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Variation in induction of labour rates across Irish hospitals; a cross-sectional study

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Background: In developed countries, rates of induction of labour (IOL) have increased and vary between hospitals. We aimed to identify whether national variations could be explained by sociodemographic, clinical and organisational differences. **Methods**: Two national databases in Ireland that routinely collect clinical and administrative data, the National Perinatal Reporting System and the Hospital Inpatient Enquiry Scheme, were used to analyse data for all women with singleton births weighing ≥500 g in 2009. We used logistic multilevel models to examine variation between hospitals, and to determine how much variation was due to individual level sociodemographic, clinical and organisational variables. Analyses were stratified for nulliparas, multiparas without prior caesarean section (CS) and multiparas with prior CS. **Results**: Of 69 304 eligible births, the rate of IOL nationally was 25.0% (range 14.5–33.2%).In nulliparas, the mean rate was 30.9% (range 18.6–45.7%). The rate was 24.8% (13.5–33.3%) and 3.8% (0.0–10.2%) for multiparas without and with prior CS, respectively. In nulliparas and multiparas without prior CS IOL was predicted by maternal birth in Ireland, increasing birthweight, antepartum complications, giving birth on a weekday and the model of obstetric care. Even after adjusting for known sociodemographic and clinical variables, variation between hospitals remained. **Conclusion**: We found that clinical, sociodemographic and organisational factors all contributed to variation. However, unexplained variation persisted possibly due to organisational factors such as hospital-specific policies on IOL. The results indicate that the prevalence of antenatal complications, changing immigration patterns and policies on IOL after previous CS are factors likely to influence future IOL rates.

Introduction

Induction of labour (IOL) is a frequently used obstetric intervention.[1] The underlying rationale is that in the absence of a spontaneous birth the risk to maternal/foetal health may increase. For example, in post-term pregnancies (>42 weeks) the risk of stillbirth increases, and thus, it may be advantageous to induce labour rather than allow the pregnancy extend further.[2,3] The maternal and foetal benefits of induction have also been reported in scenarios which include maternal hypertensive disorders, diabetes and macrosomia.[4–6]

In the USA, the rate of IOL has more than doubled in the last 20 years, from ~10% in 1990 to 23% in 2012.[7] Similar patterns have been reported in other developed countries such as Scotland and Australia.[8,9] In Ireland, the rate of IOL rose from 17% in 1999 to 25% in 2009.[10]

The rising rate of IOL may be explained by more women presenting with clinical indications for IOL. However, an Australian time series study examining the risk profile for IOL over time found that the prevalence of the most important predictor for induction, prolonged pregnancy which the authors defined as >41 weeks, did not change

between 1998 and 2007.[9] Furthermore, there is evidence from the same study to suggest that the rise in IOL is not entirely explained by increases in the prevalence of hypertension and diabetes mellitus.[9] This pattern fits with longstanding evidence demonstrating that nonclinical factors are predictive of rising obstetric intervention rates.[11,12] Women's social class, education level and insurance status have all been reported as important influences.[13,14] Likewise, organisational factors at the hospital level play a role in rates of intervention, namely whether a hospital is high volume or not or whether childbirth occurs on a weekday or not.[11,12,15]

The role of organisational factors is noteworthy, especially considering variation in IOL rates between hospitals in defined geographical areas. Even in individual cities such as New York, rates of IOL between hospitals range from 10% to 39%.[16] At a broader level, wide variation has been reported between hospitals in both Canada and Europe.[17,18]

Variation between hospitals implies differences in organisation, access to resources, internal policies and adherence to evidence-based guidelines, all of which can impact on quality of care.[11,12,19] For instance, because IOL is often associated with an increased risk of caesarean section (CS), although evidence to the contrary does exist,[3] differing rates of IOL may lead to differing rates of CS. Furthermore, in medically unwarranted IOL, the risk of greater blood loss, a longer, more painful and less satisfactory birthing process with potentially higher hospital costs, outweighs the potential benefits of IOL.[20–22] That this risk differs across hospitals is a public health concern.

The purpose of this study was to determine if rates of IOL varied between maternity units in the Republic of Ireland. Rates of IOL may differ between hospitals due to differing risk profiles of the women attending each hospital, hence our analyses adjusted for individual level clinical, sociodemographic and organisational differences.

Methods

Data

The National Perinatal Reporting System (NPRS) is the main source of data on all births (≥500 g) in Ireland. Data on the woman's marital status, social class, country of birth, obstetric history, parity and data on birthweight and gestational age at birth were sourced from this national database. Unfortunately, clinical data on births in the NPRS are limited, for example, there are no data on whether a birth was induced or if a CS was elective or emergency.

However, these data are available in a second national data source. The Hospital Inpatient Enquiry (HIPE) scheme records data on all discharges from, and deaths, in the 19 publicly funded maternity units in Ireland. In addition to detailed clinical data (e.g. maternal diagnoses and procedures), information is routinely collected on maternal age, whether maternity care was publicly or privately funded and method of delivery. Clinical data on discharges in 2009 were recorded in HIPE using the 6th Edition of *The International Statistical Classification of Diseases and Related Health Problems*, Tenth Revision, Australian Modification (ICD-10-AM) and the *Australian Classification of Health Interventions* (ACHI). In total, up to 20 diagnosis (one principal and up to 19 additional) codes and, where applicable, 20 procedure (one principal and up to 19 additional) codes were recorded.

The sample comprised all women with singleton births (live and stillborn) discharged from the 19 publicly funded hospitals in 2009 for whom an NPRS and HIPE record were available; a total of 70 889 births. Homebirths ($n = 148$ for 2009) were not included. Our dataset therefore represented 96.3% of the total number of births nationally in that year.[23]

Definitions

All women in Ireland are entitled to free maternity services, but a proportion choose to supplement their care privately through a combination of health insurance and an 'out-of-pocket' payment. The difference between private care and public care is that women in the private system choose their consultant and remain under the medical supervision of that consultant during their antenatal care and during childbirth. Both privately and publicly funded births occur on the same wards in publicly funded hospitals. Bearing this in mind, a further difference between public and private care is that after the birth, a private room (if available) is supplied to those who opt for private care. In contrast, in the public system a woman may or may not see the same physician on each of her antenatal visits and after childbirth is moved to a public ward. In the three Dublin maternity hospitals, a third model of care referred to as 'semi-private' entitles the woman to a private bed after childbirth, but not necessarily consultant provided antenatal care. In our data, semi-private births were coded as private births.

Variables

The outcome variable in this study was IOL (ACHI block 1334—medical or surgical IOL). Sociodemographic variables included: maternal age; country of birth; marital status, categorised as married or not married; and social status derived from the NPRS socio-economic group variable which is coded using a system devised by the CSO.[24] These categories were further amended into broad ''social class'' groups for the purpose of this project. Clinical variables included: hypertension, diabetes mellitus, gestational diabetes mellitus and (pre)eclampsia. We included a categorical variable for birthweight rather than gestational age due to co-linearity. Prior stillbirth or miscarriage were also included. We included a binary variable for whether childbirth took place on a weekday or weekend, and an indicator for whether care was funded privately.

Statistical analysis

Multilevel regression models

We used multilevel logistic regression models to assess variation across hospitals for IOL. All models were adjusted for the clinical, sociodemographic and organisational factors outlined above. The multilevel models allowed the influence of individual level variables to be considered (level 1) in addition to exploring how the risk of induction varies across hospitals (level 2). We used a random intercept model to allow for the hospital effect, which was estimated by σ_u. This parameter indicated the variation that remained unexplained between hospitals after adjustment. The variance partition coefficient (VPC) communicates what portion of the total variance in the models was due to between hospital variation. Our models were stratified by parity; nulliparas, multiparas without prior CS and multiparas with prior CS.

Plots

We plotted unadjusted proportions of IOL per hospital using funnel plots with 95% confidence intervals to graphically display variation in IOL rates between hospitals.[25]

Subgroup analyses

Four hospitals had >8000 births in 2009, the remaining hospitals had between 1328 and 5129 births. To test effect modification by hospital volume we included interactions between variables of interest and an indicator for a hospital being a 'high volume' hospital (>8000 births). The underlying hypothesis for this analysis was that hospitals with a high number of births may have different resources and organisational practices to manage high demand.

To maintain consistency between models, the same interaction terms were used in all parity groups, despite being sometimes insignificant.

All analyses were carried out using STATA 13.1 for Windows.

Results

In 2009, there were 70 889 births in Ireland. For the purpose of these analyses one hospital (10) was excluded as there were previously identified issues with the coding accuracy of induction procedures in 2009 in that hospital. Thus, after exclusion of these records and homebirths, 69 304 births from 18 hospitals were available for analysis.

The overall crude rate of IOL was 25.0% (range 14.5–33.2%). In nulliparas the crude rate was 31.0% (range 18.6–45.7%). The rate was lower at 24.8% (range 13.5%—33.3%) in multiparas without prior CS and 3.8% (range 0–10.2%) in multiparas with prior CS (figure 1).

Descriptive results

High rates of IOL were seen where the foetus weighed more than 4000 g and in the presence of any clinical risk (Table 1). Women with private health insurance had higher rates of IOL than women whose care was funded publicly, although this was not true for multiparas with prior CS (Table 1). Emergency CS occurred at an approximate rate of 6.2% of all IOLs in multiparas without prior CS (vs. 7.6% for women in the same group who were not induced and did not have an elective CS). The rate was 29.0% in nulliparas (vs. 18.7% in nulliparas who were not induced and did not have an elective CS) and 42.5% in multiparas with prior CS (vs. 56.6% for women not induced and did not have an elective CS).

Multivariate results according to parity

In the multi-level models, marital status was not predictive of IOL and was excluded. Age and social class were not consistently predictive of IOL across the three parity strata, and thus are not shown in Table 2**,** although these factors did remain in the models. Both nulliparas and multiparas without prior CS born in countries other than Ireland all had lower odds of IOL than Irish women.

Birthweights larger than average (defined here as category 3000 g−3499 g) were associated with an increased odds of IOL for both nulliparas and multiparas without prior CS (Table 2). Previous stillbirth was strongly predictive of IOL in multiparas with prior CS (OR 2.51, 95% CI 2.11—2.99). It was not possible to estimate how stillbirth predicted IOL in women with prior CS due to low sample sizes.

All clinical risk factors were significantly predictive of IOL in nulliparas and multiparas without prior CS; restricted foetal growth was consistently the strongest predictor across both groups. In multiparas with prior CS, only restricted foetal growth remained significant amongst the clinical predictors (OR 3.46, 95% CI 1.59–7.52) (Table 2).

Accessing maternity care privately was associated with a slight increase in odds of IOL in nulliparas, and to a greater extent in multiparas without prior CS, while associated with a lower odds in multiparas with prior CS (OR 0.69, [95% CI 0.50–0.95]) (Table 2)**.**

The proportion of total variance explained by between hospital variation was 3% and 2% for nulliparas and multiparas without prior CS, respectively. For multiparas with a prior CS, 16% of the total variance was explained by differences between the 18 maternity units. The estimates of variance across the groups indicate significant unexplained variation between hospitals, which was greatest for women with a prior CS at 0.61 in comparison to 0.08 and 0.07 for nulliparas and multiparas without prior CS (Table 2).

Results for the whole population (not stratified by parity) are given in Supplementary Table S1.

Subgroup analyses

The odds of whether a woman with (pre)eclampsia or hypertension was induced or not differed according to hospital volume, and differed within parity groups across hospital volumes also. For example, multiparas without prior CS who gave birth in high volume hospitals and who had eclampsia were more likely to be induced than similar women in smaller hospitals (figure 2 and Supplementary Table S2). High volume hospitals also had a lower odds of IOL on a weekday in comparison to smaller hospitals, although this was not the case for multiparas with prior CS.

Discussion

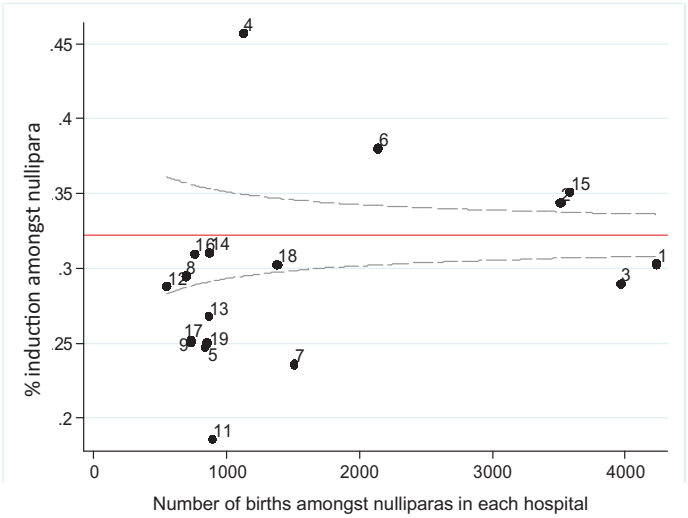
This cross sectional study of 69 304 births found variations in IOL rates between 18 maternity units. The odds of IOL was influenced by sociodemographic factors such as mothers' country of birth, previous history of miscarriage or stillbirth, antenatal pregnancy complications and birthweight, and by organisational factor; model of antenatal care. Even after adjusting for these factors, variation persisted suggesting that variation in IOL is influenced by factors other than natural case-mix across hospitals. Organisational factors such as hospital-specific policies and practices for IOL are probable contributory factors.

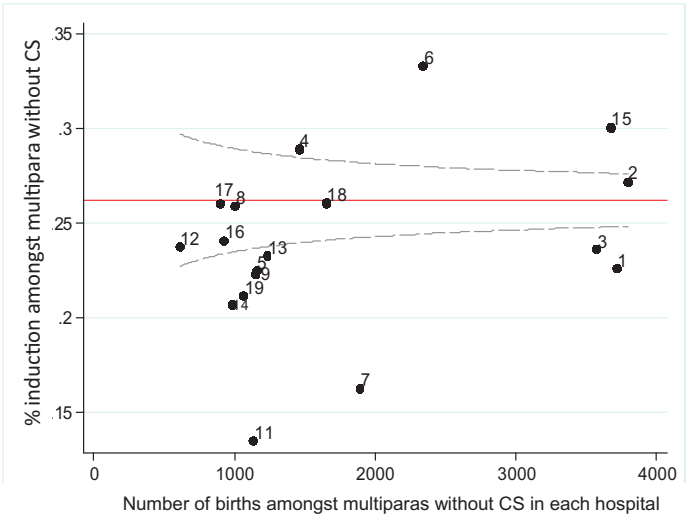
The largest amount of variation that existed between hospitals was for multiparas with prior CS. Indeed, 233 of 294 inductions in this parity subgroup were carried out in the four highest volume maternity units. The low rate of IOL in smaller units is suggestive of the reluctance of some hospitals to perform a trial of labour after caesarean (TOLAC), potentially due to concerns over the risk of uterine rupture associated with the procedure.[26] Looking ahead, the escalating rise of CS may lead to an overall decrease in IOL because of the preference to give birth by repeat CS rather than TOLAC.[27] This may further widen variation across hospitals.

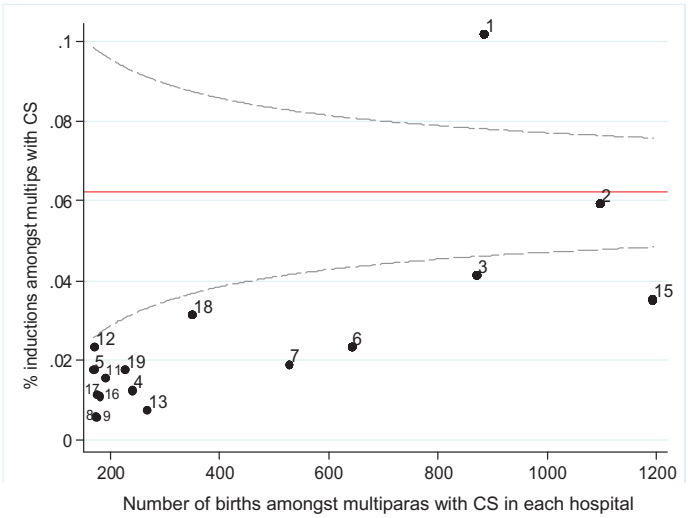
We found that nulliparas and multiparas without prior CS who accessed maternity care privately had an 8% and 41%, respectively, higher odds of IOL than women who accessed care publicly. Thus, the model of care is clearly important but more information is required on what influences clinical decision making in these different models. Women born in European, African or Asian countries all had a lower odds of IOL than Irish women, controlling for all other factors. The issue of maternal nativity and its association with obstetric intervention has been highlighted previously in Ireland and is thought to be related to obesity, which we could not adjust for in our study.[28] This finding is particularly relevant given that the marked decrease in immigrants from Eastern Europe in recent years may lead to a decrease in birth rate, but an overall increase in IOL.[29] Increasing diagnosis of gestational diabetes mellitus due to a new national policy on testing may lead to increased IOL rates based on our findings.[30] Despite the linear relationship between birth weight and odds of IOL, high birth weight is unlikely to lead to increased rates of IOL in the future due to the recent stabilisation of trends in high birth weight.[31] Consistent with a cross-sectional study on 5000 births in Scotland, our analyses showed no association between marital status and IOL, and only sporadic associations with social class.[32]

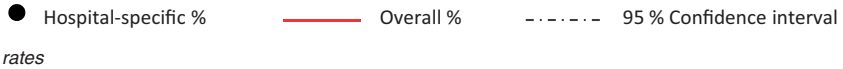
A higher odds of IOL during the week is suggestive of scheduling and/or an attempt to lighten the clinical load for sparsely staffed services at the weekend.[33] In our study, the odds of IOL on weekdays was lower in high volume hospitals than smaller volume hospitals, possibly reflecting less scheduling pressures in bigger hospitals due to different organisation of staff and resources at weekends.

We also found that the size of the hospital was an indicator for how some clinical situations are handled. Women in high risk scenarios (pre-eclampsia/eclampsia and hypertension in nulliparas and pre-eclampsia/eclampsia and foetal growth restriction in









Unadjusted rates
CS : caesarean section

Figure 1 Funnel plots demonstrating variation across hospitals for induction of labour rates. Unadjusted rates.

Table 1 Sociodemographic and clinical characteristics of nulliparas, multiparas without prior CS and multiparas with prior CS

	Nulliparas		Mulltiparas without prior CS		Multiparas with prior CS	
	Not induced (*n* = 20 205)	Induced (*n* = 9055)	Not induced (*n* = 24 283)	Induced (*n* = 8002)	Not Induced (*n* = 7458)	Induced (*n* = 294)
Age (years)						
<20	1431 (73.1)	527 (26.9)	150 (82.0)	33 (18.0)		
20–24	3898 (70.7)	1618 (29.3)	2018 (78.9)	541 (21.1)	357 (93.9)	23 (6.1)
25–29	6168 (70.5)	2580 (29.5)	5472 (76.8)	1654 (23.2)	150 (95.0)	60 (5.0)
30–34	6013 (67.0)	2956 (33.0)	8641 (75.5)	2804 (24.5)	2660 (96.3)	103 (3.7)
35–39	2311 (66.1)	1184 (33.9)	6748 (73.4)	2442 (26.6)	2628 (96.5)	96 (3.5)
≥40	384 (66.9)	190 (31.0)	1254 (70.4)	528 (29.6)	663 (98.2)	12 (1.8)
Social class						
Professional/managerial	5974 (67.3)	2904 (32.7)	5974 (72.5)	2268 (27.5)	2208 (96.0)	93 (4.0)
Clerical	5313 (68.5)	2449 (31.6)	5209 (74.7)	1767 (25.3)	1644 (96.6)	58 (3.4)
Skilled/semi-skilled	1290 (69.2)	573 (30.8)	1104 (77.5)	320 (22.5)	332 (97.1)	10 (2.9)
Unskilled	3122 (70.0)	1336 (30.0)	3093 (76.6)	946 (23.4)	826 (96.5)	30 (3.5)
Unemployed	726 (72.0)	282 (28.0)	679 (79.4)	176 (20.6)	155 (93.4)	—
Home duties	2434 (71.7)	962 (28.3)	7521 (76.6)	2303 (23.4)	2109 (96.1)	85 (3.9)
Other	1305 (71.0)	532 (29.0)	648 (75.7)	208 (24.3)	170 (96.0)	7 (4.0)
Funding						
Public	15 155 (70.4)	6369 (29.6)	18 271 (77.5)	5305 (22.5)	4335 (95.7)	195 (4.3)
Private	5050 (65.3)	2686 (34.7)	6012 (69.0)	2697 (31.0)	3123 (96.9)	9 (3.1)
Marital status						
Not married	10 385 (68.1)	4865 (31.9)	7543 (76.8)	2281 (23.2)	1606 (95.5)	76 (4.5)
Married	9820 (70.1)	4190 (29.9)	16 740 (74.5)	5721 (25.5)	5852 (96.4)	218 (3.6)
Country of mother's birth						
Ireland	13 978 (67.0)	6873 (33.0)	18 675 (73.6)	6716 (26.5)	6020 (95.6)	215 (3.5)
UK	499 (71.7)	177 (28.3)	705 (74.2)	245 (25.8)	168 (93.3)	12 (6.7)
EU-15 (ex Ireland and UK)	412 (75.9)	131 (24.1)	324 (85.7)	54 (14.3)	62 (91.2)	6 (8.8)
EU-15 to EU-27	3432 (74.3)	1187 (25.7)	1987 (83.0)	407 (17.0)	326 (96.5)	12 (3.6)
Africa	418 (76.3)	130 (23.7)	1135 (80.7)	272 (19.3)	418 (96.3)	16 (3.7)
Asia	987 (72.2)	380 (27.8)	950 (82.9)	1986 (17.1)	313 (92.9)	24 (7.1)
Other	490 (74.0)	172 (26.0)	471 (82.1)	103 (17.9)	141 (94.6)	8 (5.4)
Mode of birth						
Vaginal	9234 (72.8)	3457 (27.2)	19 577 (74.4)	6730 (25.6)	611 (84.9)	109 (15.1)
Forceps	1609 (66.0)	828 (34.0)	249 (69.4)	110 (30.6)	98 (86.7)	15 (13.3)
Vaccum	4221 (66.7)	2105 (33.3)	1401 (68.6)	642 (31.4)	205 (82.7)	43 (17.3)
Elective CS	1557 (100)	—	1234 (100.0)	—	5342 (100)	—
Emergency CS	3495 (57.1)	2624 (42.9)	1756 (77.9)	498 (22.1)	1197 (90.5)	125 (9.5)
Combined instrumental	72 (66.7)	36 (33.3)	10 (71.4)	—	—	—
Pregnancy loss						
Previous miscarriage	2878 (67.9)	1362 (32.1)	6685 (73.9)	2365 (26.1)	2228 (96.2)	89 (3.8)
Previous stillbirth	—	—	331 (56.3)	257 (43.7)	—	—
Gestational age at birth (weeks)						
<37	1324 (88.7)	169 (11.3)	1138 (86.8)	173 (13.2)	342 (98.0)	7 (2.0)
37–41	18 385 (69.8)	7954 (30.2)	22 710 (75.6)	7335 (24.4)	7014 (96.5)	252 (3.5)
≥42	496 (34.7)	932 (65.3)	435 (46.8)	494 (53.2)	102 (74.5)	35 (25.5)
Birthweight (g)						
500–2499	1103 (78.0)	312 (22.1)	843 (78.1)	236 (21.9)	245 (95.7)	11 (4.3)
2500–2999	2801 (72.8)	1049 (27.2)	2185 (76.5)	672 (23.5)	838 (96.4)	31 (3.6)
3000–3499	7677 (72.7)	2877 (27.3)	7671 (77.3)	2257 (22.7)	2429 (96.6)	86 (3.4)
3500–3999	6400 (66.1)	3278 (33.9)	9090 (75.5)	2944 (24.5)	2679 (96.2)	107 (3.8)
4000–4499	1919 (59.7)	1297 (40.3)	3771 (70.9)	1549 (29.1)	1022 (95.9)	44 (4.1)
4500+	304 (55.7)	242 (44.3)	723 (67.8)	344 (32.2)	245 (94.2)	15 (5.8)
Clinical risk factors						
Restricted foetal growth	288 (39.6)	439 (60.4)	165 (35.2)	304 (64.8)	86 (89.6)	10 (10.4)
Hypertensive disorder	569 (39.9)	857 (60.1)	356 (44.2)	449 (55.8)	221 (94.0)	14 (6.0)
Eclampsia or pre-eclampsia	463 (48.3)	495 (51.7)	170 (48.9)	178 (51.2)	—	—
Gestational diabetes mellitus	223 (50.2)	221 (49.8)	344 (54.4)	288 (45.6)	261 (95.6)	12 (4.4)
Diabetes mellitus (pre-existing)	49 (55.1)	40 (44.9)	38 (44.7)	47 (55.3)	—	—

EU-15: Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, United Kingdom, Austria, Finland and Sweden. EU-27: EU-15 plus Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia, Bulgaria and Romania.

– indicates cell sizes <5; the data agreement between the Economic and Social Research Institute and the data providers for this study requires that these values not be published. In multiparas with prior CS the <20 years and 20–24 years groups were combined due to small numbers.

multiparas without prior CS) who gave birth in high volume hospitals had a higher odds of IOL than similar clinical cases in smaller volume hospitals. Bigger hospitals likely have more specialist resources and are better equipped to deal with challenging clinical cases than smaller hospitals, which may opt for CS rather than IOL. *In utero* transfers of serious clinical cases from smaller hospitals to bigger hospitals may also contribute to the higher odds. Worth noting is that our cut-off for large-volume hospitals was >8000 births per annum which is comparatively higher than volumes in individual units internationally.[34]

Table 2 Results from multilevel models stratified for nulliparas, multiparas without prior CS and multiparas with prior CS

	Nulliparas			Multiparas without prior CS			Multiparas with prior CS		
	Induced *n* = 9055 Not induced *n* = 20 205			Induced *n* = 8002 Not induced *n* = 24 283			Induced *n* = 294 Not induced *n* = 7458		
	OR	95% CI	*P*	OR	95% CI	*P*	OR	95% CI	*P*
Country of mother's birth (ref = Ireland)									
UK	0.86	0.71–1.03	0.097	1.04	0.89–1.21	0.660	2.12	1.14–3.95	0.018
EU-15 (ex Ireland and UK)	0.62	0.5–0.76	*P*<0.0001	0.48	0.36–0.65	*P*<0.0001	2.12	0.89–5.05	0.092
EU-15 to EU-27	0.71	0.65–0.77	*P*<0.0001	0.63	0.56–0.71	*P*<0.0001	0.72	0.39–1.34	0.305
Africa	0.72	0.58–0.89	0.002	0.69	0.59–0.8	*P*<0.0001	0.73	0.42–1.26	0.254
Asia	0.86	0.75–0.98	0.021	0.62	0.52–0.73	*P*<0.0001	1.25	0.77–2.01	0.363
Other	0.71	0.59–0.85	*P*<0.001	0.65	0.52–0.81	*P*<0.001	1.15	0.55–2.42	0.712
Birthweight (ref = 3000–3499 g)									
500–2499	0.28	0.24–0.33	*P*<0.0001	0.47	0.39–0.57	*P*<0.0001	0.71	0.34–1.47	0.356
2500–2999	0.86	0.79–0.94	0.001	0.92	0.83–1.02	0.120	0.92	0.59–1.42	0.699
3500–3999	1.43	1.35–1.53	*P*<0.0001	1.14	1.07–1.22	*P*<0.0001	1.22	0.91–1.64	0.187
4000–4499	1.91	1.75–2.08	*P*<0.0001	1.45	1.34–1.57	*P*<0.0001	1.33	0.91–1.95	0.136
4500+	2.22	1.85–2.65	*P*<0.0001	1.70	1.48–1.96	*P*<0.0001	1.80	1.01–3.21	0.048
Previous miscarriage (ref= no previous miscarriage)	1.03	0.96–1.11	0.421	1.06	1.00–1.12	0.055	1.04	0.80–1.35	0.775
Previous stillbirth (ref= no previous stillbirth)	0	0	0	2.51	2.11–2.99	*P*<0.0001	0	0	0
Clinical risk factors									
Restricted foetal growth	6.94	5.78–8.34	*P*<0.0001	8.07	6.5–10.02	*P*<0.0001	3.46	1.59–7.52	0.002
Hypertensive disorder	4.10	3.65–4.6	*P*<0.0001	4.24	3.65–4.92	*P*<0.0001	1.58	0.89–2.81	0.119
Eclampsia or pre-eclampsia	3.35	2.91–3.85	*P*<0.0001	3.68	2.93–4.61	*P*<0.0001	0	0	0
Gestational diabetes mellitus	2.20	1.81–2.69	*P*<0.0001	2.74	2.31–3.25	*P*<0.0001	0.95	0.52–1.76	0.881
Diabetes mellitus (pre-existing)	1.78	1.14–2.78	0.012	3.62	2.31–5.69	*P*<0.0001	0	0	0
Weekday (ref = weekend)	1.16	1.09–1.24	*P*<0.0001	1.56	1.46–1.67	*P*<0.0001	0.68	0.49–0.96	0.027
Private (ref = public)	1.08	1.01–1.16	0.025	1.41	1.32–1.51	*P*<0.0001	0.64	0.47–0.86	0.003
Variance estimates (95% CI)	0.08 (0.04–0.17)			0.07 (0.04–0.14)			0.61 (0.20–1.51)		
Variance partition coefficient	2%			2%			16%		

Models adjusted for: age, social status, mother's country of birth, private status, birthweight, obstetric history, all clinical variables and weekday. Cell values missing where there were too few cases. EU-15: Belgium, Denmark, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, United Kingdom, Austria, Finland and Sweden. EU-27: EU-15 plus Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia, Bulgaria and Romania.
''0'' values reported where numbers were too low to run analysis.

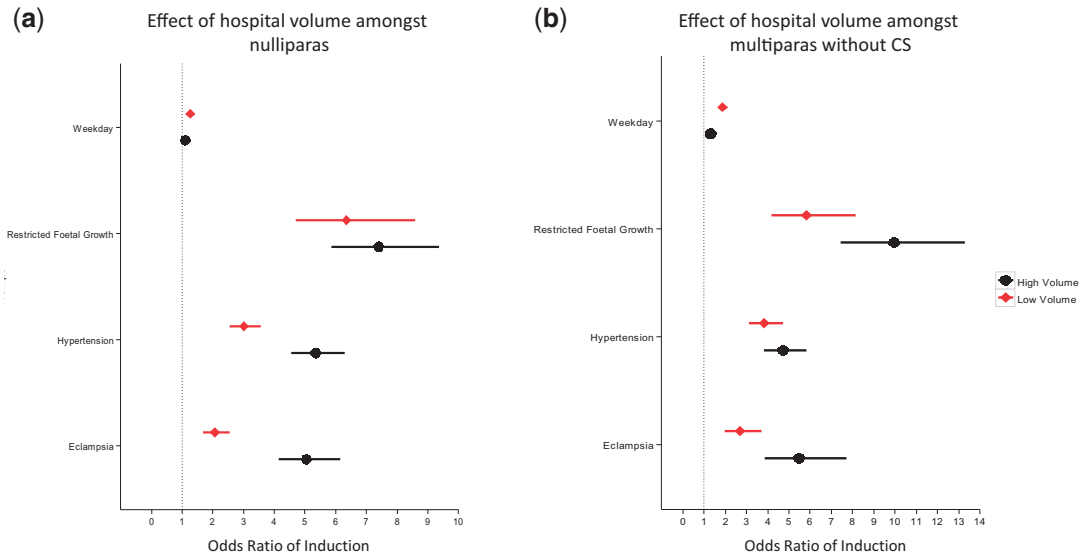


Figure 2 Effect modification by hospital volume for nulliparas and multiparas without prior CS. Interactions not plotted for multiparas with prior CS because no interaction was significant.

Our study was limited by the use of an administrative hospital data collection system, in which IOL can be underreported.[35] Furthermore, although HIPE data are inputted by trained and experienced coders, and the quality is generally accepted to be high, underreporting of prior CS in some hospitals has been identified. The resulting misclassification means that effect estimates in multiparas with prior CS may be biased towards the null. It is more difficult to assess the direction of bias in multiparas without prior CS. Individual level data on body mass index were not available in NPRS or HIPE, nor was smoking status or information

on assisted conception, all of which may have been confounding variables.[14,36] We did not know how long women born in countries outside Ireland were living in Ireland. The information on model of care does not distinguish between private care and semi-private care; the latter being unique to the three Dublin hospitals. Last, we did not have clinical information on the favourability of the cervix, which is a key determinant in the decision to induce.

Nonetheless, our study is strengthened by almost complete coverage of all births in Ireland with complementary information on clinical and sociodemographic factors obtained from two large national datasets. While the model of obstetric care in Ireland is quite distinct to that used in other health systems, our control for private/public access enhances the generalisability of our findings.

Conclusion

In nulliparas and multiparas without prior CS we found significant, albeit, small variation between Irish maternity units for IOL. In contrast, a larger amount of variation between hospitals existed for women who had a prior CS highlighting the importance for standardisation of care in this particular group.

The optimum IOL rate is not known and some of the factors influencing variation that we have identified are mainly outside the control of the maternity services, for example immigration rates and pregnancy complications. We suggest that some variation remains between hospitals due to differences in organisational culture and hospital level policies. Such factors contribute to the day to day practices within a hospital, but are challenging to measure and thus difficult to control for in epidemiological models. Information on such variables would help to augment our understanding of the significant variation between hospitals.

The variation in IOL rates is a concern. Further, IOL in certain circumstances, for example nulliparas with an unfavourable cervix, may lead to further interventions such as CS. We recommend, therefore, that clinical guidelines are developed which minimise variations in IOL rates in cases where is not a good clinical indication and the IOL is unlikely to be successful.

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Conflict of Interest: None declared.

Supplementary data

Supplementary data are available at *EURPUB* online.

Key points

- The rate of induction of labour (IOL) is increasing worldwide.
- Social and demographic factors may be explanatory factors. Organisational factors at the hospital level may also provide some clarity, especially considering evidence around varying rates of IOL across hospitals in individual cities and countries.
- This study used national level data and multilevel modelling to quantify the amount of between hospital variation, adjusting for multiple sociodeographic, clinical and organisational variables.
- Our results indicate that although case-mix explains some of the variation in IOL across hospitals, some variation persists.
- Our findings imply that the uniform adoption of a national policy would be a strategic move to improve standardisation of care for IOL, especially in multiparas with prior CS.

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Geographic and socioeconomic differences in access to revascularization following acute myocardial infarction

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Background: Geographic and socioeconomic barriers may hinder fair access to healthcare. This study assesses geographic and socioeconomic disparities in access to reperfusion procedures in acute myocardial infarction (AMI) patients residing in Piedmont (Italy). **Methods**: Coronary Care Units (CCUs) were geocoded with a geographic information system (GIS) and the shortest drive time from CCUs to patients' residence was computed and categorized as 0 to <20, 20 to <40 and ≥40 min. Using data on AMI emergency hospitalizations in 2004–2012, we employed a log-binomial regression model to evaluate the relation between drive time and use of Percutaneous Transluminal Coronary Angioplasty (PTCA) occurring within 2 days after a hospitalization for an episode of AMI, and whether this relation varied depending on the period of hospitalization. **Results**: A total of 29% of all cases with a diagnosis of AMI (n = 66 097), were revascularized within 2 days from the index admission. The further AMI patients lived from CCUs, the less likely they were to receive revascularization: compared with distance <20 min, RRs were respectively 0.84 [95% CI 0.80–0.88] and 0.78 [95% CI 0.71–0.86]. Findings also showed that less educated people had a lower relative risk of being revascularized compared to more educated people (RR = 0.78; 95% CI = 0.74–0.82). Both inequalities have reduced in recent years. **Conclusion**: This study provides evidence of reduced geographical and socioeconomic differences in revascularization use over time. Geography and socioeconomic status should not determine the type of treatment received for life-threatening conditions such as AMI.

Introduction

Acute myocardial infarction (AMI) is a serious, acute disease for which the risk of adverse outcomes is strongly related to the time delay from the onset of symptoms to definitive treatment.[1–3] Presently, in Italy 28% of heart attack victims die within the first hour and 40% within four hours from the onset of symptoms.[4] Having ready access to hospitals providing a full range of cardiovascular services might prevent adverse outcomes.[5–7] AMI can be differentiated, according to its electrocardiographic presentation,