BMJ Open

Assessing the relationship between adverse pregnancy outcomes and area-level deprivation in Wales 2014–2019: a national population-based cross-sectional study

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To cite: Brown H, Jesurasa A, Bambra C, *et al*. Assessing the relationship between adverse pregnancy outcomes and area-level deprivation in Wales 2014–2019: a national population-based cross-sectional study. *BMJ Open* 2021;**11**:e052330. doi:10.1136/bmjopen-2021-052330

► Prepublication history and additional supplemental material for this paper are available online. To view these files, please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2021-052330).

Received 13 April 2021
Accepted 25 October 2021

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ABSTRACT

Objectives The aim of this study was to assess the relationship between deciles of area-level deprivation and seven adverse pregnancy outcomes in Wales.

Design Cross-sectional analysis.

Setting 64 699 live births in Wales from 31 March 2014 to 16 September 2019.

Primary outcome variable We examined each of the following seven adverse pregnancy outcomes: (1) small for gestational age (SGA); (2) large for gestational age; (3) preterm birth; (4) third-degree or fourth-degree perineal tear; (5) major postpartum haemorrhage (MPPH); (6) a lower Apgar score at 5 min and (7) emergency caesarean section.

Results There was no significant association between increasing aggregate measures of area-level deprivation and the adverse pregnancy outcomes we studied. Women living in an area with greater access to services are more likely to have a baby that is SGA (1.27, 95% CI 1.11 to 1.49), have a greater likelihood of a perineal tear (1.74, 95% CI 1.15 to 2.61), are significantly less likely to have MPPH (0.79, 95% CI 0.64 to 0.96), have a baby with an Apgar score of 0.26 higher (95% CI 0.22 to 0.29) and are significantly less likely to have an emergency caesarean section (0.81, 95% CI 0.73 to 0.88). Women living in areas with higher employment (0.26, 95% CI 0.19 to 0.36) and better health (0.26, 95% CI 0.19 to 0.35) were less likely to experience perineal tear.

Conclusions There was no clear social-spatial gradient in area-level deprivation and adverse pregnancy outcomes. We found a stronger association for individual-level behavioural risk factors than area-level factors. These findings support the benefits that accessible and holistic person-centred care may bring through addressing individual behavioural risk factors. There is a need for improved data completeness and further individual-level data on risk factors such as employment and income to better understand the role which may be played by population-level policies and their pathways to affecting outcomes.

Strengths and limitations of this study

- Employed data from a national dataset on all live births in Wales between 31 March 2014 and 16 September 2019.
- Some data limitations such as data completeness limiting the available sample and no data on key individual risk factors such as employment and income or on the rurality of lower super output areas.
- We undertook a cross-sectional analysis so could not estimate a causal relationship between area-level factors and adverse pregnancy outcomes.

INTRODUCTION

Adverse pregnancy outcomes negatively impact on individuals, families and communities, and constitute a major public health and clinical concern. Adverse pregnancy outcomes have lifelong consequences for mothers and babies. For example, large for gestational age (LGA), small for gestational age (SGA) and preterm birth can lead to increased risk of poor health in childhood and adulthood.[1–5] LGA can increase maternal risk for major postpartum haemorrhage (MPPH), emergency caesarean section, and third-degree or fourth-degree perineal tear which can have long-term negative health consequences for the mother.[6] These outcomes can have significant economic costs for both families, the healthcare system and society. To improve pregnancy outcomes, it is important to identify modifiable risk factors that can be targeted by policy or interventions. Much of the research to date has focused on individual-level factors in pregnancy such as maternal behaviours, for example, smoking.[7] However, neighbourhood factors are a key area to explore as they can be targeted by population-level rather than individual-level interventions which may be more cost-effective to implement—and potentially better at reducing inequalities.[8]

There are several pathways by which neighbourhood-level factors may influence pregnancy outcomes. A person's neighbourhood may influence stress and associated individual health behaviours such as smoking, alcohol consumption and use of drugs.[9 10] Neighbourhoods may also influence pregnancy outcomes by influencing someone's ability to access health services (eg, late presentation)[11] or ability to access healthy and nutritious food influencing weight outcomes.[12 13] There is no standard definition of neighbourhood-level socioeconomic status (SES).[10] One common method used[14–16] is area-level deprivation. There is a body of evidence showing a relationship between adverse pregnancy outcomes and area-level deprivation.[14–19] Much of this literature has focused on a single pregnancy outcome. However, a study from Germany[19] investigated multiple birth outcomes including caesarean section, SGA, preterm birth, stillbirth and low 5-minute after birth Apgar score. They found a positive association between deprivation and preterm birth and SGA. A negative association was found between deprivation and stillbirths and a low Apgar score. These findings highlight the need to understand the impact of deprivation across a range of pregnancy outcomes. It is unlikely that area-level deprivation will impact on all outcomes equally, so focusing on a number of outcomes will help policymakers and health professionals to determine which neighbourhood factors and outcomes should be prioritised.

In Wales, over the period 2016–2019, approximately 28% of babies were born by caesarean section with half of these by emergency caesarean section, 6% of babies were SGA, 8% of babies were born before 37 weeks, 11.4% of babies were LGA, 2% of babies had an Apgar score of less than 7 at 5 min, 25% of women report a mental health condition and 28% were classified as obese (body mass index (BMI) >30 kg/m^2) at their initial assessment.[20] For the general population, compared with England, Wales has a higher median age of 42 years (England's median age is 40.3 years), had more deaths than births in 2019 and a lower population density.[21]

The aim of this study was to assess the relationship between area-level deprivation and several adverse pregnancy outcomes: (1) SGA; (2) LGA; (3) preterm birth; (4) third-degree or fourth-degree perineal tear; (5) MPPH; (6) lower Apgar score at 5 min and (7) emergency caesarean section for all live births in Wales over the period 2014–2019. To achieve this aim, we examined a composite measure of deprivation as well as the eight domains of deprivation in the Welsh Index of Multiple Deprivation (WIMD).

METHODS

Data for this study were obtained via the Secure Anonymised Information Linkage (SAIL) Gateway. SAIL is a secure storage facility for anonymised person-based data of people living in Wales. From the databank, we obtained anonymously linked data on all births in Wales over the period 31 March 2014–16 September 2019 from the Maternity Indicators Dataset (MIDS) and area-level deprivation from the WIMD dataset. Between 2014 and 2019, we had complete records from 64 699 live births in Wales. We excluded data on stillbirths due to concerns around confidentiality and excluded pregnancies which were missing postcodes so could not be linked with the WIMD data. Some women lived in England but gave birth in Welsh hospitals and these women were excluded from the analysis. We also excluded women with missing data on any of the variables used in the analysis.

The analysis follows the Strengthening the Reporting of Observational Studies in Epidemiology checklist for cross-sectional studies which can be seen in online supplemental appendix A. The data dictionary and code for the analysis are publicly available and can be accessed at the following link: https://github.com/heatherb1030/Assessing-the-relationship-between-Adverse-Pregnancy-Outcomes-and-Area-level-Deprivation-in-Wales-20.git.

Pregnancy outcomes

We evaluated the relationship between decile of area deprivation, eight domains of area-level deprivation (income, employment, health, education, access to services, housing, community safety and physical environment), and seven different adverse pregnancy outcomes:

1. SGA: this was calculated using birth weight in grams, gestational age and sex of the baby. The Royal College of Paediatrics and Child Health's growth charts[22] were used to determine babies who at birth were below the 10th percentile for weight based on their gestational age. SGA was a binary variable that was equal to one if the baby was below the 10th percentile of weight for their gestational age and zero otherwise.
2. LGA: this was calculated using the same variables as for SGA and the growth charts.[22] LGA was equal to one if the baby was above the 90th percentile of weight for gestational age and was equal to zero otherwise.
3. Preterm birth: this variable was created using gestational age at birth. Preterm birth was equal to one if the birth was before 37 completed weeks of pregnancy and was equal to zero if birth was ≥37 weeks.
4. Third-degree or fourth-degree perineal tear: this variable was created from perineal status after birth. It is a dummy variable which is equal to one if the mother had third-degree or fourth-degree perineal tear and was equal to zero otherwise.
5. MPPH: this variable was calculated using estimated blood loss during labour and after birth. It was equal to one if it was estimated that the mother's blood loss was more than 1500 mL during labour and was equal to zero otherwise.
6. Apgar score: this variable was a continuous variable based on Apgar score at 5 min after birth. The Apgar score is an assessment of the baby at birth measuring Appearance, Pulse, Grimace, Activity and Respiration. Each category is given a score of 0, 1 or 2. The 5 min score assesses how well the baby is doing outside the

mother's womb.[23] This variable was reverse coded so that a higher number indicates a worse score.

7. Emergency caesarean section: this variable was created using the variable birth mode. It was equal to one if it was recorded that the mother had an emergency caesarean section and was equal to zero if the mother had delivered by assisted or vaginal delivery.

Area-level deprivation

The level of neighbourhood deprivation was measured using the decile of deprivation from the WIMD. WIMD indices were assigned to the postcodes of the primary living address of the mother giving birth based on information provided at the first antenatal appointment. WIMD identifies small areas (geographical areas with a mean population of 1000-lower super output areas[24]) in Wales by concentration of several types of deprivation. It consists of eight domains which are comprised of a range of different indicators. The domain weighting for the index is income 23.5%, employment 23.5%, health 14%, access to services 10%, housing 5%, community safety 5% and physical environment 5%. Areas are ranked from most to least deprived compared with other areas in Wales. The deciles are a derived variable created by Statistics Wales from the ranked area data. Each domain is ranked and the average of all the domains is also ranked. The deciles are based on the distribution of the ranked data, so each decile is of equal size and all lower super output areas in Wales are included in a decile.[25]

We focus on all eight of the domains in the analysis: income, employment, health, education, access to services, housing, community safety and physical environment. There is evidence[7 9 13 14] that these domains are associated with adverse pregnancy outcomes.

Additional covariates

To identify how individual risk factors related to key social (and behavioural) determinants of health moderate the association between pregnancy outcomes and area-level deprivation, we also controlled for additional maternal variables in some model specification. We included a variable for late booking which is a binary variable that equals to one if the mother had her first antenatal appointment after 12 weeks' gestation based on clinical guidelines for late booking[26] or is equal to zero otherwise, a binary variable that equals to one if the mother reported being a smoker in the 12 months prior to conception, a binary variable that equals to one if the mother was classified as overweight/obese (BMI greater than 25 kg/m^2) at the first antenatal appointment using the WHO BMI cut-offs,[27] parity which is measured as a continuous variable and age of the mother at birth which is measured as a continuous variable. We also included year of birth with 2014 as the birth year to control for any potential time trends in pregnancy outcomes which may impact on our findings.

Analysis

Analysis of factors related to the seven adverse pregnancy outcomes was undertaken using stepwise logistic regression for binary outcomes and stepwise linear regression for continuous outcomes. The unadjusted models included WIMD and year only. We estimated models with a composite measure of WIMD as well as models with each of the eight domains of WIMD separately. Other individual risk factors that are influenced by the social determinants of health were added sequentially to determine how their addition impacted on the relationship between WIMD and the pregnancy outcome. This sequential approach is taken as individual risk factors are likely to be influenced and interact with neighbourhood characteristics (eg, deprivation) which will also be captured in WIMD.[28] In the final model, we determined if there is an independent association of area-level factors after controlling for individual risk factors.

Patient and public involvement

Patients and/or the public were not involved in this research. However, policymakers from Public Health Wales commissioned the research and were involved in the study design and interpretation of the analysis from a public health policy perspective.

RESULTS

ORs and coefficients from the unadjusted models are presented in table 1. There was no dose relationship with area-level deprivation for any of the seven pregnancy outcomes. Women living in a middle decile of deprivation (sixth/seventh) had a lower risk of having third-degree or fourth-degree perineal tear compared with women in the most deprived decile. Women in the second, seventh, ninth and least deprived deciles were more likely to have a preterm birth compared with those in the most deprived decile. Women in the second most deprived decile were significantly less likely to have MPPH than those in the most deprived decile. Women in the fifth, sixth, seventh and eighth deciles had babies with lower Apgar scores than those in the most deprived decile.

Table 2 shows the results from the fully adjusted models as the results did not change significantly with the addition of each of the individual risk factors. There are some changes in the relationship between pregnancy outcome and IMD from the unadjusted to the adjusted models. In the adjusted models (table 2), only those in the least deprived decile were at higher risk of preterm birth compared with those in the most deprived decile. Whereas in the fully adjusted model, those in the second most deprived decile were at higher risk of third-degree or fourth-degree perineal tear compared with those in the most deprived decile. In both the unadjusted and adjusted models, there was a significantly lower risk of third-degree or fourth-degree perineal tear for women in the sixth/seventh deciles compared with those in the most deprived decile. Women in the fourth–eight deciles had lower Apgar scores than those in the most deprived decile.

Table 1 Unadjusted models of the relationship between pregnancy outcomes and IMD

IMD	SGA	LGA	Preterm birth	Third or fourth perineal tear	MPPH	Apgar score	Emergency C-section
Most deprived decile	**Reference category**	**Reference category**	**Reference category**	**Reference category**	**Reference category**	**Reference category**	**Reference category**
2nd decile	1.02 (0.91 to 1.15)	1.03 (0.94 to 1.15)	1.14 (1.01 to 1.29)	1.22 (0.98 to 1.52)	0.75 (0.62 to 0.92)	0.03 (–0.07 to 0.00)	1.01 (0.92 to 1.10)
3rd decile	1.03 (0.91 to 1.16)	1.07 (0.98 to 1.16)	1.10 (0.97 to 1.25)	0.88 (0.70 to 1.12)	0.95 (0.78 to 1.14)	–0.02 (–0.02 to 0.05)	1.08 (0.99 to 1.18)
4th decile	1.01 (0.89 to 1.14)	1.06 (0.97 to 1.15)	1.11 (0.98 to 1.25)	0.82 (0.65 to 1.05)	0.97 (0.81 to 1.17)	0.09 (–0.12 to –0.05)	0.98 (0.90 to 1.08)
5th decile	1.09 (0.96 to 1.24)	1.02 (0.94 to 1.12)	1.21 (1.06 to 1.37)	0.90 (0.70 to 1.15)	0.92 (0.76 to 1.12)	0.09 (–0.13 to –0.05)	1.05 (0.95 to 1.06)
6th decile	0.96 (0.84 to 1.10)	1.01 (0.92 to 1.10)	1.28 (1.12 to 1.45)	0.63 (0.47 to 0.8)	0.96 (0.79 to 1.17)	0.18 (–0.21 to –0.14)	1.05 (0.95 to 1.0)
7th decile	1.07 (0.94 to 1.22)	1.02 (0.94 to 1.12)	1.19 (1.04 to 1.36)	0.36 (0.25 to 0.50)	0.86 (0.71 to 1.05)	0.16 (–0.20 to –0.12)	1.15 (1.05 to 1.27)
8th decile	1.04 (0.92 to 1.18)	1.08 (0.99 to 1.18)	1.15 (1.00 to 1.30)	0.86 (0.67 to 1.09)	0.97 (0.81 to 1.18)	0.11 (–0.15 to –0.08)	1.13 (1.03 to 1.24)
9th decile	0.94 (0.83 to 1.07)	0.98 (0.89 to 1.06)	1.15 (1.01 to 1.31)	1.09 (0.87 to 1.38)	0.90 (0.74 to 1.09)	0.04 (–0.07 to 0.00)	1.00 (0.92 to 1.10)
Least deprived decile	1.08 (0.96 to 1.22)	1.05 (0.97 to 1.04)	1.26 (1.11 to 1.43)	1.07 (0.85 to 1.35)	0.87 (0.72 to 1.05)	–0.01 (–0.03 to 0.04)	1.08 (0.98 to 1.19)
Number of observations	**64794**	**64794**	**64794**	**62050**	**63312**	**64155**	**64699**

All models control for year. ORs are reported for all outcomes except Apgar score which is a coefficient. CIs are in brackets.
IMD, Index of Multiple Deprivation; LGA, large for gestational age; MPPH, major postpartum haemorrhage; SGA, small for gestational age.

Table 2 Adjusted models of the relationship between pregnancy outcomes and IMD

Most deprived decile	SGA	LGA	Preterm birth	Third or fourth perineal tear	MPPH	Apgar score	Emergency C-section
	Reference category	Reference category	Reference category	Reference category	Reference category	Reference category	Reference category
2nd decile	1.01 (0.88 to 1.15)	1.03 (0.94 to 1.13)	1.11 (0.97 to 1.28)	1.27 (1.01 to 1.59)	0.76 (0.62 to 0.94)	0.02 (–0.05 to 0.02)	1.05 (0.95 to 1.16)
3rd decile	1.01 (0.89 to 1.16)	1.09 (1.00 to 1.20)	1.11 (0.97 to 1.25)	0.93 (0.73 to 1.20)	0.92 (0.75 to 1.12)	–0.03 (–0.01 to 0.07)	1.07 (0.97 to 1.19)
4th decile	1.03 (0.90 to 1.18)	1.05 (0.95 to 1.15)	1.13 (0.98 to 1.30)	0.81 (0.63 to 1.05)	1.00 (0.82 to 1.22)	–0.06 (–0.10 to –0.02)	1.02 (0.92 to 1.13)
5th decile	1.06 (0.93 to 1.22)	1.03 (0.94 to 1.14)	1.21 (1.05 to 1.40)	0.93 (0.72 to 1.15)	0.94 (0.76 to 1.16)	0.14 (–0.18 to –0.10)	1.08 (0.97 to 1.21)
6th decile	0.92 (0.79 to 1.07)	1.01 (0.91 to 1.12)	1.19 (1.03 to 1.38)	0.68 (0.51 to 0.9)	1.01 (0.82 to 1.25)	0.14 (–0.18 to –0.10)	1.07 (0.97 to 1.2)
7th decile	0.99 (0.86 to 1.14)	1.04 (0.94 to 1.15)	1.19 (1.04 to 1.36)	0.39 (0.27 to 0.55)	0.89 (0.72 to 1.11)	0.09 (–0.13 to –0.05)	1.18 (1.06 to 1.31)
8th decile	1.01 (0.88 to 1.17)	1.07 (0.97 to 1.18)	1.14 (0.98 to 1.31)	0.95 (0.74 to 1.23)	0.98 (0.80 to 1.20)	0.09 (–0.13 to –0.05)	1.15 (1.04 to 1.27)
9th decile	0.89 (0.77 to 1.02)	1.00 (0.91 to 1.10)	1.09 (0.94 to 1.26)	1.12 (0.88 to 1.43)	0.92 (0.74 to 1.13)	0.03 (–0.07 to 0.01)	1.04 (0.93 to 1.15)
Least deprived decile	1.05 (0.92 to 1.20)	1.05 (0.97 to 1.04)	1.25 (1.09 to 1.44)	1.12 (0.88 to 1.42)	0.89 (0.73 to 1.09)	–0.01 (–0.02 to 0.05)	1.10 (0.99 to 1.22)
Age	0.99 (0.99 to 1.00)	1.02 (1.01 to 1.02)	1.01 (1.01 to 1.02)	0.97 (0.96 to 0.98)	1.04 (1.03 to 1.05)	0.00 (0.00 to 0.00)	1.04 (1.04 to 1.05)
Smoker	2.03 (1.78 to 2.31)	0.55 (0.48 to 0.63)	1.59 (1.39 to 1.83)	0.18 (0.10 to 0.34)	0.63 (0.46 to 0.85)	0.05 (–0.10 to –0.01)	0.98 (0.87 to 1.12)
Overweight/obese	0.71 (0.66 to 0.76)	1.71 (1.64 to 1.79)	1.01 (0.94 to 1.07)	0.79 (0.70 to 0.89)	1.33 (1.21 to 1.47)	0.02 (–0.04 to 0.01)	1.51 (1.44 to 1.59)
Parity 1	1.20 (1.06 to 1.36)	0.89 (0.81 to 0.97)	1.27 (1.11 to 1.46)	0.44 (0.36 to 0.55)	1.28 (1.05 to 1.54)	0.01 (–0.05 to 0.02)	1.66 (1.52 to 1.82)
Parity 2	0.75 (0.66 to 0.86)	1.39 (1.27 to 1.52)	0.92 (0.80 to 1.07)	0.83 (0.68 to 1.02)	0.72 (0.59 to 0.88)	–0.02 (–0.02 to 0.05)	0.62 (0.57 to 0.69)
Parity 3	0.79 (0.68 to 0.91)	1.33 (1.21 to 1.46)	1.29 (1.12 to 1.49)	1.30 (1.05 to 1.61)	0.56 (0.45 to 0.69)	0.00 (–0.04 to 0.04)	0.49 (0.44 to 0.55)
Late booking	1.13 (0.98 to 1.30)	0.88 (0.79 to 0.98)	1.01 (0.86 to 1.18)	0.74 (0.53 to 1.02)	0.91 (0.72 to 1.16)	0.11 (–0.15 to –0.06)	1.01 (0.90 to 1.12)
Number of observations	**54 002**	**54 002**	**54 002**	**51 748**	**52 818**	**53 502**	**53 933**

All models control for year. ORs are reported for all outcomes except Apgar score which is a coefficient. CIs are in brackets.
IMD, Index of Multiple Deprivation; LGA, large for gestational age; MPPH, major postpartum haemorrhage; SGA, small for gestational age.

We find significant associations between adverse pregnancy outcomes and the individual factors we control for in the model such as maternal age, BMI at first antenatal appointment, parity smoking status at first antenatal appointment and late booking for first antenatal appointment.

The online supplemental tables 1–7 show the relationship between the seven pregnancy outcomes (LGA (online supplemental table 1), SGA (online supplemental table 2), third-degree or fourth-degree perineal tear (online supplemental table 3), MPPH (online supplemental table 4), preterm birth (online supplemental table 5), Apgar score (online supplemental table 6) and emergency caesarean section (online supplemental table 7) and the eight domains of deprivation. Across most domains, we did not find a significant association with the seven pregnancy outcomes. However, those living in areas with greater access to services were less likely to have an LGA (online supplemental table 1), were more likely to have a baby that is SGA (online supplemental table 2), had a greater likelihood of a third-degree or fourth-degree perineal tear (online supplemental table 3), were significantly less likely to have MPPH (online supplemental table 4), had a baby with a significantly higher Apgar score (online supplemental table 6) and were significantly less likely to have an emergency caesarean section (online supplemental table 7). We also find that those living in areas with higher employment and better health were less likely to have third-degree or fourth-degree perineal tear (online supplemental table 3).

DISCUSSION

We used linked data from the MIDS with WIMD to investigate the association between seven adverse pregnancy outcomes and area-level deprivation in Wales for all babies born to mothers over a 5-year period. We did not find a significant association between increasing area-level deprivation and the adverse pregnancy outcomes we studied. However, we did find a significant association between living in less deprived deciles of deprivation and preterm birth. When focusing on the domains of area-level deprivation, we found living in an area with greater access to services to be significantly associated with LGA, SGA, MPPH, third-degree or fourth-degree perineal tear, and emergency caesarean section. Women living in areas with higher employment and better health were less likely to experience third-degree or fourth-degree perineal tear. Overall, we found a stronger association with individual behavioural risk factors than area-level factors such as smoking during pregnancy and late initial presentation with pregnancy services.

Much of the literature from the UK[13–15] has found a significant association between area-level deprivation and pregnancy outcomes as did a recent study from Germany which also looked at the relationship between area-level deprivation and multiple pregnancy outcomes.[19] Most of the UK research has focused on England and not distinguished between urban and rural areas. Compared with both Scotland and England, more of the Welsh population live in rural areas[29] which may explain the lack of a clear relationship between area-level deprivation and adverse pregnancy outcomes as was predicted a priori. Many rural areas in Wales are in the highest deprivation decile. Rural areas are known to have lower healthcare provision.[30] In other countries, for example, Canada and France, heterogeneity in the impact of deprivation by rurality on adverse pregnancy outcomes has been found.[31 32] The French study[32] found differences in risks of SGA comparing women living in deprived areas in rural and urban Brittany. Deprivation experienced by women living in rural areas may differ from that of women in urban areas.[33] Deprivation indices, which are used as a proxy measure of deprivation in our analysis, are an aggregate measure of disadvantage within geographical areas and may hide variations in disadvantage.[32] Rural deprivation may be limited to a few households in a village which will be included into a larger geographical area with more affluent households influencing the overall deprivation score.[34] Using aggregate-level data, we are not able to control for relative deprivation of a woman which may be more important than mean deprivation of the area where she lives. In addition, we were not able to distinguish urban/rural in our dataset.

We found significant association between access to services and some adverse pregnancy outcomes. This suggests the possibility of a variation in service provision across Wales.[30] Differences in care in terms of staff levels and standards of practice will have an independent effect on pregnancy outcomes irrespective of the area of deprivation of where the mother lives. There are other factors at play that are likely to influence pregnancy outcomes such as social support and psychological assets which will not be captured by area-level deprivation.[35] In our linked systematic review, we assessed the evidence on individual socioeconomic indicators, which are likely to be more reflective of women's actual circumstances, and adverse pregnancy outcomes in the UK and Ireland.[35] It was found that women in lower socioeconomic groups had a significantly increased risk of a number of adverse pregnancy outcomes. Individual SES has a greater impact on individual outcomes than neighbourhood-level SES.[36] Aggregate-level or population-level factors may not capture the nuances of deprivation that lead to adverse pregnancy outcomes.

Some of the associations of adverse pregnancy outcomes with WIMD such as preterm birth and the associations we found for LGA, SGA, MPPH, third-degree or fourth-degree perineal tear, and emergency caesarean section and greater access to services may be explained that on average, mothers living in less deprived areas tend to be older than those living in more deprived deciles. Overall, the average age of mothers has been increasing over time in the UK.[37] There is evidence of increased risk of adverse pregnancy outcomes for women over 40 years which have been found to be independent of SES.[38 39]

Austerity in the UK and the economic consequences of the COVID-19 pandemic (such as rising child poverty levels[40]) have had a disproportionate impact on women and children.[40–42] However, targeted funding and management of the health services may be able to shield women against some of the negative health consequences. A continued commitment to and investment in improving pregnancy outcomes will be required in the economic aftermath of the COVID-19 pandemic to ensure the disproportionate impact of the pandemic on women and children is not further exacerbated through the pandemic's recovery phase. This study would suggest that the implementation of holistic approaches to addressing individual behavioural factors should be prioritised in future policy and guidance.

Strengths and limitations

This research used linked administrative data from Wales to understand the relationship between area-level deprivation and seven pregnancy outcomes. In this study, we investigated a wider range of pregnancy outcomes than most of the existing research which has tended to focus on one or two outcomes.[13–17 31 32] Inclusion of a broad range of wider pregnancy outcomes identified issues with data completeness within available datasets with 64 699 (46%) of the 141 398 available records containing all fields required for analysis within the final study sample.

A limitation of this research is that we needed to use population-level data to define deprivation. We did not have data on individual socioeconomic indicators such as employment status, educational attainment and housing quality which are likely to play a significant part in explaining adverse pregnancy outcomes. We also did not have data on ethnicity. We also did not have data on other adverse pregnancy-related outcomes such as gestational diabetes mellitus, pregnancy-induced hypertension and pre-eclampsia. There is evidence to suggest that ethnicity is an important contributor of pregnancy outcomes.[43]

We also did not have data on rurality to explore if this may explain some of our non-significant findings. The analysis is cross-sectional which limits causal interpretation of the findings.

Policy implications

Our results suggest that it is possible that healthcare service access is a modifiable pathway at the population level to improve pregnancy outcomes for women in Wales. Data completeness and quality has also been identified through this study as a potentially limiting factor in our ability to draw clear policy implications from this analysis, indicating improving data completeness could be an important mechanism in itself to improving our understanding of factors influencing pregnancy outcomes in Wales. Data also are needed at the individual level on risk factors such as employment and income to understand the pathways which population-level interventions could lead to improved outcomes. This is strengthened by the fact that we found individual behavioural risk factors to be more significantly associated with adverse pregnancy outcome, including outcomes that are more prevalent in Wales, namely emergency caesarean section, than population-level factors. Thus, population-level interventions should complement accessible and holistic person-centred care interventions that address the complex inter-related factors that influence behavioural risk factors. A complementary approach may be a cost-effective way to promote better pregnancy outcomes in Wales.

Acknowledgements We would like to thank the SAIL Gateway for providing access to the data and support. We would also like to thank ASK Fuse for facilitating this research project.

Contributors AM, AJ, NH, JR and HB conceived the study idea. HB performed the data analysis and drafted the paper. All authors HB, AM, AJ, NH, JR and CB edited drafts of this article and approved the final version. HB is the guarantor.

Funding The review was commissioned by Public Health Wales. Two public health consultants from Public Health Wales are coauthors on the paper. HB, JR, CB and NH are members of Fuse, the Centre for Translational Research in Public Health (www.fuse.ac.uk). Fuse is a Public Health Research Centre of Excellence funded by the five North East Universities of Durham, Newcastle, Northumbria, Sunderland and Teesside.

Disclaimer The views expressed in this paper do not necessarily represent those of the funders. The funders had no role in study design, data collection and analysis, decision to publish or preparation of the manuscript.

Competing interests None declared.

Patient consent for publication Not required.

Ethics approval The analysis plan had been assessed and approved by the SAIL Collaboration Review System (CRS). SAIL project number 1020. The CRS consists of the SAIL Management Team and the Information Governance Review Panel (IGRP). The membership of the IGRP is comprised of senior representatives from: British Medical Association (BMA), National Research Ethics Service (NRES), Public Health Wales, NHS Wales Informatics Service (NWIS), Swansea Bay University Health Board (SBUHB) and Consumer Panel for Data Linkage Research

Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement Data may be obtained from a third party and are not publicly available. Files for cleaning the variables and performing the analysis are available on GITHUB: https://github.com/heatherb1030/Assessing-the-relationship-between-Adverse-Pregnancy-Outcomes-and-Area-level-Deprivation-in-Wales-20.git. To access the data, researchers will need to fill out a data sharing agreement with SAIL Wales.

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