DOI: 10.1111/j.1471-0528.2009.02175.x
www.bjog.org

Perinatal mortality and morbidity in a nationwide cohort of 529 688 low-risk planned home and hospital births

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Accepted 26 February 2009. Published Online 15 April 2009.

Objective To compare perinatal mortality and severe perinatal morbidity between planned home and planned hospital births, among low-risk women who started their labour in primary care.

Design A nationwide cohort study.

Setting The entire Netherlands.

Population A total of 529 688 low-risk women who were in primary midwife-led care at the onset of labour. Of these, 321 307 (60.7%) intended to give birth at home, 163 261 (30.8%) planned to give birth in hospital and for 45 120 (8.5%), the intended place of birth was unknown.

Methods Analysis of national perinatal and neonatal registration data, over a period of 7 years. Logistic regression analysis was used to control for differences in baseline characteristics.

Main outcome measures Intrapartum death, intrapartum and neonatal death within 24 hours after birth, intrapartum and neonatal death within 7 days and neonatal admission to an intensive care unit.

Results No significant differences were found between planned home and planned hospital birth (adjusted relative risks and 95% confidence intervals: intrapartum death 0.97 (0.69 to 1.37), intrapartum death and neonatal death during the first 24 hours 1.02 (0.77 to 1.36), intrapartum death and neonatal death up to 7 days 1.00 (0.78 to 1.27), admission to neonatal intensive care unit 1.00 (0.86 to 1.16).

Conclusions This study shows that planning a home birth does not increase the risks of perinatal mortality and severe perinatal morbidity among low-risk women, provided the maternity care system facilitates this choice through the availability of well-trained midwives and through a good transportation and referral system.

Keywords Midwifery, perinatal mortality, pregnancy outcome.

Please cite this paper as: de Jonge A, van der Goes B, Ravelli A, Amelink-Verburg M, Mol B, Nijhuis J, Bennebroek Gravenhorst J, Buitendijk S. Perinatal mortality and morbidity in a nationwide cohort of 529 688 low-risk planned home and hospital births. BJOG 2009;116:1177–1184.

Introduction

Since the second half of the 20th century, the majority of births in the western world have taken place in hospital. However, this move from home to hospital birth for most women was not based on evidence.[1] The opinion that a hospital birth is the best option for every woman is increasingly being challenged.[2] Since 1993, the official policy in the United Kingdom, for instance, is to give women more choice in their place of birth.[3] Nonetheless, the limited evidence on the safety of planned homebirth undermines the security of women's choice.

In the recent National Institute of Clinical Excellence (NICE) guideline on intrapartum care, the need for better quality data on the safety of home birth was emphasised.[2] For lack of better data, UK perinatal mortality rates were estimated for this guideline, using information from the Confidential Enquiry into Maternal and Child Health.[2,4] Assumptions were made about the number of women who planned a home birth at booking and who were subsequently referred during pregnancy or labour. The intrapartum-related perinatal mortality appeared to be higher in planned home births at booking compared to the national average in the most recent years. This conclusion, however,

has been criticised because it was drawn on incomplete data sets with comparison groups that were fundamentally different.[5,6]

Previous studies on this subject show conflicting results.[1,7–18] Two cohort studies, one from Australia and one from the USA, have shown a higher risk of perinatal mortality in planned home births compared to hospital births.[11,16] Risk factors in the home birth group, such as breech presentation, twins and post-term births, contributed to a large extent to the excess mortality in the Australian study.[11] The American study was based on birth certificates and could not reliably exclude high risk unplanned, unassisted home births from the planned home birth group.[16]

In contrast, cohort studies in Europe and North-America showed no significant increase in perinatal mortality in planned home compared to planned hospital births.[8,9,13,15,18] However, the power of most of these studies was limited by their small sample size.[8,13,15,18] Furthermore, the definition of study groups was not always precise. For example, planned place of birth was often recorded early in pregnancy, which resulted in women who were referred during pregnancy because of complications being included in the planned home birth group.[7,8,17] In some studies, the mortality rate in the planned home birth group was compared only to national mortality statistics or to rates in other studies.[7,9–11,14] In most countries, it is not easy to identify a low-risk group of women who plan a hospital birth and distinguish them from those with risk factors.

Because of the limitations in the available studies, it remains unclear whether it is safe for low-risk women to plan their birth at home. The features of the maternity care system in the Netherlands provide an opportunity to contribute evidence to this issue. In the Netherlands, maternity care is divided into primary care for low-risk women and secondary care for women at increased risk for complications. Independent midwives provide primary care, whereas obstetricians are responsible for secondary care. Women in primary care at the onset of labour, by definition have no known risk factors and can choose to give birth at home or in hospital. Although the home birth rate has declined steadily since the mid 1960s, approximately 30% of women in the Netherlands still give birth at home.[19] Homebirth is generally considered a safe option for low-risk women. However, the Dutch maternity care system has recently come under pressure since the national perinatal mortality rate has been shown to be one of the highest in Europe.[20]

Good quality data on planned home birth are urgently needed to provide an evidence base to the debate in various western countries and to give women better information upon which to base their choice of place of birth. Causal relationships should ideally be examined in a randomised controlled trial. However, as the outcomes of interest are rare in a low-risk population, very large sample sizes would be required for such a study. Further, women have shown that they were not willing to take part in such randomised studies, as they want to choose their own place of birth.[1,21] Good quality observational studies are therefore the only source of evidence on this subject.

The Netherlands is the only western country that can provide a large enough data set to show potential differences in severe outcomes between planned home and planned hospital births among low-risk women. Homebirth is still very common and comprehensive data are available in the Netherlands Perinatal Register. Moreover, low-risk women in primary care at the onset of labour can easily be identified and compared, based on their intended place of birth.

In view of the limited evidence on the subject, we have undertaken a large national cohort study. The aim of this study was to compare perinatal outcomes between planned home and planned hospital births among women who started their labour in primary care, over a period of 7 years. We examined the influence of planned place of birth, controlled for known confounding factors.

Methods

In the Netherlands, independent primary care midwives provide care to low-risk women only. If risk factors arise during pregnancy, during labour or in the postpartum period, a woman is referred to secondary care, for which an obstetrician is responsible. The indications for referral have been agreed upon by the professional groups involved and are laid out in the so-called Obstetric Indication List. Interventions, such as pharmacological pain relief, fetal monitoring and augmentation of labour only take place in secondary care. If problems occur during a planned home birth, the woman and/or baby will be referred to secondary care in hospital.

In the Netherlands, perinatal registration data are collected in three separate databases: one for primary care (LVR-1), one for secondary obstetric care (LVR-2) and one for paediatric care (LNR). About 99% of primary care data and 100% of secondary obstetric care data are entered into these registers. All neonatal care data from academic hospitals and about 50% of other paediatric data are entered in the paediatric register. Recently, these databases have been combined into one national perinatal database via a validated linkage method.[22]

We identified all low-risk women who gave birth between 1 January 2000 and 31 December 2006 and who were in primary midwife-led care at the onset of labour. These women could therefore plan to give birth at home or in hospital. In either case, they would be assisted by their independent primary care midwife. Women who were

in obstetrician-led care at the onset of labour were not included in the study, even when they were at low risk. The midwife recorded women's intended place of birth during pregnancy. For a number of women, the intended place of birth was unknown. Some of these women waited until labour to decide where they wanted to give birth and for others the midwife would have forgotten to record the intended place of birth. The women in our study gave birth between 37 and 42 weeks gestation to a single fetus and did not have any medical or obstetric risk factors that were known before labour, such as non-cephalic presentation or a previous caesarean section. Women in primary care with a medium risk, for example because of a previous postpartum haemorrhage, are not offered a homebirth and were therefore not included in the study. We also excluded women who had prolonged rupture of membranes (more than 24 hours) without contractions, an intrauterine death before labour started or a child with a congenital abnormality. Women in our study who planned to give birth at home may have ended up giving birth in hospital, if risk factors developed during labour. Such risk factors could be, for example, failure to progress, an abnormal fetal heart rate pattern or meconium stained liquor.

Groups based on the intended place of birth (home, hospital and unknown) were compared for the following outcomes: intrapartum death, intrapartum and neonatal death up to 24 hours, intrapartum and neonatal death up to 7 days and admission after birth to a neonatal intensive care unit (NICU). We chose not to include admissions to a neonatal ward as a separate outcome as indications for these vary markedly between hospitals. If a woman used anti-depressants during pregnancy, for instance, some hospitals will admit the baby for observation for 24 hours while others will not. Admission to a NICU, on the other hand, invariably is an indicator of severe morbidity. We therefore included this outcome in our analyses.

The categories for ethnic background have previously been shown not to be filled in uniformly by midwives, likely because they are confusing. Black African women, for instance, are sometimes being classified as 'Creoles' (a category which historically was meant to apply to Surinamese women of African descent) and sometimes as 'other'. We therefore classified ethnic background dichotomously as 'Dutch' or 'non-Dutch'. Socio-economic status was based on the mean household income level of the neighbourhood, which was determined by the first four digits of the woman's postal code.

Data analysis

We compared perinatal outcomes (intrapartum death, intrapartum and neonatal death up to 24 hours, intrapartum and neonatal death up to 7 days and admission to a NICU) of planned home birth or unknown place of birth to planned hospital birth. For each outcome, we calculated the crude relative risk and its 95% confidence interval. We also calculated crude relative risks for potential confounders known to be associated with these outcomes: parity,[23] gestational age,[24] maternal age,[23] ethnic background,[23,25] and socio-economic status.[25] We then adjusted the relative risk estimates in a logistic regression analysis (enter method) to show the contribution of planned place of birth in relation to other factors to perinatal outcomes. Interaction effects were also examined for each baseline characteristic and place of birth through logistic regression analysis.

The following data were missing: parity $n = 61$, maternal age $n = 149$, ethnic background $n = 5316$, socio-economic status $n = 3987$. The effects of these missing data were examined separately and they were subsequently added to the most comparable group.

Results

Of the 529 688 women in midwife-led care at the onset of labour, 321 307 (60.7%) planned to give birth at home, 163 261 (30.8%) intended to give birth in hospital and for 45 120 (8.5%), the intended place of birth was unknown (Figure 1). Table 1 shows the baseline characteristics of these women. Women who were planning to give birth at home were more likely to be 25 years or older, of Dutch origin and have a medium or high socio-economic status than women who were planning a hospital birth or for whom planned place of birth was unknown. They were also more likely to be multiparous and give birth at 41 weeks gestation and were less likely to give birth at 37 weeks gestation.

Perinatal mortality

No significant differences were found in the crude and adjusted relative risks of perinatal mortality among the planned home birth or unknown place of birth groups compared to the planned hospital birth group (Tables 2 and 3).

Crude and adjusted relative risks of all mortality outcomes were higher among women who were primiparous (intrapartum and neonatal death 0–7 days, adj RR 1.68, 95% CI 1.34–2.10), who gave birth at 37 weeks gestation (intrapartum and neonatal death 0–7 days, adj RR 1.99, 95% CI 1.31–3.01) or 41 weeks gestation (intrapartum and neonatal death 0–7 days, adj RR 1.53 95% CI 1.20–1.93) and who were 35 years or older (intrapartum and neonatal death 0–7 days, adj RR 1.69, 95% CI 1.29–2.21). Babies of women who were younger than 25 years old had a higher crude relative risk for intrapartum death. However, after controlling for known confounding factors, this difference was not significant. Among women of non-Dutch origin, crude relative risks for intrapartum death and intrapartum or neonatal death during the first 24 hours were higher

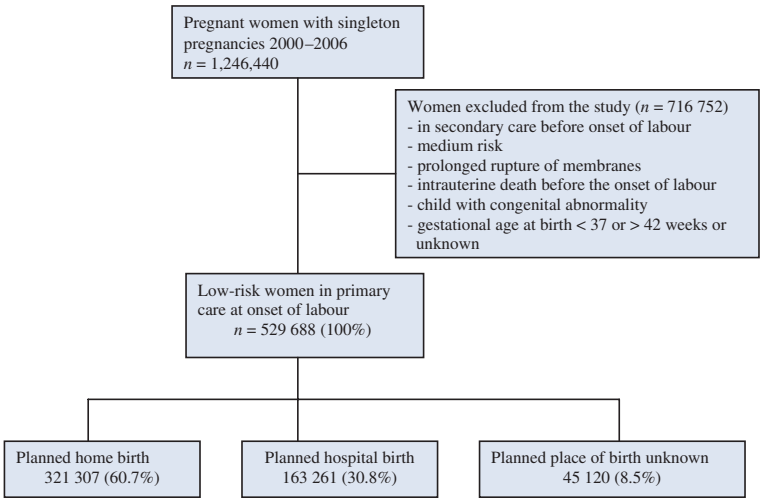

Figure 1. Flowdiagram.

Table 1. Characteristics of women in the primary midwifery care setting at the start of labour

Variable	Planned home birth 321 307 (60.7%)		Planned hospital birth 163 261 (30.8%)		Planned place of birth unknown 45 120 (8.5%)	
	n	%***	*n*	%***	*n*	%***
Parity*						
Multiparous	189 936	59.1	86 967	53.3	24 730	54.8
Primiparous	131 371	40.9	76 294	46.7	20 390	45.2
Gestational age*,**						
37	12 036	3.8	7208	4.4	2016	4.5
38–40	238 041	74.1	122 253	74.9	33 753	74.8
41	71 230	22.2	33 800	20.7	9351	20.7
Maternal age*						
<25 years	29 416	9.2	30 304	18.6	6649	14.7
25 to 34 years	237 603	74.0	106 564	65.3	30 971	68.6
≥35 years	54 288	16.9	26 393	16.2	7500	16.6
Ethnic background*						
Dutch	292 394	91.0	105 372	64.5	34 849	77.2
Non-Dutch	28 913	9.0	57 889	35.5	10 271	22.8
Socio-economic status*						
High	88 358	27.5	38 568	23.6	10 398	23.1
Medium	172 039	53.5	70 443	43.2	21 965	48.7
Low	60 910	19.0	54 250	33.2	12 757	28.3

*$P < 0.0001$.
**Gestational age in completed weeks.
***Totals may not add up to 100 because of rounding error.

and adjusted relative risks for all perinatal mortality outcomes were higher (intrapartum and neonatal death 0–7 days, adj RR 1.39, 95% CI 1.04–1.85).

Admission to a neonatal intensive care unit

Babies of women who planned a home birth were less likely to be admitted to a NICU than those born to women who planned a hospital birth (Table 3). However, this difference disappeared after controlling for known confounders. Neonates of women whose planned place of birth was unknown, had a higher crude and relative risk of being admitted to the NICU (adj RR 1.33, 95% CI 1.07–1.65).

Crude and adjusted relative risks of admission to a NICU were higher for babies of mothers who were

Table 2. Perinatal mortality during the first 24 hours in deliveries starting in the primary midwifery care setting

	Total *N*	Intrapartum death			Intrapartum and neonatal death during the first 24 hours		
		No (%)	Crude RR (CI)	Adj RR (CI)	No (%)	Crude RR (CI)	Adj RR (CI)
Intended place of birth at onset of labour							
Hospital	163 261	61 (0.04)	1.0	1.0	84 (0.05)	1.0	1.0
Home	321 307	99 (0.03)	0.83 (0.60 to 1.13)	0.97 (0.69 to 1.37)	148 (0.05)	0.90 (0.69 to 1.17)	1.02 (0.77 to 1.36)
Unknown	45 120	14 (0.03)	0.83 (0.46 to 1.48)	0.89 (0.50 to 1.59)	16 (0.04)	0.69 (0.40 to 1.18)	0.73 (0.43 to 1.25)
Parity							
Multiparous	301 633	76 (0.03)	1.0	1.0	112 (0.04)	1.0	1.0
Primiparous	228 055	98 (0.04)	1.71 (1.26 to 2.30)	1.84 (1.34 to 2.52)	136 (0.06)	1.61 (1.25 to 2.06)	1.73 (1.32 to 2.25)
Gestational age							
37	21 260	16 (0.08)	2.83 (1.67 to 4.78)	2.65 (1.56 to 4.49)	20 (0.09)	2.35 (1.48 to 3.74)	2.22 (1.39 to 3.54)
38–40	394 047	105 (0.03)	1.0	1.0	158 (0.04)	1.0	1.0
41	114 381	53 (0.05)	1.74 (1.25 to 2.42)	1.76 (1.26 to 2.44)	70 (0.06)	1.53 (1.15 to 2.02)	1.54 (1.16 to 2.03)
Maternal age							
<25 years	66 369	30 (0.05)	1.63 (1.09 to 2.45)	1.27 (0.82 to 1.95)	39 (0.06)	1.42 (1.00 to 2.02)	1.14 (0.79 to 1.66)
25 to 34 years	375 138	104 (0.03)	1.0	1.0	155 (0.04)	1.0	1.0
≥35 years	88 181	40 (0.05)	1.64 (1.14 to 2.36)	1.91 (1.31 to 2.77)	54 (0.06)	1.48 (1.09 to 2.02)	1.70 (1.24 to 2.34)
Ethnic background							
Dutch	432 615	129 (0.03)	1.0	1.0	189 (0.04)	1.0	1.0
Non-Dutch	97 073	45 (0.05)	1.56 (1.11 to 2.18)	1.73 (1.18 to 2.55)	59 (0.06)	1.39 (1.04 to 1.86)	1.54 (1.11 to 2.15)
Socio-economic status							
High	137 324	42 (0.03)	1.0	1.0	60 (0.04)	1.0	1.0
Medium	264 447	94 (0.04)	1.16 (0.81 to 1.67)	1.16 (0.80 to 1.67)	131 (0.05)	1.13 (0.84 to 1.54)	1.14 (0.84 to 1.54)
Low	127 917	38 (0.03)	0.97 (0.63 to 1.51)	0.79 (0.50 to 1.25)	57 (0.04)	1.02 (0.71 to 1.47)	0.89 (0.60 to 1.30)

Adj, adjusted; CI, confidence interval.

primiparous (adj RR 2.24, 95% CI 1.95–2.56), gave birth at 37 or 41 weeks gestation (adj RR 1.90, 95% CI 1.49–2.43 and adj RR 1.42, 95% CI 1.23–1.64 respectively), were 35 years or older (adj RR 1.52, 95% CI 1.29–1.80), of non-Dutch origin (adj RR 1.34, 95% CI 1.14–1.58) and had a low socio-economic status (adj RR 1.30, 95% CI 1.09–1.55). Babies of women younger than 25 years old had a higher crude relative risk for admission to a NICU than other women, but this difference disappeared after controlling for known confounding factors.

No effects were found of the interactions between each of the baseline characteristics and place of birth on perinatal outcomes (data not shown).

Discussion

In this large cohort study, planned home birth in a low-risk population was not associated with higher perinatal mortality rates or an increased risk of admission to a NICU compared to planned hospital birth after controlling for maternal characteristics. Although various factors, such as primiparity and age over 35, were associated with higher rates of adverse perinatal outcomes, no interaction effects were found between these factors and planned place of birth.

This study has some major strengths. As far as we know, this is the largest study into the safety of home birth. Its large sample size provided the power to detect differences in rare adverse outcomes. As it has been shown that conducting a randomised controlled trial is not possible,[1,21] the best evidence about the safety of home birth can only come from good quality, routine registrations such as the one we used in our study. Furthermore, we were able to study a group of truly low-risk women.

Our study had some limitations. First, as this was a retrospective data collection, some data were missing. The planned place of birth was not recorded for 8.5% of women. For some women, this information was missing. Others waited until labour to decide where they wanted to give birth. Babies of women whose planned place of birth was unknown were more likely to be admitted to a NICU. Prospective cohort studies may show why this group is at higher risk. In addition, paediatric data of 50% of non-academic hospitals were missing. The availability of these data depends on the willingness of paediatricians to take part in the national registration system and is not related

Table 3. Perinatal outcome during the first week after birth in deliveries starting in the primary midwifery care setting

	Total *N*	Intrapartum and neonatal death 0–7 days			Admission to NICU*		
		No (%)	Crude RR (CI)	Adj RR (CI)	No (%)	Crude RR (CI)	Adj RR (CI)
Intended place of birth at onset of labour							
Hospital	163 261	116 (0.07)	1.0	1.0	323 (0.20)	1.0	1.0
Home	321 307	207 (0.06)	0.91 (0.72 to 1.14)	1.00 (0.78 to 1.27)	540 (0.17)	0.85 (0.74 to 0.98)	1.00 (0.86 to 1.16)
Unknown	45 120	22 (0.05)	0.69 (0.44 to 1.08)	0.71 (0.45 to 1.12)	112 (0.25)	1.26 (1.01 to 1.56)	1.33 (1.07 to 1.65)
Parity							
Multiparous	301 633	159 (0.05)	1.0	1.0	378 (0.13)	1.0	1.0
Primiparous	228 055	186 (0.08)	1.55 (1.25 to 1.91)	1.68 (1.34 to 2.10)	597 (0.26)	2.09 (1.84 to 2.38)	2.24 (1.95 to 2.56)
Gestational age							
37	21 260	25 (0.12)	2.09 (1.38 to 3.16)	1.99 (1.31 to 3.01)	72 (0.34)	2.09 (1.64 to 2.66)	1.90 (1.49 to 2.43)
38–40	394 047	222 (0.06)	1.0	1.0	641 (0.16)	1.0	1.0
41	114 381	98 (0.09)	1.52 (1.20 to 1.93)	1.53 (1.20 to 1.93)	262 (0.23)	1.41 (1.22 to 1.63)	1.42 (1.23 to 1.64)
Maternal age							
<25 years	66 369	50 (0.08)	1.29 (0.95 to 1.76)	1.06 (0.76 to 1.46)	148 (0.22)	1.31 (1.09 to 1.57)	0.91 (0.75 to 1.10)
25 to 34 years	375 138	219 (0.06)	1.0	1.0	640 (0.17)	1.0	1.0
≥35 years	88 181	76 (0.09)	1.48 (1.14 to 1.92)	1.69 (1.29 to 2.21)	187 (0.21)	1.24 (1.06 to 1.46)	1.52 (1.29 to 1.80)
Ethnic background							
Dutch	432 615	269 (0.06)	1.0	1.0	741 (0.17)	1.0	1.0
Non-Dutch	97 073	76 (0.08)	1.26 (0.98 to 1.63)	1.39 (1.04 to 1.85)	234 (0.24)	1.41 (1.22 to 1.63)	1.34 (1.14 to 1.58)
Socio-economic status							
High	137 324	77 (0.06)	1.0	1.0	238 (0.17)	1.0	1.0
Medium	264 447	189 (0.07)	1.28 (0.98 to 1.66)	1.29 (0.99 to 1.68)	422 (0.16)	0.92 (0.79 to 1.08)	0.93 (0.79 to 1.09)
Low	127 917	79 (0.06)	1.10 (0.81 to 1.51)	1.00 (0.72 to 1.40)	315 (0.25)	1.42 (1.20 to 1.68)	1.30 (1.09 to 1.55)

*Neonates that were alive at birth.

to the care provided by obstetricians or midwives. It is therefore unlikely that these missing data would have affected the direction of our findings, although they will have reduced the power to find significant differences in admission to a NICU. Perinatal mortality is also recorded in the primary care and secondary obstetric care registers and is therefore less affected by the missing paediatric data.

Second, socio-economic status was based on the mean household income level of the neighbourhood, which was determined by the woman's postal code. Using this proxy measure may have led to some misclassification.

The fact that the perinatal mortality rate in the Netherlands is higher compared to other European countries while the number of home births is larger as well, has raised anxiety about the safety of planning birth at home.[26] This study shows that the relative high perinatal mortality rate in the Netherlands cannot be explained by the large number of planned home births. These results should strengthen policies that encourage low-risk women at the onset of labour to choose their own place of birth. They show that planning a home birth is a safe option in a country with a maternity care system, which facilitates this choice through adequate numbers of well-trained midwives who assess the appropriateness of a home birth and through a rapid transportation and an integrated referral system.

More research is needed into the causes of perinatal mortality. The relatively high prevalence of several maternal risk factors may contribute to the higher mortality rate in the Netherlands. The percentage of older mothers in the Netherlands, for example, is higher than in any other European country apart from Ireland and Spain (about 20% is 35 years or older).[27,28] More than twice as many mothers are of non-North European origin than in Denmark or Sweden.[29] Both high maternal age and non-Dutch background were related to adverse perinatal outcomes in our study and this is consistent with findings from other studies.[23,25] However, obstetric and midwifery care factors can also play an important role in determining perinatal outcomes. Two recent Dutch perinatal audit studies showed that several substandard care factors, such as failure to detect intrauterine growth retardation, were possibly or probably related to perinatal deaths.[30,31]

Our study was unable to answer the question whether the definition of 'low-risk' was appropriate in this study. If women are not referred in time, perinatal outcomes may be worse for low-risk women in primary midwife-led care compared with those in obstetrician-led care, regardless of

their planned place of birth. On the other hand, unnecessary referrals are likely to increase the risk of unnecessary obstetric interventions. As obstetric interventions potentially have adverse effects, a low intervention rate is an important indicator of optimal care as are good maternal and neonatal outcomes.[18] Studies in several countries have shown that low-risk women with a planned home birth are less likely to experience referral to secondary care and subsequent obstetric interventions than those with a planned hospital birth.[8,13,14,18,32,33] It is possible that the home environment is more conducive to birth without referral or interventions. On the other hand, our study confirmed earlier findings that low-risk women who choose to give birth in hospital are more likely to be primiparous and of ethnic minority background.[34] The risk of adverse perinatal outcomes is higher in these groups and therefore some self-selection may take place among women who are more likely to need obstetric interventions. In addition, women who choose a hospital birth have been shown to be less hesitant towards technological interventions.[33] More research is needed into the effect of planned place of birth on referrals and interventions, controlled for other factors.

In conclusion, this study did not show increased risks of perinatal mortality and severe perinatal morbidity, adjusted for known confounding factors, among low-risk women planning a home birth. Low-risk women should be encouraged to plan their birth at the place of their preference, provided the maternity care system is well equipped to underpin women's choice.

Disclosure of interest
We declare that we have no conflict of interest.

Contribution to authorship
All authors contributed substantially to the design of the study, A.C.J. Ravelli analysed the data, A. de Jonge prepared the manuscript and is the guarantor of the study and all authors critically revised earlier concepts of the paper and gave final approval of the version to be published.

Details of ethics approval
Ethical approval is not required for this type of study in the Netherlands.

Funding
The Dutch Ministry of Health.

Acknowledgement
This study was based on data from the Netherlands Perinatal Register. We acknowledge all midwives, obstetricians, paediatricians, nurses and residents who routinely collect the perinatal data for this register. We like to thank Prof David Taylor for critically reviewing our paper and Dr Charles Agyemang for his useful comments on earlier drafts of this article. ■

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