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Understanding ethnic inequalities in stillbirth rates: A UK population based cohort study

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Abstract

Objectives – Stillbirth rates in the UK are higher and reducing at a slower rate than comparable high-income countries. We investigate inequalities in stillbirth rates by ethnicity to facilitate development of initiatives to target those at highest risk.

Design – Population-based cohort study

Setting - UK

Participants – All singleton births at 24+ weeks gestation between 2014 and 2019

Main outcome measures – Stillbirth rate difference per 1,000 total births by ethnicity.

Results – Adjusted absolute differences in stillbirth rates were higher for babies of Black African (3.83, 95%CI: 3.35 to 4.32), Black Caribbean (3.60, 2.65 to 4.55) and Pakistani (2.99, 2.58 to 3.40) ethnicities compared with White ethnicities. Higher proportions of babies of Bangladeshi (42%), Black African (39%), Black Caribbean (37%) and Pakistani (28%) ethnicities were from most deprived areas, which are associated with an additional risk of 1.50 stillbirths per 1,000 births (95%CI 1.32 to 1.67) . Higher stillbirth rates were associated with congenital anomalies in babies of Pakistani, Bangladeshi and Black African ethnicities (0.63 to 1.05 per 1,000 births) and placental causes in Black ethnicities (1.97 to 2.24 per 1,000 births). Stillbirth rates of unexplained cause were higher for Black and Asian ethnicities (2.24 to 2.99 per 1,000 births), with over half of stillbirths recorded unexplained for babies of other Asian (60.2%), Bangladeshi (57.9%), and Indian (51.5%) ethnicities.

Conclusions - Stillbirth rates declined in the UK, but substantial excess risk of stillbirth persist among babies of Black and Asian ethnicities. The combined disadvantage for Black, Pakistani, and Bangladeshi ethnicities who are more likely to live in most deprived areas is associated with considerably higher rates. Key causes of death were congenital anomalies and placental causes.

Improved strategies for investigation of stillbirth causes are needed to reduce unexplained deaths so that interventions can be targeted to reduce stillbirths.

Article Summary

Strengths and limitations of this study

- National data with complete ascertainment of all stillbirths over a 6 year period from 2014-2019
- Inclusion of over 4 million births and over 16,000 stillbirths, which allows exploration of ethnicity with greater granularity.
- Information on cause of death allowing further understanding of inequalities in stillbirth rates.
- Despite reporting adjusted estimates, we cannot rule out residual confounding by potentially important modifiable risk factors not measured for all births.
- Ethnicity from birth notifications is in principle self-defined, but in reality may sometimes be assigned by health professionals and subject to misclassification.

Key words

Stillbirth, ethnic inequalities, perinatal mortality, mortality rates, cause of death

Introduction

The worldwide Covid-19 pandemic has highlighted the unacceptable health inequalities experienced by individuals from different ethnic groups, and the issue is receiving the global attention it has long deserved. In the UK, reports highlighting ethnic inequalities in maternal mortality[1] have also assisted in propelling this issue into the limelight, and sparked the Fivexmore campaign to change Black women's maternal health outcomes (https://www.fivexmore.com). Stillbirths are a major health burden with large disparity between and, importantly, within countries.[2-4] Ethnic inequalities in stillbirth rates have been noted in a number of high-income countries including Australia,[5] New Zealand,[6] North America,[7] and Europe[8 9] with rates often over double for migrant mothers or minority ethnic groups compared with those of White ethnicity. Recent national stillbirth data for the UK[10] and England and Wales[11] similarly report stillbirth rates to be around twice as high in babies of Black ethnicity and 60% higher in babies of Asian ethnicity compared to babies of White ethnicity.

Research into ethnic inequalities in stillbirth rates is limited, and little is known about differences in the causes of stillbirth between ethnic groups, with a lack of detailed information on cause of death in studies that have explored associations.[7 11] Minority ethnic groups in the UK are typically more socioeconomically disadvantaged and likely to have poorer health outcomes than the White population[11 12] and may have different age profiles because of migration patterns or cultural differences in timing of motherhood. It is therefore important to consider the impact these factors have on the association between ethnicity and stillbirth.[13 14]

Stillbirth rates are higher in the United Kingdom (UK) than many other comparable high-income countries, and are decreasing more slowly.[2 15] Despite targets set by the Governments across the UK to reduce stillbirths by between 35 and 50%[16-18] alongside a number of initiatives aimed at improving maternity services and care[19-23] improvements remain gradual. Here we explore recent trends in UK stillbirth rates by ethnicity, the extent to which associations between ethnicity and stillbirth are mediated by socioeconomic deprivation and maternal age, and whether cause of death varies

between ethnic groups. A greater impact on stillbirth rates may be achieved through better understanding of the multiple disadvantages that lead to higher risks of stillbirth[2 24] and the differences in the causes of death between ethnicities, so that initiatives can be targeted towards those most in need and reduce evident inequalities in stillbirth rates.

Methods

Data on all singleton live births and stillbirths from 24 weeks gestation to mothers resident in England, Wales, Scotland and Northern Ireland between 1 January 2014 and 31 December 2019 were obtained from the Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK (MBRRACE-UK) perinatal mortality surveillance programme[10] linked to birth notification and registration data. In January 2013, the Healthcare Quality Improvement Partnership commissioned the MBRRACE-UK collaboration to collect UK perinatal mortality surveillance data. MBRRACE-UK links detailed information on all deaths reported by UK hospitals with data on all births from the Patient Demographic Service (formerly the NN4B birth notification system) and birth and death registration data from the Office for National Statistics for England and Wales, National Records Scotland and Information Services Division for Scotland and the Northern Ireland Maternity System for Northern Ireland. MBRRACE-UK use stillbirth registrations from statutory notifications to ensure complete ascertainment of stillbirths.

Information about the baby's ethnicity is obtained via linkage with birth notification data for all births. Ethnic group available from birth notification data is that of the baby, as defined by the mother. We categorise baby's ethnicity as: White, Indian, Pakistani, Bangladeshi, other Asian, Black Caribbean, Black African and other Black, mixed ethnicities, and other (including Chinese). Minor variations in ethnicity classification between the four UK countries prevented reporting rates for more specific ethnicity groupings for babies of mixed ethnicity at the UK-level as well as for minority

White ethnic groups. Where routine ethnicity data was missing for a stillborn baby, we used ethnicity as recorded in MBRRACE-UK surveillance data.

We used the Children in Low-Income Families Local Measure[25] as an estimate of socioeconomic deprivation. This is an area based measure of the proportion of children living in families that are either in receipt of out-of-work benefits or in receipt of tax credits with a reported income that is less than 60% of the national median income. We allocated this to mother's postcode of residence at the time of birth through data linkage at the small area level. We ranked all areas in the United Kingdom by deprivation score, dividing them into five groups with approximately equal numbers of births in each quintile. Birth notification data were also used to provide information about maternal age, which was grouped into five year age bands (<20 years, 20-24, 25-29, 30-34, 35-39 and 40+ years).

Stillbirths were classified based on timing of death as intrapartum if the baby was known to be alive at the onset of the care episode which led to birth, and antepartum if the baby was not alive at onset of care or if the timing of death was unknown (n=559). Cause of death was classified by MBRRACE-UK reporters using the Cause of Death and Associated Conditions (CODAC) classification system[26] into the following first level categories: Infection, Intrapartum, Congenital Anomaly, Fetal, Cord Related, Placental Related, Maternal, or Unknown.

Statistical Analysis

We calculated the stillbirth rate (per 1,000 total births) by ethnicity, deprivation quintile, maternal age, country of residence at time of birth and year of birth. Binomial regression models with identity link were fitted to explore the absolute difference in stillbirth rates between ethnic groups with variance adjusted for clustering within small area (Lower super output area or data zone). All models were adjusted for country of residence (England, Scotland, Wales and Northern Ireland) to allow for differences in policy between the devolved nations that may influence stillbirth rates, and also year of birth, to allow for differences in stillbirth rates over time. Multivariable models were fitted to

adjust additionally for socioeconomic deprivation and maternal age group, with deprivation quintile fitted as a continuous variable after assessment of linearity. Interactions were fitted between ethnicity and deprivation quintile to explore whether the effect of deprivation was varied by ethnicity. Trends in ethnic inequalities over time were explored by fitting interactions with year of birth.

Sensitivity analyses

Multivariable models reported here a on a complete case basis, but repeating analyses including individuals with missing data for covariates using an additional category for those with missing data did not materially affect the results. Causes of death were examined before and after exclusion of congenital anomalies, because of the association with access and choices surrounding termination of pregnancy for fetal anomaly.

The excess stillbirth rate associated with ethnicity was calculated by applying the stillbirth rate observed for babies of White ethnicity to the number of births for each other ethnic group and comparing this number to the observed number of stillbirths for that ethnic group.

All analyses were conducted in STATA/IC version 16.0.

Patient and Public Involvement

The MBRRACE-UK collaboration includes PPI representatives and bereaved parents. The MBRRACE-UK collaboration has also established a third sector stakeholder group comprising representatives from all relevant national mother and baby charities. The PPI stakeholder group are consulted about the programme at an annual meeting held face-to-face in the past and remotely during the global pandemic. We consult them by email between the annual meetings.

Results

Between January 2014 and December 2019 there were 4,391,569 singleton births at or above 24 weeks gestation to mothers resident in the UK, of which 16,013 ended in stillbirth (3.65 per 1,000 total births, 95% confidence interval 3.58 to 3.71). Of these, 14,633 were antepartum (3.33 per 1,000, 3.27 to 3.39), and 1,380 intrapartum (0.31 per 1,000, 0.29 to 0.34). Information about ethnicity was available for 93% of all births and 98% of stillbirths; of the 4,076,056 births with information on ethnicity, 76% were classified as White, 10% Asian (including Indian, Pakistani, Bangladeshi and Other Asian groups), 5% Black (including Black Caribbean, Black African and other Black groups), 6% mixed, and 3% other ethnicities (see Table 1).

Table 1 shows the number and rate of stillbirths by ethnicity, socioeconomic deprivation, maternal age, year, and country of residence. Stillbirth rates were substantially higher in babies of Black (7.58 per 1,000, 95% CI: 7.19 to 7.99) and Asian (5.66 per 1,000, 5.42 to 5.90) ethnicities compared with babies of White (3.40 per 1,000, 95% CI: 3.33 to 3.47), mixed (3.77, 3.52 to 4.03), and Chinese or other (3.80, 3.45 to 4.17) ethnicities. Aggregating the Asian ethnicities masked higher stillbirth rates of 6.57 per 1,000 (95% CI: 6.17 to 6.99) for babies of Pakistani ethnicity and 5.53 per 1,000 (4.93 to 6.20) for babies of Bangladeshi ethnicity compared with babies of Indian ethnicity (4.97 per 1,000, 4.58 to 5.38). Stillbirth rates were universally high for babies of Black Caribbean (7.43 per 1,000, 95% CI: 6.54 to 8.43), Black African (7.64, 7.17 to 8.13) and other Black (7.47, 6.42 to 8.70) ethnicities. Stillbirth rates increased with socioeconomic deprivation, from 2.70 per 1,000 (95% CI: 2.58 to 2.81) in the least deprived quintile, to 4.80 per 1,000 (4.64 to 4.96) in the most deprived quintile. Stillbirth rates were highest in the youngest (<20 years: 4.81 per 1,000, 95% CI: 4.46 to 5.19) and oldest (>40 years: 5.42 per 1,000, 5.09 to 5.79) mothers. Stillbirth rates decreased over time from 3.96 per 1,000 (95% CI: 3.81 to 4.11) in 2014 to 3.24 per 1,000 (3.10 to 3.38) in 2019, a decrease of 18% over the six year period.

Table 1: Number of births (total, live births and stillbirths) and stillbirth rates per 1,000 total births by sociodemographic characteristics for births in the United Kingdom: 2014 to 2019

			Total births	Live births	Stillbirths	Stillbirth rate (95% CI)
Year	2014		749,288	746,322	2,966	3.96 (3.81 to 4.11)
	2015		754,545	751,732	2,813	3.73 (3.59 to 3.87)
	2016		752,232	749,328	2,904	3.86 (3.72 to 4.01)
	2017		733,283	730,623	2,660	3.63 (3.49 to 3.77)
	2018		710,197	707,768	2,429	3.42 (3.28 to 3.56)
	2019		692,024	689,783	2,241	3.24 (3.10 to 3.38)
Ethnic group	White		3,116,448	3,105,855	10,593	3.40 (3.33 to 3.47)
	Asian		426,050	423,640	2,410	5.66 (5.42 to 5.90)
		Indian	124,065	123,449	616	4.97 (4.58 to 5.38)
		Pakistani	166,443	165,350	1,093	6.57 (6.17 to 6.99)
		Bangladeshi	57,517	57,199	318	5.53 (4.93 to 6.20)
		Other Asian	78,025	77,642	383	4.91 (4.44 to 5.43)
	Black		185,861	184,452	1,409	7.58 (7.19 to 7.99)
		Black Caribbean	31,780	31,544	236	7.43 (6.54 to 8.43)
		Black African	132,005	130,997	1,008	7.64 (7.17 to 8.13)
		Black other	22,076	21,911	165	7.47 (6.42 to 8.70)
	Mixed		231,818	230,945	873	3.77 (3.52 to 4.03)
	Other		115,879	115,439	440	3.80 (3.45 to 4.17)
Country	England		3,765,551	3,751,863	13,688	3.64 (3.57 to 3.70)
	Wales		188,002	187,241	761	4.05 (3.75 to 4.36)
	Scotland		300,309	299,237	1,072	3.57 (3.36 to 3.80)
	Northern Ireland		137,707	137,215	492	3.57 (3.26 to 3.91)
Deprivation	Least deprived quintile		882,217	879,838	2,379	2.70 (2.58 to 2.81)
	2nd quintile		872,282	869,595	2,687	3.08 (2.96 to 3.21)
	3rd quintile		873,814	870,669	3,145	3.60 (3.47 to 3.73)
	4th quintile		877,204	873,630	3,574	4.07 (3.94 to 4.22)
	Most deprived quintile		873,171	868,981	4,190	4.80 (4.64 to 4.96)
Maternal age	<20 years		140,920	140,242	678	4.81 (4.46 to 5.19)
	20-24 years		644,229	641,519	2,710	4.21 (4.05 to 4.37)
	25-29 years		1,205,330	1,201,156	4,174	3.46 (3.35 to 3.58)
	30-34 years		1,360,207	1,355,712	4,495	3.31 (3.20 to 3.41)
	35-39 years		761,204	758,207	2,997	3.94 (3.79 to 4.09)
	40+ years		176,447	175,490	957	5.42 (5.09 to 5.79)
Gestation	24-27 weeks		15,041	11,271	3,770	250.7 (243.9 to 257.7)
	28-31 weeks		28,378	25,729	2,649	93.3 (90.01 to 96.8)
	32-36 weeks		225,196	221,198	3,998	17.8 (17.2 to 18.3)
	37+ weeks		4,003,991	3,998,421	5,570	1.39 (1.35 to 1.43)

Absolute differences in stillbirth rates between ethnicities, adjusted for year of birth and country of residence, before and after additional adjustment for deprivation and maternal age are shown in Table 2. The absolute difference in stillbirth rates was slightly attenuated after adjustment for deprivation and maternal age; here we discuss the adjusted rates. Adjusted stillbirth rates were 3.6 per 1,000 higher or more for babies of Black ethnicities (Rate difference: Black African: 3.83 per 1,000, 95% CI: 3.35 to 4.32; Black Caribbean: 3.60, 2.65 to 4.55; Other Black: 3.76, 2.62 to 4.89) compared with babies of White ethnicity, equating to a doubling of risk (Table 2). For babies of Asian ethnicity, the absolute rate difference compared to babies of White ethnicity was highest for babies of Pakistani, (2.99 per 1,000, 95% CI: 2.58 to 3.40) and Bangladeshi ethnicities (1.89, 1.26 to 2.52). This relates to a 44 to 87% increased risk compared to babies of White ethnicity. For babies of Indian and other Asian ethnicities, the adjusted absolute differences were less at 1.71 per 1,000 (95% CI: 1.30 to 2.11) and 1.48 per 1,000 (0.98 to 1.97) respectively, but still significantly higher than babies of White ethnicity. Babies of mixed and Chinese or other ethnicities had similar adjusted rates of stillbirth to babies of White ethnicity, with adjusted absolute rate differences of 0.27 per 1,000 (95% CI: 0.02 to 0.53) and 0.25 per 1,000 (-0.10 to 0.60) respectively. After adjustment, babies born to mothers living in the most deprived quintile had an increased absolute rate difference of 1.5 stillbirths per 1,000 total births compared to the least deprived quintile (1.50; 95% 1.32 to 1.67) (Table 2).

Table 2: Adjusted disparities in rates of stillbirth for ethnic groups, deprivation quintile and maternal age for births in the United Kingdom: 2014 to 2019

	Base models Rate difference (95% CI)	Multivariable model Rate difference (95% CI)
Ethnic group		
White	0	0
Indian	1.66 (1.65 to 1.66)	1.71 (1.30 to 2.11)
Pakistani	3.26 (2.85 to 3.67)	2.99 (2.58 to 3.40)
Bangladeshi	2.22 (1.58 to 2.85)	1.89 (1.26 to 2.52)
Other Asian	1.62 (1.12 to 2.12)	1.48 (0.98 to 1.97)
Black Caribbean	4.14 (3.19 to 5.08)	3.60 (2.65 to 4.55)
Black African	4.32 (3.84 to 4.8)	3.83 (3.35 to 4.32)
Other Black	4.18 (3.04 to 5.31)	3.76 (2.62 to 4.89)
Mixed	0.45 (0.19 to 0.71)	0.27 (0.02 to 0.53)
Other	0.45 (0.09 to 0.82)	0.25 (-0.10 to 0.6)
Deprivation		
Most deprived vs. least deprived quintile	2.08 (1.91 to 2.24)	1.50 (1.32 to 1.67)
Age		
<20 years	1.47 (1.09 to 1.85)	1.41 (1.01 to 1.80)
20-24 years	0.88 (0.69 to 1.07)	0.78 (0.58 to 0.97)
25-29 years	0.15 (0.00 to 0.30)	0.05 (-0.09 to 0.19)
30-34 years	0	0
35-39 years	0.65 (0.47 to 0.82)	0.57 (0.40 to 0.75)
40+ years	2.12 (1.76 to 2.49)	1.88 (1.51 to 2.25)

[1] Individual models (adjusted for country of residence and year of birth only)
[2] Multivariable model (also adjusted for country of residence and year of birth)

Figure 1 shows the proportion of total births (live and stillbirths) within each deprivation quintile for each ethnicity. The colour of the bars depict the stillbirth rate for babies within each ethnic group and deprivation quintile. This highlights that a much higher proportion of babies of Bangladeshi (41.7%), Black African (39.2%), other Black (38.8%), and Black Caribbean (37.3%) ethnicities are born to mothers living in the most deprived quintile. It also highlights the increased stillbirth rates experienced by babies of Black African, other Black, and Black Caribbean ethnicities across

deprivation quintile, and similarly for babies of Bangladeshi and Pakistani ethnicities. The combined impact of living in the most deprived quintile for a baby of Black African ethnicity leads to an increase in stillbirth rates of 5.70 per 1,000 (95% CI: 5.20 to 6.21) compared with babies of White ethnicity born to mothers living in the least deprived quintile. Despite the far higher proportion of babies of Bangladeshi, Black African, other Black, and Black Caribbean ethnicities living in most deprived areas, ethnic inequalities were similar across socioeconomic deprivation quintiles (p-value for interaction=0.31). There was no evidence of ethnic inequalities in stillbirth rates changing significantly between 2014 and 2019, shown by a non-significant interaction between ethnic group and year in the adjusted model (p=0.22).

FIGURE 1

By applying the rate of stillbirth for babies of White ethnicity to all other ethnic groups, we estimated that 1,869 stillbirths could potentially have been prevented over the six years from 2014 to 2019 if ethnic inequalities did not exist, a 12% reduction in stillbirths. The largest reduction in the number of stillbirths would be in the Pakistani (527 stillbirths) and Black African (559 stillbirths) groups.

Figure 2 shows the cause of stillbirth by baby's ethnicity. Stillbirth rates for most causes showed similar patterns to overall differences by ethnicity (Figure 2a). The highest rates of stillbirth were attributed to unexplained causes, with rates much higher in babies of Black African (2.99 per 1,000 total births, 95% CI: 2.70 to 3.29), Black Caribbean (2.90, 2.30 to 3.49) than babies of white ethnicity (1.29, 1.25 to 1.33), but also higher in babies of Asian ethnicities (2.24-2.56/1,000). Stillbirth rates (per 1,000 total births) caused by congenital anomalies were substantially higher for babies of Pakistani ethnicity (1.05, 95% CI: 0.89 to 1.20), Bangladeshi (0.80, 0.57 to 1.03), Black African (0.63,

0.49 to 0.76), and Other Black (0.73, 0.37 to 1.08) ethnicities than babies of White ethnicity (0.19, 0.17 to 0.20). Rates of congenital anomalies for babies of Indian ethnicity (0.24, 0.16 to 0.33) were similar to babies of White ethnicity. Babies of Black ethnicities had around double the rate of stillbirths associated with placental causes compared with babies of White ethnicity (Black Caribbean: 2.24 per 1,000, Black African: 1.97 per 1,000, White: 1.03/1,000).

FIGURE2

Since the percentage of stillbirths due to congenital anomalies is likely to be influenced by both access and choices around prenatal screening and termination of pregnancy, we reviewed the percentage of deaths attributed to each cause excluding congenital anomalies (Figure 3). In total, over 40% of stillbirths were recorded as unknown cause. The proportion of stillbirths of unknown cause was higher in babies of Bangladeshi (57.9%), Indian (51.5%) and other Asian (60.2%) ethnicities compared with all other ethnicities, where the proportion recorded as unknown cause was 43-47%. Conversely, a lower proportion of deaths attributed to placental causes was observed for these groups, with 18.5% for Bangladeshi and 19.1% for other Asian ethnicities compared with 36.3% for babies of Pakistani ethnicity, 34.2% for White, and 34.0% for Black Caribbean ethnicities.

FIGURE3

Discussion

Stillbirth rates for singleton births in the United Kingdom have decreased by 18% between 2014 and 2019, but ethnic inequalities persist. Crude stillbirth rates are highest in babies of Black African, Black Caribbean, and Pakistani ethnicities and adjusting for deprivation and maternal age only marginally attenuated this increased risk. The increased risks associated with deprivation were consistent for all ethnic groups. However, higher proportions of babies of Black Caribbean, Black African, Bangladeshi and Pakistani ethnicities born to mothers living in the most deprived areas placing them at additional risk. Rates of stillbirth attributed to unknown causes were high, with particularly high rates for babies of Black ethnicities, and accounted for high proportions of stillbirths for babies of Asian ethnicities. Key causes of stillbirth were placental related causes and congenital anomalies, which had higher rates in babies of Black ethnicities.

A major strength of our study is the use of high quality population surveillance data for mortality over a six-year period, with complete ascertainment of stillbirths from 24 weeks gestation including termination of pregnancies. This ensures generalisability to the UK population as well as providing detailed information on cause of death and facilitating exclusion of termination of pregnancies from stillbirth estimates. Few high-income countries have similar active national programme of stillbirth surveillance.[6] Our large sample size allowed exploration of ethnicity with more granularity as recommended by Khunti et al.[27] to ensure disaggregation of groups with different cultural, religious, social and economic experiences. This highlighted differences in stillbirth rates between babies of Indian, Pakistani and Bangladeshi ethnicities not seen in previous studies[28 29] which looked at aggregated data. However, surveillance data has limitations associated with routine data. Routine ethnicity classification is in principle self-defined, but in reality may be assigned by the health professional completing the notification[30] with potential for misclassification. Misclassification has been found to be a particular issue for more granular mixed and other ethnic groups[31], here we report on granular Asian and Black ethnic groups where misclassification is less of a problem, and aggregated mixed or other ethnic groups.

Measurement of deprivation is limited to area level data on income deprivation and there is a lack of information on other potentially important modifiable risk factors for all births. MBRRACE-UK are currently undertaking a Confidential Enquiry to review the quality of care provision for Black mothers who experience a stillbirth or neonatal death which will facilitate greater understanding than can be attained through routine data alone.

Our finding of increased stillbirth rates in babies of Black and Asian ethnicities is consistent with other UK [28 29 32] and international studies[7] but few studies have explored differences in cause of death by ethnicity, and recent ONS estimates for England and Wales give infant mortality rates by ethnicity and limited cause of death, but not for stillbirth.[11] Our finding of inequalities in stillbirth rates caused by congenital anomalies could be influenced by access and choices surrounding termination of pregnancies, with Pakistani mothers in particular less likely to choose to terminate their pregnancy when an anomaly is identified, while termination rates are also lower in more deprived areas.[33] There may be differences in provision and/or uptake of antenatal screening for Pakistani women,[34] a population where consanguinity is also more prevalent.[35]

Further emphasis on the need for collecting detailed information on cause of death in national surveillance programmes will aid our understanding of the high rates of stillbirth experienced by babies of Black and Asian ethnicities and improve our ability to monitor and reduce stillbirth inequalities[36]. Efforts to increase uptake of post mortem[37] and other investigations after stillbirth could reduce the high numbers of unexplained stillbirths seen in our study and in other high income countries[36]. A new classification system being piloted by the International Stillbirth Alliance could facilitate this and address the limitations of current practices which have insufficient detail on placental pathology resulting in large proportions of unexplained stillbirths.[38] These strategies will facilitate the design of services to address the specific needs of the populations they serve and reduce unacceptable ethnic inequalities.

Figure 1: Stillbirth rates by ethnicity and deprivation quintile, with bar sizes reflecting the percentage of babies for each ethnicity born in each deprivation quintile, and colours showing the stillbirth rate within these groups.

Figure 2: Cause of death for stillbirths (rate per 1,000 total births) by ethnic group for births in the United Kingdom: 2014 to 2019

Figure 3: Cause of death for stillbirths as a percent of stillbirths (excluding those caused by congenital anomalies) by ethnic group for births in the United Kingdom: 2014 to 2019

Author Contributions

The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

JK is the Principle Investigator holding the grant to deliver the Maternal, Newborn and Infant Clinical Outcome Review programme by the MBRRACE-UK collaboration. ESD leads the perinatal arm of the MBRRACE-UK programme. ESD, ACF, BM & LKS are members of the MBRRACE-UK collaboration. Contributions are as follows: funding: ESD, JK, BM, LKS; supervision: ESD, BM LKS; conceptualisation and study design: ESD, JK, BM, RJM, LKS; Data curation: IG, BM, RJM; methodology: BM, RJM, LKS; Statistical analysis: RJM, LKS; visualisation; RJM, LKS, original draft: RJM,LKS. All authors were involved with reviewing, critically appraising and editing the manuscript. All authors have approved the final version. RJM is guarantor. The corresponding author attests that all listed authors meet authorship criteria and no others meeting the criteria have been omitted.

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Competing interest statement

All authors have completed the Unified Competing Interest form (available on request from the corresponding author) and declare:

ESD, JD-B, ACF, IG, JK, BKM RJM, LKS had no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work.

Ethical approval

Not required. Approvals were granted for UK collection of patient identifiable data and access to statutory data without consent as follows:
England and Wales: National Information Governance Board ECC 5-05 (f)/2012 (from 10.10.2012) and the Confidentiality Advisory Group of the Health Research Authority 15/CAG/0119 (from 01.05.2015); Health & Social Care Information Centre (HSCIC), Data Access Advisory Group:DARS-NIC-359651-H3R1P-v5.2.
Scotland - The NHS Scotland Caldicott Guardian: 2014-62 MBRRACE-UK Programme – Update (2013-05) the Public Benefit and Privacy Panel for Health and Social Care (1920-0131) and The Privacy Advisory Committee, ISD, NHS National Services Scotland: PAC16/14. Due to the different data privacy arrangements in Northern Ireland only de-identified data is provided to the MNICORP programme.

Data sharing

Data may be requested from the data controller, the Healthcare Quality Improvement Partnership (HQIP). A Data Access Request Form can be obtained from https://www.hqip.org.uk/national-programmes/accessing-ncapop-data/#.XQeml_lKhjU.

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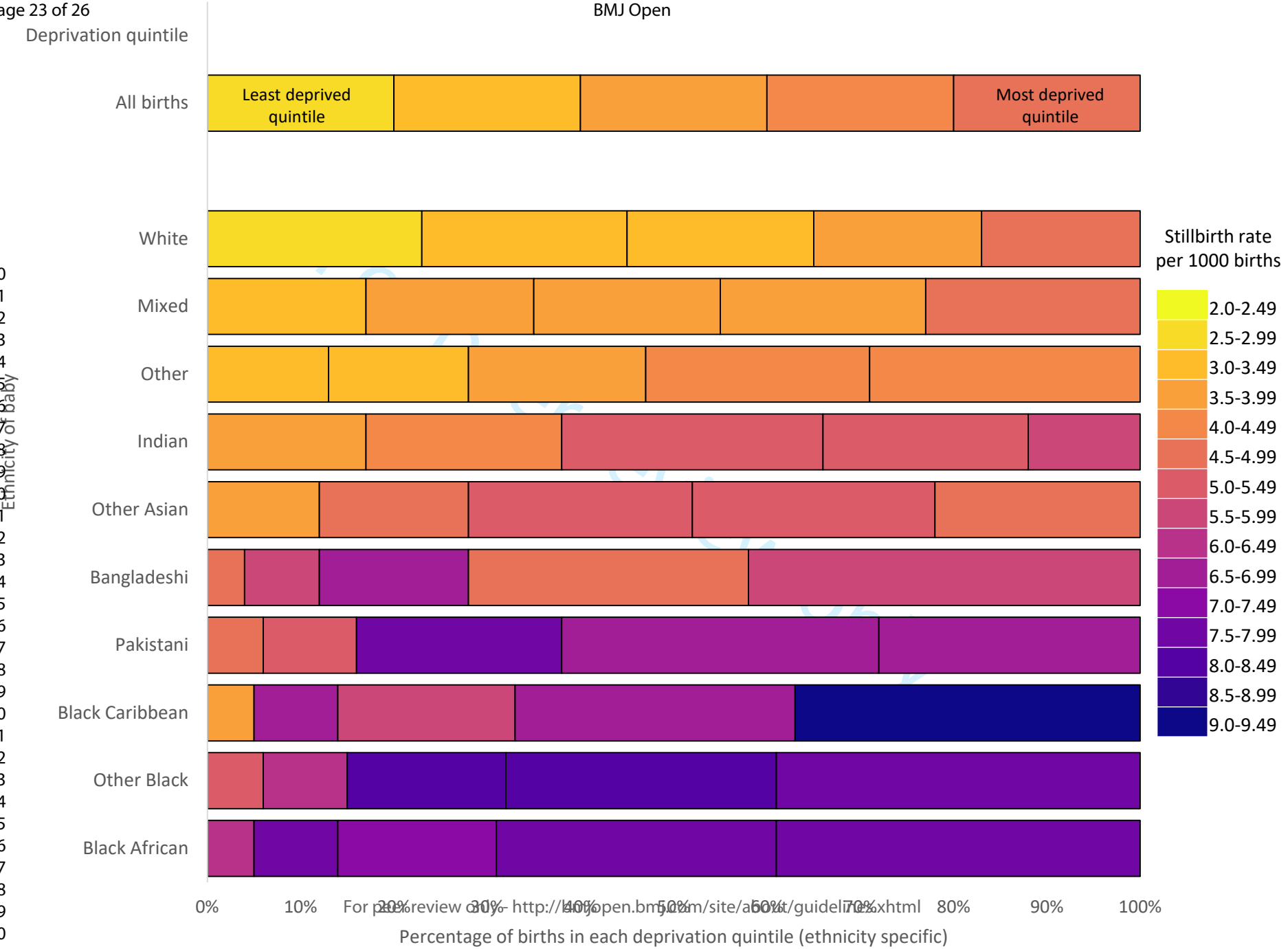

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	P1 & P2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	P2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	P4
Objectives	3	State specific objectives, including any prespecified hypotheses	P4
Methods			
Study design	4	Present key elements of study design early in the paper	P5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	P5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	P5
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	P5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	P5-6
Bias	9	Describe any efforts to address potential sources of bias	P7
Study size	10	Explain how the study size was arrived at	P5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	P5-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	P6-7
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	P8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	P8 & Table 1
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	Report numbers of outcome events or summary measures over time	Table 1,p9

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	P10-11
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	P12-13
Discussion			
Key results	18	Summarise key results with reference to study objectives	P14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	P14-15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	P15
Generalisability	21	Discuss the generalisability (external validity) of the study results	P14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	P17

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

BMJ Open

Understanding ethnic inequalities in stillbirth rates: A UK population based cohort study

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Understanding ethnic inequalities in stillbirth rates: A UK population based cohort study

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Abstract

Objectives –To investigate inequalities in stillbirth rates by ethnicity to facilitate development of initiatives to target those at highest risk.

Design – Population-based perinatal mortality surveillance linked to national birth and death registration (MBRRACE-UK)

Setting - UK

Participants –4,391,569 singleton births at ≥24^{+0} weeks gestation between 2014 and 2019

Main outcome measures – Stillbirth rate difference per 1,000 total births by ethnicity.

Results – Adjusted absolute differences in stillbirth rates were higher for babies of Black African (3.83, 95% CI: 3.35 to 4.32), Black Caribbean (3.60, 95% CI: 2.65 to 4.55) and Pakistani (2.99, 95% CI 2.58 to 3.40) ethnicities compared with White ethnicities. Higher proportions of babies of Bangladeshi (42%), Black African (39%), Black Caribbean (37%) and Pakistani (28%) ethnicities were from most deprived areas, which were associated with an additional risk of 1.50 stillbirths per 1,000 births (95%CI 1.32 to 1.67) . Exploring primary cause of death, higher stillbirth rates due to congenital anomalies were observed in babies of Pakistani, Bangladeshi and Black African ethnicities (range 0.63 to 1.05 per 1,000 births) and more placental causes in Black ethnicities (range 1.97 to 2.24 per 1,000 births). For the whole population over 40% of stillbirths were of unknown cause, however this was particularly high for babies of other Asian (60.0%), Bangladeshi (58.2%), and Indian (51.5%) ethnicities.

Conclusions - Stillbirth rates declined in the UK, but substantial excess risk of stillbirth persists among babies of Black and Asian ethnicities. The combined disadvantage for Black, Pakistani, and Bangladeshi ethnicities who are more likely to live in most deprived areas is associated with considerably higher rates. Key causes of death were congenital anomalies and placental causes.

Improved strategies for investigation of stillbirth causes are needed to reduce unexplained deaths so that interventions can be targeted to reduce stillbirths.

Article Summary

Strengths and limitations of this study

- National data with complete ascertainment of all stillbirths over a 6 year period from 2014-2019
- Inclusion of over 4 million births and over 16,000 stillbirths, which allows exploration of ethnicity with greater granularity.
- Information on cause of death allows further understanding of inequalities in stillbirth rates.
- Despite reporting adjusted estimates, we cannot rule out residual confounding by potentially important modifiable risk factors not measured for all births.
- Ethnicity from birth notifications is in principle self-defined, but in reality may sometimes be assigned by health professionals and therefore subject to misclassification.

Key words

Stillbirth, ethnic inequalities, perinatal mortality, mortality rates, cause of death

Introduction

The worldwide Covid-19 pandemic has highlighted the unacceptable health inequalities experienced by individuals from different ethnic groups, and the issue is receiving the global attention it has long deserved. In the United Kingdom (UK), reports of ethnic inequalities in maternal mortality[1] have highlighted this issue and sparked the Fivexmore campaign to change Black women's maternal health outcomes (https://www.fivexmore.com). Stillbirths are a major health burden with large disparity between and, importantly, within countries.[2-4] Ethnic inequalities in stillbirth rates have been noted in a number of high-income countries including Australia,[5] New Zealand,[6] North America,[7] and Europe[8 9] with rates often over double for migrant mothers or minority ethnic groups compared with those of White ethnicity. Recent national stillbirth data for the UK[10] and England and Wales[11] similarly report stillbirth rates to be around twice as high in babies of Black ethnicity and 60% higher in babies of Asian ethnicity compared to babies of White ethnicity.

Research into ethnic inequalities in stillbirth rates is limited, and little is known about differences in the causes of stillbirth between ethnic groups. Studies including stillbirth cause are lacking detailed information on cause of death..[7 11] Minority ethnic groups in the UK are typically more socioeconomically disadvantaged and likely to have poorer health outcomes than the White population[11 12] and may have different age profiles because of migration patterns or cultural differences in timing of motherhood. It is therefore important to consider the impact these factors have on the association between ethnicity and stillbirth.[13 14]

Stillbirth rates are higher in the UK than many other comparable high-income countries, and are decreasing more slowly.[2 15] Despite targets set by the Governments across the UK to reduce stillbirths by between 35 and 50%[16-18] alongside a number of initiatives aimed at improving maternity services and care[19-23] improvements remain gradual. A greater impact on stillbirth rates may be achieved through better understanding of the multiple disadvantages that lead to higher risks of stillbirth[2 24] and the differences in the causes of death between ethnicities, so that initiatives

can be targeted towards those most in need and reduce evident inequalities in stillbirth rates. Here we explore recent trends in UK stillbirth rates by ethnicity, the extent to which associations between ethnicity and stillbirth are mediated by socioeconomic deprivation and maternal age, and whether cause of death varies between ethnic groups.

Methods

Data on all singleton live births and stillbirths from 24 weeks gestation to mothers resident in England, Wales, Scotland and Northern Ireland between 1 January 2014 and 31 December 2019 were obtained from the Mothers and Babies: Reducing Risk through Audits and Confidential Enquiries across the UK (MBRRACE-UK) perinatal mortality surveillance programme[10] linked to birth notification and registration data. In January 2013, the Healthcare Quality Improvement Partnership commissioned the MBRRACE-UK collaboration to collect UK perinatal mortality surveillance data. MBRRACE-UK links detailed information on all deaths reported by UK hospitals with data on all births from the Patient Demographic Service (formerly the NN4B birth notification system) and birth and death registration data from the Office for National Statistics for England and Wales, National Records Scotland and Information Services Division for Scotland and the Northern Ireland Maternity System for Northern Ireland. MBRRACE-UK use stillbirth registrations from statutory notifications to ensure complete ascertainment of stillbirths.

Information about the baby's ethnicity is obtained via linkage with birth notification data for all births. We categorise baby's ethnicity as: White, Indian, Pakistani, Bangladeshi, other Asian, Black Caribbean, Black African and other Black, mixed ethnicities, and other (including Chinese). Minor variations in ethnicity classification between the four UK countries prevented reporting rates for more specific ethnicity groupings for babies of mixed ethnicity at the UK-level as well as for minority White ethnic groups. Where routine ethnicity data was missing for a stillborn baby, we used ethnicity as recorded in MBRRACE-UK surveillance data.

We used the Children in Low-Income Families Local Measure[25] as an estimate of socioeconomic deprivation. This is an area based measure of the proportion of children living in families that are either in receipt of out-of-work benefits or in receipt of tax credits with a reported income that is less than 60% of the national median income. We allocated this to mother's postcode of residence at the time of birth through data linkage at the small area level. We ranked all areas in the United Kingdom by deprivation score, dividing them into five groups with approximately equal numbers of births in each quintile. Birth notification data were also used to provide information about maternal age, which was grouped into five year age bands (<20 years, 20-24, 25-29, 30-34, 35-39 and 40+ years).

Stillbirths were classified based on timing of death as intrapartum if the baby was known to be alive at the onset of the care episode which led to birth, and antepartum if the baby was not alive at onset of care or if the timing of death was unknown (n=559). Cause of death was classified by local MBRRACE-UK reporters at each hospital using the Cause of Death and Associated Conditions (CODAC) classification system[26] into the following first level categories: Infection, Intrapartum, Congenital Anomaly, Fetal, Cord Related, Placental Related, Maternal, or Unknown.

Statistical Analysis

We calculated the observed stillbirth rate (per 1,000 total births) by ethnicity, deprivation quintile, maternal age, country of residence at time of birth and year of birth. Binomial regression models with identity link were fitted to explore the absolute difference in stillbirth rates separately for ethnicity, deprivation quintile (fitted as a continuous variable after assessment of linearity) and maternal age, with variance adjusted for clustering within small area (Lower super output area or data zone). These models were adjusted for country of residence (England, Scotland, Wales and Northern Ireland) to allow for differences in policy between the devolved nations that may influence stillbirth rates, and year of birth, to allow for differences in stillbirth rates over time. Multivariable models were then fitted including all factors to take into account confounding of maternal age and

deprivation on estimates of ethnic differences in stillbirth rates. Interactions were fitted between ethnicity and deprivation quintile to explore whether the effect of deprivation was varied by ethnicity. Trends in ethnic inequalities over time were explored by fitting interactions with year of birth.

Sensitivity analyses

Multivariable models reported here are on a complete case basis, but repeating analyses including individuals with missing data for covariates using an additional category for those with missing data did not materially affect the results. Causes of death were examined before and after exclusion of stillbirths where the primary cause of death was congenital anomalies, because of the association with access and choices surrounding termination of pregnancy for fetal anomaly.

The excess stillbirth rate associated with ethnicity was calculated by applying the stillbirth rate observed for babies of White ethnicity to the number of births for each other ethnic group and comparing this number to the observed number of stillbirths for that ethnic group.

All analyses were conducted in STATA/IC version 16.0.

Patient and Public Involvement (PPI)

The ongoing MBRRACE-UK collaboration includes PPI representatives and bereaved parents. The MBRRACE-UK collaboration has also established a third sector stakeholder group comprising representatives from all relevant national mother and baby charities. The PPI stakeholder group are consulted about the programme at an annual meeting held face-to-face in the past and remotely during the global pandemic. We consult them by email between the annual meetings.

Results

Between January 2014 and December 2019 there were 4,391,569 singleton births at or above 24 weeks gestation to mothers resident in the UK, of which 16,013 ended in stillbirth (3.65 per 1,000 total births, 95% confidence interval (95% CI) 3.58 to 3.71). Of these, 14,633 were antepartum (3.33 per 1,000, 95% CI: 3.27 to 3.39), and 1,380 intrapartum (0.31 per 1,000, 95% CI: 0.29 to 0.34). Information about ethnicity was available for 93% of all births and 98% of stillbirths; of the 4,076,056 births with information on ethnicity, 76% were classified as White, 10% Asian (including Indian, Pakistani, Bangladeshi and Other Asian groups), 5% Black (including Black Caribbean, Black African and other Black groups), 6% mixed, and 3% other ethnicities (see Table 1).

Table 1 shows the number and rate of stillbirths by ethnicity, socioeconomic deprivation, maternal age, year, and country of residence. Stillbirth rates were substantially higher in babies of Black (7.58 per 1,000, 95% CI: 7.19 to 7.99) and Asian (5.66 per 1,000, 95% CI: 5.42 to 5.90) ethnicities compared with babies of White (3.40 per 1,000, 95% CI: 3.33 to 3.47), mixed (3.77, 95% CI: 3.52 to 4.03), and Chinese or other (3.80, 95% CI: 3.45 to 4.17) ethnicities. Aggregating the Asian ethnicities masked higher stillbirth rates of 6.57 per 1,000 (95% CI: 6.17 to 6.99) for babies of Pakistani ethnicity and 5.82 per 1,000 (95% CI: 5.21 to 6.51) for babies of Bangladeshi ethnicity compared with babies of Indian ethnicity (4.97 per 1,000, 95% CI: 4.58 to 5.38). Stillbirth rates were universally high for babies of Black ethnicity, with rates of over 7 per 1,000 births (Table 1). Stillbirth rates increased with socioeconomic deprivation, from 2.70 per 1,000 (95% CI: 2.58 to 2.81) in the least deprived quintile, to 4.80 per 1,000 (95% CI: 4.64 to 4.96) in the most deprived quintile. Stillbirth rates were highest in the youngest (<20 years) and oldest (>40 years) mothers (Table 1). There was an 18% decrease in stillbirth rates over six years (Table 1).

Table 1: Number of births (total, live births and stillbirths) and stillbirth rates per 1,000 total births by sociodemographic characteristics for births in the United Kingdom: 2014 to 2019

			Total births	Live births	Stillbirths	Stillbirth rate (95% CI)
Year	2014		749,288	746,322	2,966	3.96 (3.81 to 4.11)
	2015		754,545	751,732	2,813	3.73 (3.59 to 3.87)
	2016		752,232	749,328	2,904	3.86 (3.72 to 4.01)
	2017		733,283	730,623	2,660	3.63 (3.49 to 3.77)
	2018		710,197	707,768	2,429	3.42 (3.28 to 3.56)
	2019		692,024	689,783	2,241	3.24 (3.10 to 3.38)
Baby's ethnicity	White		3,116,448	3,105,855	10,593	3.40 (3.33 to 3.47)
	Asian		426,050	423,640	2,410	5.66 (5.42 to 5.90)
		Indian	124,065	123,449	616	4.97 (4.58 to 5.38)
		Pakistani	166,443	165,350	1,093	6.57 (6.17 to 6.99)
		Bangladeshi	57,517	57,199	335	5.82 (5.21 to 6.51)
		Other Asian	78,025	77,642	366	4.69 (4.23 to 5.20)
	Black		185,861	184,452	1,409	7.58 (7.19 to 7.99)
		Black Caribbean	31,780	31,544	236	7.43 (6.54 to 8.43)
		Black African	132,005	130,997	1,008	7.64 (7.17 to 8.13)
		Black other	22,076	21,911	165	7.47 (6.42 to 8.70)
	Mixed		231,818	230,945	873	3.77 (3.52 to 4.03)
	Other		115,879	115,439	440	3.80 (3.45 to 4.17)
Country	England		3,765,551	3,751,863	13,688	3.64 (3.57 to 3.70)
	Wales		188,002	187,241	761	4.05 (3.75 to 4.36)
	Scotland		300,309	299,237	1,072	3.57 (3.36 to 3.80)
	Northern Ireland		137,707	137,215	492	3.57 (3.26 to 3.91)
Deprivation	Least deprived quintile		882,217	879,838	2,379	2.70 (2.58 to 2.81)
	2nd quintile		872,282	869,595	2,687	3.08 (2.96 to 3.21)
	3rd quintile		873,814	870,669	3,145	3.60 (3.47 to 3.73)
	4th quintile		877,204	873,630	3,574	4.07 (3.94 to 4.22)
	Most deprived quintile		873,171	868,981	4,190	4.80 (4.64 to 4.96)
Maternal age	<20 years		140,920	140,242	678	4.81 (4.46 to 5.19)
	20-24 years		644,229	641,519	2,710	4.21 (4.05 to 4.37)
	25-29 years		1,205,330	1,201,156	4,174	3.46 (3.35 to 3.58)
	30-34 years		1,360,207	1,355,712	4,495	3.31 (3.20 to 3.41)
	35-39 years		761,204	758,207	2,997	3.94 (3.79 to 4.09)
	40+ years		176,447	175,490	957	5.42 (5.09 to 5.79)

Absolute differences in stillbirth rates between ethnicities, adjusted for year of birth and country of residence, before and after additional adjustment for deprivation and maternal age are shown in Table 2. The absolute difference in stillbirth rates was slightly attenuated after adjustment for deprivation and maternal age; here we discuss the adjusted rates. Adjusted stillbirth rates were 3.6 per 1,000 higher or more for babies of Black ethnicities compared with babies of White ethnicity, equating to a doubling of risk (Table 2). For babies of Asian ethnicity, the absolute rate difference compared to babies of White ethnicity was highest for babies of Pakistani, (2.99 per 1,000, 95% CI: 2.58 to 3.40) and Bangladeshi ethnicities (2.18 per 1,000, 95% CI: 1.54 to 2.83). This relates to a 61 to 88% increased risk compared to babies of White ethnicity. For babies of Indian and other Asian ethnicities, the adjusted absolute differences were less, but still significantly higher than babies of White ethnicity (Table 2). After adjustment, babies born to mothers living in the most deprived quintile had an increased absolute rate difference of 1.5 stillbirths per 1,000 total births compared to the least deprived quintile (1.50, 95% 1.32 to 1.67).

Table 2: Adjusted disparities in rates of stillbirth for ethnic groups, deprivation quintile and maternal age for births in the United Kingdom: 2014 to 2019

	Base models Rate difference (95% CI)	Multivariable model Rate difference (95% CI)
Baby's ethnicity		
White	0	0
Indian	1.66 (1.25 to 2.06)	1.71 (1.30 to 2.11)
Pakistani	3.26 (2.85 to 3.67)	2.99 (2.58 to 3.40)
Bangladeshi	2.51 (1.86 to 3.16)	2.18 (1.54 to 2.83)
Other Asian	1.41 (0.92 to 1.90)	1.27 (0.79 to 1.76)
Black Caribbean	4.14 (3.19 to 5.08)	3.60 (2.65 to 4.55)
Black African	4.32 (3.84 to 4.80)	3.83 (3.35 to 4.32)
Other Black	4.18 (3.04 to 5.31)	3.76 (2.62 to 4.89)
Mixed	0.45 (0.19 to 0.71)	0.27 (0.02 to 0.53)
Other	0.45 (0.09 to 0.82)	0.25 (-0.10 to 0.60)
Deprivation		
Most deprived vs. least deprived quintile	2.08 (1.91 to 2.24)	1.50 (1.32 to 1.67)
Age		
<20 years	1.47 (1.09 to 1.85)	1.41 (1.01 to 1.80)
20-24 years	0.88 (0.69 to 1.07)	0.78 (0.58 to 0.97)
25-29 years	0.15 (0.00 to 0.30)	0.05 (-0.09 to 0.19)
30-34 years	0	0
35-39 years	0.65 (0.47 to 0.82)	0.57 (0.40 to 0.75)
40+ years	2.12 (1.76 to 2.49)	1.88 (1.51 to 2.25)

[1] Separate models for ethnicity, deprivation and maternal age, each model adjusted for country of residence and year of birth.
[2] Multivariable model including ethnicity, deprivation and maternal age (also adjusted for country of residence and year of birth)

Figure 1 shows the proportion of total births (live and stillbirths) within each deprivation quintile for each ethnicity (For underlying numbers see supplementary table S1). The colour of the bars depict the stillbirth rate for babies within each ethnic group and deprivation quintile. This highlights that a much higher proportion of babies of Bangladeshi (41.7%), Black African (39.2%), other Black (38.8%), and Black Caribbean (37.3%) ethnicities are born to mothers living in the most deprived quintile. It

also highlights the increased stillbirth rates experienced by babies of Black African, other Black, and Black Caribbean ethnicities across deprivation quintile, and similarly for babies of Bangladeshi and Pakistani ethnicities. The combined impact of living in the most deprived quintile for a baby of Black African ethnicity leads to an increase in stillbirth rates of 5.70 per 1,000 (95% CI: 5.20 to 6.21) compared with babies of White ethnicity born to mothers living in the least deprived quintile. Despite the far higher proportion of babies of Bangladeshi, Black African, other Black, and Black Caribbean ethnicities living in most deprived areas, ethnic inequalities were similar across socioeconomic deprivation quintiles (p-value for interaction=0.31). There was no evidence of ethnic inequalities in stillbirth rates changing significantly between 2014 and 2019, shown by a non-significant interaction between ethnicity and year in the adjusted model (p=0.22).

FIGURE 1

By applying the rate of stillbirth for babies of White ethnicity to all other ethnic groups, we estimated that 1,869 stillbirths could potentially have been prevented over the six years from 2014 to 2019 if ethnic inequalities did not exist, a 12% reduction in stillbirths. The largest reduction in the number of stillbirths would be in the Pakistani (527 stillbirths) and Black African (559 stillbirths) groups.

Figure 2 shows the cause of stillbirth by baby's ethnicity. Stillbirth rates for most causes showed similar patterns to overall differences by ethnicity (Figure 2a). Stillbirth rates with no known cause were much higher in babies of Black African (2.99 per 1,000, 95% CI: 2.70 to 3.29), Black Caribbean (2.90 per 1,000, 95% CI: 2.30 to 3.49) than babies of white ethnicity (1.29 per 1,000, 95% CI: 1.25 to 1.33), but also higher in babies of Asian ethnicities (ranging from 2.24 per 1,000 to2.56per1,000). Stillbirth rates (per 1,000 total births) where the primary cause was a congenital anomaly were

substantially higher for babies of Pakistani, Bangladeshi, Black African, and Other Black ethnicities. Rates of congenital anomalies for babies of Indian ethnicity (0.24 per 1,000, 95% CI: 0.16 to 0.33) were similar to babies of White ethnicity. Babies of Black ethnicities had around double the rate of stillbirths associated with placental causes compared with babies of White ethnicity (Figure 2).

FIGURE2

Since the percentage of stillbirths due to congenital anomalies is likely to be influenced by both access and choices around prenatal screening and termination of pregnancy, we reviewed the percentage of deaths attributed to each cause excluding congenital anomalies (Figure 3). In total, over 40% of stillbirths were recorded as unknown cause. The proportion of stillbirths of unknown cause was higher in babies of Bangladeshi (58.2%), Indian (51.5%) and other Asian (60.0%) ethnicities compared with all other ethnicities, where the proportion recorded as unknown cause was 43 to 47%. Conversely, a lower proportion of deaths attributed to placental causes was observed for these groups (Figure 3).

FIGURE3

Discussion

Stillbirth rates for singleton births in the United Kingdom have decreased by 18% between 2014 and 2019, but ethnic inequalities persist. Crude stillbirth rates are highest in babies of Black African, Black Caribbean, and Pakistani ethnicities and adjusting for deprivation and maternal age only marginally attenuated this increased risk. The increased risks associated with deprivation were consistent for all ethnic groups. However, higher proportions of babies of Black Caribbean, Black African, Bangladeshi and Pakistani ethnicities born to mothers living in the most deprived areas

placing them at additional risk. Rates of stillbirth attributed to unknown causes were high, with particularly high rates for babies of Black ethnicities, and accounted for high proportions of stillbirths for babies of Asian ethnicities. Key causes of stillbirth were placental related causes and congenital anomalies, which had higher rates in babies of Black ethnicities.

A major strength of our study is the use of high quality population surveillance data for mortality over a six-year period, with complete ascertainment of stillbirths from 24 weeks gestation including termination of pregnancies. This ensures generalisability to the UK population as well as providing detailed information on cause of death and facilitating exclusion of termination of pregnancies from stillbirth estimates. Few high-income countries have similar active national programme of stillbirth surveillance.[6] Our large sample size allowed exploration of ethnicity with more granularity as recommended by Khunti et al.[27] to avoid combining groups with different cultural, religious, social and economic experiences. This highlighted differences in stillbirth rates between babies of Indian, Pakistani and Bangladeshi ethnicities not seen in previous studies[28 29] which looked at aggregated data. However, surveillance data has limitations associated with routine data. Routine ethnicity classification is in principle self-defined, but in reality may be assigned by the health professional completing the notification[30] with potential for misclassification. Misclassification has been found to be a particular issue for more granular mixed and other ethnic groups[31], here we report on granular Asian and Black ethnic groups where misclassification is less of a problem, and aggregated mixed or other ethnic groups.

Measurement of deprivation is limited to area level data on income deprivation. In addition, there is a lack of information in the birth notification data regarding mother's country of birth, gravidity and previous stillbirths as well as other potentially modifiable risk factors such as antenatal attendance and smoking during pregnancy. Therefore, residual confounding cannot be ruled out. MBRRACE-UK are currently undertaking a Confidential Enquiry to review the quality of care provision for Black

mothers who experience a stillbirth or neonatal death which will facilitate greater understanding than can be attained through routine data surveillance alone.

Our finding of increased stillbirth rates in babies of Black and Asian ethnicities is consistent with other UK [28 29 32] and international studies[7] but few studies have explored differences in cause of death by ethnicity, and recent ONS estimates for England and Wales give infant mortality rates by ethnicity and limited cause of death, but not for stillbirth.[11] Our finding of inequalities in stillbirth rates caused by congenital anomalies could be influenced by access and choices surrounding termination of pregnancies, with Pakistani mothers in particular less likely to choose to terminate their pregnancy when an anomaly is identified, while termination rates are also lower in more deprived areas.[33] There may be differences in provision and/or uptake of antenatal screening for Pakistani women,[34] a population where consanguinity is also more prevalent.[35]

Further emphasis on the need for collecting detailed information on cause of death in national surveillance programmes will aid our understanding of the high rates of stillbirth experienced by babies of Black and Asian ethnicities and improve our ability to monitor and reduce stillbirth inequalities[36]. Efforts to increase uptake of post mortem[37] and other investigations after stillbirth could reduce the high numbers of stillbirths of unknown cause seen in our study and in other high income countries[36]. The International Stillbirth Alliance are in the process of developing and evaluating a hybrid classification system building on the strengths of existing classification systems[38] such as CODAC and incorporating the principles of the WHO ICD-PM classification. This should address the limitations of current classification systems such as the lack of sufficient detail on placental pathology resulting in large proportions of unexplained stillbirthsl.[39] These strategies will facilitate the design of services to address the specific needs of the populations they serve and reduce unacceptable ethnic inequalities.

Figure 1: Stillbirth rates by ethnicity and deprivation quintile, with bar sizes reflecting the percentage of babies for each ethnicity born in each deprivation quintile, and colours showing the stillbirth rate within these groups.

Figure 2: Cause of death for stillbirths (rate per 1,000 total births) by baby's ethnicity for births in the United Kingdom: 2014 to 2019

Figure 3: Cause of death for stillbirths as a percent of stillbirths (excluding those caused by congenital anomalies) by baby's ethnicity for births in the United Kingdom: 2014 to 2019

Author Contributions

The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted.

JK is the Principal Investigator holding the grant to deliver the Maternal, Newborn and Infant Clinical Outcome Review programme by the MBRRACE-UK collaboration. ESD leads the perinatal arm of the MBRRACE-UK programme. ESD, ACF, BM & LKS are members of the MBRRACE-UK collaboration. Contributions are as follows: funding: ESD, JK, BM, LKS; supervision: ESD, BM LKS; conceptualisation and study design: J D-B, ESD, JK, BM, RJM, LKS; Data curation: IG, BM, RJM; methodology: BM, RJM, LKS; Statistical analysis: RJM, LKS; visualisation; RJM, LKS, original draft: RJM,LKS. All authors were involved with reviewing, critically appraising and editing the manuscript. All authors have approved the final version. RJM is guarantor. The corresponding author attests that all listed authors meet authorship criteria and no others meeting the criteria have been omitted.

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Competing interest statement

All authors have completed the Unified Competing Interest form (available on request from the corresponding author) and declare:

ESD, JD-B, ACF, IG, JK, BKM RJM, LKS had no support from any organisation for the submitted work; no financial relationships with any organisations that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work.

Ethical approval

Not required. Approvals were granted for UK collection of patient identifiable data and access to statutory data without consent as follows:
England and Wales: National Information Governance Board ECC 5-05 (f)/2012 (from 10.10.2012) and the Confidentiality Advisory Group of the Health Research Authority 15/CAG/0119 (from 01.05.2015); Health & Social Care Information Centre (HSCIC), Data Access Advisory Group:DARS-NIC-359651-H3R1P-v5.2.
Scotland - The NHS Scotland Caldicott Guardian: 2014-62 MBRRACE-UK Programme – Update (2013-05) the Public Benefit and Privacy Panel for Health and Social Care (1920-0131) and The Privacy Advisory Committee, ISD, NHS National Services Scotland: PAC16/14. Due to the different data privacy arrangements in Northern Ireland only de-identified data is provided to the MNICORP programme.

Data availability statement

Data may be requested from the data controller, the Healthcare Quality Improvement Partnership (HQIP). A Data Access Request Form can be obtained from https://www.hqip.org.uk/national-programmes/accessing-ncapop-data/#.XQeml_lKhjU.

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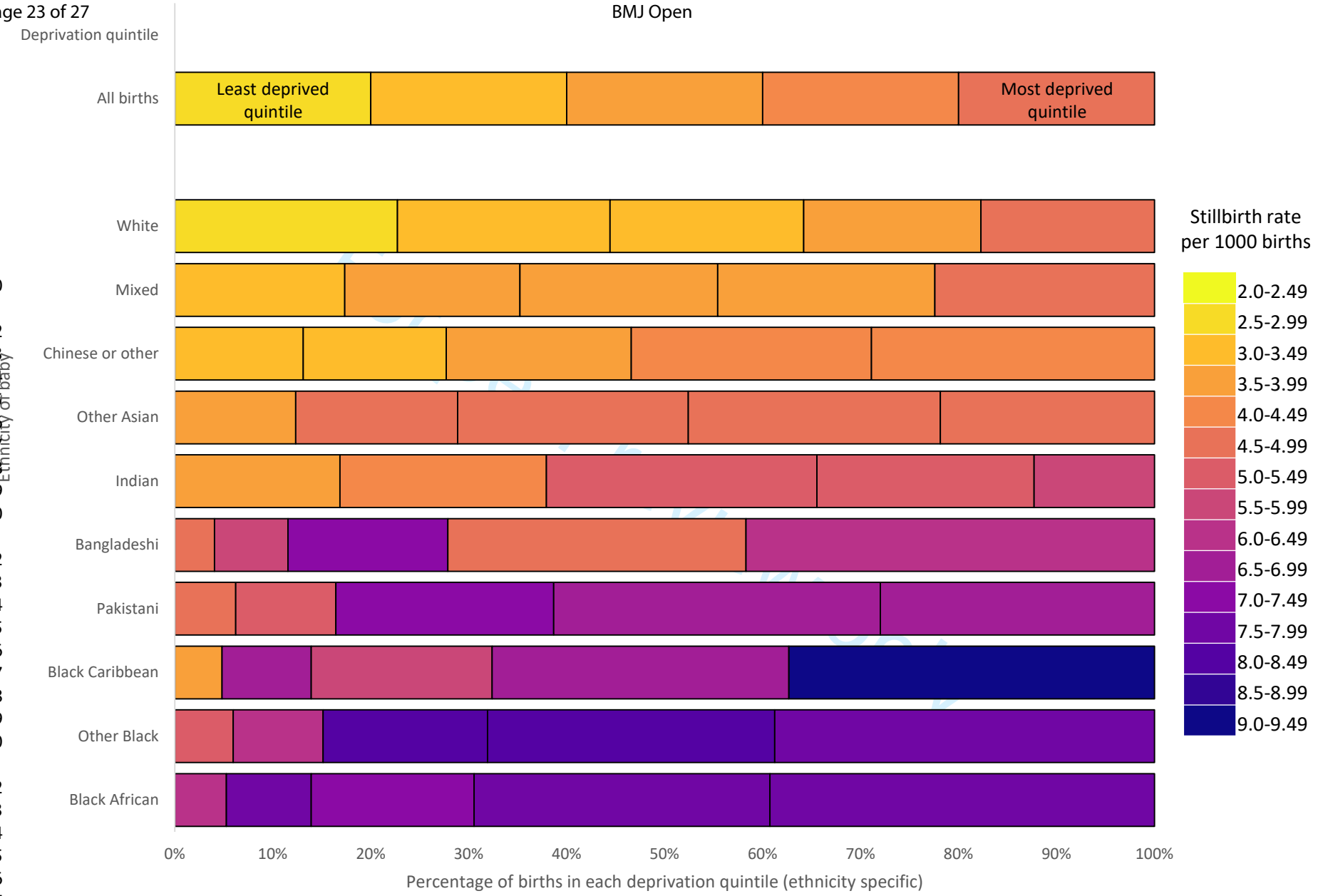

Table S1: Percentage (number) of births, and stillbirth rate per 1,000 total births (number) by deprivation quintile and baby's ethnicity in the UK: 2014 to 2019 (Numbers used in Figure 1)

		DEPRIVATION QUINTILE									
		Least deprived quintile		Quintile 2		Quintile3		Quintile 4		Most deprived quintile	
		Total births % (n)	Stillbirths Rate (n)	Total births % (n)	Stillbirths Rate (n)	Total births % (n)	Stillbirths Rate (n)	Total births % (n)	Stillbirths Rate (n)	Total births % (n)	Stillbirths Rate (n)
BABY'S ETHNICITY	White	22.72 (705,826)	2.73 (1,924)	21.69 (673,889)	3.00 (2,024)	19.78 (614,513)	3.30 (2,025)	18.09 (561,853)	3.67 (2,061)	17.72 (550,514)	4.60 (2,531)
	Indian	16.86 (20,871)	3.83 (80)	21.06 (26,081)	4.41 (115)	27.62 (34,202)	5.32 (182)	22.18 (27,457)	5.35 (147)	12.28 (15,207)	5.98 (91)
	Pakistani	6.22 (10,348)	4.74 (49)	10.21 (16,977)	5.36 (91)	22.24 (36,975)	7.14 (264)	33.34 (55,441)	6.93 (384)	27.99 (46,535)	6.53 (304)
	Bangladeshi	4.06 (2,334)	4.71 (11)	7.5 (4,314)	5.8 (25)	16.31 (9,381)	7.04 (66)	30.43 (17,503)	4.91 (86)	41.70 (23,987)	6.13 (147)
	Other Asian	12.34 (9,607)	3.85 (37)	16.54 (12,876)	4.82 (62)	23.53 (18,321)	4.97 (91)	25.73 (20,035)	4.94 (99)	21.86 (17,023)	4.52 (77)
	Black Caribbean	4.81 (1,527)	3.93 (6)	9.11 (2,895)	6.91 (20)	18.46 (5,864)	5.63 (33)	30.29 (9,623)	6.96 (67)	37.33 (11,857)	9.28 (110)
	Black African	5.25 (6,929)	6.06 (42)	8.67 (11,435)	7.52 (86)	16.62 (21,925)	7.34 (161)	30.21 (39,856)	7.75 (309)	39.24 (51,768)	7.88 (408)
	Black other	5.96 (1,315)	5.32 (7)	9.17 (2,022)	6.43 (13)	16.79 (3,704)	8.10 (30)	29.32 (6,467)	8.04 (52)	38.77 (8,552)	7.37 (63)
	Mixed	17.35 (40,155)	3.01 (121)	17.88 (41,362)	3.72 (154)	20.19 (46,724)	3.51 (164)	22.15 (51,264)	3.76 (193)	22.42 (51,884)	4.59 (238)
	Other	13.11 (15,149)	3.37 (51)	14.59 (16,859)	3.20 (54)	18.88 (21,812)	3.53 (77)	24.52 (28,331)	4.17 (118)	28.9 (33,387)	4.13 (138)

STROBE Statement—Checklist of items that should be included in reports of ***cohort studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	P1 & P2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	P2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	P4
Objectives	3	State specific objectives, including any prespecified hypotheses	P4
Methods			
Study design	4	Present key elements of study design early in the paper	P5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	P5
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	P5
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	P5-6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	P5-6
Bias	9	Describe any efforts to address potential sources of bias	P7
Study size	10	Explain how the study size was arrived at	P5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	P5-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	P6-7
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	P8
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	P8 & Table 1
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	Report numbers of outcome events or summary measures over time	Table 1,p9

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included (*b*) Report category boundaries when continuous variables were categorized (*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	P10-11
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	P12-13
Discussion			
Key results	18	Summarise key results with reference to study objectives	P14
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	P14-15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	P15
Generalisability	21	Discuss the generalisability (external validity) of the study results	P14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	P17

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.