

Induction of labour in singleton pregnancy and subsequent risk of childhood special educational need: Scottish population cohort study

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Abstract

Background

Induction of labour occurs in approximately 1 in 3 pregnancies in high income countries. Induction of labour is recommended from 41 weeks to reduce the risks of stillbirth, neonatal death and neonatal intensive care admission by the World Health Organisation and the National Institute for Health and Care Excellence (NICE) in the UK, however in recent years the gestational age at delivery has decreased. In this study we aimed to determine the childhood outcomes of Induction of labour at term compared to those expectantly managed.

Methods and Findings:

We conducted a population cohort study of all children born after 37 weeks between 1988–2015 using routinely collected Scottish maternity data linked to school census data. The exposure was induction of labour with no recognised medical indication at each week of term (37–41 weeks gestation). For each week we identified a comparison group of women who had been expectantly managed and delivered after the gestation at which the comparator induction of labour had been performed. The primary outcome was special educational need (a learning or physical difficulty) at school. Analyses were performed using multiple logistic regression. Of 721 177 women with singleton pregnancy, 158 217 underwent elective induction of labour (21.9%). At each week of gestation between 37 and 40 completed weeks, elective induction of labour was associated with an increased risk of special educational need compared with expectant management (adjusted odds ratio for induction of labour at 39 weeks compared to expectant management 1.18 [95% CI 1.12–1.24]; $p < 0.001$). However at 41 weeks gestation there was no difference in the risk of special educational need between the groups (adjusted OR 1.01, 95% CI [0.95–1.07]; $p = 0.762$).

Conclusion

Compared to expectant management, elective induction of labour at each week from 37–40 weeks' gestation is associated with an increased risk of special educational need in children. This information should be used when counselling women especially regarding induction of labour before 41 weeks' gestation.

Introduction

Induction of labour is an increasingly common intervention performed in maternity services with approximately one in three singleton pregnancies between gestations of 37–42 weeks induced in Scotland [1], Wales and England [2]. It is indicated when the risks of continuing a pregnancy are assessed to be higher than those associated with delivery. Rising induction of labour rates are thought to

result from higher levels of risk factors for induction as well as changes in the way clinicians manage such risks [1]. Elective induction of labour at term has been found to reduce perinatal mortality [3] and, when carried out for maternal health reasons such as gestational hypertension, reduce the risk of adverse maternal health outcomes [4]. The ARRIVE randomised controlled trial (RCT) trial [5] and subsequent meta-analysis published in 2018 and 2019 [6] respectively looked at induction of labour in low risk nulliparous women and reported that women in the induction of labour group at 39 weeks gestation had a reduction in the risk of Caesarean birth, peripartum infection, meconium aspiration in the neonate and perinatal mortality compared to the expectantly managed group. Other guidance suggests that induction of labour should not be routinely offered before 41 weeks gestation. For example, the UK National Institute for Health and Care excellence (NICE) guideline which we follow in the UK recommends induction of labour from 41 weeks to reduce the risks of stillbirth, neonatal death and neonatal intensive care unit (NICU) admission however also states that evidence is still needed to determine the optimum timing of induction of labour [7]. The World Health Organisation (WHO) also supports this approach but recognises that the quality of evidence underpinning this recommendation is low [8]. A number of studies have shown a decrease in the mean gestational age at birth, mean gestational age decreased in the US from 40 weeks in 1994 to 39 weeks in 2004 [9] and in Scotland there has been a left shift in average gestational age at birth with 40.2% of births occurring at 40 + 0 weeks or greater in 2019 compared to 54.7% of births occurring at 40 + 0 weeks or greater in 2005 [10]. It is thought that this may be due to the emerging body of evidence surrounding earlier induction of labour to reduce perinatal mortality [3]. The Society for Maternal and Fetal medicine (SMFM) statement on elective induction of labour in low-risk nulliparous women at term supports offering induction of labour in this group from 39 weeks [11]. It is known that during the third trimester of pregnancy there is a fourfold increase in brain size and induction of labour may be associated with an interruption in the normal fetal brain development [12]. There have been a number of studies examining both the immediate perinatal outcomes and the long-term consequences of induction of labour on child development but the results are conflicting.[13, 14, 22, 24].

The aim of this study was to determine if induction of labour in singletons born at term (37–41 weeks) in Scotland was associated with an increased risk of Special educational need at school compared to those pregnancies expectantly managed using a large maternity dataset linked to childhood education records. We carried out two analyses with different comparator groups – the first comparing those who had been induced versus those expectantly managed and delivered after the gestation at which the induction of labour took place and the second comparator being women delivered at or beyond the gestation of induction of labour. We hypothesised that induction of labour would be associated with an increased risk of Special educational need due lowering the gestation at birth and therefore potentially interrupting the normal fetal brain development. We also carried out an exploratory analysis looking at academic attainment with the hypothesis that if induction of labour increased the risk of Special educational need this would in turn result in lower academic attainment in the induction of labour group.

Methods

The study was approved by NHS Scotland Public Benefit and Privacy Panel (PBPP 1516 – 0391). All data were nonidentifiable and individual patient consent not required. A data processing and sharing agreement was produced between the University of Edinburgh and Information Services Division and the Scottish Exchange of Educational Data (ScotXed). The study protocol was pre-specified and the PBPP application form is included in the supporting information (S1 File). The study was reported as per the Reporting of Studies Conducted using Observational Routinely-Collected Data (RECORD) guideline (S2 File).

Study Population

A population cohort study of all singleton pregnancies born after 37 weeks in Scotland, UK born between 1 January 1988 and 31 December 2015.

Databases

We obtained data from the Scottish Morbidity Record 02 (SMR02) and the Scottish Exchange of Educational Data (ScotXed). The study population was derived from the SMR02 maternity database which collects data on all women discharged from Scottish maternity hospitals and includes information on maternal, obstetric and neonatal outcomes. The ScotXed contains details on the pupil census and has been conducted annually since 2005. The data for the school census are provided by head teachers at each school (including local authority/grant-aided/independent and self governing schools) and collated by their local education authority with a response rate of 99.8%. The information includes whether a child has a special educational need. The SMR02 is subject to regular quality assurance checks and has been more than 99% complete since 1980 [15]. Using SMR02 as the base population, the education data from the ScotXed database was record-linked to the SMR02 by Information Services Division. The linkage methodology has been described previously [16].

Inclusion and exclusion criteria

Women were included if they had a singleton birth at or after 37 weeks gestation. Births were excluded from both arms if there was a relative or absolute contraindication to induction of labour including malpresentation, previous Caesarean birth, poor obstetric history (previous stillbirth or neonatal death as these were considered a medical indication for induction of labour) or if there was a recognised medical indication for induction of labour. As part of data cleaning, we removed pregnancies with a gestational age at birth recorded as missing or greater than 44 weeks or maternal age less than 10 years due to the high chance of these being data errors. Multiple births were also excluded as the NICE guidance for induction of labour for multiple births is to offer elective induction of labour at an earlier gestation than in singleton pregnancies.

Outcomes, exposures and covariates

The exposure of interest was induction of labour without known medical indication. In SMR02, the indication for delivery is not recorded, but medical conditions in pregnancy are (recorded using the

international classification of diseases [ICD], ninth and tenth revisions [17]). Medically-indicated delivery was defined as at least one of the following conditions: hypertensive disease (ICD-10 o10), diabetes mellitus (ICD-10 o24), thromboembolic disease (ICD-10 o22), liver disorders (ICD-10 o26), antenatal investigation of abnormality (ICD-10 o42) and poor obstetric history (previous stillbirth or neonatal death ICD-10 oo1). The full list of codes included in the analysis can be found in the supporting information (S3 File). In the absence of any of these conditions being recorded, we considered the induction of labour before 41 weeks to be without medical indication. For each gestation in the induction of labour cohort we identified a comparison group of women who had been expectantly managed and delivered after the gestation at which the comparator induction of labour had been performed i.e for those induced at 37 weeks the comparator was those still pregnant at 38 weeks onwards.

The primary outcome was a record of Special educational need at school. Special educational need is defined by the Department of Education as being unable to benefit fully from school without help beyond that normally given to school children of the same age [18]. In this study, Special educational need was defined as a record of any of the following: intellectual disabilities, dyslexia, physical or motor impairment, language or speech disorder, autistic spectrum disorder and social, emotional or behavioural difficulties.

An exploratory analysis of academic achievement at school and leaver destination was performed. Highest academic attainment was derived from the number of examinations attained at each level of the Scottish Credit and Qualifications Framework [19] and converted into the following: poor educational attainment (low [≥ 1 at level 2, < 5 at level 3, or < 2 at level 4], basic attainment [≥ 5 at level 3, ≥ 2 at level 4, or ≤ 4 at level 5]), high educational attainment (broad attainment [≥ 7 at level 4, > 5 at level 5, or < 3 at level 6], and highest attainment [> 1 at level 7 or ≥ 3 at level 6]). School leaver destination was defined as a dichotomous variable of higher or further education, employment, or training, or unemployment.

Statistical analyses

Summary statistics were derived and compared by the exposure of induction of labour without known medical indication. To determine the associations between induction of labour and the risk of special educational need at school univariate and multivariable logistic regression analyses were performed. The covariates included in the multivariable analysis were maternal age at birth (categorised as ≤ 20 , 21–30, 31–40 and > 40 years), parity during the index pregnancy (para 0 or para ≥ 1), year of birth, area socioeconomic deprivation quintile of postcode of residence (defined by the Carstairs quintile 1991, 2001 and 2011 depending on the year of delivery [20]), gestation and sex-specific birthweight centiles (categorised as < 3 , 4–10, 11–90, 91–97 or > 97), 5 minute Apgar score (categorised as < 7 and > 7), fetal sex (male or female), marital status (categorised as married or unmarried), maternal smoking (categorised as smoker or non/ex smoker) and maternal height (categorised as < 150 , 150–154, 155–159, 160–164, 165–169, 170–174, > 174). Missing covariate values were not included in the multivariable analysis model. We carried out a secondary analysis with the comparator being women delivered at or beyond the gestation of induction of labour to explore the effect of potential bias on

results given gestation is only recorded in completed weeks. Leaver status and highest academic achievement were analyzed using multivariable logistic regression modelling.

Sensitivity Analyses

To assess the changes in obstetric practice over time and potential changes to the definition of Special educational need a sensitivity analysis was performed excluding births before the year 2000.

Given the known association of low birth weight with Special educational need a further sensitivity analysis was performed excluding births with birthweight centile <3rd centile.

We also performed a sensitivity analysis excluding births with Apgar scores < 7 given the known association of low Apgar scores with Special educational need and a sensitivity analysis including medical indication for induction of labour as a covariate rather than excluding these from the analysis given the risk of exposure contamination and overestimation of association.

P values for hypothesis tests were two sided and set at $P < 0.05$. All analyses were undertaken using STATA, version 14.1 (Stata Corporation).

Results

The SMR02 database contained 1 003 031 singleton infants born in Scotland between January 1st 1988 and December 31 2015. Following data cleaning and data linkage to the education records there were 756 499 children remaining. Of these, 35 322 were ineligible for inclusion because they fulfilled one or more of the exclusion criteria. Of the remaining 721 177 children, 158 217 (21.9%) had induction of labour without known medical indication and 66 846 (9.2%) had a record of Special educational need. When we looked at the education records by year, the years 1988–1993 had very few records of Special educational need and were therefore removed from the analysis. The process of deriving the study cohort is outlined in Fig. 1.

Table 1 shows the characteristics of the cohort according to the exposure of induction of labour.

Overall, among the mothers, 323 567 (44.9%) were primigravida, 361 004 (50.1%) were aged between 21 and 30 years. There was a comparable spread of births in both the induction of labour and the expectant management groups across the years of deliveries studied and across the deprivation quintiles (Table 1). Women undergoing induction of labour were more likely to be primiparous (84 513 [53.8%] in the induction of labour group vs 239 034 [42.7%] in the expectant management group) and a higher proportion of induction of labour took place in the later time periods (63 782 [40.3%] deliveries at 41 weeks in the induction of labour group vs 106 247 [18.9%] in the expectant management group). Among the infants 367 945 (51%) were male and the largest proportion of infants were delivered at 40 and 41 weeks gestation (400 038 [55.5%]). 15 724 (2.2%) had a 5-minute Apgar score less than seven.

Table 1
Baseline demographics of the population of 721 177 singletons born in Scotland according to induction of labour status (158 217 IOL [21.9%] vs 562 960 [78.1%])

Variable	Total	Induction of labour	Expectant Management
Gestation (weeks)	36 847	7 508 (4.7)	29 339 (5.2)
37	94 643	16 438 (10.4)	78 205 (13.9)
38	166 348	20 875 (13.2)	145 473 (25.8)
39	229 999	35 291 (22.3)	194 708 (34.6)
40	170 029	63 782 (40.3)	106 247 (18.9)
41	23 311	14 323 (9.1)	8 988 (1.6)
42	0		
missing			
Maternal Age (years)			
< 20	81 244	19 112 (12.1)	62 132 (11.0)
21–30	361 004	80 683 (51.0)	280 321 (49.8)
31–40	268 330	55 851 (35.3)	212 479 (37.7)
> 40	10 599	2 571 (1.6)	8 028 (1.4)
Missing	0		
Parity			
0	323 567	84 513 (53.8)	239 034 (42.7)
1	393 385	72 695 (46.2)	320 690 (57.3)
Missing	4245		
Year of birth			
1995–1999	215 916	47 838 (30.2)	168 078 (29.9)
2000–2004	199 608	45 755 (29.9)	153 853 (27.3)
2005–2009	216 126	45 082 (28.5)	171 044 (30.4)
2010–2015	89 527	19 542 (12.4)	69 985 (12.4)
Missing	0		
Deprivation category*			
*Carstairs quintile closest to the year of delivery, I – least deprived, V – most deprived			

Variable	Total	Induction of labour	Expectant Management
I	142 078	29 855 (18.9)	112 223 (20.0)
II	139 663	30 222 (19.1)	109 441 (19.5)
III	144 510	32 072 (20.3)	112 438 (20.0)
IV	144 143	32 505 (20.6)	111 638 (19.9)
V	149 771	33 327 (21.1)	116 444 (20.7)
<i>Missing</i>	<i>1012</i>		
BW Centile			
< 3	21 895	6 504 (4.1)	15 391 (2.7)
4–10	50 533	12 458 (7.9)	38 075 (6.8)
11–20	73 962	16 259 (10.3)	57 708 (10.3)
21–80	430 805	90 344 (57.1)	340 461 (60.5)
81–90	72 365	15 994 (10.1)	56 371 (10.0)
91–97	49 967	11 299 (7.1)	38 668 (6.9)
98–100	21 390	5 306 (3.4)	16 084 (2.9)
<i>Missing</i>	<i>260</i>		
Fetal sex			
Male	367 945	92 825 (51.5)	275 120 (50.8)
Female	353 232	87 258 (48.5)	265 974 (49.2)
<i>Missing</i>	<i>0</i>		
Maternal Height (cm)			
< 150	36 683	7 464 (5.9)	29 219 (6.5)
150–154	106 745	22 229 (17.6)	84 516 (18.7)
155–159	174 046	37 984 (30.1)	136 062 (30.1)
160–164	146 543	32 643 (25.8)	113 900 (25.2)
165–169	75 473	17 543 (13.9)	57 930 (12.8)
170–174	27 086	6 520 (5.2)	20 566 (4.6)
> 174	142 609		
*Carstairs quintile closest to the year of delivery, I – least deprived, V – most deprived			

Variable	Total	Induction of labour	Expectant Management
Missing			
Apgar at 5 mins	15 724	4 207 (2.7)	11 517 (2.1)
< 7	703 009	153 685 (97.3)	549 324 (98.0)
> 7	2444		
missing			
Smoking status	166 782	35 750 (25.0)	131 032 (25.7)
Current	485 739	107 168 (75.0)	378 571 (74.3)
Ex/non smoker	68 656		
missing			
Marital status	390 350	82 757 (52.3)	307 593 (54.6)
Married	330 827	75 460 (47.7)	255 367 (45.4)
Not married	0		
Missing			
*Carstairs quintile closest to the year of delivery, I – least deprived, V – most deprived			

In the primary analysis there was an increased risk of Special educational need in the induction of labour group compared to the expectant management group in both the univariate and multivariable analyses in the gestational age weeks of 37–40 weeks (Table 2). The association between induction of labour and Special educational need demonstrated a linear response with a decreasing risk of Special educational need in the induction of labour group with advancing gestational age at birth (i.e. the risk of Special educational need was highest in the induction of labour group at 37 weeks compared to expectant management; adjusted [adj.] odds ratio [OR] 1.35, 95% confidence intervals [CI 1.24–1.47]; $p < 0.001$), Fig. 2). At 41 weeks there was no difference in the risk of Special educational need in the induction of labour group compared to the expectant management group (adj. OR 1.01, [95% CI 0.95–1.01]; $p = 0.762$, Table 2).

Table 2

Special educational need with elective induction of labour at each week of gestation compared with expectant management beyond gestation of induction of labour

Week of gestation	No. outcome/no. in group		Univariate analysis IOL v expectant management		Multivariate analysis IOL v expectant management	
	Elective IOL	Expectant Management	OR (95%CI)	p value	Adj. OR* (95% CI)	p value
37	884/7 508 (11.8)	62 713/684 330 (9.2)	1.32 (1.23–1.42)	< 0.001	1.35 (1.24–1.47)	< 0.001
38	1 897/16 438 (11.5)	52 737/589 687 (8.9)	1.32 (1.27–1.39)	< 0.001	1.28 (1.21–1.36)	< 0.001
39	2 159/20 875 (10.3)	37 302/423 339 (8.8)	1.19 (1.14–1.25)	< 0.001	1.18 (1.12–1.24)	< 0.001
40	3 393/35 291 (9.6)	16 919/193 340 (8.8)	1.11 (1.07–1.15)	< 0.001	1.11 (1.06–1.16)	< 0.001
41	5 920/63 782 (9.3)	2051/23 311 (8.8)	1.06 (1.01–1.12)	0.030	1.01 (0.95–1.07)	0.762
* adj. for maternal age, parity, year of delivery, deprivation category, gestation specific birthweight centile, marital status, maternal smoking, 5 min Apgar score, fetal sex and maternal height						

In the secondary analyses comparing induction of labour at or beyond the week of gestation, the results were very similar to the primary analysis in the multivariable analyses with the risk of special educational need highest in the induction of labour group at 37 weeks compared to expectant management at or beyond the gestation of induction of labour (adj. OR 1.34 [95% CI 1.23–1.45]; $p < 0.001$, Table 3).

Table 3

Special educational need with elective induction of labour (IOL) at each week of gestation compared with expectant management at or beyond gestation of induction of labour

Week of gestation	No. outcome/no. in group		Univariate analysis IOL v expectant management		Multivariate analysis IOL v expectant management	
	Elective IOL	Expectant Management	OR (95%CI)	p value	Adj. OR* (95% CI)	p value
37	884/7 508 (11.8)	65 962/713 669 (9.24)	1.31 (1.22–1.41)	< 0.001	1.34 (1.23–1.45)	< 0.001
38	1 897/16 438 (11.5)	60 816/667 892 (9.1)	1.30 (1.24–1.37)	< 0.001	1.26 (1.19–1.34)	< 0.001
39	2 159/20 875 (10.3)	50 578/568 812 (8.9)	1.18 (1.13–1.24)	< 0.001	1.16 (1.10–1.23)	< 0.001
40	3 393/35 291 (9.6)	33 909/388 048 (8.7)	1.11 (1.07–1.15)	< 0.001	1.12 (1.08–1.17)	< 0.001
41	5 920/63 782 (9.3)	10 999/129 558 (8.5)	1.10 (1.07–1.14)	0.030	1.06 (1.01–1.11)	0.002
* adj. for maternal age, parity, year of delivery, deprivation category, gestation specific birthweight centile, marital status, maternal smoking, 5 min Apgar score, fetal sex and maternal height						

The exploratory analysis of academic attainment included information on 459 435 children. Special educational need was associated with lower academic attainment at school (S1 Table) however induction of labour was not associated with low attainment at school (Adj. OR 1.00, 95% CI [0.95–1.06]; $p = 0.894$), Table 4). The analysis of leaver destination included 393 275 children. Induction of labour was not associated with an increased risk of unemployment after leaving school (adj. OR 1.00, 95% CI [0.97–1.03]; $p = 0.863$, Table 4].

Table 4
Association between Induction of labour (IOL) and Academic attainment and leaver status

Educational Outcome	No. outcome/no. in group		Univariate analysis IOL v expectant management		Multivariate analysis IOL v expectant management	
	Elective IOL	Expectant Management	OR (95%CI)	p value	Adj. OR* (95% CI)	p value
Poorer academic attainment	2 876/100 900 (2.9)	11 305/358 535 (3.1)	1.11 (1.06–11.16)	< 0.001	1.00 (0.95–1.06)	0.894
Leaver Status (unemployed at 6 months)	8 870/85 609 (10.4)	33 049/307 666 (10.7)	1.04 (1.01–1.07)	0.001	1.00 (0.97–1.03)	0.863
* adj. for maternal age, parity, year of delivery, deprivation category, gestation specific birthweight centile, marital status, maternal smoking, 5 min Apgar score, fetal sex and maternal height						

Sensitivity Analyses

Findings were similar to those of the main study for both the primary and secondary analysis in the logistic regression models performed excluding births born before the year 2000 (S2 Table & S3 Table) and excluding babies born with a birthweight < 3rd centile (S4 Table & S5 Table). The additional sensitivity analyses excluding those with Apgars < 7 and adding medical indication for induction as a covariate rather than removing them from the analysis had similar results to the main study for the primary analysis (S6 Table & S7 Table).

Discussion

Main Findings

Our population cohort study of 721, 177 children examined the associations of induction of labour exposure at 37 weeks gestation or greater and the risk of Special educational need in the children at school and how this risk varied depending on gestational age at birth. Our findings suggest that induction of labour at each week from 37 weeks gestation is associated with an increased risk of Special educational need at school in the children until 41 weeks when there is no association between induction of labour and the risk of Special educational need at school. In our exploratory analysis of school outcomes on leaving school there was no association between induction of labour and unemployment or lower academic attainment.

Interpretation

Previous studies have shown that there is a decreased risk of Special educational need with advancing gestational age at birth up to 40 weeks gestation [21, 22], it is therefore not surprising that induction of labour prior to 40 weeks results in an increased risk of Special educational need as there is likely to be a

protective effect of advancing gestation. These results are contrasting to studies reporting on school outcomes according to gestational age at birth which have shown no difference in school outcomes in children born at 39 versus 40 weeks and 41 versus 40 weeks [23] and no difference in cognitive outcomes in adolescence in a sibling analysis of those born at 34–39 weeks versus 40 weeks [24]. The increased risk of Special educational need with induction of labour at 40 weeks in our study is surprising and in contrast to two previous Australian studies [14, 25] which reported no differences in adverse developmental outcomes with induction of labour at 39 weeks gestation or 39/40 weeks' gestation respectively. Our finding of no association between induction of labour and academic attainment are in contrast to the results of the study carried out in the Netherlands [13] which found a more consistent association with school performance scores and induction of labour, with school performance scores increasing with advancing gestational age and induction of labour associated with lower mean school performance scores compared to the expectantly managed group which is similar to our special educational need findings. A recent observational study investigating the relationship between induction of labour and childhood school performance revealed an inconsistent association between elective induction at term and school outcomes when comparing low-risk nulliparous patients induced at 39 and 40 weeks to those managed expectantly [25]. Children of patients induced at 39 weeks had poorer educational outcomes at ages 7–9 but not at older ages, whilst those induced at 40 weeks had comparable outcomes at ages 7–9 but poorer outcomes at ages 9–11 and 11–13. In contrast, a study exploring global childhood developmental outcomes in children aged 4–6 after elective birth (caesarean birth and induction of labour) at 39–39 + 6 (weeks + days) compared to expectant management found no increase in childhood developmental vulnerability in those delivered electively [14]. Our findings highlight the need for further studies (ideally with follow up of randomised controlled trials to reduce the risk of residual confounding) to assess the longer-term effects of induction of labour at 37–41 weeks gestations.

One possible explanation for the increase in Special educational need in the induction of labour group prior to 41 weeks gestation is that induction of labour interrupts the optimal gestation for birth with disruption of the fetal brain development and interrupting the initiation of labour before the fetus is ready for birth [12]. Another possible explanation is that induction of labour per se contributes to the outcome rather than gestation. For example, induction of labour involves increased use of oxytocin which could result in an increased risk of unrecognised hypoxia. However, in the sensitivity analysis removing those with Apgars < 7 (S7 Table) from both groups the results were similar to the main findings. Another potential explanation for this result is that despite the exclusion of medical indications for induction of labour (inferred from *ICD-10* codes) we may have missed some women who underwent elective induction of labour for a medical reason leading to higher risk women being included in the induction of labour group which may have caused an over estimation of the odds of special educational need in the induction of labour group compared to the expectant management group. However, a sensitivity analysis excluding babies who were less than the third birthweight centile for gestational age, showed similar findings to the main study.

The secondary analysis using the comparator of at or beyond the week of gestation showed a similar trend to the primary analysis with an increased odds of special educational need up to 41 weeks gestation.

Although the results of our exploratory analysis of leaver destination and lower academic attainment at the end of school should be interpreted with caution due to the reduced sample size it is reassuring that there is no association with induction of labour and these poorer outcomes.

Strengths and limitations

This study has a number of strengths. Firstly, using an unselected population database ensured that every singleton pregnancy meeting the inclusion criteria was included thus reducing selection bias. To our knowledge this is the largest population-based study to examine the risk of Special educational need in those undergoing induction of labour. Our Special educational need variable was derived from routine data sources reducing recall and ascertainment bias and it included all-school age children in Scotland and was therefore representative of the population as a whole. By performing the analysis using 2 different comparator groups we reduced the chances of bias due to the recording only of completed weeks of gestation.

The study also has limitations due to the nature of routinely collected data. Missing covariates are a limitation and lead to a reduction in study size – due to our large sample size we opted to remove missing covariates rather than performing multiple imputation. Another limitation is that the study spans a very large timeframe and obstetric practice is likely to have changed over time, we tried to investigate this by performing the sensitivity analysis excluding births before 2000 but even between 2000 and 2015 obstetric practice is likely to have changed. Residual confounding is a potential limitation and although we tried to mitigate this, for example by using ICD-10 codes to try to determine medical reasons for induction of labour and using social deprivation as a proxy for maternal education, residual confounding from unmeasured variables cannot be eliminated.

Conclusion

induction of labour is an increasingly common intervention carried out across the World and the gestational age at delivery has been reducing over time. Our findings have important implications for clinical practice in the decision to undertake elective delivery, in the absence of a medical indication, particularly in the early term (37–38 weeks gestation) period where the risk of Special educational need is highest. Our findings support the current clinical guidance of induction of labour from 41 weeks to reduce perinatal and maternal complications without adversely affecting long term neurodevelopmental outcomes in the children.

Declarations

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Figures

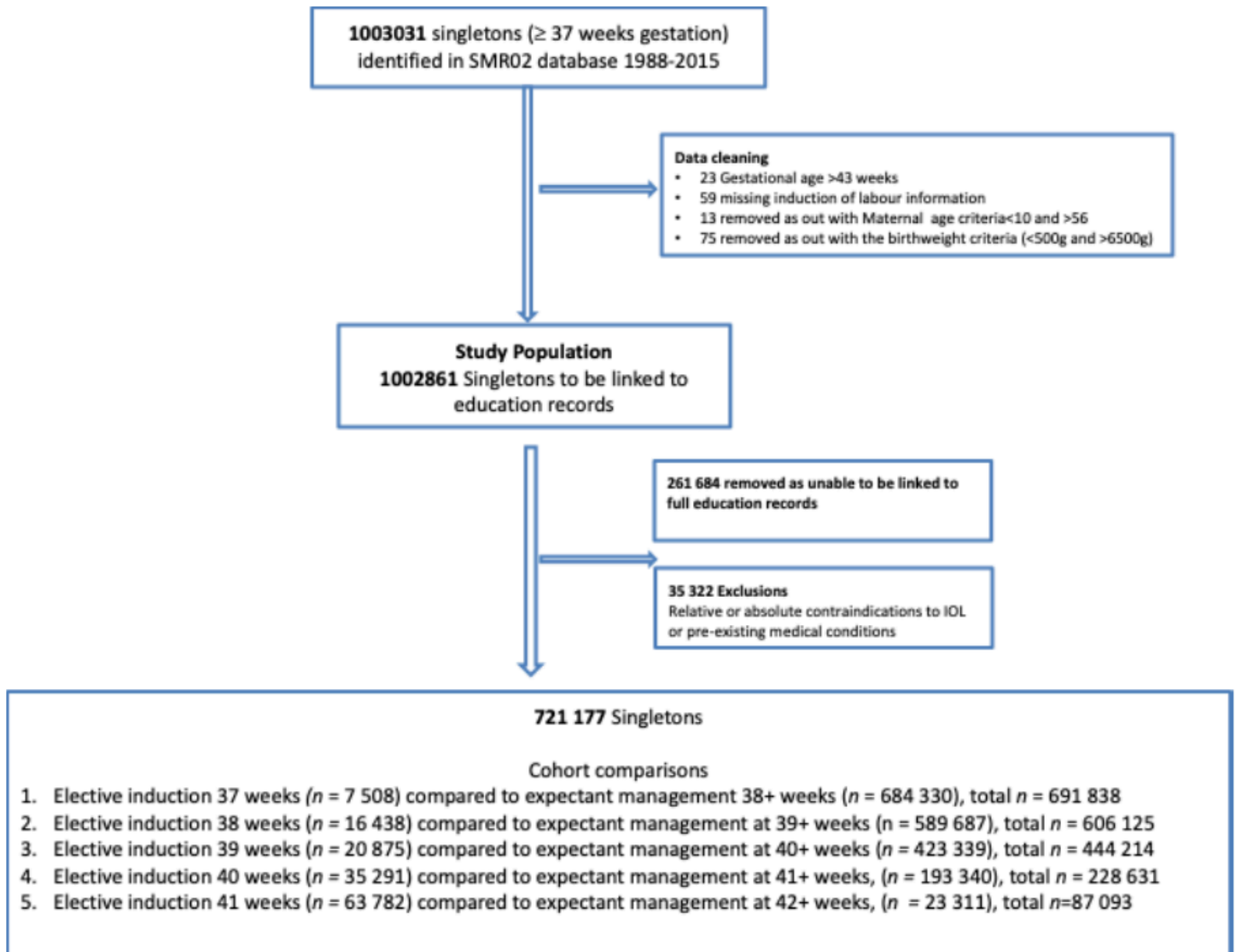


Figure 1

Derivation of the study cohort

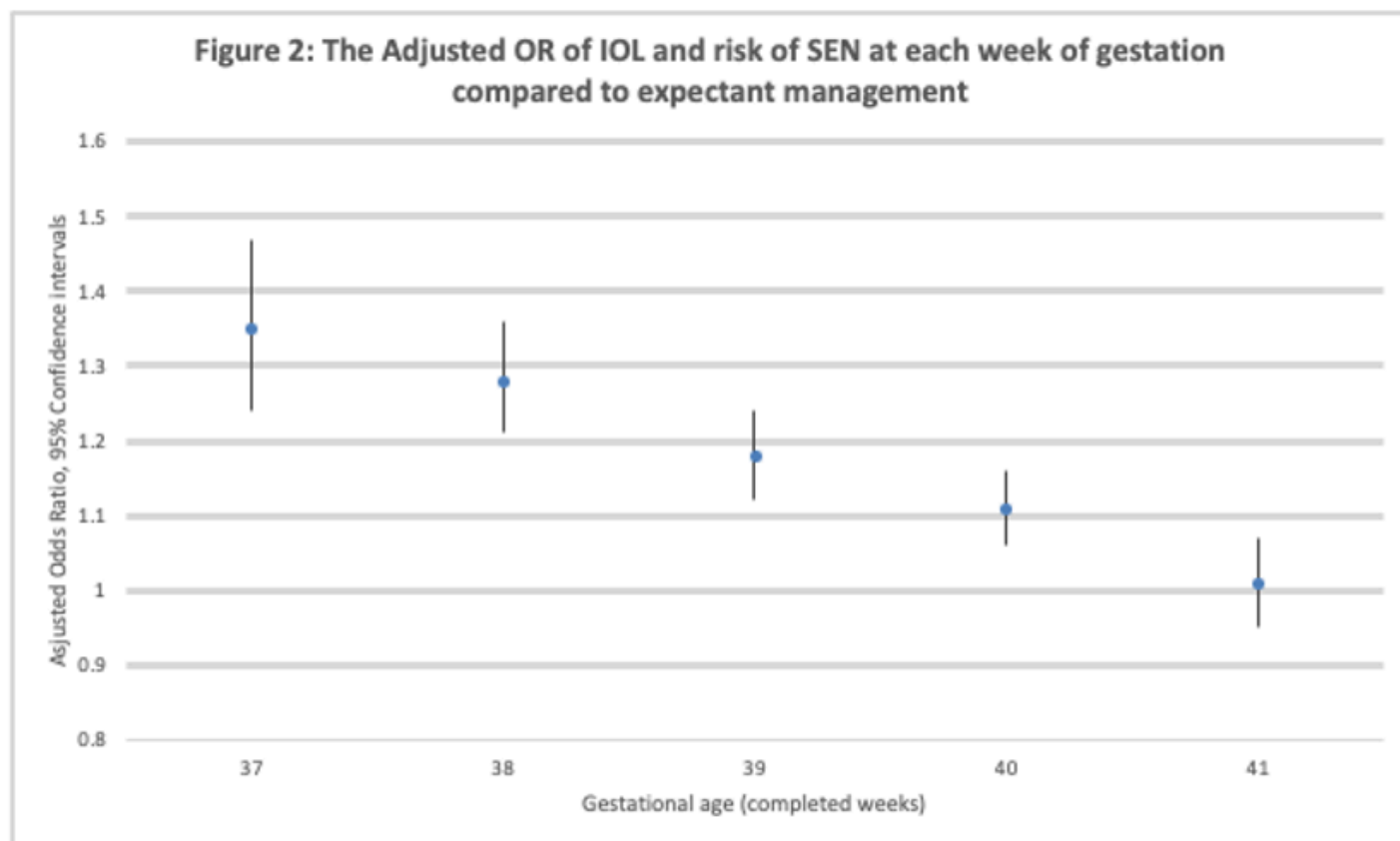


Figure 2

See image above for figure legend

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