

## Value of routine ultrasound examination at 35–37 weeks' gestation in diagnosis of non-cephalic presentation

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**CONTRIBUTION****What are the novel findings of this work?**

The study reports the incidence of non-cephalic presentation at a routine ultrasound examination at 35<sup>+0</sup> - 36<sup>+6</sup> weeks' gestation and subsequent management of such pregnancies.

**What are the clinical implications of this work?**

Routine ultrasound examination at 35<sup>+0</sup> - 36<sup>+6</sup> weeks' gestation detects non-cephalic presentation in about 5% of pregnancies. Such diagnosis could potentially improve pregnancy outcome by preventing unexpected abnormal presentation in labor and through ECV reducing the incidence of non-cephalic presentation.

**ABSTRACT**

Background: Undiagnosed non-cephalic presentation in labor carries increased risks for both the mother and baby. Routine pregnancy care based on maternal abdominal palpation fails to detect the majority of non-cephalic presentations.

Objective: To report the incidence of non-cephalic presentation at a routine scan at 35<sup>+0</sup> - 36<sup>+6</sup> weeks' gestation and subsequent management of such pregnancies.

Methods: This was a retrospective analysis of prospectively collected data in 45,847 singleton pregnancies that had undergone routine ultrasound examination at 35<sup>+0</sup> - 36<sup>+6</sup> weeks' gestation. Patients with breech or transverse / oblique presentation were divided into two groups, first those that would have elective cesarean section for fetal or maternal indications other than the abnormal presentation, and second, those that would potentially require ECV. The latter group was reassessed in 1-2 weeks and if there was persistence of the abnormal presentation the parents were offered the options of ECV versus elective cesarean section at 38-40 weeks' gestation. Multivariable logistic regression analysis was carried out to determine which of the factors from maternal and pregnancy characteristics provided a significant contribution in the prediction of first, non-cephalic presentation at the 35<sup>+0</sup> - 36<sup>+6</sup> weeks scan, second, successful ECV from non-cephalic to cephalic presentation, and third, spontaneous rotation from non-cephalic to cephalic presentation.

Results: First, at 35<sup>+0</sup> - 36<sup>+6</sup> weeks the fetal presentation was cephalic in 43,416 (94.7%) pregnancies, breech in 1,987 (4.3%) and transverse or oblique in 444 (1.0%). Second, multivariable analysis demonstrated that the chance of non-cephalic presentation increased with increasing maternal age and weight, decreasing height, earlier gestational age at scan, and it was higher in the presence of placenta previa, oligohydramnios and polyhydramnios, in nulliparous than parous women and lower in women of South Asian and mixed racial origin than in White women. Third, 22% of cases of non-cephalic presentation were not eligible for ECV because of planned cesarean section for indications other than the malpresentation. Fourth, of those eligible for ECV only 48.5% (646/1,332) accepted the procedure and this was successful in 39.0% (252/646) of cases. Fifth, the chance of successful ECV increased with increasing maternal age and was lower in nulliparous than parous women. Sixth, in 33.9% (738/2,179) of pregnancies with non-cephalic presentation where successful ECV was not carried out there was a subsequent spontaneous rotation to cephalic presentation. Seventh, the chance of spontaneous rotation from non-cephalic to cephalic presentation increased with increasing interval between the scan and delivery and

decreased with increasing birth weight, it was higher in women of Black than White racial origin, if the presentation was transverse or oblique than breech and if there was polyhydramnios and lower in nulliparous than parous women and in the presence of placenta previa. Eighth, in 109 (0.3%) of cephalic presentations there was subsequent rotation to non-cephalic presentation and in 41% of these the diagnosis was made during labor. Ninth, in the total of 2,431 cases of non-cephalic presentation at the time of the scan the presentation at birth was cephalic in 985 (40.5%); in 738 (74.9%) this was due to spontaneous rotation and in 247 (25.1%) due to successful ECV. Tenth, prediction of non-cephalic presentation at the 35<sup>+0</sup> - 36<sup>+6</sup> weeks scan and successful ECV from maternal and pregnancy factors was poor, but prediction of spontaneous rotation from non-cephalic to cephalic presentation was moderately good and this could be incorporated in the counselling of women prior to undertaking ECV.

Conclusions: The problem of unexpected non-cephalic presentation in labor can to a great extent be overcome by a routine ultrasound examination at 35<sup>+0</sup> - 36<sup>+6</sup> weeks' gestation. The incidence of non-cephalic presentation at the 35<sup>+0</sup> - 36<sup>+6</sup> weeks scan was about 5%, but, in about 40% of these cases the presentation at birth was cephalic, mainly due to subsequent spontaneous rotation and to a lesser extent as a consequence of successful ECV.

## INTRODUCTION

Routine ultrasound examination at 35<sup>+0</sup> - 36<sup>+6</sup> weeks' gestation is beneficial for the diagnosis of previously undetected fetal abnormalities,<sup>1</sup> prediction of preeclampsia,<sup>2-4</sup> prediction of small and large for gestational age neonates,<sup>5-12</sup> and assessment of fetal oxygenation.<sup>13</sup>

Another potential benefit of a routine scan at 35<sup>+0</sup> - 36<sup>+6</sup> weeks' gestation is the diagnosis of non-cephalic presentation. Undiagnosed non-cephalic presentation in labor is associated with increased risks for both the mother and baby.<sup>14</sup> A major trial reported that in breech vaginal delivery there is a higher perinatal mortality and morbidity than with breech elective cesarean section.<sup>15</sup> After publication of this trial there was a shift toward elective cesarean section when breech presentation was detected at term from about 50% to more than 90%.<sup>16,17</sup> However, such rise in cesarean section is associated with increased risks of short and long term maternal and fetal complications.<sup>18-21</sup> Consequently, the Royal College of Obstetricians and Gynaecologists and the American College of Obstetricians and Gynecologists recommend that an external cephalic version (ECV) should be offered to all eligible woman diagnosed with breech presentation at term in order to reduce non-cephalic presentation at delivery and the rate of cesarean section.<sup>22-24</sup> However, a high proportion of breech presentations at term are not detected by routine abdominal palpation and therefore the rate of potentially undiagnosed breech presentation in labor is relatively high.<sup>25-27</sup>

The objectives of this study are to report the incidence of non-cephalic presentation at a routine scan at 35<sup>+0</sup> - 36<sup>+6</sup> weeks' gestation and subsequent management of such pregnancies.

## METHODS

This was a retrospective analysis of prospectively collected data in 45,847 singleton pregnancies that had undergone routine ultrasound examination at 35<sup>+0</sup> - 36<sup>+6</sup> weeks' gestation at King's College Hospital, London or Medway Maritime Hospital, Gillingham, UK between March 2014 and September 2018. During this visit we recorded maternal demographic characteristics and medical history and carried out an ultrasound examination, which included, fetal anatomy, fetal biometry for calculation of EFW using the formula by Hadlock *et al.*,<sup>28</sup> fetal presentation (cephalic, breech and transverse or oblique), placental position, measurement of deepest vertical pool of amniotic fluid and fetal Doppler. Gestational age was determined by the measurement of fetal crown-rump length at 11-14 weeks or the fetal head circumference at 19-24 weeks.<sup>29,30</sup> The ultrasound examinations were carried out by examiners who had obtained the Fetal Medicine Foundation certificate of competence in ultrasound examination for fetal abnormalities. The women gave written informed consent to participate in the study, which was approved by the NHS Research Ethics Committee. The inclusion criteria for this study were singleton pregnancies delivering a non-malformed live birth or stillbirth. We excluded pregnancies with aneuploidies and major fetal abnormalities.

Patients with breech or transverse / oblique presentation were divided into two groups, first those that would have elective cesarean section for fetal or maternal indications other than the abnormal presentation, and second, those that would potentially require ECV. The latter group was reassessed in 1-2 weeks and if there was persistence of the abnormal presentation the parents were offered the options of ECV versus elective cesarean section at 38-40 weeks' gestation. ECV was carried out by obstetricians or trained midwives at 37-38 weeks' gestation under ultrasound guidance and after the administration of terbutaline (0.25 mg subcutaneously).

Data on pregnancy outcome were collected from the hospital maternity records and included gestational age at delivery, method of onset of labor and delivery, presentation at birth and birth weight. Birth weight percentile was derived from the Fetal Medicine Foundation fetal and neonatal population weight charts.<sup>31</sup>

### Statistical analysis

Data were expressed as median (interquartile range [IQR]) for continuous variables and n (%) for categorical variables. Mann-Whitney U-test and  $\chi^2$ -square test or Fisher's exact test,

were used for comparing outcome groups for continuous and categorical data, respectively. Significance was assumed at 5%.

Univariable and multivariable logistic regression analysis was carried out to determine which of the factors from maternal and pregnancy characteristics provided a significant contribution in the prediction of first, non-cephalic presentation at the 35<sup>+0</sup> - 36<sup>+6</sup> weeks scan, second, successful ECV from non-cephalic to cephalic presentation, and third, spontaneous rotation from non-cephalic to cephalic presentation. Prior to the regression analysis, the continuous variables, such as age, weight and height were centred by subtracting the arithmetic mean from each value. Multiple categorical variables were dummy coded as binary variables to estimate the independent effect of each category. Predicted probabilities from logistic regression analysis were used to construct receiver operating characteristic (ROC) curves to assess performance of screening for each of the three outcomes.

The statistical package SPSS 24.0 (IBM SPSS Statistics for Windows, Version 24.0, Armonk, NY: IBM Corp; 2016) was used for data analyses.

## RESULTS

### Patient characteristics

The study population of 45,847 singleton pregnancies included 43,416 (94.7%) in which the presentation was cephalic at the 35<sup>+0</sup> - 36<sup>+6</sup> weeks ultrasound examination, 1,987 (4.3%) with breech presentation and 444 (1.0%) with transverse or oblique presentation (Table 1). In the group with breech presentation, compared to those with cephalic presentation, the median maternal age was higher, there was a lower prevalence of women of Black, South Asian and mixed racial origin and those with an anterior or posterior placental location and a higher prevalence of nulliparous women, those conceived by *in vitro* fertilization and those with lateral or fundal placental location. In the group with transverse or oblique presentation, compared to those with cephalic presentation, the median maternal age and estimated fetal weight were higher and maternal height was lower, and there was a higher prevalence of parous women, women of Black racial origin, those with preexisting or gestational diabetes mellitus, placentae with a lateral, fundal or previa location and polyhydramnios.

### Findings at the 35<sup>+0</sup> - 36<sup>+6</sup> weeks scan and subsequent pregnancy management

In the 43,416 pregnancies with cephalic presentation at the 35<sup>+0</sup> - 36<sup>+6</sup> weeks scan (Table 2), 43,307 (99.7%) remained cephalic at birth. In 109 (0.3%) there was subsequent spontaneous rotation to a non-cephalic presentation, including 45 (41.3%) in which the diagnosis was made during labor and 64 (58.7%) in which the diagnosis was made before labor. In the latter group, ECV was attempted in 9 (14.1%), ECV was declined in 35 (54.7%) and no ECV was attempted because of planned cesarean section for reasons other than the malpresentation in 20 (31%).

In the 1,987 pregnancies with breech presentation at the 35<sup>+0</sup> - 36<sup>+6</sup> weeks scan (Table 2), ultrasound examination 1-2 weeks later demonstrated spontaneous rotation to cephalic presentation in 327 (16.5%). In 620 (31.2%) cases ECV was attempted and this was successful in 239 (31.2%). In 611 (30.7%) cases ECV was declined, but in 113 (18.5%) of these there was subsequent spontaneous rotation to cephalic presentation. In 50 (2.5%) cases there was spontaneous onset of labor before planned ECV. In 379 (19.1%) cases no ECV was attempted because of planned cesarean section for reasons other than the malpresentation and in 31 (8.2%) of these there was subsequent spontaneous rotation to cephalic presentation.

In the 444 pregnancies with transverse or oblique presentation at the 35<sup>+0</sup> - 36<sup>+6</sup> weeks scan (Table 2), ultrasound examination 1-2 weeks later demonstrated spontaneous rotation to cephalic presentation in 180 (40.5%). In 26 (5.9%) cases ECV was attempted and this was successful in 13 (50%). In 75 (16.9%) cases ECV was declined, but in 48 (64.0%) of these there was subsequent spontaneous rotation to cephalic presentation. In 5 (1.1%) cases there was spontaneous onset of labor before planned ECV. In 158 (35.6%) cases no ECV was attempted because of planned cesarean section for reasons other than the malpresentation and in 41 (25.9%) of these there was subsequent spontaneous rotation to cephalic presentation.

Therefore, in our population first, the incidence of non-cephalic presentation at 35<sup>+0</sup> - 36<sup>+6</sup> weeks' gestation was 5.3% (2,431/45,847), second, 22.1% of cases of non-cephalic presentation (379 breech and 158 transverse / 2,431) were not eligible for ECV because of planned cesarean section for indications other than the malpresentation, third, of those eligible for ECV (1,231 breech and 101 transverse) only 48.5% (646/1,332) accepted the procedure and this was successful in 39.0% (252/646) of cases, fourth, in 33.9% (738/2,179) of pregnancies with non-cephalic presentation where successful ECV was not carried out there was a subsequent spontaneous rotation to cephalic presentation.

In the total of 2,431 cases of non-cephalic presentation at the time of the scan (1,987 breech plus 444 transverse or oblique) the presentation at birth was cephalic in 985 (40.5%); in 738 (74.9%) this was due to spontaneous rotation and in 247 (25.1%) due to successful ECV.

### **Prediction of non-cephalic presentation at 35<sup>+0</sup> - 36<sup>+6</sup> weeks' gestation**

In the total population 45,847 pregnancies logistic regression analysis was carried out to determine which of the factors from maternal and pregnancy characteristics provided a significant contribution in the prediction of non-cephalic presentation at the 35<sup>+0</sup> - 36<sup>+6</sup> weeks scan. The following variables were examined: maternal age, weight, height, racial origin (White, Black, South Asian, East Asian, mixed), parity (nulliparous or parous), method of conception (natural, *in vitro* fertilization, use of ovulation induction drugs), diabetes mellitus (gestational, preexisting or none), gestational age at the scan, EFW percentile, placental position (previa or non-previa) and amniotic fluid deepest pool.

In the multivariable analysis significant prediction of non-cephalic presentation was provided by maternal age, weight, height, South Asian and mixed racial origin, gestational age at scan, placenta previa and amniotic fluid deepest pool ( $R^2=0.022$ ;  $p<0.0001$ ) (Table 3). The

area under ROC curve for prediction of non-cephalic presentation from maternal and pregnancy factors was 0.601 (95%CI:0.590-0.613) with a detection rate of 18.4% for a false positive rate of 10% (Figure 1).

### **Successful ECV from non-cephalic to cephalic presentation**

In the 646 pregnancies with non-cephalic presentation where ECV was attempted logistic regression analysis was carried out to determine which of the factors from maternal and pregnancy characteristics provided a significant contribution in the prediction of successful ECV. The following variables were examined: age, weight, height, racial origin, parity, method of conception, diabetes mellitus, non-cephalic presentation (breech or transverse/oblique), EFW percentile, placental position (anterior, posterior, lateral or fundal) and amniotic fluid deepest pool.

In the multivariable analysis significant prediction of successful ECV was provided by maternal age and parity ( $R^2=0.087$ ;  $p<0.0001$ ) (Table 4). The area under ROC curve for prediction of successful ECV from maternal and pregnancy factors was 0.653 (95%CI:0.610-0.696) with a detection rate of 22.2% for a false positive rate of 10% (Figure 1).

### **Spontaneous rotation from non-cephalic to cephalic presentation**

In the 2,184 pregnancies with non-cephalic presentation at the 35<sup>+0</sup> - 36<sup>+6</sup> weeks scan where successful ECV was not carried out logistic regression analysis was carried out to determine which of the factors from maternal and pregnancy characteristics provided a significant contribution in the prediction of spontaneous rotation to cephalic presentation. The following variables were examined: age, weight, height, racial origin, parity, method of conception, diabetes mellitus, non-cephalic presentation (breech or transverse/oblique), placental position (previa or non-previa), amniotic fluid deepest pool, interval to delivery, EFW and birth weight percentile.

In the multivariable analysis significant prediction of spontaneous rotation to cephalic presentation was provided by Black racial origin, parity, transverse fetal lie, placental previa, polyhydramnios, interval from scan to delivery and birth weight percentile ( $R^2=0.481$ ;  $p<0.0001$ ) (Table 5). The area under ROC curve for prediction of spontaneous rotation to cephalic rotation from maternal and pregnancy factors was 0.852 (95%CI:0.834-0.870) with a detection rate of 62.4% for a false positive rate of 10% (Figure 1).

## DISCUSSION

### Main findings

The main findings of the study are: first, at 35<sup>+0</sup> - 36<sup>+6</sup> weeks the fetal presentation was non-cephalic in about 5% of pregnancies; second, the chance of non-cephalic presentation increased with increasing maternal age and weight, decreasing height, earlier gestational age at scan, and it was higher in the presence of placenta previa, oligohydramnios and polyhydramnios, in nulliparous than parous women and lower in women of South Asian and mixed racial origin than in White women; third, about 20% of cases of non-cephalic presentation were not eligible for ECV because of planned cesarean section for indications other than the malpresentation; fourth, in our hospitals only half of women with non-cephalic presentation agreed to ECV and when this was carried out it was successful in only 39% of cases; fifth, the chance of successful ECV increased with increasing maternal age and was lower in nulliparous than parous women; sixth, in one third of pregnancies with non-cephalic presentation where successful ECV was not carried out there was a subsequent spontaneous rotation to cephalic presentation; seventh, the chance of spontaneous rotation from non-cephalic to cephalic presentation increased with increasing interval between the scan and delivery and decreased with increasing birth weight, it was higher in women of Black than White racial origin, if the presentation was transverse or oblique than breech and if there was polyhydramnios and lower in nulliparous than parous women and in the presence of placenta previa; eighth, in 0.3% of cephalic presentations there was subsequent rotation to non-cephalic presentation and in 41% of these the diagnosis was made during labor; ninth, in 41% of cases of non-cephalic presentation at the time of the scan the presentation at birth was cephalic, mainly due to spontaneous rotation (75%) and to a lesser extent due to successful ECV (25%); and tenth, prediction of non-cephalic presentation at the 35<sup>+0</sup> - 36<sup>+6</sup> weeks scan and successful ECV from maternal and pregnancy factors was poor, but prediction of spontaneous rotation from non-cephalic to cephalic presentation was moderately good and this could be incorporated in the counselling of women prior to undertaking ECV.

### Comparison with findings from previous studies

A previous study of routine ultrasound examination at 36 weeks' gestation in 3,879 singleton pregnancies in nulliparous women reported that the incidence of breech presentation was 4.6%; in the group with breech, compared to those with cephalic presentation, there was a

higher maternal age, but no significant difference in BMI or birth weight percentile.<sup>31</sup> In our considerably larger study, which included both nulliparous and parous women, the incidence of non-cephalic presentation was similar, but in addition to increased maternal age significant contributors to such presentation were increased weight and decreased height and many other maternal and pregnancy characteristics.

In our study we did not record the findings from routine clinical examination before the ultrasound scan. Studies undertaken as part of a research protocol in which clinical examination was followed by an ultrasound scan reported that palpation correctly identified non-cephalic presentations in 57-70% of cases; however, the design of such studies is likely to have introduced positive bias in favor of clinical examination.<sup>25,26</sup> A more realistic estimate of accuracy of routine clinical examination in the detection of non-cephalic presentation is 44%, as reported in a study from Cambridge, UK.<sup>27</sup> Additionally, a study from Oxford, UK, reported that ultrasound examination confirmed non-cephalic presentation in only 41% of 7,775 pregnancies suspected of breech presentation during routine antenatal care.<sup>32</sup>

In our study only 49% of eligible women with non-cephalic presentation agreed to ECV and when this was carried out it was successful in only 39% of cases. Our patients were counselled and managed by their own obstetricians and midwives rather than in a dedicated clinic. In the Cambridge study the uptake of ECV among eligible women was 65% and this was successful in only 14% of cases.<sup>27</sup> In contrast, in the Oxford study, where all women with breech presentation were managed in a specialist clinic, the uptake of ECV among eligible women was 90% and this was successful in 49% of cases.<sup>32</sup> In relation to the timing of ECV, a Cochrane review of three trials reported that the success rate is higher if ECV is carried out at 34-35 weeks' gestation, rather than at 37-38 weeks, but at the expense of a higher rate of preterm birth.<sup>33</sup>

We found a high spontaneous rotation from non-cephalic presentation between the time of the 35<sup>+0</sup> - 36<sup>+6</sup> weeks scan and delivery. This is consistent with the results of a registry on 127,171 births which reported that the frequency of breech presentation for births at 35-36 weeks' gestation was 4.9% and this declined to 3.6% for births at 37-38 weeks, 2.6% at 39-40 weeks and 1.7% at >40 weeks.<sup>34</sup>

Our findings of maternal and pregnancy characteristics that predict non-cephalic presentation and successful ECV are consistent with those of previous studies.<sup>24,32,35</sup> In addition we report on the predictors of spontaneous rotation from non-cephalic to cephalic presentation.

## Implications for clinical practice

Routine ultrasound examination at 35<sup>+0</sup> - 36<sup>+6</sup> weeks' gestation detects non-cephalic presentation in about 5% of pregnancies. Such diagnosis could potentially improve pregnancy outcome by preventing unexpected abnormal presentation in labor and through ECV reducing the incidence of non-cephalic presentation. However, the study has highlighted that in a small number of cases of first, cephalic presentation at the time of the scan, second, those with spontaneous rotation from non-cephalic to cephalic presentation, and third, those with successful ECV, there was subsequent spontaneous rotation to non-cephalic presentation, at the rate of 0.3%, 1.2% and 2.1%, respectively. Consequently, the only strategy that would truly avoid unexpected non-cephalic presentation in labor is to perform a routine ultrasound examination in all women on admission to the labor ward.

In cases of breech presentation ECV, compared with no attempted ECV, reduces the incidence of non-cephalic presentation at birth and the rate of cesarean deliveries.<sup>36</sup> However, our study has highlighted that the main contributor to cephalic presentation at birth in cases of non-cephalic presentation at the 35<sup>+0</sup> - 36<sup>+6</sup> weeks scan is spontaneous rotation rather than ECV. It is possible that the contribution of ECV could be increased by women being seen in specialist clinics where the uptake and success of the procedure may be higher.

## Strengths and limitations of the study

The strengths of our study are examination of a large number of pregnancies undergoing a routine ultrasound examination at 35<sup>+0</sup> - 36<sup>+6</sup> weeks' gestation to determine presentation and description of the subsequent management of pregnancies with abnormal presentation.

This was not a randomized trial on the contribution of the 35<sup>+0</sup> - 36<sup>+6</sup> weeks scan in predicting presentation at birth. Other limitations include lack of reporting of presentation at routine clinical examination prior to the scan and absence of a standardized protocol for the management of pregnancies with non-cephalic presentation, which was left to the decision of the attending obstetricians and midwives. Consequently, the uptake of ECV and success of the procedure are not generalisable.

## Conclusions

The performance of abdominal palpation during routine antenatal care in the diagnosis of non-cephalic presentation at term is poor, resulting in a high proportion of such pregnancies being undiagnosed when they present in labor. This problem can, to a great extent, be overcome by a routine ultrasound examination at 35<sup>+0</sup> - 36<sup>+6</sup> weeks' gestation. The incidence of non-cephalic presentation at the 35<sup>+0</sup> - 36<sup>+6</sup> weeks scan was about 5%, but, in about 40% of these cases the presentation at birth was cephalic, mainly due to subsequent spontaneous rotation and to a lesser extent as a consequence of successful ECV.

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**Figure legend**

**Figure 1.** The area under ROC curve for prediction of non-cephalic presentation at the 35<sup>+0</sup> - 36<sup>+6</sup> weeks scan (blue), successful ECV (black) and spontaneous rotation from non-cephalic to cephalic presentation (red) from maternal and pregnancy factors.

**Table 1.** Maternal and pregnancy characteristics according to fetal presentation at 35<sup>+0</sup> - 36<sup>+6</sup> weeks' gestation.

Variable	Fetal presentation at 35 <sup>+0</sup> - 36 <sup>+6</sup> weeks' gestation		
	Cephalic (n=43,416)	Breech (n=1987)	Transverse (n=444)
Age (years), median (IQR)	31.5 (27.2-35.3)	32.8 (28.9-36.3)**	35.2 (30.4-35.3)**
Weight (Kg) , median (IQR)	79 (70-90)	79 (71-91)	82 (73-92)**
Height (cm) , median (IQR)	165 (160-169)	165 (161-169)	163 (159-168)**
Racial origin			
White, n (%)	32,307 (74.4)	1,602 (80.6)	249 (56.1)
Black, n (%)	6,811 (15.7)	244 (12.3)**	141 (31.8)**
South Asian, n (%)	2,089 (4.8)	68 (3.4)**	30 (6.8)
East Asian, n (%)	892 (2.1)	34 (1.7)	13 (2.9)
Mixed, n (%)	1,317 (3.0)	39 (2.0)**	11 (2.5)
Parity			
Nulliparous, n (%)	19,671 (45.3)	1,073 (54.0)**	109 (24.5)**
Parous, n (%)	23,745 (54.7)	914 (46.0)	335 (75.5)
Conception			
Natural, n (%)	41,972 (96.7)	1,876 (94.4)	425 (95.7)
<i>In vitro</i> fertilization, n (%)	1,207 (2.8)	95 (4.8)**	16 (3.6)
Ovulation drugs, n (%)	237 (0.5)	16 (0.8)	3 (0.7)
Diabetes mellitus			
Pre-existing, n (%)	447 (1.0)	23 (1.2)	10 (2.3)*
Gestational, n (%)	1,800 (4.1)	80 (4.0)	39 (8.8)**
GA (weeks) , median (IQR)	36.1 (35.9-36.4)	36.1 (35.9-36.4)	36.1 (35.9-36.4)
EFW (%), median (IQR)	52.7 (27.7-76.2)	53.0 (27.3-79.1)	68.7 (40.7-86.6)**
Placental position			
Anterior, n (%)	19,710 (45.4)	819 (41.2)**	196 (44.1)
Posterior, n (%)	18,698 (43.1)	783 (39.4)**	127 (28.6)**
Lateral, n (%)	2,984 (6.9)	187 (9.4)**	50 (11.3)**
Fundal, n (%)	1,839 (4.2)	185 (9.3)**	41 (9.2)**
Placenta previa, n (%)	185 (0.4)	13 (0.7)	30 (6.8)**
Amniotic fluid deepest pool			
<2 cm, n (%)	40 (0.1)	5 (0.3)	1 (0.2)
2-7 cm, n (%)	42,879 (98.8)	1,956 (98.4)	416 (93.7)
≥8 cm, n (%)	497 (1.1)	26 (1.3)	27 (6.1)**

GA= gestational age; EFW=estimated fetal weight

Bonferonni adjusted significance value: \*\* p<0.01; \* p<0.025

**Table 2.** Fetal presentation at 35<sup>+0</sup> - 36<sup>+6</sup> weeks' gestation and subsequent management.

<b>Total</b>	<b>45,847</b>	<b>Cesarean section</b>
<b>Presentation cephalic</b>	<b>43,416 (94.7%)</b>	
Remained cephalic at birth	43,307 (99.7%)	10,168 (23.5%)
Spontaneous rotation to breech / transverse	109 (0.3%)	109 (100%)
Diagnosis in labor	45 (41.3%)	
Diagnosis before labor	64 (58.7%)	
ECV attempted	9 (14.1%)	
Successful	-	
Failure	9 (100%)	
ECV declined	35 (54.7%)	
No ECV - planned CS for other indication	20 (31.2%)	
<b>Presentation breech</b>	<b>1,987 (4.3%)</b>	
Spontaneous rotation to cephalic	327 (16.5%)	
Remained cephalic	323 (98.8%)	72 (22.3%)
Spontaneous rotation to breech	4 (1.2%)	4 (100%)
ECV attempted	620 (31.2%)	
Successful	239 (38.5%)	
Remained cephalic	234 (97.9%)	60 (25.6%)
Spontaneous rotation to breech	5 (2.1%)	5 (100%)
Failure	381 (61.5%)	
Remained breech	379 (99.5%)	371 (97.9%)
Spontaneous rotation to cephalic	2 (0.5%)	-
ECV declined	611 (30.7%)	
Remained non-cephalic	498 (81.5%)	492 (86.1%)
Spontaneous rotation to cephalic	113 (18.5%)	38 (33.6%)
No ECV - went into labor before	50 (2.5%)	47 (94.0%)
No ECV - planned CS for other indication	379 (19.1%)	
Remained breech	348 (91.8%)	347 (99.7%)
Spontaneous rotation to cephalic	31 (8.2%)	31 (100%)
<b>Presentation transverse / oblique</b>	<b>444 (1.0%)</b>	
Spontaneous rotation to cephalic	180 (40.5%)	38 (21.1%)
ECV attempted	26 (5.9%)	
Successful	13 (50.0%)	5 (38.5%)
Failure	13 (50.0%)	13 (100%)
ECV declined	75 (16.9%)	
Remained non-cephalic	27 (36.0%)	27 (100%)
Spontaneous rotation to cephalic	48 (64.0%)	21 (43.8%)
No ECV - went into labor before	5 (1.1%)	5 (100%)
No ECV - planned CS for other indication	158 (35.6%)	158 (100%)
Remained non-cephalic	117 (74.1%)	
Spontaneous rotation to cephalic	41 (25.9%)	

ECV = external cephalic version

**Table 3.** Fitted regression model with maternal and pregnancy characteristics for the prediction of non-cephalic presentation at 35<sup>+0</sup> - 36<sup>+6</sup> weeks' gestation.

Characteristic	Univariable		Multivariable	
	OR (95% CI)	P value	OR (95% CI)	P value
Maternal age - 30 (years)	1.05 (1.04-1.06)	<0.001	1.06 (1.05-1.07)	<0.001
Maternal weight – 82 (Kg)	1.005 (1.002-1.007)	<0.001	1.006 (1.004-1.009)	<0.001
Maternal height – 165 (cm)	0.99 (0.99-1.00)	0.731	0.99 (0.98-0.99)	0.001
Racial origin				
White (reference)	1.00			
Black	0.99 (0.88-1.10)	0.815		
South Asian	0.82 (0.67-1.01)	0.059	0.79 (0.64-0.98)	0.028
East Asian	0.92 (0.68-1.24)	0.580		
Mixed	0.66 (0.50-0.88)	0.005	0.69 (0.52-0.91)	0.010
Nulliparous	1.14 (1.05-1.24)	0.001	1.32 (1.22-1.44)	<0.001
Conception				
Natural	1.00			
<i>In vitro</i> fertilization	1.68 (1.38-2.05)	<0.001		
Ovulation drugs	1.46 (0.92-2.34)	0.112		
Diabetes mellitus				
Pre-existing	1.32 (0.93-1.89)	0.123		
Gestational	1.19 (0.98-1.44)	0.073		
Gestational age (weeks)	0.86 (0.78-0.94)	0.001	0.84 (0.77-0.92)	<0.001
Estimated fetal weight (%)	1.003 (1.002-1.004)	<0.001		
Placental position				
Non-previa (Reference)	1.00			
Previas	4.21 (3.01-5.88)	<0.001	3.60 (2.56-5.04)	<0.001
Amniotic fluid deepest pool				
2-7 cm (Reference)	1.00			
<2 cm	2.71 (1.15-6.40)	0.023	2.65 (1.12-6.31)	0.027
≥8 cm	1.93 (1.45-2.57)	<0.001	1.72 (1.29-2.30)	<0.001

OR = odds ratio; CI = confidence interval

**Table 4.** Fitted regression model with maternal and pregnancy characteristics for the prediction of successful ECV from non-cephalic to cephalic presentation.

Characteristic	Univariable		Multivariable	
	OR (95% CI)	P value	OR (95% CI)	P value
Maternal age - 30 (years)	1.06 (1.02-1.09)	0.001	1.04 (1.01-1.07)	0.022
Maternal weight – 82 (Kg)	1.00 (0.99-1.01)	0.988		
Maternal height – 165 (cm)	1.00 (0.98-1.03)	0.807		
Racial origin				
White (reference)	1.00			
Black	1.66 (1.04-2.64)	0.034		
South Asian	1.70 (0.75-3.86)	0.206		
East Asian	0.85 (0.29-2.52)	0.769		
Mixed	0.94 (0.31-2.86)	0.92		
Nulliparous	0.36 (0.26-0.50)	<0.001	0.39 (0.28-0.54)	<0.001
Conception				
Natural (Reference)	1.00			
<i>In vitro</i> fertilization	1.09 (0.46-2.57)	0.852		
Ovulation drugs	1.05 (0.17-6.30)	0.961		
Diabetes mellitus				
Pre-existing	1.57 (0.39-6.35)	0.525		
Gestational	1.14 (0.55-2.36)	0.732		
Non-cephalic presentation				
Breech (Reference)	1.00			
Transverse/oblique	1.59 (0.73-3.50)	0.245		
Estimated fetal weight (%)	1.01 (1.00-1.01)	0.076		
Placental position				
Posterior (Reference)	1.00			
Anterior	0.95 (0.67-1.36)	0.790		
Lateral	0.73 (0.42-1.27)	0.261		
Fundal	1.28 (0.73-2.26)	0.392		
Amniotic fluid deepest pool				
2-7 cm (Reference)	1.00			
<2 cm	-	-		
≥8 cm	0.31 (0.04-2.67)	0.286		

OR = odds ratio; CI = confidence interval

**Table 5.** Fitted regression model with maternal and pregnancy characteristics for the prediction of spontaneous rotation from non-cephalic to cephalic presentation.

Characteristic	Univariable		Multivariable	
	OR (95% CI)	P value	OR (95% CI)	P value
Maternal age - 30 (years)	1.01 (1.00-1.03)	0.129		
Maternal weight – 82 (Kg)	1.007 (1.002-1.012)	0.011		
Maternal height – 165 (cm)	1.00 (0.99-1.01)	0.934		
Racial origin				
White (reference)	1.00			
Black	2.37 (1.88-3.00)	<0.001	1.69 (1.24-2.26)	0.001
South Asian	1.28 (0.81-2.01)	0.290		
East Asian	0.91 (0.46-1.78)	0.775		
Mixed	0.82 (0.42-1.61)	0.569		
Nulliparous	0.32 (0.27-0.39)	<0.001	0.35 (0.28-0.44)	<0.001
Conception				
Natural (reference)	1.00			
<i>In vitro</i> fertilization	0.71 (0.46-1.12)	0.143		
Ovulation drugs	1.71 (0.66-4.45)	0.272		
Diabetes mellitus				
Pre-existing	0.48 (0.20-1.18)	0.111		
Gestational	0.86 (0.57-1.31)	0.483		
Non-cephalic presentation				
Breech (reference)	1.00			
Transverse/oblique	4.49 (3.60-5.61)	<0.001	4.44 (3.32-5.94)	<0.001
Placental position				
Non-previa (reference)	1.00			
Previas	0.20 (0.07-0.55)	0.002	0.22 (0.07-0.66)	0.014
Amniotic fluid deepest pool				
2-7 cm (reference)	1.00			
<2 cm	0.39 (0.05-3.36)	0.393		
≥8 cm	1.56 (0.89-2.71)	0.119	2.11 (1.03-4.35)	0.042
Interval from scan to delivery (weeks)	2.95 (2.65-3.29)	<0.001	3.17 (2.81-3.57)	<0.001
Estimated fetal weight (%)	1.005 (1.002-1.008)	0.001		
Birth weight (%)	1.002 (0.999-1.005)	0.136	0.99 (0.98-0.99)	0.002

OR = odds ratio; CI = confidence interval

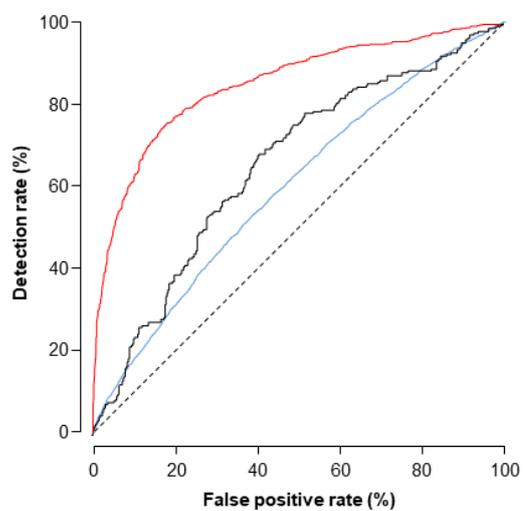


Figure 1