Research Article

The Relationship between Neonatal Gastroschisis, Maternal BMI and Social Deprivation in a UK Population

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Received: 21 June 2019; **Accepted:** 10 July 2019; **Published:** 22 July 2019

Abstract

In this paper, we examine the association between social deprivation and gastroschisis in a UK population. We used the UK postcode to determine social deprivation using the government Index of Multiple Deprivation (IMD). IMD ranks areas from 1 being the most deprived to 32,844 as the least socially deprived area. This is the first time that IMD has been used to examine a potential link between social deprivation and any fetal abnormality. Our findings suggest that social deprivation is associated with low maternal age, but is not an additional risk for fetal gastroschisis.

Keywords: Gastroschisis; Neonatal Gastroschisis; Social Deprivation; Maternal BMI; Fetal

1. Introduction

Gastroschisis is a congenital defect of the abdominal wall with paraumbilical herniation of the abdominal organs usually to the right of the normally inserted umbilicus. It is usually an isolated structural defect, not associated with chromosome defects. The incidence is 1-2 per 10,000 live births, though more recent data suggest increases in several countries [1], strengthening the need to study risk factors. There is substantial disagreement regarding the developmental pathogenesis of gastroschisis [2], but a number of specific risk factors have been identified that appear to confer susceptibility. These include young maternal age [3, 4], lower pre-pregnancy body mass index (BMI) [4], use of vasoactive medications [5, 6], use of drugs of abuse and smoking [7, 8], genetic polymorphisms [9], and short interval between menarche and first pregnancy [7].

Many of these factors may be associated with social class and deprivation. To investigate whether there is a link between social status and gastroschisis, we used the Index of Multiple Deprivation (IMD) [10, 11] to compare the incidence of gastroschisis with the likelihood of deprivation. The IMD is the English government's official measure of social deprivation, dividing England into 32,844 small areas. The areas are designed to be of similar population size, averaging 1500 residents. The IMD uses the English postcode to calculate the IMD rank for that postcode [10, 11]. For each small area in England seven domains are taken into consideration: income (22.5%), employment (22.5%), health deprivation and disability (13.5%), education skills and training (13.5%), barriers to housing and services (9.3%), crime (9.3%), and living environment (9.3%). The information from these seven domains is then used to produce an overall relative measure of deprivation [10]. The Index of Multiple Deprivation ranks every small area in England from 1 (most deprived area) to 32,844 (least deprived area) [10]. Therefore the higher the score is, the less deprived is the area and the lower the score, the more deprived the area. Our study used the IMD rank from 2015. We used this to compare whether there is any difference in the IMD rank between mothers of fetuses with gastroschisis and the remainder of our maternity population.

2. Methods

We identified all cases of gastroschisis in live born singleton infants from the Wessex Fetal Medicine Database during 2005-14 and compared them with two controls from the birth register at the Princess Anne Hospital in Southampton. The first control was the next mother in the register to deliver an infant without gastroschisis. The second control was the next mother age-matched (to within one year) to deliver an unaffected infant. We excluded multiple pregnancies and those with intra-uterine death or stillbirth. The IMD score for each woman was found by entering her registered postcode into the government IMD tool [11]. This then gives each postcode a name and code which can be entered into the Government excel spreadsheet to obtain the IMD rank for that area [10].

2.1 Statistical analysis

We first produced descriptive data for the case and control groups. We used a Fisher-Yates transformation to represent the IMD rank scores in standardised normal form (mean zero, standard deviation unity). Maternal age and body mass index were right-skewed in distribution and we took log transformations of them to normalise them for regression analysis. To respect the design, we used matched sets conditional logistical regression to analyse differences between cases and controls, controlling for age, BMI and pregnancy number. We used SPSS version 24 for computations.

3. Results

Four cases were excluded as no deprivation score could be obtained for them using the IMD tool [10]. Two were from the Channel Islands and therefore not resident in England; two were excluded as no score could be obtained, despite ensuring the correct postcode was used. There were 111 cases included and they were compared with 111 controls from each group, giving a total of 333 subjects. Table 1 shows the descriptive data for all the cases and controls. The pregnancy order is the order of the pregnancy, i.e. 1^{st} pregnancy, 2^{nd} pregnancy, 3^{rd} pregnancy, etc.

The table suggests that mothers who had babies affected with gastroschisis had a lower age when compared to the next delivery control. Their average body mass index was lower than that of the control groups. The average IMD in the affected group was 15139.68; in the next delivery control group it was 17296.39 and in the age match control group 10274.549.

Measurement	Cases (n=111)			Next Delivery Controls (n=111)			Age Matched Controls (n=111)		
	Mean	Standard Deviation	Minimum, Maximum	Mean	Standard Deviation	Minimum, Maximum	Mean	Standard Deviation	Minimum, Maximum
IMD Rank†	15139.68	8436.781	608, 32153	17296.39	10274.549	287, 32188	14359.08	10330.765	708, 32774
IMD Score (z)*	0.01	0.79	-2.03, 2.42	-0.12	1.05	-2.12, 2.71	0.10	1.11	-2.90, 2.16
Age (years)	22.2	5.0	14.7, 40.0	28.7	6.1	16.8, 41.3	22.2	5.0	14.8, 40.0
Body mass index (kg/m^2)	24.5	3.9	16.7, 36.8	25.8	5.6	16.5, 47.6	24.8	5.3	16.9, 42.9
Pregnancy Order	1.7	1.3	1, 9	2.5	1.7	1, 8	1.7	0.9	1, 5

†Low values are found in the most deprived areas; *High values are found in the most deprived areas.

Table 1: Descriptive Statistics.

Table 2 shows the results from joint logistic regression models designed to measure the association (odds ratio) of gastroschisis with maternal age, body mass index, pregnancy number and deprivation score, and to test their significance. Gastroschisis was strongly associated with young maternal age, as we have previously reported [13], but had no further association with body mass index, pregnancy number or deprivation score. To explore this further, we divided the deprivation scores into five equal groups across the 333 subjects. Table 3 shows the use of logistic regression models to measure the association between gastroschisis and deprivation score. There was no trend across the groups in incidence of gastroschisis. The only excess occurred in the very central group.

Predictor		Model 1: Cases v All Controls			Model 2: Cases v Next Delivery Controls			Model 3: Cases v Age Matched Controls		
		Odds Ratio	95% CI	p-value	Odds Ratio	95% CI	p-value	Odds Ratio	95% CI	p-value
Deprivation Score (z)		0.92	0.70, 1.20	0.6	0.88	0.58, 1.36	0.6	0.91	0.67, 1.24	0.5
Age (ln years)		0.029	0.005, 0.176	<0.001	0.006	0.001, 0.050	<0.001	3.301	0.003, 3859	0.7
Body mass index (ln kg/m^2)		0.74	0.18, 3.00	0.7	0.61	0.08, 4.51	0.6	0.76	0.16, 3.64	0.8
Pregnancy Number	1	1.00	Baseline	-	1.00	Baseline	-	1.00	Baseline	-
	2	0.72	0.38, 1.35	0.7	0.66	0.28, 1.59	0.4	0.71	0.35, 1.44	0.3

	3+	0.76	0.36, 1.60	0.8	1.10	0.45, 2.70	0.8	0.74	0.30, 1.82	0.5

Models are adjusted for age, body mass index and pregnancy number. CI=confidence interval

Table 2: Conditional logistic regression models to measure the association between gastroschisis and deprivation score.

Fifths of Deprivation Score	Cases	Next Delivery Controls	Age Matched Controls	All subjects	Model 1: Cases v All Controls		Model 2: Cases v Next Delivery Controls		Model 3: Cases v Age Matched Controls	
					Odds Ratio (95% CI)	p-value	Odds Ratio (95% CI)	p-value	Odds Ratio (95% CI)	p-value
>26200	17	31	19	67	1.0 (baseline)	-	1.0 (baseline)	-	1.0 (baseline)	-
(18100,26200)	17	24	25	66	0.9 (0.4-2.1)	0.8	1.2 (0.4-3.8)	0.7	0.8 (0.3-2.0)	0.6
(11400,18100)	37	16	13	66	3.6 (1.5-8.6)	<0.001	3.6 (1.0-12.9)	0.05	3.8 (1.3-11.1)	0.01
(6000,11400)	22	22	23	67	1.1 (0.5-2.7)	0.8	0.8 (0.2-2.6)	0.7	1.3 (0.5-3.8)	0.6
≤ 6000†	18	18	31	67	0.9 (0.4-2.1)	0.8	1.4 (0.4-5.4)	0.6	0.7 (0.3-1.8)	0.4
All	111	111	111	333						

†Low values are found in the most deprived areas; *High values are found in the least deprived areas; Models are adjusted for age, body mass index and pregnancy number. CI=confidence interval.

Table 3: Conditional logistic regression models to measure the association between gastroschisis and deprivation score, measured in fifths.

Considering all 333 subjects there was a strong inverse association between age and deprivation-younger mothers tending to have higher deprivation scores. The standardised deprivation score decreased by 1.102 units per unit change in ln(log of age(years)), with standard error 0.214 and p-value <0.001. Similar effect sizes were seen in the three subgroups: 1.145 (0.345), p=0.001 for the cases; 1.409 (0.431), p=0.001 for the next deliveries; 1.141 (0.495), p=0.02 for the age-matched controls. However, deprivation had no additional effect on the incidence of gastroschisis, beyond that attributable to young age.

4. Discussion

This is the first study, we are aware of that has attempted to relate deprivation score to the incidence of a prenatally detectable fetal anomaly. Our hypothesis was that young maternal age might be linked to social deprivation and that this might be associated with an increased incidence of gastroschisis. We confirmed the previously reported association between young maternal age and gastroschisis. Deprivation index was higher in younger women, but it was not associated with gastroschisis once allowance was made for maternal age. There has been little published data regarding the incidence of gastroschisis and social class. An Ovid medline search for "gastroschisis and social class", "gastroschisis and family income", "gastroschisis and social deprivation" gave no results. Torfs et al. [14] suggested that on univariate matched paired analysis, there were significant associations with mother's education, yearly family income, marital status, a history of mother's smoking, mother's father's absence from home during mother's youth, more than one elective abortion, a short interval between menarche and first pregnancy, siblings from different fathers, and with use of a recreational drug, alcohol or tobacco during the trimester preceding pregnancy.

The strengths of this study are the relatively large number and complete set of cases drawn from across the entire population of central South England, as we are the tertiary Fetal Medicine Centre for this area; the careful matched case-control design; and the wide variation in maternal deprivation in the region. Our measurements were all recorded at the moment of delivery, so there is no selection or information bias. This was a retrospective study on data from 2007 until 2014. The limitations of the paper are that we did not record smoking history, education, income or medications used in pregnancy. This paper demonstrates a novel method of investigating the relationship between social deprivation and fetal anomalies that might be applicable to other conditions, even though we have not demonstrated a link with gastroschisis. Our results suggest that young maternal age is the dominant risk factor for gastroschisis and there is no additional contribution from low maternal body mass index or a high level of social deprivation.

Disclosure

There are no competing interests and no individuals or companies that have financially contributed to this study.

Acknowledgements

We would like to thank Sally Boxall Nurse Specialist in Wessex Fetal Medicine Department for help with access to the WANDA Database.

Ethical Approval

Ethics approval to maintain and use the data in this register have been obtained from the Trent Multicentre Research Ethics Committee (Ethics number 09/H0405/48).

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Citation: Hale J, Derbyshire A, Taylor A, Osmond C, Wellesley D, Howe DT. The Relationship between Neonatal Gastroschisis, Maternal BMI and Social Deprivation in a UK Population. Journal of Pediatrics, Perinatology and Child Health 3 (2019): 090-095.