UNIVERSITY OF AMSTERDAM

UvA-DARE (Digital Academic Repository)

Improving perinatal outcome: towards individualized care

Kazemier, B.M.

Publication date
2015
Document Version
Final published version

Link to publication

Citation for published version (APA):
Kazemier, B. M. (2015). *Improving perinatal outcome: towards individualized care*. [Thesis, fully internal, Universiteit van Amsterdam].

General rights
It is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), other than for strictly personal, individual use, unless the work is under an open content license (like Creative Commons).

Disclaimer/Complaints regulations
If you believe that digital publication of certain material infringes any of your rights or (privacy) interests, please let the Library know, stating your reasons. In case of a legitimate complaint, the Library will make the material inaccessible and/or remove it from the website. Please Ask the Library: https://uba.uva.nl/en/contact, or a letter to: Library of the University of Amsterdam, Secretariat, P.O. Box 19185, 1000 GD Amsterdam, The Netherlands. You will be contacted as soon as possible.

UvA-DARE is a service provided by the library of the University of Amsterdam (https://dare.uva.nl)

Download date:17 Nov 2026

CHAPTER 11

Optimal timing of near-term delivery in different ethnicities: a national cohort study

B.M. Kazemier
A.C.J. Ravelli
C.J.M. de Groot
B.W.J. Mol

Published in British Journal of Obstetrics and Gynaecology, 2014

ABSTRACT

Objectives
To study possible ethnic disparities in perinatal mortality and morbidity independent of the occurrence of pregnancy complications. In addition, to study the probabilities of adverse neonatal outcome for delivery compared with 1 week of expectant management for each week of gestational age in the range of 36-42 weeks.

Design
National cohort study.

Setting
The Netherlands.

Population
All women who were recorded as being white European (982,318), Mediterranean (94,130) or African-Caribbean (25,253) descent with singleton cephalic births delivered between 36^{+0}-42^{+6} weeks of gestation. Women with hypertension, pre-eclampsia, or diabetes, or with fetuses that were small for gestational age (<10^{th} percentile) or with congenital anomalies were excluded. Data were obtained from the Netherlands Perinatal Registry (1999-2007).

Methods
Numbers of antepartum, intrapartum/neonatal death, and neonatal morbidity, were expressed using the fetus/neonate-at-risk approach. For each week of gestation, we compared the probability of adverse neonatal outcome (intrapartum/neonatal death in that week) for delivery with the probability of adverse neonatal outcome for expectant management (antepartum death in that week plus intrapartum/neonatal death and morbidity in the subsequent week).

Results
Women of Mediterranean and African-Caribbean descent who were near term were at increased risk of antepartum, intrapartum/neonatal death and neonatal morbidity compared to white European women. Expectant management from 40 weeks of gestation onwards was associated with an increased probability of adverse neonatal outcome in white European women and women of Mediterranean descent compared with delivery (RR1.45, 95%CI 1.25-1.68 and RR 1.69, 95%CI 1.11-2.60, and with number needed to deliver to prevent one adverse neonatal outcome being 563 and 364, respectively). This was not observed for women of African-Caribbean descent.

Conclusions
Ethnic disparities in perinatal outcomes were observed, with higher risks for women of Mediterranean descent. Expectant management in white European and Mediterranean women after 39 weeks is associated with an increased risk of adverse neonatal outcome.

INTRODUCTION

The impact of ethnicity on obstetric outcomes has gained a lot of attention in recent years. Previous studies have shown ethnic disparities in perinatal mortality[1], morbidity, mean duration of pregnancy[2-4] and even differences in maturation or development between ethnicities have been described[5-7]. In addition, it is known that certain ethnicities are at higher risk for pregnancy complications such as gestational diabetes[8;9], hypertensive disorders[10] and growth restriction[11]. Whether disparities in perinatal outcome, including mortality and morbidity, exist independent of pregnancy complications is not known.

There is evidence guiding the decision regarding the optimal for delivery for pregnancies complicated by diabetes or hypertension but there is no evidence to guide timing of delivery for women of specific ethnic origin who do not have pregnancy complications. Optimal timing of delivery depends on the balance between the risk of antepartum fetal death with continued pregnancy during the antepartum period compared to the risk to the neonate in the postpartum period [12]. Although other investigators have analysed these competing risks by week in the general population [13;14], a comparison between women of white European, Mediterranean and Africa-Caribbean descent, independent of pregnancy complications has not been performed before.

Our objective was to explore whether there are ethnic disparities in perinatal mortality and morbidity for women without pregnancy complications. In addition, we studied the competing risks of expectant management compared to delivery, in three low risk ethnic groups (women of white European, Mediterranean and African Caribbean descent), in order to assess the optimal timing of delivery.

METHODS

Database

Data were obtained from the Netherlands Perinatal Registry (PRN) between 1999 and 2007. [15] The PRN database is obtained by a validated linkage of three different registries: the midwifery registry (LVR1), the obstetrics registry (LVR2) and the neonatology registry (LNR) of hospital admissions of newborns[16;17]. The PRN registry contains population-based data on pregnancies, provided care (interventions, referrals, deliveries and (re) admission) of newborns of 96% of all deliveries in the Netherlands. Details on entry, linkage, aggregation, validation and verification of the data are published elsewhere.[16;17] Since the registry contains anonymous data, no ethical approval was required. The Netherlands Perinatal Registry gave approval for the use of data for the purpose of this study (approval number 11.86).

Inclusion and exclusion criteria

The study population comprised all singleton births delivered between 36^{+0} and 42^{+6} weeks of gestation. Although our interest was in disparities at full term, we included the 36th week in case the optimal timing of delivery for one of the ethnicities turned out to be in the early term period. In addition, information for 36 weeks of gestation was necessary to accurately estimate probabilities at 37 weeks. Gestational age was based

on ultrasound or last menstrual period. We excluded women with chronic or pregnancy induced hypertension, pre-eclampsia, diabetes and babies with congenital anomalies and growth restriction (defined as birth weight below the 10th percentile) because the timing of delivery could be influenced by such pregnancy complications. In addition, we excluded women with a pregnancy in non-cephalic presentation as breech position is associated with an increased risk of neonatal mortality and morbidity. To make a week-to-week comparison, enough births must be delivered each week per ethnicity in order to have enough events. As death is a rare event in the term period, (two neonatal deaths per 1000 births in the Netherlands[18]), we set our limit at at least 500 births per week. Only the three main ethnic groups in the Netherlands, i.e. white European, Mediterranean and African-Caribbean women had enough births for accurate estimates of our outcome measures, the other ethnicities such as South Asian women, had too few births per week and were therefore excluded.

Ethnicity

We categorized the resulting low risk cohort into three different subclasses based on race/ethnicity of the women (throughout the article referred to as ethnicity); white European, Mediterranean and African-Caribbean women. In the PRN database, the ethnicity of the women is registered on the basis of race, ethnic and geographical background. White European women are defined as born in the Netherlands or of West European origin. Mediterranean women consist of Turkish and North-African (mainly Moroccan) women. Most of the African-Caribbean women have their origins in the former Dutch colony Surinam, the Dutch Antilles and sub-Saharan Africa (Somalia/Ghana). The ethnicity of the women is classified by the care provider during gestation by assigning women to a predefined group [19].

The socio-economic status (SES) indicators were created on the basis of the four-digit postcode of the pregnant woman. The SES indicators included the data from The Netherlands Institute for Social Research (SCP) in three categories (10th, 10–90, and ≥90th percentile), and the mean household equivalent income for neighbourhoods as low and high (<40%, ≥40%)[18]

Outcome measures

We looked at four outcome measures: antepartum death; intrapartum/neonatal death; neonatal morbidity; and adverse neonatal outcome. Antepartum death was defined as all deaths occurring before the start of the delivery, while intrapartum/neonatal death was defined as death occurring during labour or in the first 28 days of life. We grouped intrapartum and neonatal death because most intrapartum deaths are caused by events during labour and delivery such as cord prolapse and asphyxia[20;21]. Since neonatal death is a rare event for babies born at term, we created a composite measure for 'adverse neonatal outcome' consisting of both intrapartum/neonatal death and serious neonatal morbidity.

Serious neonatal morbidity was a composite outcome which included any of the following; meconium aspiration, necrotizing enterocolitis, respiratory distress syndrome, birth trauma or intraventricular haemorrhage.

Statistical Analysis

We compared baseline characteristics among the three ethnic groups using the ANOVA test for continues values and Chi-square test for dichotomous variables. Tests were performed two-sided, and a *P*-value <0.05 was considered to indicate statistical significance. Gestational age-specific probabilities of births, antepartum deaths and intrapartum/neonatal deaths were estimated using the fetuses/neonates-at-risk approach[13;22;23]. A moving average (death on any specific day plus deaths on day before and after divided by three) was applied to correct for daily fluctuations (Figure 1).

In addition, we compared the probability of death in the case of delivery versus expectant management. We compared, for each week separately, the probability of death in the case of delivery versus expectant management for one week. The number needed to deliver to prevent one death was calculated by taking the reciprocal of the absolute risk difference between delivery and expectant management for one week. Data analyses were conducted with SAS (SAS institute Inc, Cary, NC, USA version 9.2).

A detailed description of the definitions and calculations of probabilities using the fetuses/neonates-at-risk-approach, and the comparison between delivery and expectant management can be found in appendix S1- Methodology.

RESULTS

From January 1st, 1999 until December 31st, 2007 a total of 1,491,534 singleton deliveries from 36^{+0} weeks onwards without congenital anomalies were identified in the PRN database. We excluded women with hypertensive complications or maternal diabetes (125,865) and non-cephalic presentation (77,223), small for gestational age (119,923) or ethnicities other than those specified to be included in this study (66,822). After application of the in- and exclusion criteria, 1,101,701 deliveries made up our study population: 982,318 white European women (89.2%), 94,130 Mediterranean women (8.5%) and 25,253 African-Caribbean women (2.3%).

The maternal and neonatal characteristics of the cohort per ethnic category are shown in table 1. More often, Mediterranean and African-Caribbean had low socio-economic status than white European women (63.8%, 65.4% and 18.3% respectively P<0.0001). Deliveries were induces in 26.6% of white European women, to 27.9% of the Mediterranean and 32.5% of the African-Caribbean women (P < 0.0001).

Table 2 presents the gestational age specific probabilities of antepartum death and intrapartum/neonatal death for the three different ethnic groups (probabilities per day are available upon request). There were 1,132 antepartum deaths in the white European women (1.2‰) which was significantly lower than the 156 deaths in the Mediterranean women (1.7‰) and 47 deaths in the African-Caribbean women (1.9 ‰) (P<0.0001). There were 1,002, 123 and 39 Intrapartum/neonatal deaths in the white European women (1.0‰), Mediterranean women (1.3‰) African-Caribbean women (1.6‰), respectively (P=0.012). Neonatal morbidity occurred in 4,053 of the white European women (4.1‰), 414 of the Mediterranean women (4.4‰) and 232 of the African-Caribbean women (9.2‰)

(P<0.0001). The number of women delivered at 36, 37, 38, 39 and 40 weeks of gestation was higher in the African-Caribbean women compared to white European women (P<0.0001 in all weeks). The composite morbidity probability was significantly higher in African-Caribbean women compared with white European women at 38, 39, 40, 41 and 42 weeks of gestation (P=0.007, <0.0001, <0.0001, <0.0001, and 0.009 respectively). The composite adverse neonatal outcome among African-Caribbean women was significantly higher compared with white European women at 37, 38, 39, 40, 41 and 42 weeks of gestation (P=0.01, 0.003, <0.0001, <0.0001, <0.0001, 0.006 respectively.

The probabilities are plotted in Figure 2. For each week of gestation the cumulative probability of antepartum death was highest in African-Caribbean women and lowest in white European women. The probability of intrapartum/neonatal death was also lowest in white European women and higher among Mediterranean and African-Caribbean women. The probability of neonatal morbidity was highest among African-Caribbean women.

Table 1 | Baseline characteristics of the women of different ethnic groups.

	white European (N=982,318)	**Mediterranean (N=94,130)**	**African-Caribbean (N=25,253)**	***p*-value***
Maternal characteristics				
Maternal age, mean (SD) (years)	30.7 (4.6)	28.2 (5,4)	27.8 (6.2)	<0.0001
Nulliparous, %	44.3	35.8	40.2	<0.0001
Low socio-economic status, %	18.3	63.8	65.4	<0.0001
Delivery characteristics				
Gestational age at delivery, weeks, median	40+1	40+1	39+6	<0.0001
Induction of labour, %	26.6	27.9	32.5	<0.0001
Caesarean section total, %	9.0	7.5	13.5	<0.0001
Elective Caesarean section, %	3.0	2.3	3.5	<0.0001
Emergency Caesarean section (fetal distress, non progression), %	6.0	5.2	10.0	<0.0001
Neonatal characteristics				
Male, %	51.3	51.0	51.2	0.225
Birth weight, mean (SD)	3615 (447)	3565 (431)	3463 (425)	<0.0001

*Differences in characteristics between all groups, not between each group separately.

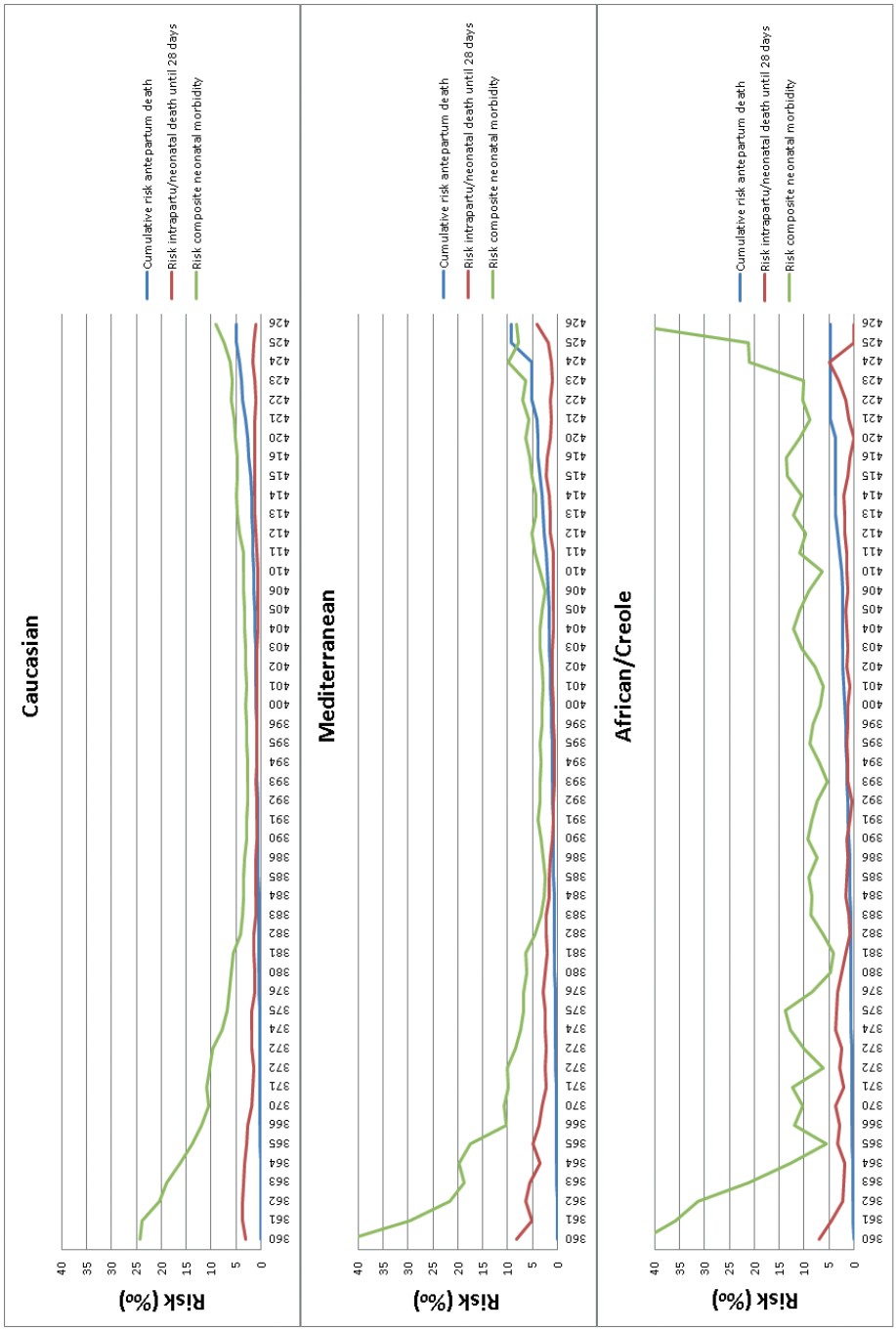

Figure 1 | Balance between antepartum death, intrapartum/neonatal death, and neonatal morbidity in white European, Mediterranean, and African-Caribbean women.

Table 2 | Gestational age specific risks of births, antenatal deaths and intrapartum/neonatal deaths for different ethnicities per week.

		Gestational age							
		36^0 - 36^6	**37^0 - 37^6**	**38^0 - 38^6**	**39^0 - 39^6**	**40^0 - 40^6**	**41^0 - 41^6**	**42^0 - 42^6**	**Total**
Total births, N	white European	20,346	48,627	126,087	233,024	298,971	199,325	55,938	982,318
	Mediterranean	1,819	4,678	12,341	22,880	27,838	18,394	6,180	94,130
	African-Caribbean	683	1,684	4,130	6,496	6,884	3,993	1,383	25,253
Total births, %	white European	2.07	4.95	12.84	23.72	30.44	20.29	5.69	100.00
	Mediterranean	1.93	4.97	13.11	24.31	29.57	19.54	6.57	100.00
	African-Caribbean	2.70	6.67	16.35	25.72	27.26	15.81	5.48	100.00
Total births, cumulative %	white European	2.07	7.02	19.86	43.58	74.02	94.31	100	N.A.
	Mediterranean	1.93	6.90	20.01	44.32	73.89	93.43	100	N.A.
	African-Caribbean	2.70	9.37	25.72	51.44	78.80	94.51	100	N.A.
Live births, N	white European	20,189	48,462	125,870	232,827	298,755	199,188	55,895	981,186
	Mediterranean	1,797	4,654	12,318	22,853	27,812	18,364	6,176	93,974
	African-Caribbean	673	1,679	4,125	6,482	6,878	3,987	1,382	25,206
Ongoing pregnancies, N	white European	982,318	961,972	913,345	787,258	554,234	255,263	55,938	N.A.
	Mediterranean	94,130	92,311	87,633	75,292	52,412	24,574	6,180	N.A.
	African-Caribbean	25,253	24,570	22,886	18,756	12,260	5,376	1,383	N.A.
Antepartum deaths, N	white European	157	165	217	197	216	137	43	1,132
	Mediterranean	22	24	23	27	26	30	4	156
	African-Caribbean	10	5	5	14	6	6	1	47
Probability antepartum death/1000	white European	0.16	0.17	0.24	0.25	0.39	0.54	0.77	1.15
	Mediterranean	0.23	0.26	0.26	0.36	0.50	1.22	0.65	1.66
	African-Caribbean	0.40	0.20	0.22	0.75	0.49	1.12	0.72	1.86

Table 2 | Continued

		Gestational age							
		36^0 - 36^6	**37^0 - 37^6**	**38^0 - 38^6**	**39^0 - 39^6**	**40^0 - 40^6**	**41^0 - 41^6**	**42^0 - 42^6**	**Total**
Cumulative probability antepartum death/1000	white European	0.16	0.33	0.57	0.82	1.21	1.75	2.51	N.A.
	Mediterranean	0.23	0.49	0.76	1.11	1.61	2.83	3.48	N.A.
	African-Caribbean	0.40	0.60	0.82	1.56	2.05	3.17	3.89	N.A.
Intrapartum/neonatal deaths, N	white European	66	82	146	199	227	212	70	1,002
	Mediterranean	8	13	24	16	25	28	9	123
	African-Caribbean	3	6	7	6	9	6	2	39
Probability intrapartum/ neonatal deaths/1000	white European	3.27	1.69	1.16	0.85	0.76	1.06	1.25	1.02
	Mediterranean	4.45	2.79	1.95	0.70	0.90	1.52	1.46	1.31
	African-Caribbean	4.46	3.57	1.70	0.93	1.31	1.50	1.45	1.55
Composite morbidity, N	white European	361	408	516	657	952	850	309	4,053
	Mediterranean	39	36	47	82	85	86	39	414
	African-Caribbean	12	21	29	51	59	44	16	232
Probability composite morbidity/1000	white European	17.94	8.43	4.10	2.82	3.19	4.27	5.54	4.13
	Mediterranean	21.80	7.76	3.82	3.59	3.06	4.69	6.32	4.41
	African-Caribbean	17.88	12.55	7.04	7.88	8.59	11.05	11.59	9.22
Adverse neonatal outcome, N	white European	427	490	662	856	1179	1062	379	5,055
	Mediterranean	47	49	71	98	110	114	48	537
	African-Caribbean	14	27	36	57	68	50	18	270
Probability adverse neonatal outcome/1000	white European	21,15	10,11	5,26	3,68	3,95	5,33	6,78	5,15
	Mediterranean	26,15	10,53	5,76	4,29	3,96	6,21	7,77	5.71
	African-Caribbean	20,80	16,08	8,73	8,79	9,89	12,54	13,02	10.71

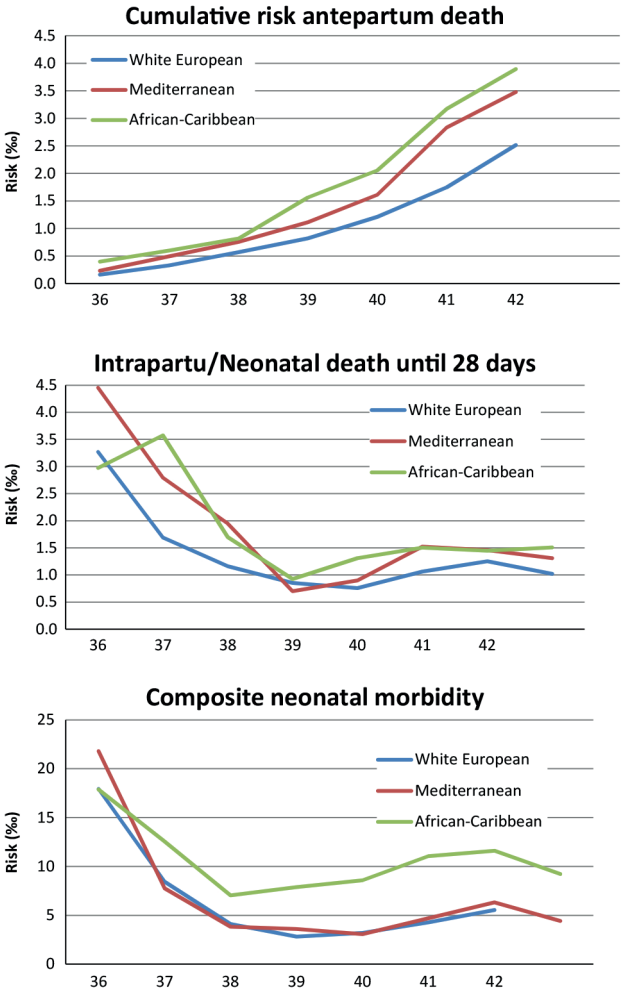

Figure 2 | risks per week of gestation for the three outcome measures among different ethnicities.

The relative risks of adverse neonatal outcome with expectant management for one week compared to delivery are expressed in table 3, as well as the numbers needed to delivery to prevent one additional case of adverse neonatal outcome (death or serious morbidity). For white European women the probabilities of adverse neonatal outcome with both delivery and expectant management are quite low. At 36 weeks, 37 weeks and 38 weeks, expectant management is associated with significantly less adverse neonatal outcome compared to delivery (3.91 vs 5.26 per 1000, RR 0.74 95%CI 0.64-0.87 at 38 weeks, table 3). From the 40th week onwards, expectant management is associated with a higher probability of adverse neonatal outcome compared to delivery (5.72 vs 3.95 per 1000, RR1.45 95%CI 1.25-1.68). The numbers needed to deliver to prevent one adverse neonatal outcome vary from 1,923 at 39 weeks to 504 at 41 weeks (table 3).

For Mediterranean women, expectant management was associated with fewer adverse neonatal outcomes at 36 and 37 weeks of gestation. At 38 and 39 weeks of gestation the confidence intervals overlap. At 40 weeks of gestation expectant management is associated with a significantly greater number of adverse neonatal outcomes (0.90 vs 2.02 per 1000, RR1.69 95%CI 1.11-2.60). The numbers needed to deliver to prevent one adverse neonatal outcome ranged from 39,287 at 39 weeks of gestation to 359 at 41 weeks of gestation.

For African-Caribbean women, all confidence levels included 1.0, indicating no statistically significant difference in outcome for expectant management versus delivery.. A non-significant trend was visible for expectant management at 36 and 37 weeks of gestation. From 38 weeks of gestation onwards the trend was towards lower risk of adverse neonatal outcome with delivery (9.01 vs 8.73 per 1000 RR1.03 95%CI 0.41-2.63 at 38 weeks of gestation). The numbers needed to deliver to prevent one adverse neonatal outcome range from 3,511 at 38 weeks of gestation to 318 at 40 weeks of gestation.

The probabilities of adverse neonatal outcome and death with delivery and expectant management with 95% confidence intervals are listed in supplementary tables S1 and S2), the relative risks and numbers needed to delivery when only looking at death as an outcome are listed in supplementary table S3. The probabilities of death with delivery versus expectant management and the probability of neonatal morbidity with delivery are visualized in figure 1.

Table 3 | Relative Risk with 95% Confidence Interval, and absolute risk of adverse neonatal outcome with expectant management compared to delivery for each week.

	white European				Mediterranean				African-Caribbean			
	Relative risk	**95%CI**	**Absolute risk difference**	**Number needed to deliver**	**Relative risk**	**95%CI**	**Absolute risk difference**	**Number needed to deliver**	**Relative risk**	**95%CI**	**Absolute risk difference**	**Number needed to deliver**
36	**0.49**	**0.40-0.58**	-10.88	x	**0.41**	**0.25-0.68**	-15.39	x	0.79	0.35-1.78	-4.33	x
37	**0.54**	**0.45-0.64**	-4.68	x	**0.57**	**0.35-0.93**	-4.50	x	0.56	0.21-1.44	-7.15	x
38	**0.74**	**0.64-0.87**	-1.35	x	0.79	0.49-1.26	-1.21	x	1.03	0.41-2.63	0.28	3,511
39	1.14	0.98-1.33	0.52	1923	1.01	0.66-1.54	0.03	39,287	1.21	0.67-2.17	1.84	544
40	**1.45**	**1.25-1.68**	1.77	563	**1.69**	**1.11-2.60**	2.75	364	1.32	0.57-3.04	3.14	318
41	**1.37**	**1.15-1.64**	1.99	504	1.45	0.97-2.16	2.79	359	1.13	0.48-2.63	1.60	625

DISCUSSION

Main findings

Mediterranean and African-Caribbean women at full term were at increased risk of antepartum, intrapartum/neonatal death and neonatal morbidity compared with white European women. Our data show that although there are ethnic disparities in the probabilities of death and morbidity, the optimal timing of delivery in white European women is 39 weeks of gestation and in women from Mediterranean' descent 38 and 39 weeks of gestation. For African-Caribbean women no statistically significant differences were found between both strategies but there was a trend towards better neonatal outcome with delivery from 38 weeks of gestation onwards.

Strength and limitations

The strength of this study is the size of the cohort (1,101,701 deliveries), including women over a long but recent period (1999-2007). Data are derived from a reliable and validated linked population-based database [16]. The database includes almost all deliveries in the country (96%) and is therefore a good reflection of our population.

Although there are interesting findings from this study, there are limitations. A common weakness in studies on race or ethnicity is the classification of groups; this is difficult and inconsistent between studies [24]. Our registry has used the same method of categorization for more than 15 years, with predefined groups assigned by caregivers. Whether this type of ethnicity registration is correct in current health care is debatable, as the number of babies born with multiple ethnicities has increased over time. In addition, grouping Turkish and Moroccan women as one ethnic group, is questionable, and it is possible that the studied outcomes could be different for each of these groups However, even with this rather rough subdivision by ethnic group, our study shows ethnic disparities in fetal and neonatal death that could be independent of whether women have medical complications associated with pregnancy (or not) .

Another limitation of our study is that the exact time of antepartum death was not known. Antepartum death could have occurred several days before the diagnosis. As a result, the probability of adverse outcome at an earlier gestational age would be higher than currently estimated. This would shift the line representing the probability of antepartum death to the left (i.e to a lower gestational age), and possibly suggests an earlier optimal time for delivery.

Moreover, misclassification of the type of fetal death is also a weakness of this stuy. The exact timing of fetal death is in some cases difficult to define. The distinction between intrapartum and neonatal death is sometimes difficult to make. Combining the intrapartum/neonatal death group decreases the chance of this type of misclassification. Although most intrapartum deaths result from events caused by labour some might be caused by events before labour. In those cases, grouping intrapartum death with neonatal death might be the wrong choice.

An additional point of discussion is the gestational age estimation. Our database does not contain information on pregnancy dating. In the Netherlands the first official dating protocol was established in 2011, and before this no uniform pregnancy dating was

performed. The use of ultrasound was introduced gradually in obstetric care in the 1980's. During our study period crown-rump-length and head circumference measurements increasingly replaced last menstrual period for dating, however no data is available on how pregnancy was dated in individual cases. Since obstetric care is accessible for all inhabitants in the Netherlands regardless of ethnicity or socio-economic status, we do not expect differences in gestational age estimation between the groups.

Ideally, this study should be done in a population without any medical interference, to study the natural course of pregnancy; however this is unethical. In the Netherlands, most antepartum deaths are induced, we therefore chose to include both inductions as spontaneous starts of delivery. By including only spontaneous deliveries (i.e. excluding induced or operative delivery) we would introduce a selection bias by excluding the group with the largest number of antepartum deaths. Conversely, by including deliveries that were induced, we introduce a medical decision factor that could have influenced the outcome. Women who have pregnancy related complications would probably be delivered earlier than women with uncomplicated pregnancies. We tried to correct for this by excluding all women with co-morbidities.

Furthermore, it should be emphasized that the probabilities presented are based on crude mortality and morbidity probabilities for each group and have not been corrected for variations in all possible maternal risk factors. We tried to rule out important confounders for neonatal death such as pregnancy complications, growth restriction and non-cephalic presentation. We were unable to correct for other confounders such as BMI and smoking during pregnancy because these variables are not (or not reliably) registered in the Dutch Perinatal database. In the Netherlands, health care is in principle accessible for everybody, regardless of socio-economic status or background and we anticipate no differences in quality of health care for different ethnic groups which might explain the disparities in outcomes. However, although the access to healthcare is the same in the Netherlands, possibly women from non-white European background access antenatal care at later gestational ages or less frequently.

Interpretation

The rate of caesarean sections and induction were highest in the African-Caribbean group. A previous study reported an increased risk of caesarean sections in black women both for non-reassuring fetal heart tracings as non-progression.[24] Although the overall rate of caesarean sections reported by Washington *et al.* is much higher than in our cohort (20.8 vs 13.5%), we found the same trend in our data namely that black women had the highest rate of caesarean sections. A shorter mean duration of pregnancy in Blacks has been described in our paper as well as in in several previous articles[3;4;18;25;26]. Similarly a lower incidence of RDS [27] and earlier development of gross motor skills[28] in blacks have previously been described. Although all confidence interval crossed one in African-Caribbean women, there was a non-significant trend towards less adverse neonatal outcome with delivery from 38 weeks onwards, which is earlier than in white European women.

Another group also published an abstract about ethnic differences in the risk of perinatal death. They found that at 38 weeks the risk of mortality with delivery was the same as that for expectant management in both Black and Caucasian women although the absolute

death rate was double in Black women[29]. A difference with our study is that Rosenstein *et al.* used infant mortality (deaths in the first year of life) instead of neonatal death. This might explain the difference in optimal week of delivery.

Conclusion

We don't know whether our observed differences are due to genetic differences or by (un)known other confounding factors, but the implications for management are the same. Whatever the reason, our study suggest that the probabilities of antepartum and intrapartum/neonatal death in African-Caribbean and Mediterranean women is higher than in white European women independent of the occurrence of pregnancy complications. Therefore, we think that more attention should be paid to the ethnicity of the mother during obstetrical decision-making. Our study helps to highlight the importance of personalized medicine in both risk assessments and treatment strategies, so we can improve our ability to counsel and care for women on an individual basis.

REFERENCES

1. Ravelli AC, Schaaf JM, Eskes M, Abu-Hanna A, de ME, Mol BW. Ethnic disparities in perinatal mortality at 40 and 41 weeks of gestation. J Perinat Med 2013; 41(4):381-388.
2. Omigbodun AO, Adewuyi A. Duration of human singleton pregnancies in Ibadan, Nigeria. J Natl Med Assoc 1997; 89(9):617-621.
3. Papiernik E, Alexander GR, Paneth N. Racial differences in pregnancy duration and its implications for perinatal care. Med Hypotheses 1990; 33(3):181-186.
4. Patel RR, Steer P, Doyle P, Little MP, Elliott P. Does gestation vary by ethnic group? A London-based study of over 122,000 pregnancies with spontaneous onset of labour. Int J Epidemiol 2004; 33(1):107-113.
5. Caughey AB, Stotland NE, Washington AE, Escobar GJ. Who is at risk for prolonged and postterm pregnancy? Am J Obstet Gynecol 2009; 200(6):683-685.
6. Laursen M, Bille C, Olesen AW, Hjelmborg J, Skytthe A, Christensen K. Genetic influence on prolonged gestation: a population-based Danish twin study. Am J Obstet Gynecol 2004; 190(2):489-494.
7. Onah HE. Effect of prolongation of pregnancy on perinatal mortality. Int J Gynaecol Obstet 2003; 80(3):255-261.
8. Kim SY, Saraiva C, Curtis M, Wilson HG, Troyan J, Sharma AJ. Fraction of gestational diabetes mellitus attributable to overweight and obesity by race/ethnicity, California, 2007-2009. Am J Public Health 2013; 103(10):e65-e72.
9. Sridhar SB, Ferrara A, Ehrlich SF, Brown SD, Hedderson MM. Risk of large-for-gestational-age newborns in women with gestational diabetes by race and ethnicity and body mass index categories. Obstet Gynecol 2013; 121(6):1255-1262.
10. Carr A, Kershaw T, Brown H, Allen T, Small M. Hypertensive disease in pregnancy: an examination of ethnic differences and the Hispanic paradox. J Neonatal Perinatal Med 2013; 6(1):11-15.
11. Khalil A, Rezende J, Akolekar R, Syngelaki A, Nicolaides KH. Maternal racial origin and adverse pregnancy outcome: a cohort study. Ultrasound Obstet Gynecol 2013; 41(3):278-285.
12. Silver RM. Previous stillbirth, late preterm, and early-term birth. Semin Perinatol 2011; 35(5):302-308.
13. Smith GC. Life-table analysis of the risk of perinatal death at term and post term in singleton pregnancies. Am J Obstet Gynecol 2001; 184(3):489-496.
14. Yudkin PL, Wood L, Redman CW. Risk of unexplained stillbirth at different gestational ages. Lancet 1987; 1(8543):1192-1194.
15. Utrecht PRN Foundation. The Netherlands Perinatal Registry (homepage on the internet). 2012.
16. Meray N, Reitsma JB, Ravelli AC, Bonsel GJ. Probabilistic record linkage is a valid and transparent tool to combine databases without a patient identification number. J Clin Epidemiol 2007; 60(9):883-891.
17. Tromp M, Ravelli AC, Meray N, Reitsma JB, Bonsel GJ. An efficient validation method of probabilistic record linkage including readmissions and twins. Methods Inf Med 2008; 47(4):356-363.

18. Ravelli AC, Tromp M, Eskes M, Droog JC, van der Post JA, Jager KJ et al. Ethnic differences in stillbirth and early neonatal mortality in The Netherlands. J Epidemiol Community Health 2011; 65(8):696-701.

19. Ravelli AC, Tromp M, van HM, Steegers EA, Tamminga P, Eskes M et al. Decreasing perinatal mortality in The Netherlands, 2000-2006: a record linkage study. J Epidemiol Community Health 2009; 63(9):761-765.

20. Alberman E, Blatchley N, Botting B, Schuman J, Dunn A. Medical causes on stillbirth certificates in England and Wales: distribution and results of hierarchical classifications tested by the Office for National Statistics. Br J Obstet Gynaecol 1997; 104(9):1043-1049.

21. Stubblefield PG, Berek JS. Perinatal mortality in term and post-term births. Obstet Gynecol 1980; 56(6):676-682.

22. Hilder L, Costeloe K, Thilaganathan B. Prolonged pregnancy: evaluating gestation-specific risks of fetal and infant mortality. Br J Obstet Gynaecol 1998; 105(2):169-173.

23. Joseph KS. The natural history of pregnancy: diseases of early and late gestation. BJOG 2011; 118(13):1617-1629.

24. Bhopal RS. Research agenda for tackling inequalities related to migration and ethnicity in Europe. J Public Health (Oxf) 2012; 34(2):167-173.

25. Balchin I, Whittaker JC, Patel RR, Lamont RF, Steer PJ. Racial variation in the association between gestational age and perinatal mortality: prospective study. BMJ 2007; 334(7598):833.

26. Ravelli AC, Schaaf JM, Eskes M, Abu-Hanna A, de ME, Mol BW. Ethnic disparities in perinatal mortality at 40 and 41 weeks of gestation. J Perinat Med 2013; 41(4):381-388.

27. Kavvadia V, Greenough A, Dimitriou G, Hooper R. Influence of ethnic origin on respiratory distress syndrome in very premature infants. Arch Dis Child Fetal Neonatal Ed 1998; 78(1):F25-F28.

28. Iloeje SO, Obiekwe VU, Kaine WN. Gross motor development of Nigerian children. Ann Trop Paediatr 1991; 11(1):33-39.

29. Rosenstein M.G., Cheng Y.W., Marshall N., Nicholson J., Caughey A.B. Racial/ethnic differences in the risk of perinatal death stratified by gestational age. Am.J.Obstet.Gynecol. 204, S235. 2011.

Table S1 | Probability of adverse neonatal outcome per 1000 with delivery or expectant management for one week.

Probability of adverse neonatal outcome per 1000 (95% CI)	**Week 36 (36+0 to 36+6)**	**Week 37 (37+0 to 37+6)**	**Week 38 (38+0 to 38+6)**	**Week 39 (39+0 to 39+6)**	**Week 40 (40+0 to 40+6)**	**Week 41 (41+0 to 41+6)**
White European; delivery in week	21.15 (19.42-22.9)	10.11 (9.29-10.99)	5.26 (4.88-5.66)	3.68 (3.45-3.93)	**3.95 (3.73-4.18)**	**5.33 (5.03-5.65)**
White European; 1 week expectant	**10.27 (9.34-11.20)**	**5.43 (4.99-5.88)**	**3.91 (3.62-4.21)**	4.20 (3.91-4.48)	5.72 (5.32-6.13)	7.31 (6.52-8.12)
Mediterranean; delivery in week	26.15 (20.27-33.03)	10.53 (8.06-13.65)	5.76 (4.59-7.20)	4.29 (3.53-5.20)	**3.96 (3.30-4.75)**	6.21 (5.19-7.41)
Mediterranean; 1 week expectant	**10.76 (7.51-14.02)**	**6.02 (4.42-7.62)**	4.55 (3.49-5.61)	4.31 (3.38-5.25)	6.70 (5.38-8.03)	8.99 (6.44-11.55)
African-Caribbean; delivery in week	20.80 (12.81-31.94)	16.08 (11.29-22.38)	8.73 (6.73-11.85)	8.79 (6.85-11.22)	9.89 (7.88-12.35)	12.54 (9.64-16.15)
African-Caribbean; 1 week expectant	16.48 (5.48-27.48)	8.93 (2.72-15.14)	9.01 (5.78-12.24)	10.63 (7.72-13.54)	13.03 (9.61-16.45)	14.14 (8.79-19.49)

Numbers in bold are the preferred strategies that result in statistically significant less mortality.

Table S2 | Probability of death per 1000 with delivery or expectant management for one week.

Probability of death per 1000 (95% CI)	Week 36 (36+0 to 36+6)	Week 37 (37+0 to 37+6)	Week 38 (38+0 to 38+6)	Week 39 (39+0 to 39+6)	Week 40 (40+0 to 40+6)	Week 41 (41+0 to 41+6)
White European; delivery in week	3.24 (3.18-3.31)	1.69 (1.65-1.72)	1.16 (1.14-1.18)	**0.85 (0.83-0.86)**	**0.76 (0.75-0.77)**	**1.06 (1.05-1.08)**
White European; 1 week expectant	**1.85 (1.06-2.65)**	1.33 (0.95-1.71)	1.09 (0.88-1.30)	1.01 (0.86-1.16)	1.45 (1.29-1.61)	1.79 (1.55-2.03)
Mediterranean; delivery in week	4.45 (4.22-4.68)	2.79 (2.67-2.92)	1.95 (1.23-2.02)	**0.70 (0.67-0.73)**	**0.90 (0.87-0.93)**	1,53 (1.47-1.58)
Mediterranean; 1 week expectant	3.03 (-0.09-6.15)	2.21 (0.63-3.79)	0.96 (0.12-1.80)	1.26 (0.74-1.77)	2.02 (1.35-2.70)	2.68 (1.52-3.84)
African-Caribbean; delivery in week	4.46 (4.09-4.84)	3.57 (3.35-3.81)	1.70 (1.59-1.82)	0.93 (0.86-1.00)	1.31 (1.23-1.39)	1.51 (1.40-1.62)
African-Caribbean; 1 week expectant	3.97 (-.1.18-9.12)	1.90 (-1.05-4.85)	1.14 (-0.24-2.53)	2.05 (0.91-3.20)	1.99 (0.64-3.34)	2.56 (0.29-4.83)

Numbers in bold are the preferred strategies that result in statistically significant less mortality.

Table S3 | Relative risks and absolute risks of death with expectant management compared to delivery in a certain week.

	White European				Mediterranean				African-Caribbean			
	Relative risk	95%CI	Absolute risk difference	Number needed to deliver	Relative risk	95%CI	Absolute risk difference	Number needed to deliver	Relative risk	95%CI	Absolute risk difference	Number needed to deliver
36	**0.57**	**0.43 - 0.75**	-1.42	x	0.68	0.30 - 1.53	-1.42	x	0.89	0.25 - 3.22	-0.49	x
37	0.79	0.60 - 1.02	-0.36	x	0.79	0.40 - 1.55	-0.58	x	0.53	0.16 - 1.74	0.167	x
38	0.94	0.76 - 1.16	-0.07	x	**0.49**	**0.27 - 0.87**	-0.99	x	0.67	0.21 - 2.12	-0.55	x
39	1.18	0.97 - 1.44	0.16	6,437	1.80	0.97 - 3.33	0.56	1,794	2.22	0.85 - 5.77	1.13	885
40	**1.91**	**1.59 - 2.31**	0.69	1,440	**2.25**	**1.30 - 3.89**	1.12	891	1.52	0.54 - 4.28	0.69	1,458
41	**1.68**	**1.36 - 2.08**	0.72	1,379	**1.76**	**1.05 - 2.94**	1.15	867	1.70	0.55 - 5.27	1.06	945

SUPPLEMENTARY METHODS

Antepartum death
For a fetus to be at risk of antepartum death (AD) at 36^{+0} it is obviously necessary to be alive at 36^{+0}. Consequently, the probability of antepartum death was calculated as a proportion of the ongoing pregnancies (OP) at a particular gestation. Probability of antepartum death at day n = $AD_n/OP_n * 1000$

Cumulative probability of antepartum death
The cumulative probability of antepartum death at day N was calculated by summing the probabilities of antepartum death of the previous days. Inevitably, the cumulative probability of antepartum death will increase with increasing gestation. The cumulative probability represents the probability of antepartum death in case of expectant management from 36^{+0} weeks (n0) onward.

Cumulative probability of antepartum death at day n= $(AD_{n0}/OP_{n0} * 1000)+(AD_{n1}/OP_{n1} * 1000) ... (AD_{n..}/OP_{n..} 1000)$

Intrapartum/neonatal death
In concurrence, the probability of intrapartum/neonatal death (IND) at any gestational age is obtained by dividing the number of intrapartum and neonatal deaths at that gestation by the number of neonates at probability of intrapartum/neonatal death at that gestation. The neonates at risk of intrapartum/neonatal death at a certain gestational age include all delivered neonates (DN) that did not die antepartum.

Probability of intrapartum/neonatal death at day n = $IND_n/DN_n * 1000$

Neonatal morbidity
The denominator used for the probability of neonatal morbidity (NM) are all alive fetuses (AF) born at that gestation, since only alive fetuses can suffer morbidity.

Probability of neonatal morbidity at day n = $NM_n/AF_n * 1000$

Comparison probability of death with delivery versus expectant management
Once delivery has started, either spontaneously or by induction of labour, the probability of death is based on intrapartum/neonatal death. With expectant management the probability of death is based on the composite of intrapartum/neonatal death and the probability of antepartum death. The probability of death between delivery and expectant management per one week gestation was compared as previously proposed by Rosenstein et al [19]. For example, delivery in the 36^{th} week was compared to an expectant management in the 36^{th} week and subsequent delivery in the 37^{th} week. The probability of death with delivery is defined as the probability of intrapartum/neonatal deaths in that week divided by neonates born during that week.

Probability of death with delivery at week x = $IND_x/DNx * 1000$

The probability of death with one week expectant management was defined as the probability of antepartum death during that week plus the probability of intrapartum/neonatal death with delivery in the subsequent week. The confidence interval of this composite outcome was calculated using the sum of the variances plus twice the covariance of the estimates of antepartum death and intrapartum/neonatal death.

Probability of death with one week expectant management at week x = ($AD_x/OP_x + IN_{x+1}/DN_{x+1}$) *1000.