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Title:

Socioeconomic deprivation as a risk factor for stillbirth: a case-control study

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Abstract

Background: Stillbirth is a devastating outcome for families. Identifying and addressing risk factors is of crucial importance. Level of deprivation has been linked to adverse perinatal outcomes, including stillbirth.

Methods: An observational case-control study was conducted, matching cases of stillbirth (n=127) with a control cohort of live births (n=266, ratio 2:1). Retrospective data on maternal characteristics, pregnancy details and neonatal outcomes from 2018-2021 was collected from a tertiary maternity unit in the Republic of Ireland. The Pobal HP Deprivation Index was used to categorise small areas into levels of deprivation. Maternal age, parity, BMI, booking visit gestation were considered potential confounding factors. Statistical analysis using SPSS, included: descriptive statistics, Chi-squared tests, T-tests. Logistic regression for crude and multivariate analysis, including odds ratio calculations, were used to identify differences in risk of stillbirth across the deprivation levels and categories of confounding factors.

Results: The results demonstrated no statistically significant correlation between level of deprivation and risk of having a stillbirth ($p=0.288$) in this sample. When readjusted into quintiles of deprivation, a slightly higher representation of stillbirth was noted in the more deprived levels, though not statistically significant. When examining by cause of death, there was a significant association between deprivation and placental causes of death ($p=0.048$). High BMI was consistently associated with stillbirth, while late booking visit gestation and advanced maternal age also showed associations.

Conclusions: This study found no clear link between deprivation and stillbirth but observed higher placental-related stillbirth in deprived quintiles, emphasising the need for further national research.

Keywords: Socioeconomic deprivation; Stillbirth; Perinatal mortality; Maternity care; Inequality.

1. Introduction

Health inequality arises from multiple interdependent factors often described as social determinants of health (SDH), which are the non-medical conditions such as those in which people are born, grow and live (Koh, 2020; Weinstein et al. 2017; WHO, SDH). Key determinants such as income, education, employment, housing and access to services are closely linked with the broader concept of deprivation, described as a measurable disadvantage relative to one's community or society (Townsend, 1987). Understanding its impact on health outcomes is the first step in addressing disparities.

Socioeconomic deprivation is associated with health inequalities (Carstairs and Morris, 1989; Marmot, 2010). There is mounting evidence internationally that deprivation significantly impacts perinatal health and contributes to adverse perinatal outcomes such as low birth weight, preterm labour, and perinatal mortality (Vos et al. 2014). In the UK, infants from deprived areas were identified as being two times more likely to be stillborn (Draper et al. 2021). Stillbirth is a devastating outcome that has profound clinical, emotional, and financial consequences (Heazell et al. 2016), and its disproportionate occurrence in deprived populations highlights a need for targeted preventive strategies. However, in the Irish context, data on this association remains limited. National reports from the National Perinatal Epidemiology Centre (NPEC) in Ireland highlight the worryingly static rates of stillbirth (San Lazaro Campillo et al. 2023), yet the impact of socioeconomic deprivation on stillbirth risk is underexplored (Keane et al. 2025; Thomson et al. 2021). Recent evidence also shows that women in minority ethnic groups are consistently overrepresented in perinatal mortality reports in Ireland, with sociodemographic differences suggesting important inequities in risk (Leitao et al. 2025). A recently published scoping review of the literature from high-income countries found no Irish studies examining the effect that deprivation has on risk of stillbirth using composite measures, demonstrating a clear gap in the published literature the country (Keane et al. 2025).

While individual measures like income (Best et al. 2019), education (Mackenbach et al. 2016) and employment (Paul et al. 2023) provide insight into deprivation, composite indices better capture its multidimensional nature (Townsend, 1987; Zelenina et al. 2022). Deprivation indices categorize deprivation and help identify disparities within geographic areas, guiding resource allocation (Cabrera-Barona et al. 2015; Carstairs, 1995; Townsend, 1987). The Pobal HP Deprivation Index, available in Ireland (Haase and Pratschke, 2017a; Haase and Pratschke, 2017b), has shown that life expectancy is lowest in the most deprived areas (Central Statistics Office (CSO), 2019) for example, but the measure is not yet used in maternity care services.

Also identified in the literature are other possible contributing factors associated with both deprivation and adverse perinatal health outcomes, such as ethnicity, parity, maternal age, and

smoking status. Body Mass Index (BMI) is also continually evidenced in the literature as having links with both deprivation and adverse perinatal outcome (Kent et al, 2021; San Lazaro Campillo et al, 2023). Access to care, such as the gestation at which one attends their first antenatal appointment (booking visit), is another potential confounding factor. With individuals from areas identified as more socioeconomically deprived being more likely to attend their booking appointment later in their pregnancies (Kapaya et al, 2015), which is also seen as a contributing factor to poor perinatal outcome (Draper et al, 2020).

This study aims to investigate whether residing in a more socioeconomically deprived area is associated with an increased risk of stillbirth in an Irish population. It also explores whether specific causes of stillbirth may be more prevalent in deprived areas. Our central hypothesis is that individuals living in more deprived areas have a higher likelihood of experiencing stillbirth, in line with the available international literature (Keane et al. 2025). We further hypothesise that this association may be mediated or confounded by maternal factors such as age, BMI, and booking visit gestation.

2. Participants, Ethics and Methods

2.1 Study design

This observational case-control study matched cases of stillbirth with a control cohort of live births (Table 1), targeting an approximate 2:1 control-to-case ratio. All stillbirths during the period from January 1st 2018 to December 31st 2021 were collected from a single tertiary maternity unit in Ireland, and twice the number of live births were selected from the same period. To ensure a complete comparison, an additional 5% of controls were included to account for potential missing data. The sample of 127 cases and 266 controls had 80% power, at the 5% level of statistical significance, to detect an odds ratio of 1.83, based on 60% of cases versus 45% of controls living in above-average deprived areas. Ethical approval was obtained via the Clinical Research Ethics Board, University College Cork (ECM 4 (q) 13/12/2022).

Table 1: Definition of study measures and variables used

Study measures	Definition/description
Stillbirth (case)	<ul style="list-style-type: none"> “A child born weighing 500 grams or more or having a gestational age of 24 weeks or more who shows no sign of life” as per the Stillbirths Registration Act, 1994 (Section 1)
Live birth (control)	<ul style="list-style-type: none"> “The complete expulsion or extraction from its mother of a product of conception weighing 500 grams or more (...) which, after such separation, breathes or shows any other evidence of life” (Lawson and Mayberry, 1994) The criteria of a gestational age of 24 weeks or more was also followed for the control group Early and late neonatal deaths were excluded from the control cohort
The Pobal HP Deprivation Index ¹³	<ul style="list-style-type: none"> Identifies small geographical areas with 80-100 households on average, each small area given unique code Fourteen Indicators from Census data (categorised into Demographic Profile, Social Class Composition and Labour Market Situation)(Haase and Pratschke, 2017b) weighted positively or negatively to calculate score Numerical score then categorised into one of eight levels of deprivation Index used to determine the small area code and level of deprivation for each participant’s residence in the study
Congenital anomaly	<ul style="list-style-type: none"> Any genetic or structural defect from conception or embryogenesis (National Perinatal Epidemiology Centre, 2022)
Variable	List
Sociodemographic health indicators/ potential confounding factors	<ul style="list-style-type: none"> ○ Maternal age ○ Parity ○ BMI ○ Antepartum engagement with services (i.e. gestation at booking visit to a maternity unit)

Further factors collected for stillbirth cases alone ^a	<ul style="list-style-type: none"> ○ Marital status ○ Employment status ○ Ethnicity ○ Smoking status ○ Previous experience of pregnancy loss ○ Cause of death
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Note: ^aThese variables were only available for the stillbirth cohort and could not be obtained for the control cohort due to the data availability.

2.2 Data sources and collection procedures

Obstetric and infant data on births that occurred from January 1st 2018 to December 31st 2021, was collected from Cork University Maternity Hospital, a large maternity unit (>5,000 birth/year). All stillbirths that occurred during the study time period were identified from the NPEC Perinatal Mortality National Clinical Audit (PMNCA). The control cohort of live births was randomly selected from the hospital's birth list, after removing cases of stillbirth. Approximately double the number of stillbirths per calendar year were selected from a birth list of live births only (stillbirth cases removed). No additional matching by maternal characteristics, pregnancy risk profile, or geographic area was performed; instead, controls were selected using a simple random sampling procedure to ensure representativeness of the source population.

Data was collected from the electronic health records for the whole cohort. The clinical stillbirth data were then crosschecked with the NPEC PMNCA data to ensure accurate case identification and triangulation of data using the NPEC's standardised and validated dataset, as consolidated with the National Perinatal Reporting System (NPRS).

The addresses for the cohort were gathered from the Integrated Patient Management System, a national administration system for hospital admissions.

The data gathered was anonymised and compiled onto the secured main study database in Microsoft Excel. General Data Protection Regulation (GDPR) regulations were adhered to throughout the project with confidentiality maintained (European Union, 2016).

2.3 Statistical analysis

Data was analysed using IBM SPSS (Statistical Package for the Social Sciences) V29.0.1.0.

Frequency tables examined characteristics. Comparisons were made with national Census data, where available (CSO, 2023). Chi-squared and individual sample T-tests were used to compare cases and controls according to the deprivation levels and confounding factors. Further comparisons examined the association of the cause of death with deprivation. Odds ratios were calculated using

logistic regression including multivariable models, adjusted for relevant confounding factors (Table 1).

The Pobal Deprivation Index has eight levels of deprivation (Haase and Pratschke, 2017a). However, to reflect the profile of the study cohort, this classification was transformed into quintiles through the ranking function in SPSS. The quintiles are described as affluent, above average, average, below average and deprived, based on the calculated deprivation score as per the Pobal HP deprivation index.

Booking visit gestation data was measured in completed weeks of gestation. Health service advice for gestation at booking visit to a maternity hospital is 8-12 weeks (Health Service Executive), while some tertiary units suggest up to 14 weeks (The Rotunda Hospital Dublin). International literature varies, however, generally over 20 weeks is seen as late (Kent et al. 2021). Hence, the categories chosen for booking visit gestation were 8-14 weeks, 15-19 weeks and over 20 weeks.

While it would have been ideal to use universal BMI categories in analyses as per the Centers for Disease Control and Prevention (CDC), due to the small number of individuals with BMI in the “underweight” category, this group was condensed with the “healthy” BMI group into a category “lean” (up to 24.9kg/m²), in addition to “overweight” (25-29.9kg/m²) and “obese” (30kg/m² or more) categories. This is aligned with NPEC PMNCA BMI analysis (San Lazaro Campillo et al., 2023). Maternal age, in keeping with the NPEC PMNCA was categorised into: <25 years, 25-29 years, 30-34 years, 35-39 years and ≥40 years of age (San Lazaro Campillo et al., 2023).

3. Results

3.1 Characteristics of those who had a stillbirth

Table 2 shows the sociodemographic characteristics examined for individuals who had a stillbirth (n=127). The majority were of white Irish ethnicity (79.5%), lived with their partner (91.3%) and were in full or part-time employment (82.7%, compared to 60.4% of the general female population). A total of 12.6% were documented as smokers at their initial booking visit.

Those with Irish Traveller ethnicity appear overrepresented in this cohort of individuals who had a stillbirth compared with the Irish female population (3.1% vs 0.7%). However, this is based on small sample sizes.

Of those who had a previous pregnancy (n=92, 72.4%), 50 (54.3%) had experienced a previous pregnancy loss at <24 weeks gestation with <500g birthweight, with only one individual having had a previous stillbirth (1.1%).

Table 2: Socioeconomic characteristics of individuals who had a stillbirth (N=127), 2018-2021

Characteristic	Category	Frequency, n(%)	Comparison to National Statistics 2022 (CSO, 2023) (%)
Marital Status	Married	85 (66.9)	-
	Never Married	40 (31.5)	
	Separated/Divorced	2 (1.6)	
Living with Partner ^a	No	8 (6.3)	-
	Yes	116 (91.3)	
Smoking status ^b	Smoker	16 (12.6)	-
	Non-smoker	105 (82.7)	
Previous pregnancy	No	35 (27.6)	-
	Yes	92 (72.4)	
Ethnic Group	White Irish	101 (79.5)	69.8
	Irish Traveller	4 (3.1)	0.7
	Other White	14 (11)	13.8
	Asian/ Asian Irish	3(2.4)	4.6
	Black/ Black Irish	2 (1.6)	2.1
	Mixed	3 (2.4)	-
Employment status ^c	Employed	105 (82.7)	60.4
	Unemployed	7 (5.5)	8.0
	Home Duties	11 (8.7)	8.6
	Student	2 (1.6)	22.1
	Other	1 (0.8)	0.8

Notes: ^aLiving with partner unknown for 3 individuals. ^bSmoking status unknown for 6 individuals.

^cEmployment status unknown for 1 individual.

Major congenital anomaly (MCA) was the primary cause of death for stillbirths (35.4%, n=45), followed by placental conditions (32.3%, n=41). Placental conditions included fetal or maternal vascular malperfusion, among others. Nine stillbirths (7.1%) had a cause of death undetermined. Mechanical issues (n=9, 7.1%) causing the death included cord prolapse, nuchal cord or other cord entanglement, shoulder dystocia and uterine rupture. Fetal conditions (n=8, 6.3%) included problems such as twin-to-twin transfusion syndrome and feto-maternal haemorrhage.

3.2 Association of deprivation with stillbirth

A total of 127 stillbirths (32.3%) and 266 controls (67.7%) were selected. Figure 1 illustrates the distribution across the five levels of deprivation where no statistically significant difference was observed ($p=0.311$).

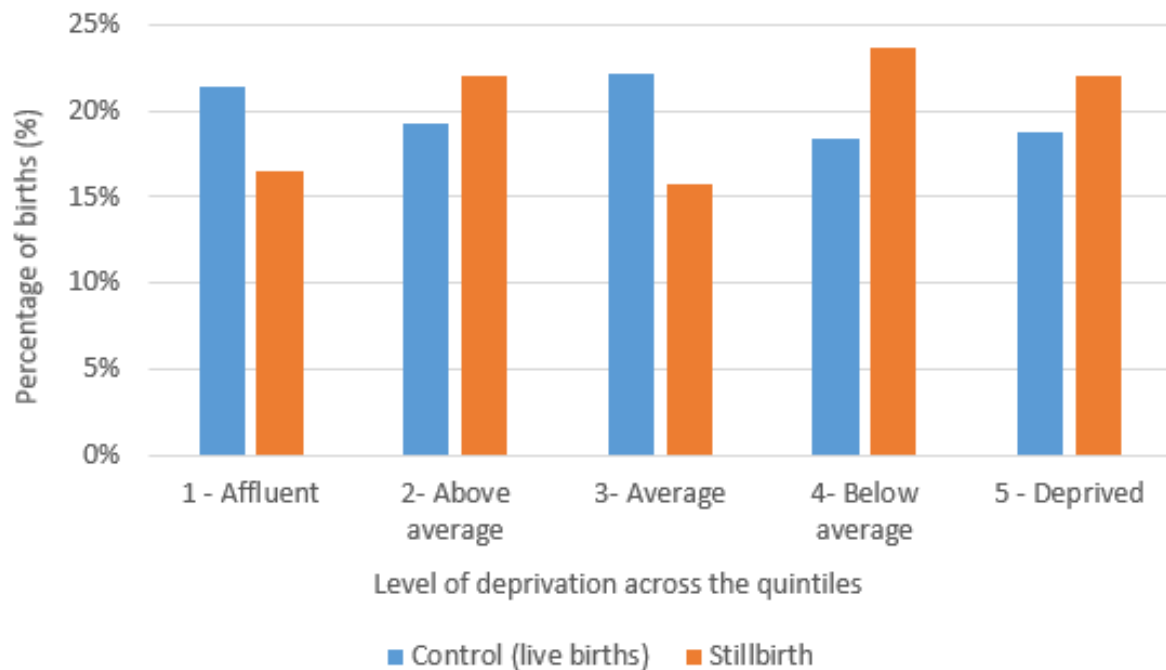


Figure 1: Percentage of stillbirths and controls across each level of deprivation, using quintiles

Although there was no statistical significance overall, there was a slightly higher representation of stillbirths in the more deprived group 4 (23.6% stillbirth vs 18.4% control) and group 5 (22% stillbirth vs 18.8% control). There was a slightly higher representation of controls in the “affluent” group (16.5% stillbirth vs 21.4% control) and “average” group (15.7% stillbirth vs 22.2% control).

There was no difference in the risk of stillbirth between the most and least deprived groups after excluding cases of MCA ($p=0.433$). Similarly, there was no significant association across the quintiles of deprivation and specific causes of stillbirth, i.e. MCA ($p=0.87$), placental conditions ($p=0.28$), and the other conditions ($p=0.24$). However, more than half of stillbirths due to placental conditions related to quintiles 4 and 5 (53.7%), whereas only 37.2% of controls were in these quintiles. The crude odds ratio indicated a weak association between deprivation and stillbirth due to placental conditions (OR=1.95, 95% CI 1.01-3.79, $p=0.048$).

3.2 Confounding factors on the association of deprivation with stillbirth

Table 3 demonstrates the crude and adjusted odd ratios for rates of deprivation and the confounding factors of age, BMI and booking visit gestation for cases and controls. No significant difference was noted in whether the individual was nulliparous or multiparous in a univariate analysis ($p=0.850$). Given that its inclusion did not improve model performance, the multivariate analysis was conducted without parity.

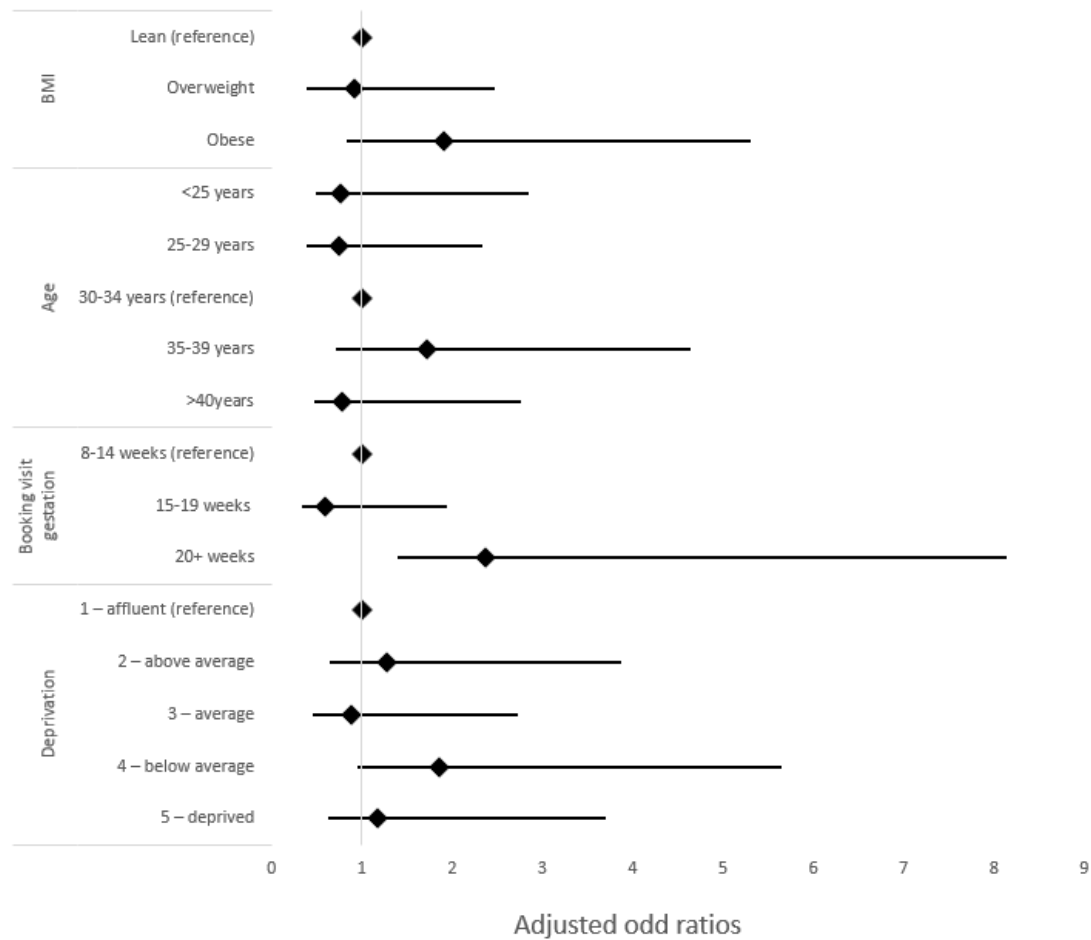
Table 3: Association between maternal, clinical and socioeconomic factors and risk of stillbirth

Factor	Category	Stillbirths N(%)	Controls N(%)	Crude Odds ratio (OR)	Lower 95% CI	Upper 95% CI	p-value	Adjusted Odds ratio (aOR)	Lower 95% CI	Upper 95% CI	p-value
BMI ^b	Lean	48 (40.7%)	127 (47.7%)	1.00	(ref)			1.00	(ref)		
	Overweight	34 (28.8%)	92 (34.6%)	0.98	0.58	1.64	0.932	0.92	0.54	1.56	0.751
	Obese	36 (30.5%)	47 (17.7%)	2.03	1.17	3.5	0.011*	1.91	1.07	3.4	0.028*
Age ^c	<25 years	8 (6.3%)	20 (7.5%)	0.96	0.39	2.34	0.925	0.77	0.28	2.07	0.598
	25-29 years	16 (12.7%)	42 (15.8%)	0.91	0.46	1.8	0.791	0.75	0.36	1.59	0.457
	30-34 years	43 (34.1%)	103 (38.7%)	1.00	(ref)			1.00	(ref)		
	35-39 years	51 (40.5%)	79 (29.7%)	1.55	0.94	2.55	0.088	1.72	1.01	2.92	0.047*
	>40years	8 (6.3%)	22 (8.3%)	0.87	0.36	2.11	0.760	0.78	0.3	1.99	0.602
Booking visit gestation ^d	8-14 weeks	100 (81.3%)	213 (82.6%)	1.00	(ref)			1.00	(ref)		
	15-19 weeks	9 (7.3%)	33 (12.8%)	0.58	0.27	1.26	0.169	0.6	0.27	1.34	0.215
	20+ weeks	14 (11.4%)	12 (4.7%)	2.49	1.11	5.57	0.027*	2.37	0.97	5.77	0.058
Parity ^a	Nulliparous	51 (40.5%)	105 (39.5%)	1.00	(ref)						
	Multiparous	75 (59.5%)	161 (60.5%)	0.96	0.62	1.48	0.850	-	-	-	-
Deprivation	1 – affluent	21 (16.5%)	57 (21.4%)	1.00	(ref)			1.00	(ref)		
	2 – above average	28 (22%)	51 (19.2%)	1.49	0.76	2.94	0.250	1.27	0.62	2.6	0.523
	3 – average	20 (15.7%)	59 (22.2%)	0.92	0.45	1.88	0.819	0.88	0.42	1.84	0.729
	4 – below average	30 (23.6%)	49 (18.4%)	1.66	0.85	3.27	0.141	1.86	0.91	3.79	0.090
	5 – deprived	28 (22%)	50 (18.8%)	1.52	0.77	3.01	0.228	1.18	0.56	2.52	0.661

Notes: ^aParity showed no effect on risk using a Hosmer-Lemeshow test, and its inclusion did not improve model fit, thus, it was excluded from the final multivariate analysis. Parity unknown for 1 case.

^bBMI unknown for 9 cases. ^cAge unknown for 1 case. ^dBooking visit gestation unknown for 4 cases and 8 controls,

*Indicates significance.



Notes: ^aParity showed no effect on risk using a Hosmer-Lemeshow test, and its inclusion did not improve model fit, thus, it was excluded from the final multivariate analysis.

Figure 2: Forest plot demonstrating association between maternal, clinical and socioeconomic factors and risk of stillbirth

As demonstrated in Table 3 and Figure 2, those in the obese category were twice as likely to have a stillbirth than those with a BMI in the lean category (aOR 1.91 95% CI 1.07-3.40, $p=0.028$). A significant difference in BMI between cases and controls ($p=0.009$) was also noted (supplementary eTable 1), reiterating the association between BMI and stillbirth risk. In the multivariate model (Table 3), individuals in the age group 35-39 years showed a significant risk of stillbirth (aOR 1.72 95% CI 1.01-2.92, $p=0.047$). While a booking visit gestation at >20 weeks demonstrates an aOR=2.37, this was not statistically significant (95% CI 0.97-5.77, $p=0.058$). However, in the crude analysis, individuals who had their initial booking visit at >20 weeks gestation had more than double the risk of stillbirth than those booking between 8 and 14 weeks of gestation (OR 2.49 95% CI 1.11 – 5.57, $p=0.027$), suggesting an influence of the other confounding factors. Deprivation examined in the multivariate model continued to demonstrate no significant difference in risk throughout the five levels, before and after adjusting for the confounding factors.

4. Discussion

In this case-control study at a tertiary maternity unit in the ROI, a general association between deprivation and stillbirth risk was not evidenced. While this may differ from the international literature on the topic (Keane et al. 2025; Novillo-Del-Álamo et al. 2023), contextual factors influencing perinatal outcomes in Ireland should be considered. The absence of a clear association highlights the complexity of stillbirth aetiology and the need for ongoing investigation.

The use of area-level deprivation as a proxy for individual socioeconomic status in this study carries the potential for ecological fallacy, as not all individuals within a deprived area necessarily experience socioeconomic disadvantage. Consequently, the findings may not fully capture the nuances of individual-level risk. Aggregate deprivation indices however, can capture the multidimensional nature of deprivation (Townsend, 1987; Zelenina et al. 2022) reflecting broader contextual influences on health that single indicators may overlook. Nevertheless, other research suggests low sensitivity in composite measurements (Bradford et al. 2023; McCartney et al. 2023). This may be particularly relevant for areas without extreme levels of deprivation (i.e. “extremely affluent” or “extremely deprived”) as was the case in this study (supplementary eFigure 1). Further research in Ireland with larger, more diverse and nationally representative cohorts may determine if significance is affected. Although deprivation did not significantly impact stillbirth risk, the more deprived quintiles showed a higher proportion of stillbirths than controls. This aligns with international literature associating higher levels of deprivation with higher risk of stillbirth (Keane et al. 2025; Novillo-Del-Álamo et al. 2023; Vos et al. 2014). However, firm conclusions cannot be drawn as the statistical findings did not yield enough evidence to support this.

When examining causes of death across the deprivation quintiles, a significant association between placental-related stillbirths and above average deprivation was noted. This could indicate the influence of deprivation on placental efficiency, the placenta’s ability to supply the nutrients, oxygen and hormones required for fetal growth and development (Fowden et al. 2009). Previous studies support this observation (Arechvo et al 2023; Best et al. 2019), reporting higher rates of stillbirth in deprived groups and discussing the potential influence of deprivation on placental efficiency though the significance did not remain in one study once adjusted for certain maternal risk factors. This suggests that the relationship may not be due to a direct effect of deprivation on the placenta but rather may be mediated through a higher prevalence of chronic disease, pregnancy-associated conditions or health behaviours in more deprived populations. This aligns with wider research on the social determinants of health in pregnancy (Girardi et al. 2023; WHO, SDH), which highlights how structural and socioeconomic disadvantage influences maternal health behaviours, access to care, and ultimately pregnancy outcomes. The relationship between placental-related stillbirth and

deprivation is a notable finding that could provide an opportunity for targeted clinical interventions. This could include supporting behaviour change for modifiable risk factors, such as smoking, alcohol consumption and nutrition, which can impact on placental health (Teo et al. 2023). Additionally, enhancing screening protocols for those identified at higher deprivation-related risk could improve early detection and outcomes (Arechvo et al. 2023; Ashoor et al. 2022; Field et al. 2016).

The slight increase in stillbirth risk in the group aged 35-39 years in this study, aligns with available literature (Gordon et al. 2013; Huang et al. 2008; Lean et al. 2017). This finding is particularly relevant in light of EURO-Peristat's identification of a higher percentage of childbearing women over age 35 in Ireland (Euro-Peristat, 2022). Though previous research indicates a continuous increase in stillbirth risk with rising maternal age (Gordon et al. 2013, Lean et al. 2017), this was not found in this study. The limited number of those aged 40 or more may have contributed to this.

A robust association between BMI and stillbirth was observed. Individuals with a BMI in the obese category demonstrated a two-fold risk of stillbirth, reflecting previous research (Chu et al. 2007; Thornton et al. 2023; Woolner et al. 2015). These findings highlight obesity as a key risk factor for stillbirth. Given that higher BMI has also been associated with those living in areas of greater deprivation (Feuillet et al. 2020; Stafford et al. 2010), there is a need for tailored support in more disadvantaged communities, where both high BMI and stillbirth risk may be disproportionately high. A booking visit gestation after 20 weeks to the maternity unit also appeared to increase stillbirth risk. A shift in the category of booking attendance, e.g. from 20 weeks gestation compared to 15 weeks gestation, might make a difference to the relative risk. Interestingly, literature suggests that placental dysfunction related stillbirth can be mitigated by specific early screening in those identified as more at risk, ideally at a gestation of 11-13 weeks (Arechvo et al. 2023). This would be a crucial initiative to support both tailored screening and encouraging access to antenatal care earlier in the pregnancy. For this study, booking visit gestation served as a proxy for access to care. Further exploration into access to care, such as frequency of attendance, would be important in developing interventions to promote engagement for those identified as having higher levels of deprivation (Jinga et al. 2019). Previous research notes that initiatives encouraging access to care should include respectful and tailored care, continuity of care, cultural sensitivity, active community engagement, awareness programmes and family planning education (Downe et al. 2009; Escañuela Sánchez et al. 2022; Jinga et al. 2019; Origlia et al. 2017).

It could be argued that the health inequalities divide is potentially limited in the ROI during perinatal period due to the free maternity care that is available through the Health Service Executive's (HSE) Maternity and Infant Care Scheme, which may allow for increased accessibility across socioeconomic groups (De Maeseneer et al. 2007; van Weel and Kidd, 2018). However, some studies note that poor

pregnancy outcomes are still seen in higher rates amongst individuals from more disadvantaged areas despite universal healthcare systems being available (Joseph et al. 2007; Kapaya et al. 2015). While access to health care is important, it may not be sufficient to improve health outcomes of those more socioeconomically deprived (Hood et al. 2016).

There is a complex interplay of the factors associated with deprivation and stillbirth risk, for example, individuals with obesity and social deprivation were more likely to access care later in their pregnancy (Barber et al. 2017). Research highlights that targeting modifiable or behavioural risk factors can lower stillbirth risk (Escañuela Sánchez et al. 2019; Flenady et al. 2011). Our study suggests that although area-level deprivation alone may not influence stillbirth risk, modifiable risk factors, possibly more prevalent in deprived areas, could be targeted specifically to reduce stillbirth risk (Hesselman et al. 2019).

While this study may be a starting point, there is a need for expanded national research to understand the relationship between deprivation and perinatal outcomes in Ireland. The MBRRACE-UK reports show that including sociodemographic indicators in national audit can yield actionable insights (Draper et al. 2023). Integration of socioeconomic and deprivation data into national clinical audit would provide a more representative dataset, allowing for more in-depth investigation, ultimately supporting equitable healthcare and opportunity for targeted interventions to improve perinatal care (Burns, 2015; Marmot, 2010).

4.1 Strengths and limitations

The study addresses a pertinent issue, responding to a gap in literature regarding the impact of deprivation on stillbirth within the Irish population. Key methodological strengths include robust population-based sampling which included the utilisation of a statistically significant 2:1 control-to-case ratio. The use of a randomised approach to the selection of the control group also strengthens the findings by minimising selection bias risks (Iwagami and Shinozaki, 2022; Wacholder et al. 1992). The use of clearly defined measurements and data obtained from comprehensive data sources, including robust triangulation of data between two validated datasets, contribute to the advantages of this study. This effective case ascertainment as well as gathering cases and controls from the same setting which would have standardised reporting, reduces any potential measurement bias. Adjustment for available confounding factors and an in-depth analysis, including multivariate analysis, further enhance the strength of this study. The application of a multidimensional deprivation index provides a more comprehensive assessment of socioeconomic status than single indicator measures.

However, some limitations warrant consideration. The focus on a single outcome, stillbirth, may limit broader insights that more extensive perinatal outcome data could offer. The single centre design over one time period may limit the generalisability to other settings or populations and potentially overlook shifts in deprivation evolving over time. Incomplete reporting of ethnicity hindered the analysis of its potential confounding effects or its role as a risk factor for stillbirth. This is particularly relevant as a recent study using NPEC data found women in ethnic minority groups were over-represented in perinatal mortalities (Leitao et al. 2024). Similarly, other relevant maternal risk factors such as marital status, employment status, smoking status, and previous pregnancy loss were not uniformly reported and thus, were unavailable for the control cohort. Unmeasured demographic, environmental and clinical variables limit the ability to assess and adjust for potential confounders, introducing a risk of residual confounding that may affect the internal validity of the findings. Without these data, it could not be determined whether the observed association between deprivation and stillbirth is independent of these factors, which also limits the study's clinical applicability in terms of informing targeted interventions. Furthermore, the absence of certain variables hinders the ability to assess whether the sample reflects broader maternity populations, thereby reducing the generalisability of the findings to more diverse settings or different time periods.

5. Conclusion

This case-control study at an Irish maternity unit found no overall association between deprivation and stillbirth risk, deviating from international literature. While adjusting to quintiles did not change the overall significance, a subtle shift in the variances, particularly in stillbirth due to placental causes, was observed. This revealed a slightly higher percentage of stillbirth attributed to placental causes in the more deprived quintiles. This study highlights factors, like BMI and booking visit gestation, influencing stillbirth risk and maternal age showing more nuanced associations. However, due to the limited generalisability of this study, the need for more extensive, diverse population studies on this topic is indicated, including integrating socioeconomic indicators into national clinical audits. This would allow for the development of focused initiatives to improve maternal and infant outcomes and enhance healthcare equity.

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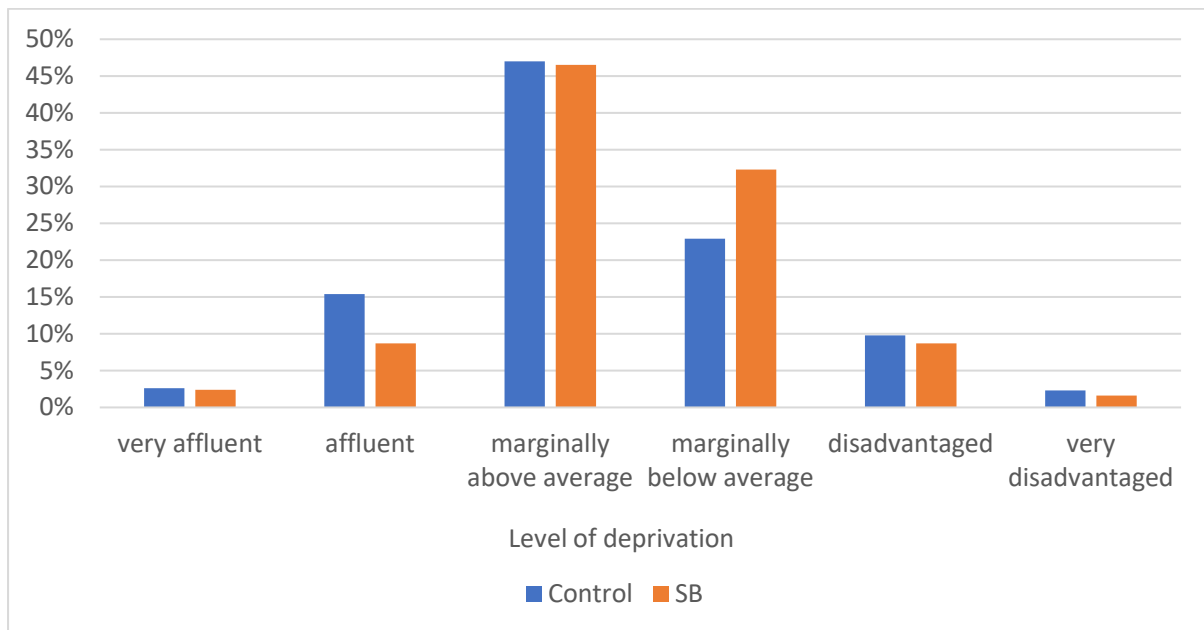
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Supplementary materials



eFigure 1: Percentage of stillbirths (SB) and controls across each level of deprivation

Although there was no statistically significant difference across the levels of deprivation overall (eFigure 1), there was some variance throughout the categories with a slightly higher percentage of controls in the “affluent” category (15.4% controls vs 8.7% cases) and a slightly higher percentage of cases in the “marginally below average” category (22.9% controls vs 32.3% cases).

Additionally, there were no individuals from in the “extremely affluent” or “extremely deprived” areas and few were in the “very affluent”, (n= 10, 2.5%) and “very disadvantaged”, (n=8, 2%) categories. A large portion of the study population were distributed into the “marginally above average” category at 184 (46.8%), with a further 102 (26%) in the “marginally below average” category. Hence, the vast majority of the study sample, 72.8% (n=286 of 393), lies within in the middle categories (“marginally above/below average”).

Considering this, the data was classified into quintiles, using the score identified for each small area to further examine the association in a more appropriate representation of the national profile of this cohort.

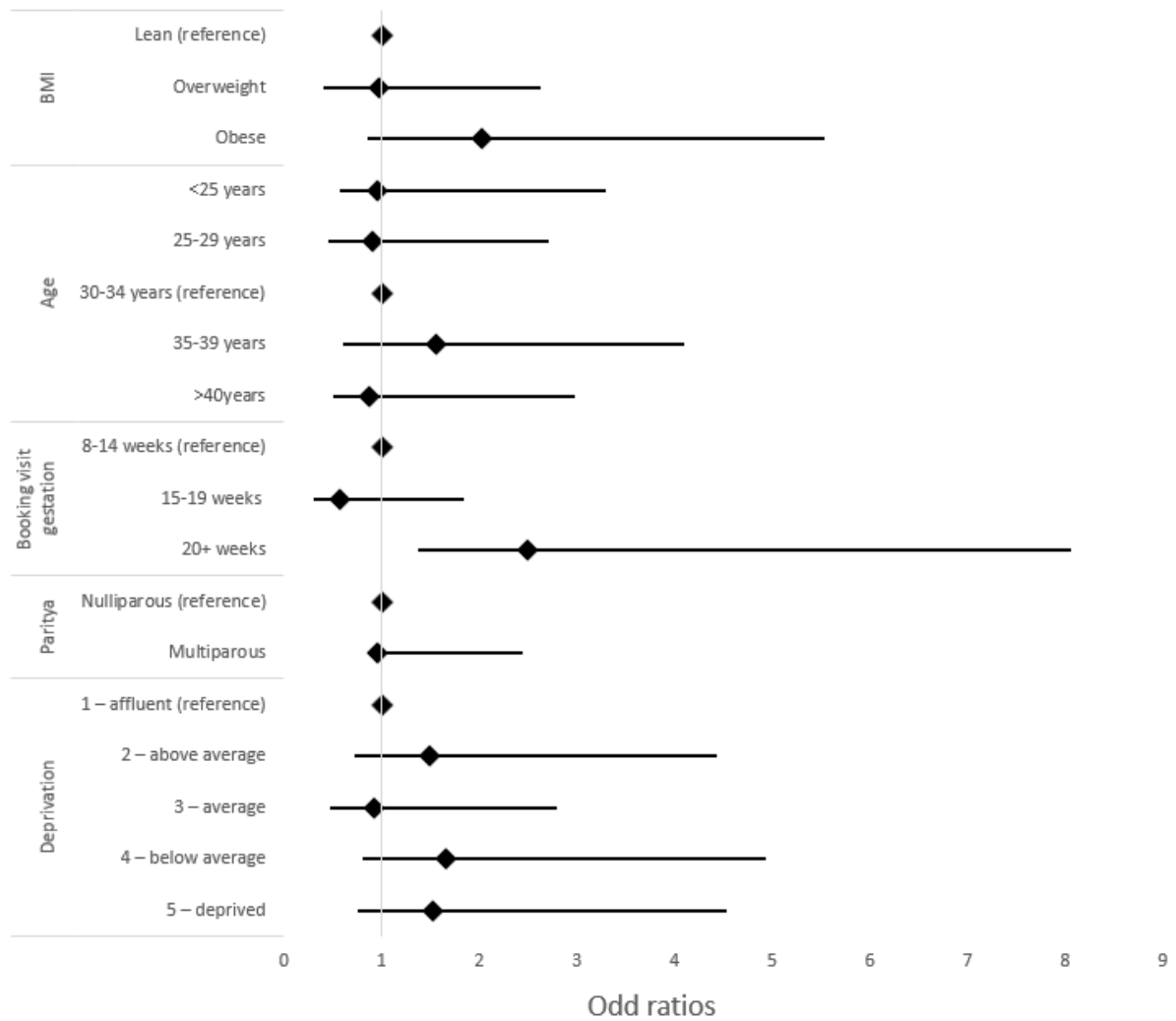
eTable 1: Comparison of potential confounding factors between stillbirths and controls

Factor*	Control	Stillbirth		
	M (SD)	M (SD)	t(df)	p-value
Age	32.5 (5.3)	33.4 (5)	-1.64 (256.3)	0.102
BMI	26.3 (5.1)	27.9 (6.3)	-2.64 (381)	0.009*
Booking visit gestation	13.6 (3.5)	14 (4.9)	-1.03 (379)	0.303

Note: M=Mean. SD = Standard Deviation. t= t statistic. df= degree of freedom. *indicates significance.

As age, BMI and booking visit gestation were all identified as potential confounding factors, these were analysed individually using individual sample t-tests. eTable 1 shows a statistically significant difference in BMI between cases (SBs) and controls (p-value = 0.009).

Maternal age and booking visit gestation did not show statistically significant differences. Parity was not examined in this analysis.



eFigure 2: Forest plot demonstrating crude association between maternal, clinical and socioeconomic factors and risk of stillbirth