) when adjusted for socioeconomic deprivation, smoking, BMI, and the other maternal risk factors.

	Stillbirth	Preterm birth	Birth with fetal growth restriction
Socioeconomic deprivation*			
No adjustment	23·6% (16·7 to 29·8)	18·5% (16·9 to 20·2)	31·1% (28·3 to 33·8)
Adjustment			
Ethnic group	19·0% (11·8 to 25·7)	18·4% (16·7 to 20·0)	25·3% (22·3 to 28·2)
Ethnic group, smoking, BMI	11·6% (3·6 to 19·0)	11·9% (10·1 to 13·7)	16·4% (13·0 to 19·6)
Ethnic group, smoking, BMI, all maternal factors†	12·4% (3·5 to 20·4)	10·1% (8·0 to 12·1)	16·5% (12·7 to 20·2)
Ethnic group‡			
No adjustment	11·7% (9·8 to 13·5)	1·2% (0·8 to 1·6)	16·9% (16·1 to 17·8)
Adjustment			
Socioeconomic group	10·8% (8·9 to 12·6)	0·1% (–0·3 to 0·5)	15·2% (14·3 to 16·1)
Socioeconomic group, smoking, BMI	13·0% (11·1 to 14·8)	2·6% (2·2 to 3·0)	19·2% (18·4 to 20·1)
Socioeconomic group, smoking, BMI, all maternal factors†	12·6% (10·4 to 14·7)	1·2% (0·7 to 1·7)	19·5% (18·6 to 20·4)

Data are % (95% CI). BMI=body-mass index. *Compared with those in the least deprived quintile. †Age, parity, pre-existing medical conditions, previous obstetric complications, and conditions in the current pregnancy sufficient to recommend that the woman gives birth in an obstetric-led setting. ‡Compared with White women.

Table 2: **Population attributable fractions of stillbirth, preterm birth, and birth with fetal growth restriction by socioeconomic deprivation and ethnicity**

The risk of FGR varied according to ethnicity, from 1·4% in White women to 3·5% in South Asian women (figure 2; p<0·0001) with a corresponding population attributable fraction of 16·9% (95% CI 16·1–17·8). Adjustment for socioeconomic deprivation, smoking, BMI, and other risk factors had little effect and produced a population attributable fraction of 19·5% (18·6–20·4).

The proportion of stillbirths that would not have occurred if all women had the same stillbirth risk as the least deprived White women was substantially increased in women from more deprived socioeconomic backgrounds and minority ethnic groups (figure 3). More detailed information about the distribution of maternal risk factors by ethnicity and socioeconomic deprivation is available in the appendix (p 10). Attributable fractions for stillbirth were especially high in women in the most deprived socioeconomic group if they were Black (63·7%, 95% CI 58·1–68·6), South Asian (53·5%, 47·1–59·1), or from Mixed or other ethnic background (38·8%, 28·0–48·0). Similarly, high attributable fractions were found for FGR in women in the most deprived socioeconomic group if they were South Asian (71·7%, 70·1–73·1), Black (55·0%, 51·7–58·0), or from Mixed or other ethnic background (47·8%, 43·9–51·5). Similar results were seen in analyses of stillbirth and FGR risk in term births, in analyses in which preterm birth was defined as a birth before 34 completed weeks of gestation and in which a small baby was defined as birthweight under the 10th centile (small for gestational age; appendix p 5), and

Socioeconomic deprivation (national quintiles)	White	South Asian	Black	Mixed and other
Stillbirth				
1 (least deprived)	Reference	33·3% (27·0 to 39·0)	48·0% (41·5 to 53·7)	12·1% (–0·2 to 23·0)
2	–8·6% (–20·9 to 3·6)	38·8% (28·9 to 47·3)	52·3% (43·5 to 59·6)	19·4% (3·8 to 32·5)
3	18·6% (8·6 to 27·5)	45·6% (37·3 to 52·9)	57·6% (50·2 to 63·9)	28·4% (15·0 to 39·8)
4	17·7% (8·0 to 26·4)	45·1% (37·2 to 52·1)	57·2% (50·0 to 63·3)	27·7% (14·4 to 38·9)
5 (most deprived)	30·4% (22·5 to 37·5)	53·5% (47·1 to 59·1)	63·7% (58·1 to 68·6)	38·8% (28·0 to 48·0)
Preterm				
1 (least deprived)	Reference	5·2% (3·0 to 7·5)	0·5% (–3·1 to 4·1)	–9·2% (–13·0 to –5·6)
2	–8·6% (–20·9 to 3·6)	11·7% (8·4 to 15·0)	7·4% (3·0 to 11·6)	–1·7% (–6·3 to 2·8)
3	12·6% (10·1 to 15·0)	17·1% (14·1 to 20·1)	13·0% (9·0 to 16·9)	4·6% (0·3 to 8·7)
4	20·1% (17·9 to 22·2)	24·2% (21·6 to 26·7)	20·5% (17·0 to 23·8)	12·8% (9·0 to 16·4)
5 (most deprived)	31·8% (30·0 to 33·5)	35·3% (33·2 to 37·4)	32·2% (29·3 to 34·9)	25·7% (22·6 to 28·7)
Fetal growth restriction				
1 (least deprived)	Reference	53·9% (52·3 to 55·5)	26·3% (21·8 to 30·5)	14·5% (9·3 to 19·4)
2	12·9% (7·9 to 17·6)	59·8% (57·1 to 62·3)	35·8% (30·4 to 40·7)	25·5% (19·3 to 31·2)
3	18·4% (13·9 to 22·7)	62·3% (59·9 to 64·5)	39·8% (34·9 to 44·3)	30·2% (24·5 to 35·5)
4	29·4% (25·8 to 32·9)	67·3% (65·4 to 69·1)	47·9% (43·9 to 51·6)	39·6% (34·9 to 44·0)
5 (most deprived)	39·1% (36·0 to 42·0)	71·7% (70·1 to 73·1)	55·0% (51·7 to 58·0)	47·8% (43·9 to 51·5)

***Figure 3*: Attributable fractions of stillbirth, preterm birth, and birth with fetal growth restriction by socioeconomic deprivation and ethnic group**

Data are attributable fraction (95% CI), calculated by comparison with White women or women in the least deprived quintile. Darker colours indicate higher group attributable fraction.

in analyses that excluded births with missing data on maternal risk factors (appendix p 6).

Discussion

In this study of more than 1 million births in England, 24% of stillbirths, 19% of preterm livebirths, and 31% of livebirths with FGR would not have occurred if all women had the same risk of adverse pregnancy outcomes as women in the least deprived socioeconomic group. These population attributable fractions were considerably lower when adjusted for ethnicity, maternal smoking, and BMI at the onset of pregnancy, which suggests that much of the socioeconomic inequalities in pregnancy outcomes can be explained by the combined influences of these maternal characteristics.

12% of stillbirths, 1% of preterm births, and 17% of births with FGR would not have occurred if all women had the same risks as White women. Adjustment for socioeconomic deprivation, maternal smoking, and BMI had little effect on these population attributable fractions.

About half of stillbirths and about three quarters of births with FGR in South Asian women in the most deprived areas could be attributed to socioeconomic and ethnic inequalities. Similarly, about two thirds of stillbirths and about half of births with FGR in Black women from the most deprived areas could be attributed to socioeconomic and ethnic inequalities.

We used a large set of routinely collected data including 94% of births that occurred in England during the study period. A few NHS hospitals were unable to contribute to the National Maternity and Perinatal Audit, primarily because of limitations of their local clinical information systems.[10] This provides strong support for the representativeness of our findings.

Our study has several limitations. We used an aggregate area-based measure to capture the level of socioeconomic deprivation. The socioeconomic status of people living in a particular area can vary, which will have led to non-differential misclassification of the socioeconomic status of some women and probably led to regression dilution, so our results might underestimate the true extent of socioeconomic differences in pregnancy outcomes.[17] Deprivation measures covering smaller areas (or even individual households) are needed to quantify more accurately the effect of socioeconomic deprivation on adverse pregnancy outcomes and overall health.

There are ongoing concerns about the accuracy of the coding of ethnic groups in the Hospital Episode Statistics database. However, comparison of ethnicity codes in 59 000 patients in the database against self-reported ethnicity information indicated a high level of agreement, especially for the distinction between patients with a White and those with another ethnic background (agreement level 98%). The level of agreement was worse for distinguishing specific minority ethnic groups such as Indian, Pakistani, and Bangladeshi, and therefore we used higher-level ethnic categories.[18]

The interpretation of the attributable fraction as the percentage of adverse outcomes that would not have occurred if women were not exposed to a different background depends on the assumption that biases are absent and that there is no effect modification.[9] It is unlikely that this assumption is fully met in the context of our study, because exposures such as socioeconomic deprivation and ethnicity are linked to many other circumstances, including overall health, health-related behaviour, nutrition, lifestyle factors, and wider aspects of adversity that are all recognised risk factors of poor pregnancy outcomes.[19]

Socioeconomic and ethnic inequalities in birth outcomes in the UK and many other high-income countries are widely reported.[20] There are many possible reasons for these inequalities and causal pathways are long and complex.[21] Socioeconomic deprivation and minority ethnic background are typically linked to a wider pattern of adverse circumstances, including increased rates of maternal smoking, obesity, and mental illness. Other pathways through which socioeconomic and ethnic inequalities can influence pregnancy outcomes are environmental or pollution exposure; social isolation and paucity of social cohesion; poor access to maternity care and health care in general; and increased chronic stress because of economic strain, insecure employment, and more frequent stressful life events.[22]

Increased stillbirth and FGR birth rates in women from minority ethnic backgrounds are not explained by socioeconomic deprivation alone. Other factors related to discrimination based on race, religion, and culture can contribute to a societal disadvantage and increase the risk of poor pregnancy outcomes.[23] In addition, physiological differences between ethnic groups might lead to differences in maternal immunological, vascular, and endocrine responses.[24] All this indicates that more detailed causal mediation analysis is a research priority.

Policy initiatives to reduce stillbirth, preterm birth, and FGR in England should take these causal complexities into account. Most initiatives that aim to reduce adverse pregnancy outcomes recommend that maternity services focus on individual risk factors and specific groups identified as at high risk.[25,26] Our results suggest that initiatives focusing on individual choices and behaviour and the antenatal care that they receive will have limited effects, because this approach puts the onus on individual women to control risk factors that are at least partly due to social context and societal attitudes. Clinical interventions available to maternity services to mitigate the risk of adverse perinatal outcomes, such as monitoring fetal growth more precisely and frequently[27] and considering elective birth at term,[28] can only have limited impact as they tackle the consequences of socioeconomic and ethnic inequalities.

Our results highlight the potential effect of public health approaches in reducing the risk of adverse pregnancy outcomes. For example, the population attributable fraction of socioeconomic inequalities for stillbirth and FGR reduced considerably if we took maternal smoking and obesity at the onset of pregnancy into account. Initiatives to reduce smoking and improve dietary habits in the community, as part of wider public health initiatives addressing a broader range of lifestyle factors and adverse maternal circumstances, provide important opportunities to improve the health of mothers and birth outcomes.

Attempts to address inequalities in pregnancy outcomes or wider inequalities in health will have to move from addressing the downstream factors such as specific clinical conditions and lifestyle factors, to the conditions that ultimately influence the choices that individuals can make about their own lives.[29] These upstream factors include access to high-quality education, employment, and fairness in terms of income and welfare support.[29] As risk is spread across the whole population, interventions must address the whole population to achieve their maximum benefit.[30]

The largest increases in excess risk of stillbirth and birth with FGR occurred in women from South Asian and Black ethnic backgrounds in the more deprived socioeconomic groups. Our estimates suggest that two thirds of stillbirths in Black women in the most deprived socioeconomic group would not have occurred if they had the same risk as White women in the least deprived socioeconomic group. Similarly, about three quarters of birth with FGR would not have occurred in the most deprived South Asian women if they had same risk as the least deprived White women. These observations underscore the relevance of the complementary nature of the population and high-risk approaches to prevention of adverse births outcomes.[31]

National programmes to make pregnancy safer can only be realistically achieved through plans that include midwives and obstetricians, public health professionals, and politicians. High-quality audits of maternity care and pregnancy outcomes linked to quality improvement initiatives are key to monitoring the outcome of these clinical interventions[31]—for example, by use of a score card that is being implemented in Australia[32] to focus on indicators of antenatal and intrapartum care and on social marginalisation and disadvantage.[3]

Concerted action is needed to reduce inequalities in pregnancy outcomes. Maternity services and public health professionals should work closely with politicians to address the full complexity of the pathways that contribute to the socioeconomic and ethnic differences in pregnancy outcomes, targeting the entire population and those groups at the highest risk.

Contributors

JJ, KW, JH, AK, TH, and JvdM conceived the study. All authors were involved in the design. JJ and JvdM analysed the data. All authors interpreted the results. JJ and JvdM wrote the report with contributions from all other authors. JH, AK, TH, and JvdM are joint senior authors. JJ and IG-U accessed and verified the underlying data. JvdM and JJ had final responsibility for the decision to submit for publication.

National Maternity and Perinatal Audit Project Team members

Fran Carroll, Megan Coe, George Dunn, Alissa Frémeaux, Ipek Gurol-Urganci, Tina Harris, Jane Hawdon, Jennifer Jardine, Asma Khalil, Julia Langham, Jan van der Meulen, Patrick Muller, Dharmintra Pasupathy, Sophie Relph, Louise Thomas, Lara Waite, and Kirstin Webster.

Declaration of interests
All authors declare funding from the Healthcare Quality Improvement Partnership to deliver the National Maternity and Perinatal Audit Programme. We declare no other competing interests.

Data sharing
Data used in this study were collected for the National Maternity and Perinatal Audit and are available on request to the data controllers (the Healthcare Quality Improvement Partnership for Maternity Information System data and NHS Digital for HES data). Please contact the authors if you require further guidance.

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