Ultrasound Obstet Gynecol 2024
Published online in Wiley Online Library (wileyonlinelibrary.com). **DOI:** 10.1002/uog.27625.

Maternal ethnicity and socioeconomic deprivation: influence on adverse pregnancy outcomes

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KEYWORDS: composite adverse outcome of pregnancy; ethnicity; indices of multiple deprivation; pre-eclampsia; preterm birth; small-for-gestational age; socioeconomic deprivation; stillbirth; uteroplacental dysfunction

CONTRIBUTION

What are the novel findings of this work?
The risk of pregnancy complications related to placental dysfunction is higher in women of black and Asian ethnicity compared to women of white ethnicity. Even so, the majority of these adverse pregnancy outcomes occur in white women living in the most deprived socioeconomic conditions.

What are the clinical implications of this work?
Both ethnicity and socioeconomic deprivation should be considered in the prediction of placenta-mediated disorders to prevent underestimation of the effective burden of these adverse pregnancy outcomes in the overall population.

ABSTRACT

Objective *To evaluate the relative importance of ethnicity and socioeconomic deprivation in determining the likelihood and prevalence of placentally derived composite of adverse pregnancy outcomes (CAPO) and composite of severe adverse pregnancy outcomes (CAPO-S).*

Methods *This was a single-center retrospective cohort study of data obtained in a tertiary maternity unit. Data regarding ethnicity and socioeconomic deprivation (as measured with indices of multiple deprivation) were collected for 13 165 singleton pregnancies screened routinely in the first trimester for pre-eclampsia using the Fetal Medicine Foundation combined risk-assessment algorithm. CAPO was defined as the presence of one or more interrelated outcomes associated with placental dysfunction, namely, hypertensive disorders of pregnancy, preterm birth, birth weight* $\leq 10^{th}$ *centile and stillbirth. CAPO-S was defined as the presence of one or more of the following: hypertensive disorders of pregnancy at* $< 37+0$ *weeks, preterm birth at* $< 34+0$ *weeks, birth weight* $\leq 5^{th}$ *centile and stillbirth at* $< 37+0$ *weeks.*

Results *The prevalence of CAPO was 16.3% in white women, 29.3% in black women and 29.3% in South Asian women. However, half (51.7%) of all CAPO cases occurred in white women. There was a strong interaction between ethnicity and socioeconomic deprivation, with a correlation coefficient of −0.223. Both ethnicity and socioeconomic deprivation influenced the prevalence of CAPO and CAPO-S, with the contribution of ethnicity being the strongest.*

Conclusions *Black and Asian ethnicity, as well as socioeconomic deprivation, influence the prevalence of placenta-mediated adverse pregnancy outcomes. Despite this, most adverse pregnancy outcomes occur in white women, who represent the majority of the population and are also affected by socioeconomic deprivation. For these reasons, inclusion of socioeconomic deprivation should be considered in early pregnancy risk assessment for placenta-mediated CAPO.* © *2024 The Authors. Ultrasound in Obstetrics & Gynecology published by John Wiley & Sons Ltd on behalf of International Society of Ultrasound in Obstetrics and Gynecology.*

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Accepted: 18 February 2024

INTRODUCTION

Black and ethnic minority groups represent a subset of the population at greatest risk of an adverse health outcome. In pregnancy, complications such as pre-eclampsia and perinatal mortality are more prevalent in women of black and South Asian ethnicity when compared with white women[1–3]. Similarly, socioeconomic deprivation also constitutes a key driver for both general and pregnancy-specific adverse outcomes[3–6].

Maternal ethnicity, but not socioeconomic deprivation, is included in the Fetal Medicine Foundation (FMF) first-trimester combined screening test for pre-eclampsia[7]. The exclusion of socioeconomic deprivation is justified in the study of Arechvo *et al*., who concluded that inclusion of indices of multiple deprivation (IMD) as a measure of socioeconomic deprivation[8] in the FMF algorithm did not improve screening performance for pre-eclampsia[9]. However, women identified as being at high risk of preterm pre-eclampsia by the FMF algorithm are also at increased risk of developing a wide range of additional adverse pregnancy outcomes related to uteroplacental dysfunction, including small-for-gestational-age birth, preterm birth and stillbirth[10–12].

The aim of this study was to evaluate the relative importance of ethnicity and socioeconomic deprivation in determining the likelihood and the burden of a composite of adverse pregnancy outcomes (CAPO), which include hypertensive disorders of pregnancy, preterm birth, small-for-gestational age and stillbirth, in a population screened routinely for preterm pre-eclampsia in the first trimester using the FMF algorithm.

METHODS

This was a single-center retrospective cohort study of data obtained between March 2018 and May 2022 at St George's University Hospitals NHS Foundation Trust, which is a tertiary maternity unit in the UK. Data were routinely collected from all women screened for preterm pre-eclampsia in the first trimester using the FMF multifactorial algorithm. IMD indices were used as a well-established and validated measure of relative deprivation by inclusion of data from seven domains (income, employment, education, health and disability, crime, barriers to housing and services, and living environment) combined according to their respective weights, for small, postcode-defined geographical areas. Each neighborhood is ranked according to the level of deprivation relative to other areas, with categorization into 1 of 10 (decile) groups. The most deprived areas were allocated to the lowest group (Group 1), while the least deprived were in the highest group (Group 10). IMD indices have been used extensively in the literature as a proxy for socioeconomic deprivation[3,9,13], and are periodically updated[8].

Participant characteristics collected at the first trimester visit included maternal race (white, black, South Asian, mixed and other) and postcode used to calculate IMD. Ethnicity was self-reported. Only women with complete information on socioeconomic deprivation and ethnicity were included in the study. All women with a risk of preterm pre-eclampsia of ≥ 1 in 50 were offered a program of monitoring and intervention: daily administration of 150 mg prophylactic aspirin as well as serial ultrasound growth scans at 28 and 36 weeks' gestation and induction of labor from $40+0$ weeks[10]. As per the saving babies' lives care bundle version 3, induction of labor was offered after $37+0$ weeks in cases of estimated fetal weight (EFW) $< 5^{th}$ centile and after $39+0$ weeks when EFW $< 10^{th}$ centile[14]. CAPO was defined as the presence of one or more interrelated outcomes associated with placental dysfunction, namely, hypertensive disorders of pregnancy[15], preterm birth[16], birth weight $\leq 10^{th}$ centile (according to the international standards developed by INTERGROWTH-21st[17]) and stillbirth. Composite of severe adverse pregnancy outcomes (CAPO-S) was defined as the presence of one or more of the following: preterm hypertensive disorders of pregnancy ($< 37+0$ weeks), preterm birth $< 34+0$ weeks, birth weight $\leq 5^{th}$ centile and preterm stillbirth ($< 37+0$ weeks).

Outcome data were collected retrospectively from the ultrasound database and maternity birth registry, which undergo systematic clinical governance evaluation. The present study was deemed not to require ethics committee approval or signed patient consent as per the Health Research Authority decision tool. Summary data are expressed as median and interquartile range for continuous variables and as number and percentage for categorical variables. Correlation between ethnicity, CAPO and IMD was tested using Spearman's Rho and Pearson's chi-square tests. Logistic regression analysis (uni-/bi-/multivariate) was performed to examine the association between ethnicity, IMD and CAPO (or CAPO-S); white ethnicity and the group with the lowest level of deprivation (IMD decile 10) were chosen as the reference. The model R^2 coefficient was 0.19 for the analysis performed with only ethnicity as independent variable and 0.21 with ethnicity and IMD deciles for both CAPO and CAPO-S. Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 28.0.1.0 (IBM Corp., Armonk, NY, USA). $P < 0.05$ was considered statistically significant.

RESULTS

Data were obtained from 13 165 singleton pregnancies screened between March 2018 and May 2022. Maternal demographic and socioeconomic deprivation indices are shown in Table 1. Women of non-white ethnicity constituted 35.6% of the study population and 5.5% were in the lowest two deprivation deciles (IMD deciles 1 and 2). Rates of hypertensive disorders of pregnancy, preterm birth, small-for-gestational-age birth and stillbirth were 5.1%, 5.0%, 13.7% and 0.5%, respectively. The distribution of maternal ethnicity by IMD is shown in Figure 1. Women of white, Asian and mixed/other backgrounds had similar distributions for

Table 1 Maternal demographic characteristics and pregnancy outcomes in 13 165 women with singleton pregnancy included in study

Characteristic	*Value*
Maternal age (years)	32 (29–35)
Maternal weight (kg)	66.0 (58.9–75.9)
Maternal height (cm)	164 (160–169)
Maternal BMI (kg/m^2)	24.3 (21.8–28.0)
Ethnicity	
White	8484 (64.4)
Black	1528 (11.6)
South Asian	2232 (17.0)
Mixed/other	921 (7.0)
IMD decile	
Deciles 1 and 2	719 (5.5)
Deciles 3 and 4	3273 (24.9)
Deciles 5 and 6	4025 (30.6)
Deciles 7 and 8	3065 (23.3)
Deciles 9 and 10	2083 (15.8)
Adverse pregnancy outcome	
Hypertensive disorder of pregnancy	667 (5.1)
Small-for-gestational age (< 10th centile)	1803 (13.7)
Preterm birth	656 (5.0)
Stillbirth	64 (0.5)
CAPO	2683 (20.4)
CAPO-S	1244 (9.4)

Data are given as median (interquartile range) or *n* (%). BMI, body mass index; CAPO, composite of adverse pregnancy outcomes; CAPO-S, composite of severe adverse pregnancy outcomes; IMD, indices of multiple deprivation (deciles 1 and 2, most deprived; deciles 9 and 10, least deprived).

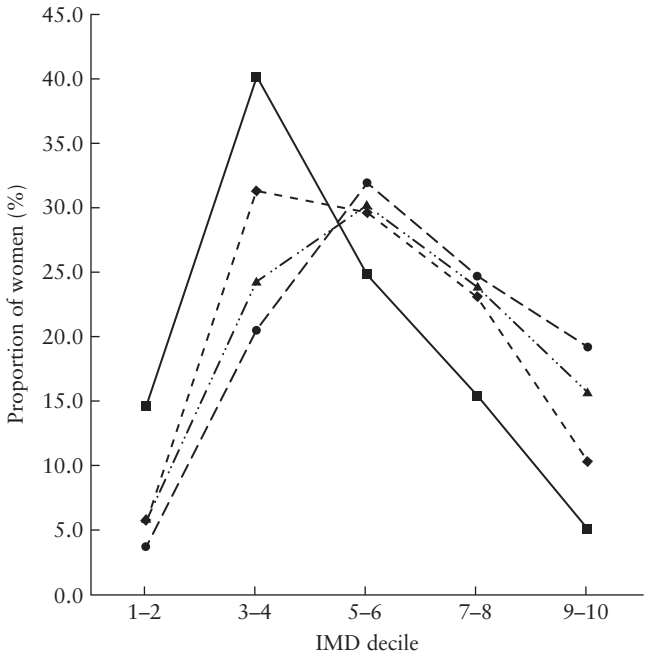

Figure 1 Distribution of ethnic groups according to indices of multiple deprivation (IMD) decile (deciles 1 and 2, most deprived; deciles 9 and 10, least deprived). —●—, white; —■—, black; - -◆- -, Asian; —▲···, mixed/other.

IMD deciles, whereas women of black ethnicity showed a distribution skewed to the lowest IMD deciles.

The overall incidence of CAPO and CAPO-S was 20.4% ($n = 2683$) and 9.4% ($n = 1244$), respectively. The prevalence of CAPO was 16.3% in white women, 29.3% in black women and 29.3% in South Asian women (Table 2). However, half (51.7%) of all CAPO cases occurred in white women, with 24.4% and 16.7% of all CAPO cases occurring in the South Asian and black groups, respectively. Similar trends were noted for CAPO-S cases (Table S1). The prevalence of CAPO decreased from 25.3% in women from the lowest IMD deciles (deciles 1 and 2, i.e. most deprived) to 18.3% in women from the highest IMD deciles (deciles 9 and 10, i.e. least deprived). Similar trends were noted for CAPO-S cases (Table S2). White women from the most deprived areas (IMD deciles 1–4) accounted for 14.5% and 13.8% of all CAPO and CAPO-S cases, respectively (Figures S1 and S2).

There was a significant interaction ($P < 0.001$) between ethnicity and IMD with a correlation coefficient of −0.223. This interaction was particularly strong for women of black (Pearson's chi-square value, 614.4, $P < 0.001$) and white ethnicities (Pearson's chi-square value, 869.8, $P < 0.001$), weaker for Asian (Pearson's chi-square value, 96.4, $P < 0.001$) and non-significant for mixed/other backgrounds ($P = 0.96$) (Table S2). In view of the strong interaction between ethnicity and IMD, the data were subjected to multivariate rather than univariate/bivariate analyses. In multivariate analysis, only ethnicity was a significant predictor of CAPO ($P < 0.001$), whereas both ethnicity ($P < 0.001$) and IMD ($P = 0.002$) were significant predictors of CAPO-S (Table 3 and Figure 2). The risk of developing CAPO-S was 2.4 (95% CI, 2.0–2.8) and 2.8 (95% CI, 2.4–3.2) times higher for black and South Asian women, compared with white women. The risk of developing CAPO-S was 2.2 (95% CI, 1.5–3.1) times higher for women belonging to the IMD decile 3 group as compared with women from the IMD decile 10 group (Table 2). In the subgroup of the population composed only of women of white ethnicity, there were significant correlations between IMD indices and both CAPO and CAPO-S (Table S3).

DISCUSSION

Hypertensive disorders of pregnancy, small-for-gestational-age birth, preterm birth and stillbirth are potentially avoidable adverse pregnancy outcomes. Despite this, 1 in 5 women in our study population developed at least one of the composite adverse pregnancy outcomes, with 1 in 10 women developing at least one severe adverse pregnancy outcome. Maternal ethnicity appears to have a stronger influence than socioeconomic deprivation, represented by IMD, with the risk of CAPO being higher in black and South Asian women. Despite this pattern, within our study population, the majority of adverse pregnancy outcomes (51.7%) occurred in white women, who represent the largest group (64.4%) and are impacted by the effects of socioeconomic deprivation,

Table 2 Prevalence of composite of adverse pregnancy outcome (CAPO) according to ethnicity and index of multiple deprivation (IMD)

Parameter	N	*CAPO (n)*	*Prevalence of CAPO (%) (95% CI)*	*Percentage out of all CAPO cases (%) (95% CI)*
Ethnicity				
White	8484	1386	16.3 (15.5–17.1)	51.7 (50.6–52.7)
Black	1528	447	29.3 (27.0–31.5)	16.7 (14.8–18.5)
South Asian	2232	655	29.3 (27.5–31.2)	24.4 (22.6–26.2)
Mixed/other	921	195	21.2 (18.5–23.8)	7.3 (5.6–8.9)
IMD decile*				
Deciles 1 and 2	719	182	25.3 (22.1–28.5)	6.8 (4.9–8.6)
Deciles 3 and 4	3273	758	23.2 (21.7–24.6)	28.3 (26.7–29.8)
Deciles 5 and 6	4025	807	20.0 (18.8–21.3)	30.1 (28.7–31.5)
Deciles 7 and 8	3065	555	18.1 (16.7–19.5)	20.7 (19.3–22.1)
Deciles 9 and 10	2083	381	18.3 (16.6–20.0)	14.2 (12.7–15.7)

*IMD deciles 1 and 2, most deprived; IMD deciles 9 and 10, least deprived.

Table 3 Multivariate logistic regression showing the impact of ethnicity and index of multiple deprivation (IMD) decile on composite of adverse pregnancy outcomes (CAPO) and composite of severe adverse pregnancy outcomes (CAPO-S)

	CAPO		*CAPO-S*	
Parameter	*OR (95% CI)*	P	*OR (95% CI)*	P
Ethnicity		< 0.001		< 0.001
White	Reference		Reference	
Black	2.01 (1.77–2.30)	< 0.001	2.39 (2.01–2.83)	< 0.001
South Asian	2.10 (1.88–2.34)	< 0.001	2.81 (2.44–3.24)	< 0.001
Mixed/other	1.37 (1.16–1.62)	< 0.001	1.63 (1.30–2.06)	< 0.001
IMD decile*		0.05		0.002
Decile 10	Reference		Reference	
Decile 1	1.46 (0.77–2.78)	0.25	1.79 (0.71–4.50)	0.22
Decile 2	1.18 (0.91–1.52)	0.22	1.80 (1.20–2.71)	0.005
Decile 3	1.23 (0.98–1.54)	0.07	2.16 (1.50–3.11)	< 0.001
Decile 4	1.06 (0.85–1.31)	0.61	1.88 (1.32–2.68)	< 0.001
Decile 5	1.03 (0.82–1.28)	0.82	1.54 (1.06–2.23)	0.02
Decile 6	1.05 (0.85–1.29)	0.66	1.85 (1.30–2.62)	< 0.001
Decile 7	0.90 (0.72–1.11)	0.31	1.44 (1.00–2.07)	0.05
Decile 8	0.99 (0.77–1.26)	0.92	1.70 (1.14–2.52)	0.009
Decile 9	1.02 (0.81–1.29)	0.87	1.70 (1.16–2.49)	0.006

*IMD deciles 1 and 2, most deprived; IMD deciles 9 and 10, least deprived. OR, odds ratio.

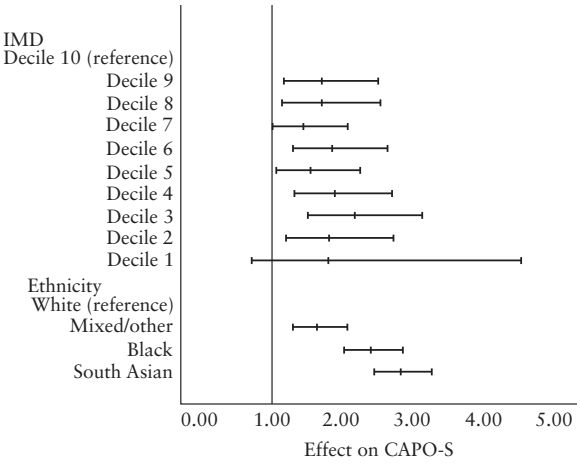

Figure 2 Forest plot showing results of logistic regression analysis conducted to determine interaction between ethnicity, indices of multiple deprivation (IMD) and composite of severe adverse pregnancy outcomes (CAPO-S) in the study population. IMD deciles 1 and 2, most deprived; IMD deciles 9 and 10, least deprived. Datapoints are odds ratio and bars are 95% CI.

with 14% of all CAPO cases occurring in white women from the lowest IMD deciles (deciles 1–4).

Comparison with existing literature

There are no other published studies on the impact of ethnicity and socioeconomic deprivation on CAPO; however, a cohort study of 1 155 981 women demonstrated an increased individual risk for stillbirth, preterm birth, and small-for-gestational-age birth in women from minority ethnic backgrounds and living in the most deprived IMD groups[5]. The authors concluded that concerted action was needed to reduce socioeconomic and ethnic inequalities in pregnancy outcomes but stopped short of specifying how this could be achieved other than by targeting black and South Asian women in deprived socioeconomic groups. A more recent publication, by Arechvo *et al.*, showed that in a cohort of 159 125 singleton pregnancies, the risks of pre-eclampsia and stillbirth were 2- to 3-fold higher in women of black ethnicity when compared with white women[3]. They also reported

that women living in underprivileged conditions had an increased risk of pre-eclampsia and stillbirth. However, the authors demonstrated that incorporating IMD quintiles into screening algorithms did not improve the prediction of pre-eclampsia or stillbirth. It is of note that in the latter study, only 15% of women were of black origin, whereas 47% were from the most socioeconomically deprived areas (IMD quintiles 1 and 2)[3].

Interpretation and biological plausibility of study findings

According to the World Health Organization report on social determinants of health, inequity plays a fundamental role in determining health outcomes[18]. Migrants fleeing from persecution or war-torn regions are known to have poorer health outcomes. However, the prevalence of illness among immigrants converges toward that of the host population with increased duration of residence over the decades through a process termed acculturation[19]. Immigration, ethnicity and socioeconomic deprivation interact with existing societal structures of power, privilege and sexual/ethnic oppression to shape health experiences and outcomes of pregnancy[20,21]. The data of the current study and that of Arechvo *et al.* demonstrate that both ethnicity and socioeconomic deprivation show a strong correlation with pre-eclampsia, stillbirth and CAPO. Ethnicity had a stronger impact on adverse pregnancy outcomes than did socioeconomic deprivation[3], and this can be exemplified through the strong correlation highlighted in our data. An alternative explanation is that maternal ethnicity is, in fact, a better proxy for socioeconomic deprivation than calculated IMD indices. The limitation of IMD indices is that the choice of components and their relative weighting in the construction of the overall multiple deprivation score is unavoidably subjective.

Clinical and research implications

The FMF first-trimester combined screening algorithm has demonstrated superior detection rates for pre-eclampsia and small-for-gestational-age birth compared with the use of a checklist-based approach[22]. This can be attributed to the algorithm's incorporation of various demographic characteristics, risk factors and biomarkers, including ethnicity but not IMD indices[3,7,10,23,24].

It is a common incorrect assumption that risk represents a good proxy for the burden of disease. Our data demonstrated that even if black women had the highest risk (~30%) for CAPO, only 17% of CAPO cases occurred in this group, with 52% occurring in white women. This disjunction between risk and burden emphasizes that the impact of socioeconomic deprivation is a crucial factor. Even though the risk of CAPO may be lower in white women, this group constitutes a significant portion (65%) of the study cohort and was not immune to the deleterious impact of socioeconomic deprivation, which was significantly correlated with adverse pregnancy outcomes. The discordance is likely to be more evident in a larger cohort, such as the one in the study by Jardine *et al.*, in which only 17% of women were of black or Asian origin, yet 51% were from the lowest four IMD deciles[5]. Relying solely on race in screening algorithms may result in underserving socioeconomically deprived white women; hence, it is necessary to incorporate both ethnicity and IMD indices for more personalized and equitable CAPO prediction models.

Recent research indicates that an effective early pregnancy CAPO risk assessment, facilitating modified care with increased surveillance and targeted interventions including aspirin prophylaxis and serial fetal wellbeing scans, has led to reduced incidence of adverse pregnancy outcomes[7,10,12,23]. These findings suggest that relatively simple healthcare solutions can address disparities, even though the underlying mechanisms connecting ethnicity and socioeconomic deprivation to adverse pregnancy outcomes remain complex.

Strengths and limitations

This retrospective study, the data for which spanned 5 years, included over 13 000 women from a London-based tertiary maternity unit, which implemented the FMF combined screening program and interventions in 2018. This led to notable reductions in preterm pre-eclampsia, small-for-gestational-age births and stillbirth rates[10–12], and might have variably underestimated the associations of ethnicity and socioeconomic deprivation with CAPO. Furthermore, the study involved a single-center cohort in which the distributions of ethnicity and IMD deciles may be different from those of the national population.

Conclusions

Ethnicity and socioeconomic deprivation are both correlated with the risk of developing placenta-mediated adverse pregnancy outcomes which, in combination, affect 1 in 5 pregnancies. Although maternal ethnicity had a stronger influence on CAPO than socioeconomic deprivation represented by IMD deciles, the burden of adverse pregnancy outcomes was higher in white women, who represent the largest group and are still impacted by the effects of socioeconomic deprivation. Pregnancy risk assessment algorithms should take both ethnicity and socioeconomic deprivation into account in the prediction of placenta-mediated adverse outcomes of pregnancy.

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SUPPORTING INFORMATION ON THE INTERNET

The following supporting information may be found in the online version of this article:

Figure S1 Distribution of cases with composite adverse pregnancy outcomes (CAPO) ($n = 2683$) in study population according to ethnicity and indices of multiple deprivation (IMD). IMD deciles 1 and 2, most deprived; IMD deciles 9 and 10, least deprived.

Figure S2 Distribution of cases with composite severe adverse pregnancy outcomes (CAPO-S) ($n = 1244$) in the study population according to ethnicity and indices of multiple deprivation (IMD). IMD deciles 1 and 2, most deprived; IMD deciles 9 and 10, least deprived.

Table S1 Prevalence of composite of severe adverse pregnancy outcomes (CAPO-S) according to ethnicity and index of multiple deprivation (IMD) decile

Table S2 Interaction between ethnicity and index of multiple deprivation (IMD) decile

Table S3 Correlation between index of multiple deprivation (IMD) decile and composite adverse pregnancy outcomes (CAPO) and composite severe adverse pregnancy outcomes (CAPO-S) in women of white ethnicity