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Implementation of integrated maternity care in the southwestern region of the Netherlands: evaluation of its effect on preterm birth, low birthweight infants and number of secondary care consultations

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ABSTRACT

Objectives To determine whether integrated maternity care is associated with reduced preterm births (PTB) and fewer small-for-gestational-age infants (SGA), and whether its implementation leads to a reduction of secondary care consultations.

Design Retrospective study.

Setting Integrated maternity care organisation in the southwestern region of the Netherlands.

Participants All singleton pregnancies (≥24 weeks) within integrated maternity care organisation Annature between 2015 and 2020.

Intervention Implementation of a shared maternity record in primary and secondary care.

Methods Data of 20 818 women were derived from patient records and from the Netherlands Perinatal Registry. Intervention was the introduction of integrated maternity care in January 2018. Through multivariate logistic regression and segmented regression analysis we assessed the combined prevalence of SGA and PTB (SGA-PTB) before (2015–2017), and after the intervention (2018–2020). Regional rates were contrasted with nationwide rates (n=782 176).

Main outcome measures SGA-PTB prevalence and mean number of secondary care consultations per pregnancy.

Results SGA-PTB prevalence declined from 618/3443 (17.9%) in 2015 to 560/3501 (16.0%) in 2017 to 507/3459 (14.7%) in 2020 (p<0.005). Mean number of secondary care consultations declined from six per pregnancy in 2015 to three in 2020. Logistic regression demonstrated a significant decline in odds of SGA-PTB (OR 0.83 (95% CI 0.77 to 0.89)) between 2015–2017 and 2018–2020 adjusted for changes in sociodemographic characteristics over time. A statistically significant average monthly 7.3% (p=0.05) reduction in SGA-PTB prevalence and 12.4% (p<0.005) mean monthly reduction in secondary care consultations were demonstrated for 2015–2017. Immediately after the intervention, mean monthly prevalence of SGA-PTB dropped non-significantly to 14.7%. Between 2018 and 2020 a significant 15.2% (p<0.005) reduction in secondary care consultations was shown.

Conclusion Our results suggest that implementation of integrated maternity care was associated with reduced PTBs and/or low birth weight, and fewer secondary care consultations. These encouraging findings were observed in a less favourable sociodemographic profile and should be confirmed in other regions with sufficiently large populations, and the possibility to test individual components of integrated maternity care.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ The generalisability for regional hospitals in the southwestern region of the Netherlands is adequate since 93% of the pregnant women in Breda region were served by integrated maternity care organisation Annature.
⇒ This study included a cohort of 20 818 women with low numbers of missing data since an integrated patient record was used.
⇒ This study assessed the effects of integrated maternity care on the combined outcomes small-for-gestational-age and preterm birth.
⇒ Limitations: the analysis was not adjusted for confounders, arising from changes over time in the sociodemographic profiles. Moreover, we were not able to discern the number of primary care consultations before the introduction of an integrated patient record. The relatively small size of the cohort available in Breda may have contributed to the failure to show statistically significant changes to the combined prevalence of small-for-gestational-age and preterm birth at the intervention point.

INTRODUCTION

The decline in perinatal mortality in the Netherlands, and in Europe, stagnated from 2015.[1–5] In terms of perinatal mortality, the

Netherlands ranked 10th place compared with other European countries in 2015, with a perinatal mortality rate of 4.2 per 1000 births. Scandinavia was considered the highest-ranking European subregion with a perinatal mortality rate of 3.5 per 1000 births.[1] In the majority of cases, perinatal mortality is preceded by preterm birth (PTB) and birth weight below the 10th percentile, also known as small-for-gestational-age (SGA).[6–9] The relatively high Dutch perinatal mortality rate has raised concerns about the quality of maternity care in the Netherlands.

Research has suggested that this high rate may be partly attributed to the organisation of the Dutch maternity care system, where pregnancies are allocated to the different tiers of the care system based on their estimated risk for complications, with delivery of primary, secondary and tertiary care by separate providers.[10] In the Netherlands, prenatal and natal care for women with low-risk pregnancies is provided by community midwives (primary, midwife-led care). These midwives are independent obstetric caregivers who work in small group practices. Prenatal care for intermediate-risk pregnancies is provided by obstetric caregivers in the hospital (secondary, obstetrician-led care), while high-risk pregnant women receive prenatal care in university medical centres (tertiary care). Throughout their pregnancy, about 80% of pregnant women in the Netherlands received prenatal care from multiple obstetric professionals, both in primary, secondary and tertiary care.[10] However, after referral from primary to secondary care, the community midwife was no longer involved, which led to discontinuity of care and potential loss of valuable medical information.

To improve the quality of maternity care in the Netherlands, the report of the Dutch Steering Group Pregnancy and Childbirth on 'Safe care during pregnancy and childbirth' stressed the need for organisational improvement with closer, level-transcending collaboration between community midwives and obstetricians through an 'integrated maternity care' model.[10] Likewise, in the region of Breda in the southwestern part of the Netherlands, the obstetric caregivers of primary and secondary care also noticed that a lack of integration between different levels of care led to fragmented care delivery and caused dissatisfaction for both the patients and the obstetric care givers, as this partition hindered interprofessional collaboration. Before 2012, primary maternity care in the region of Breda was provided by 13 community midwifery practices unified in a midwifery alliance, while secondary care was provided by the maternity unit of the Amphia hospital in Breda, by consultant obstetricians and by local postnatal maternity care organisations. Maternity care was provided in separate echelons of primary, community midwife-led care and secondary, obstetrician-led care, as is common in the Netherlands. Within these separate echelons, obstetric caregivers worked autonomously and used separate patient records. Furthermore, the primary and secondary obstetric caregivers worked with different protocols, which led to treatment variations and consequently to discontinuity of care.

Influenced by national policy and by the need to improve the quality of maternity care, a large first step towards organisational improvement was taken in the Breda region in 2012 with the foundation of an integrated ultrasound centre. An integrated record for all ultrasounds of pregnant women in the region was introduced, regardless of whether they received midwife-led or obstetrician-led care. This collaboration increased the mutual trust between obstetric caregivers of primary and secondary care and created the opportunity to expand the interprofessional collaboration to a more integrated form of maternity care, leading to the foundation of integrated maternity care organisation Annature in 2016. Annature is an integrated maternity care organisation that is contracted via bundled payment for their services. Bundled payment is the compensation of healthcare providers 'on the basis of expected costs for clinically defined episodes of care'.[11] With bundled payment, healthcare providers are reimbursed for all the care provided for women during their pregnancy, which empowers the care givers to coordinate and integrate the required care.[12] Annature consists of a multidisciplinary network of primary care midwives, the maternity care unit of the Amphia hospital, consultant obstetricians and caregivers from local maternity care organisations. These professionals cooperate closely and work with joint and integrated protocols, an integrated patient record, and shared quality cycles to evaluate the quality of maternal care. Online supplemental figure 1 displays a comprehensive timeline of the structural organisational innovations in the context of integrated maternity care that have been implemented since 2012, some of which are explained further in the following.

The next step towards closer collaboration was the introduction of 'buddy consultations', which implied that a consultant obstetrician carried out prenatal consultations together with the community midwife at the community midwifery practice once every 6 weeks and remained available for accessible peer consultation throughout a woman's pregnancy. This approach especially aimed to reach socially vulnerable pregnant women and pregnant women with intermediate-risk pregnancies.

Furthermore, obstetric professionals from primary and secondary care developed integrated maternity care protocols and care pathways to enhance woman-centred care. Within these care pathways, the prenatal consultations are systematically planned and the different responsibilities of the obstetric professionals (ie, community midwives, clinical midwives and consultant obstetricians) are clearly outlined. Care pathways stimulate organised and efficient prenatal care, help to reduce the variability in clinical practice and improve clinical outcomes.[13 14]

While the community midwife provides care for all low-risk pregnant women, shared care is provided for the intermediate-risk pregnancies, such as women with an SGA infant in their prior pregnancy. Shared care means shared responsibility of the community midwife and the obstetric caregivers (ie, clinical midwife or consultant

obstetrician) in the hospital, whereas previously, standard care for intermediate-risk pregnant women was provided only in secondary care. An example of a shared care pathway is presented in online supplemental figure 1 for the care pathway 'small-for-gestational-age in prior pregnancy' (below the timeline).

Improved interprofessional collaboration between the primary and secondary care setting requires adequate interprofessional communication. In October 2017, an integrated patient record was introduced for all primary care and secondary care professionals to be able to document their notes in the same patient record and have access to lab and ultrasound results. This integrated patient record lowered the barriers for peer consultation and enhanced patient-centred care.

For every pregnant woman in the first trimester of her pregnancy, a multidisciplinary meeting is held by obstetric caregivers, that is, the community midwife and the 'buddy-consultant obstetrician'. Together, they discuss the pregnant woman's situation in terms of physical, social, lifestyle and mental health to identify possible risk factors regarding her pregnancy. Thus, adequate maternity care is ensured by assigning her to a personalised care pathway.

Although large steps towards improved interdisciplinary collaboration have been taken so far, there is a need for scientific evidence regarding the potential effects of integrated perinatal care.[15] An important question that needs to be answered is whether integrated maternity care is associated with health benefits, such as a reduction of perinatal morbidity, and enhanced efficacy of care. Previous studies[16–18] have demonstrated promising results regarding intensified professional collaboration and perinatal outcomes. According to previous research, reduced prenatal consultations are associated with fewer interventions and improvement of perinatal outcomes.[19] However, this study adds to previous knowledge as it evaluates a newly introduced integrated care model with a high degree of multidisciplinary collaboration which has not yet been covered by previous research.

The first aim of our study was to determine whether integrated maternity care is associated with reduced PTBs and fewer SGA infants. Our second aim was to determine whether integrated maternity care reduced the number of in-hospital prenatal care consultations by obstetricians, as an indicator of efficacy of care.

MATERIALS AND METHODS

We evaluated the newly introduced integrated maternity care by means of a retrospective cohort study. Records were included if women were pregnant with singleton pregnancies of ≥24 weeks of gestation and received prenatal and natal care within integrated maternity care organisation Annature in the region of Breda, the Netherlands, within the years 2015–2020. Of the pregnant women in our region, 93% were served by integrated maternity care organisation Annature. We compared studydata from 3 years during which integrated maternity care was implemented (2015–2017) and 3 years thereafter (2018–2020). Nationwide data on perinatal outcomes from midwifery alliances that are not involved in integrated maternity care were provided by the Netherlands Perinatal Registry (PRN), which covers 96% of all births in the Netherlands.[2] Detailed information about maternal and neonatal characteristics were collected from the women's electronic medical records, after which the data were anonymised. Data prior to 2018 lacked information of the community midwifery practices, so these data were derived from the PRN database. From 2018 onwards, these data were derived from the integrated patient records, which comprised more detailed data at the individual level.

Outcomes

The two primary outcomes were defined: first, the combined prevalence of PTBs and SGA infants (ie, SGA-PTB), and second, the mean number of secondary care consultations per month. PTB was defined as birth before 37 completed weeks of gestation. Pregnancy was dated using the crown-rump length until 13 weeks of gestation. From 13 weeks of gestation onwards, the distantia biparietalis and the head circumference (HC) were also measured. In late pregnancy, from 18 weeks of gestation, the transverse diameter of the cerebellum (transverse cerebellar diameter or TCD) was used in addition to the HC for term determination, after which the ultrasound was repeated after 2 weeks and in case of a discrepancy, the term was adjusted based on an average of the HC and TCD measurements.[20]

SGA was defined as a birth weight below the 10th percentile using the birth weight curve of Hoftiezer.[21] The birth weight percentile according to the curve of Hoftiezer is calculated automatically when the infant's birth weight is registered in the patient record. During the entire study period, this method was used to calculate the birth weight percentile.

The second primary outcome was the mean number of prenatal care consultations per pregnancy in primary care and secondary care. Primary care consultations took place at the midwifery practice and were carried out by the community midwife. Secondary care consultations either took place at the hospital or through telehealth and were carried out by a consultant obstetrician, an obstetric resident or a clinical midwife.

Analysis

The effect of the implementation of integrated maternity care on the prevalence of SGA-PTB was evaluated in two ways: first, by performing a multivariate logistic regression analysis adjusted for common confounders: maternal age (in years), parity (the number of births carried to a viability), ethnicity, and living in a deprived neighbourhood (defined as a residential area with various infrastructural and social shortcomings). We compared the odds of SGA-PTB in two 3-year intervals (2015–2017 vs 2018–2020). Secondly, we evaluated the

prevalence of SGA-PTB, and the number of secondary care consultations by performing segmented periodic regression analysis. The advantage of interrupted time series analysis with segmented regression is its ability to detect shifts or trend changes in the outcome before and after an intervention, which makes it suitable for assessing effects of policy interventions where randomised controlled trials are not applicable.[22] Segmented periodic regression involves partitioning the outcome data into time intervals while fitting a separate regression line segment to each interval. For this analysis, the intervention was the implementation of integrated maternity care, and each time interval comprised 1 month. As this analysis only allowed us to determine one timepoint at which an intervention was introduced, January 2018 was chosen which was after the transition to an integrated patient record.

When performing the segmented periodic regression analysis we used two steps; (1) the first step estimates the slopes of monthly rate of SGA-PTB (or mean number of secondary care consultations per pregnancy), and their values at the intervention point (intercept), January 2018, hereby examining trends in each of the two periods before and after the intervention show a significant decline. The intercept β_0 is a measure of the SGA-PTB prevalence immediately before the intervention, and the coefficient β_2 represents SGA-PTB prevalence at the point of intervention. Coefficients β_1 and β_3 represent the average monthly change (trends) in SGA-PTB prevalence (number of secondary care consultations) in each period. (2) The second step of segmented regression estimates changes and examines whether there is a step change at the time of the intervention and estimates difference in the slopes (trends) in the two intervals before and after the intervention, that is the difference between SGA-PTB slopes in the periods before and after the intervention. The coefficient β_3 represents the step change in the relevant outcome at the time of the intervention in January 2018.

In the years 2015–2017, about 20% of women gave birth in primary care, and were therefore not yet registered in our electronic medical record. We corrected for this missing number by calculating 0 secondary care consultations per pregnancy for these women. Therefore, only for the mean number of primary care consultations per month, no preintervention and postintervention comparison could be carried out due to missing data. From 2018 onwards, after the introduction of an integrated patient record, the primary care consultations were registered in the integrated patient record and were available for analysis. Therefore, the changes in mean numbers of primary care consultations per month could be reliably measured from September 2018 onwards.

Baseline characteristics were compared between period 2015–2017 and 2018–2020 by using χ^2 test. The analyses were performed using IBM SPSS statistics V.27. The significance threshold (alpha) was set at p<0.05.

Patient and public involvement

None.

RESULTS

Between January 2015 and December 2020, a total of 20 818 pregnant women received prenatal and natal care in the region of Breda within integrated maternity care organisation Annature. The distribution of demographic and obstetric characteristics is presented in table 1. Compared with the years 2015–2017, in subsequent years 2018–2020 more women were of advanced maternal age, while in 2018–2020 the number of caesarean births had decreased, and the number of spontaneous births had increased. The mean perinatal mortality rate was 1.9/1000 births, ranging from 1.2/1000 to 2.9/1000 births.

Table 2A shows the SGA-PTB annual prevalence between 2015 and 2020, which declined from 618/3443 (17.9%) in 2015 to 507/3459 (14.7%) in 2020 (p<0.005). The odds of SGA-PTB adjusted for sociodemographic factors were 17% (95% CI 11% to 23%) lower in 2018–2020 than in 2015–2017 (online supplemental table 1).

Table 2B shows the parameter estimates of the first step of the linear segmented regression model of the effect of integrated maternity care on the mean prevalence of SGA-PTB per month. A statistically significant 7.3% (p=0.05) reduction in prevalence of PTB and SGA was demonstrated in the period 2015–2017 (table 2B). Immediately after the introduction of the intervention in January 2018, the mean prevalence was estimated as 14.7%. The results of this part of the segmented regression analysis are visualised in figure 1. At the same time, no decreasing trend was observed within the national PRN data (blue line).

However, as demonstrated in online supplemental table 2, the substantial trend change at the intersection (β_2) was not significant (coefficient 0.001, p=0.16).

Prenatal care consultations

Online supplemental table 3 presents the average number of prenatal consultations in primary care and secondary care per pregnancy per year between 2015 and 2020. In 2015, there were on average six care consultations per pregnancy, which decreased to an average of three secondary care consultations per pregnancy in 2020. In 2018, there were on average 10 primary care consultations per pregnancy, which decreased to an average of 8 primary care consultations per pregnancy in 2020.

We also included online supplemental table 4 with the parameter estimates of the linear segmented regression model of the effect of integrated maternity care on the mean monthly secondary care consultations per pregnancy. A statistically significant reduction in secondary care consultations was demonstrated both during and after the implementation of the intervention (a 12.4% (p<0.001) reduction for 2015–2017 and a 15.2% (p<0.001) reduction for 2018–2020).

Table 1 Demographic characteristics of all pregnant women served by integrated maternity care organisation 'Annature', Breda region, the Netherlands

Demographic characteristics	2015–2017 n=10 407	2018–2020 n=10 411	P value*
Demographic factors n (%)			
Parity			<0.001
Primiparous	4864 (46.7)	4604 (44.2)	
Multiparous	5543 (53.3)	5804 (55.7)	
Maternal age			<0.001
≤24	702 (6.7)	588 (5.6)	
25–34	7152 (68.7)	7211 (69.3)	
≥35	2346 (22.5)	2612 (25.1)	
Ethnicity			<0.001
Missing	1676 (16.1)	82 (0.8)	
Dutch	7585 (72.9)	8614 (82.7)	
Non-Dutch	1146 (11.0)	1715 (16.5)	
Neighbourhood			<0.001
Non-deprived neighbourhood	9928 (95.4)	9806 (94.2)	
Deprived neighbourhood	479 (4.6)	605 (5.8)	
Intake pregnancy			<0.001
Missing	768 (7.4)	26 (0.2)	
Intake before 10 weeks of gestation	7470 (71.8)	8826 (84.8)	
Obstetric characteristics			
Induction of labour	2416 (23.2)	2489 (23.9)	<0.001
Mode of delivery			0.079
Spontaneous vaginal delivery	7499 (72.1)	7832 (75.2)	
Vacuum assisted delivery	807 (7.8)	831 (8.0)	
Caesarean section	1809 (17.4)	1737 (16.7)	

Data are in n (%). Period 2015–2017 before implementation of integrated maternity care; period 2018–2020 after implementation of integrated maternity care.
*Missing values were excluded from χ^2 analysis.

Figure 2 shows the results of the segmented regression analysis for the mean number of secondary care consultations (red line) and the mean number of primary care consultations (blue line) per month for all pregnant women who received prenatal care within integrated maternity care organisation Annature.

For the primary care consultations, no preintervention and postintervention comparison could be conducted, as described in the Methods section. However, a decrease of the mean number of primary care consultations per month became apparent from January 2018 until the end of the study period, with a statistically significant 11.5% (p<0.001) reduction in primary care consultations.

DISCUSSION

The implementation of integrated maternity care was associated with a reduction in the prevalence of PTB or SGA children, while such a reduction was not observed in the same period for the Dutch national trend of these outcomes. Second, pregnant women received fewer prenatal secondary care consultations after the introduction of integrated care, suggesting improved efficacy of care. This decline was particularly pronounced in the mean number of secondary care consultations per pregnancy, which was reduced by half over the course of the study. Multivariate logistic regression adjusted for sociodemographic changes in the population over the study period is consistent with a significant decline in the SGA-PTB prevalence in the second half of the study compared with the first half. The first step in segmented regression analysis demonstrated a significant decline in monthly SGA-PTB prevalence in the period 2015–2017 before the intervention and no further change after the intervention. The second step in segmented regression analysis showed the step change at the time of the intervention was not statistically significant.

Our findings on the association of the implementation of integrated maternity care and a reduced prevalence of SGA-PTB are in line with results of several earlier studies. Kroll-Desrosiers *et al*[16] evaluated the effect of multidisciplinary coordinated maternity care on birth weight and found improved birth weights in 12 of 27 studies which reported birth weight as a main outcome. Another review, in which different models of prenatal care were compared, found a reduction in the risk of PTB in women who received care through a midwife-led continuity of care model compared with routine prenatal care.[17] Furthermore, the intervention review of Sandall *et al*[18] compared midwife-led care to other models of care and found a lower relative risk of PTB among women who received midwife-led care versus other models of care (RR 0.76, 95% CI 0.64 to 0.91). They found no differences between these models of care among low birth weight (<2500 g) infants. Although these studies demonstrated promising results regarding intensified professional collaboration and perinatal outcomes, our study covers a newly introduced integrated care model with a high degree of multidisciplinary collaboration, which has not yet been covered by previous research.

Our findings on the association of the implementation of integrated maternity care and a reduced prevalence of SGA-PTB are in contrast with a recent report from the National Institute for Health and Environment,[23] in which the Dutch perinatal mortality rate between 2008 and 2018 was analysed. This report showed that the decline in the

Table 2A Prevalence of combined outcome small-for-gestational-age and preterm birth (SGA-PTB) for period 2015–2020 within integrated maternity care organisation 'Annature', Breda region, the Netherlands. Below: multivariate regression analysis comparing 2015–2017 versus 2018–2020

Prevalence of combined SGA-PTB per year						
	2015 n=3443	2016 n=3463	2017 n=3501	2018 n=3447	2019 n=3505	2020 n=3459
SGA-PTB, n (%)	618 (17.9)	582 (16.8)	560 (16.0)	509 (14.8)	496 (14.2)	507 (14.7)

Multivariate regression analysis comparing effects over time: SGA-PTB in 2018–2020 versus 2015–2017			
	Adjusted OR*	95% CI	P value
SGA-PTB	0.83	0.77 to 0.89	<0.001

*Adjusted for maternal age, parity, ethnicity and living in a deprived neighbourhood.

perinatal mortality rate up to 2015 did not continue in subsequent years, which was mainly attributed to PTBs.

The differences between our findings and previous literature may be explained by the large package of structural innovations to integrate maternity care in the region of Breda. Future research should focus on the efficacy and effectiveness of individual components of integrated maternity care.

Despite the worsening demographic profile of the study population over time, we found a decrease in PTBs and SGA infants our region. However, their prevalence remained higher than the nationwide rates. In our follow-up study, the potential factors that contribute to this discrepancy will be further assessed.

In the present study, we found a significant decline in the number of secondary care consultations per pregnancy over the past 5 years, which could be regarded as an indicator of improved efficacy of care, and thus of improved quality of care.[24] This finding is in line with the findings of Reece *et al*,[25] who found a significant decline in prenatal visits and higher birth weights in very high-risk pregnancies in a multidisciplinary maternity care system.

There may be other explanations for the decline in the mean number of secondary care consultations per pregnancy. First, the different responsibilities of the primary and secondary care professionals are clearly defined within the integrated care pathways, which benefits the informational continuity of care. Informational continuity of care, which is considered an essential part of continuity of care, is defined as individualising patient care by using information on previous events and personal circumstances.[26] Second, the use of an integrated electronic patient record enhances coordination of care on an informed basis, as described in previous literature,[27] and may have lowered the barriers for peer consultation. This integrated record, together with the availability of a consultant obstetrician in the context of the implemented 'buddy consultations', ensured easy and accessible peer consultation, which may have led to fewer outpatient visits for consultation with the obstetrician in the hospital.

Our results suggest that integrated maternity care contributes to the reduction of PTBs, low birth weight and prenatal care consultations with the obstetrician in the hospital. Although our study design did not allow us to determine which components of integrated maternity care are the most beneficial, intensified multidisciplinary collaboration contributes unmistakably to value-based maternity care.[28]

Table 2B Segmented regression model predicting the mean monthly prevalence of combined outcome small-for-gestational-age and preterm birth (SGA-PTB) within integrated maternity care organisation 'Annature', Breda region, the Netherlands

	Coefficient	95% CI	t-statistic	P value
Intercept β_0 Mean monthly SGA-PTB prevalence before the intervention	0.160	0.151 to 0.169	18.591	<0.001
Baseline trend β_1 Month-to-month change in mean SGA-PTB prevalence before intervention	−0.073	−0.073 to −0.073	−1.964	0.05
Level change after intervention β_2 Mean monthly SGA-PTB prevalence immediately after intervention	0.147	0.139 to 0.155	17.741	<0.001
Level change after intervention β_3 Month-to-month change in mean SGA-PTB prevalence after intervention	0.002	0.002 to 0.002	0.044	0.965

No correction for autocorrelation.

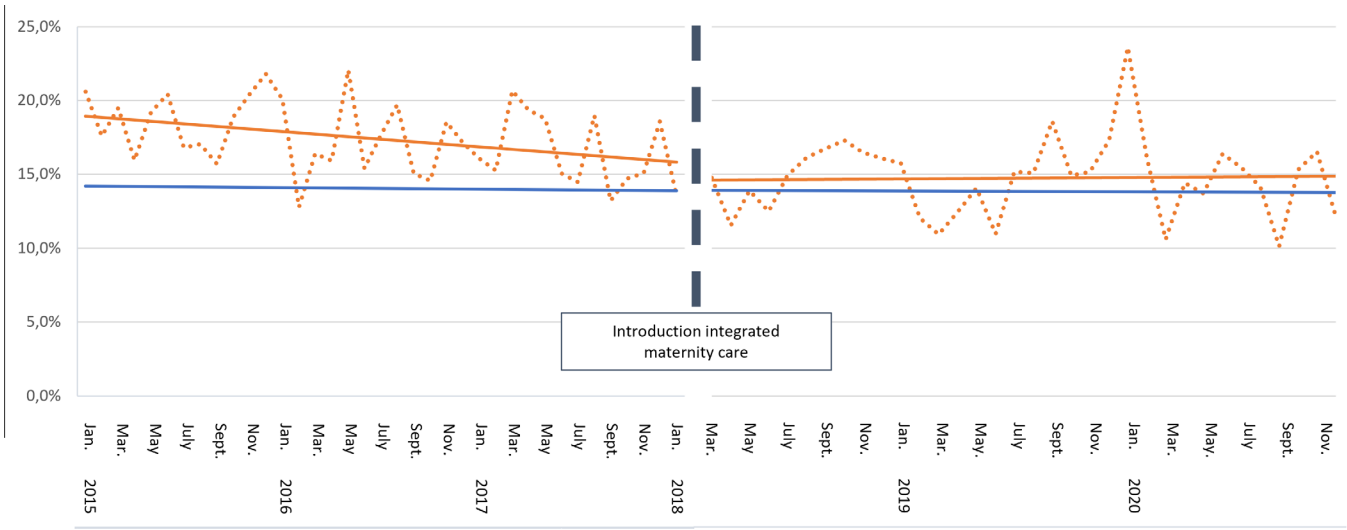

Figure 1 Prevalence (%) of preterm birth and small-for-gestational-age (SGA-PTB) infants per month from January 2015 to December 2020 within Integrated maternity care organisation 'Annature' (dotted orange line) with the trend (orange line). The blue line demonstrates the trend in the Dutch prevalence of SGA-PTB, registered by Perinatal Registration the Netherlands.

Strengths of our study include the availability of improved data from implementation of an integrated patient record in 2017 which provided us with data at the individual level. Furthermore, both multivariate logistic regression, and segmented regression analysis was used to calculate the effect size 3 years prior to the intervention (2015–2017) and 3years after the intervention (2018–2020). An important advantage of segmented regression analysis is the possibility to show an insightful graphical display of the results, which allow for a visual assessment of the series over time.[29] An important assumption of Interrupted Time Series designs includes the continuity assumption, which is met when there are no other interventions or confounding covariates than the intervention in analyses changed at the threshold.[30 31] However, this method assumes the intervention occurred at a single point in time, whereas as has been described, integration of primary and secondary maternity care involved a number of steps over several years. The generalisability for regional hospitals in southwestern region of the Netherlands is adequate since 93% of the pregnant women in Breda region were served by integrated maternity care

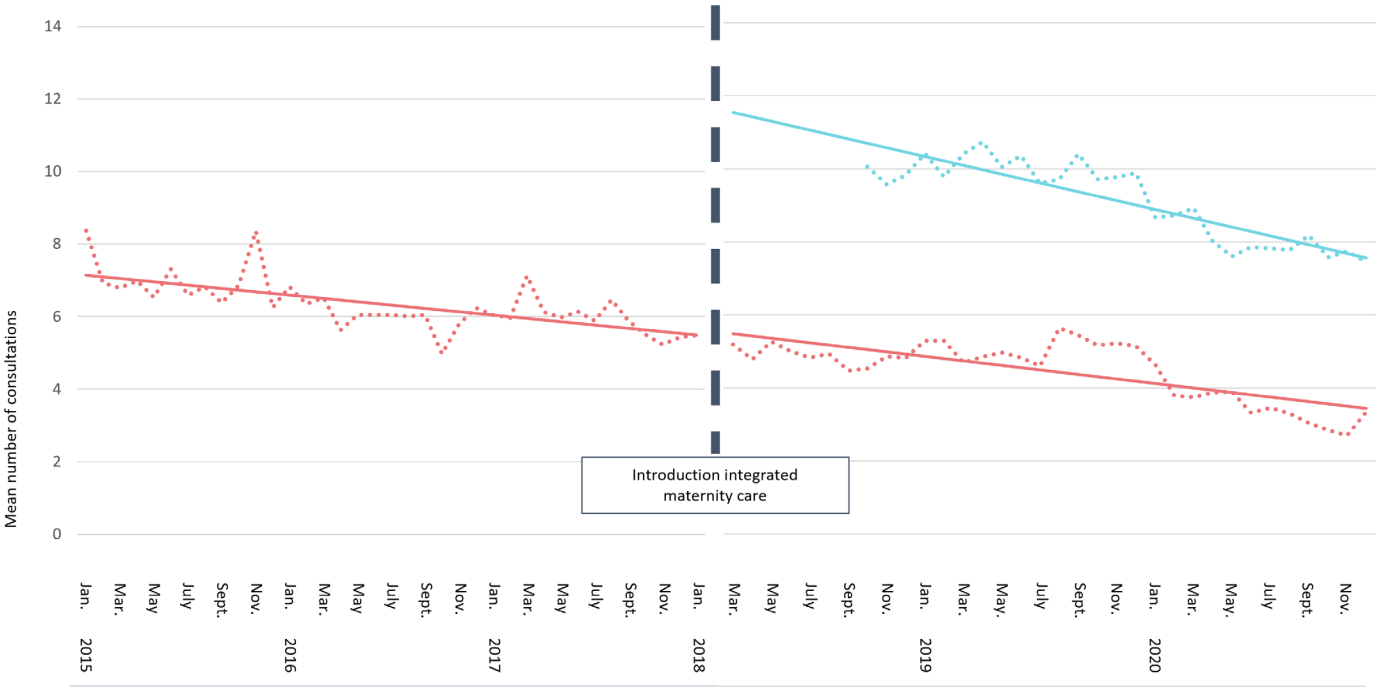

Figure 2 Trend in mean number of prenatal secondary care consultations (red line) and mean number of prenatal primary care consultations (blue line) per pregnancy per month from January 2015 to December 2020 within Integrated maternity care organisation 'Annature', Breda region, the Netherlands.

organisation Annature. The remaining 7% of the women received care from a midwifery practice that was not part of the integrated maternity care organisation Annature or delivered in another hospital.

There are other limitations that need to be mentioned. In our study, we have described in detail the process of the implementing integrated maternity care. This is a process over time rather than a sudden policy change overnight as the interprofessional collaboration becomes more intense. Therefore, the implementation of integrated maternity care could be seen as a complex intervention consisting of several elements being introduced at different time points.[32] One way to address this issue would be to add several intervals in the interrupted time series regression model indicating the times at which these different elements (ie, integrated ultrasound centre, multidisciplinary meeting, care pathways, etc), were introduced. However, as each individual element is unlikely to affect perinatal outcomes on its own, and the integrated patient record is considered to be a major step in increasing interprofessional collaboration, January 2018 was arbitrarily chosen as the introduction of the intervention. The whole package of structural innovations is fundamental for improving the interprofessional collaboration and was a gradual process over time. We have observed a significant decline in SGA-PTB in the period leading up to the intervention in 2018.

Furthermore, we defined a composite outcome, SGA-PTB, which has the advantage of enhanced statistical power. However, careful interpretation is required as an infant could be small-for-gestational age, preterm or both. Therefore, the results for a composite outcome may overrate the effects of individual elements.

In addition, we were not able to determine the number of primary care consultations before the introduction of our integrated patient record. From 2018 onwards, after the introduction of our integrated patient record, the primary care consultations were registered, and were available for analysis. Therefore, we only know that the number of primary care consultations did not increase after the intervention. In addition, the average number of secondary care consultations is influenced by the number of women who did not give birth in secondary care. The dataset did not include data on the number of secondary care consultations for these women, who accounted for 20% of the total population of women. We corrected for this missing number by calculating 0 secondary care consultations per pregnancy. This may have led to an underestimation of secondary care consultations before the intervention, as most women who deliver in primary care typically have one or two secondary care consultations during pregnancy.

From March 2020 onwards, it is likely that the COVID-19 pandemic partly contributed to the decline in the number of prenatal care consultations, which can be considered a moderating factor. In addition, the possibility of reduced staffing levels at the time of the COVID-19 pandemic cannot be completely ruled out due to the deployment of staff in so-called COVID-19 departments. However, during this period a part of the prenatal care consultations were replaced with eHealth consultations, which were included when calculating the average number of consultations during pregnancy, mitigating the impact of the COVID-19 pandemic to this number. The effect of the pandemic on care usage in general has been described by recent literature.[33] In addition, the study population included a service-based cohort which we could not yet be compared with national data. Future research is warranted to compare our regional perinatal outcomes with national figures to evaluate which components of integrated maternity care work and which do not. The preferred analytical method for these comparisons is difference-in-differences analysis since it evaluates the causal effects of observational data and focuses on changes rather than on absolute levels.[34] Finally, we suggest that our work can serve as a pilot study to justify a larger study to test whether the use of an integrated patient record alone, or in combination with integrated care pathways can improve perinatal outcomes without increasing the use of secondary care services.

CONCLUSION

Our results strongly suggest that implementation of integrated maternity care was associated with reduced PTBs and/or low birth weight and fewer secondary care consultations. Since PTB and low birth weight precede the majority of cases of perinatal mortality, integrated maternity care may also be expected to contribute to the reduction of perinatal mortality. These encouraging findings were observed in a less favourable sociodemographic profile and should be confirmed in other regions with sufficiently large populations, and the possibility to test individual components of integrated maternity care.

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Contributors JK, JS, JV, AF, MH and AH conceived the study. JK developed the study design and analytical approach, in consultation with other project team members. JK, JS, JV and AH linked the data sources. JK and AH performed the statistical analyses, which was supervised by JK. AH drafted the initial version of the manuscript. All authors contributed to the interpretation of the findings and reviewed and edited the manuscript for intellectual content. All authors approved the final version of the manuscript and agreed to be accountable for all aspects of the work. AH is the guarantor. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting the criteria have been omitted. Annature Research Collaboration consists of all primary care midwives, the maternity care unit of the Amphia hospital, consultant obstetricians and caregivers from local maternity care organisations. Indirectly, all caregivers within Annature Research Collaboration contributed to laying a good foundation for this study.

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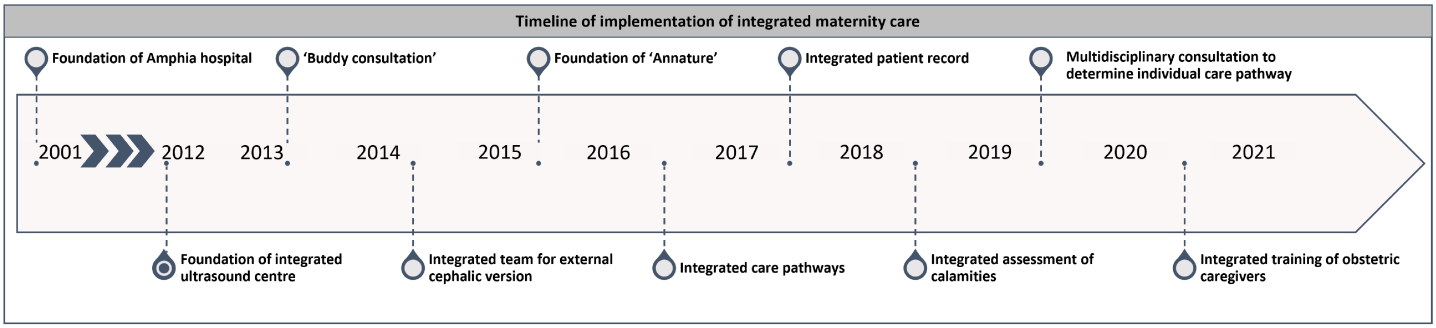
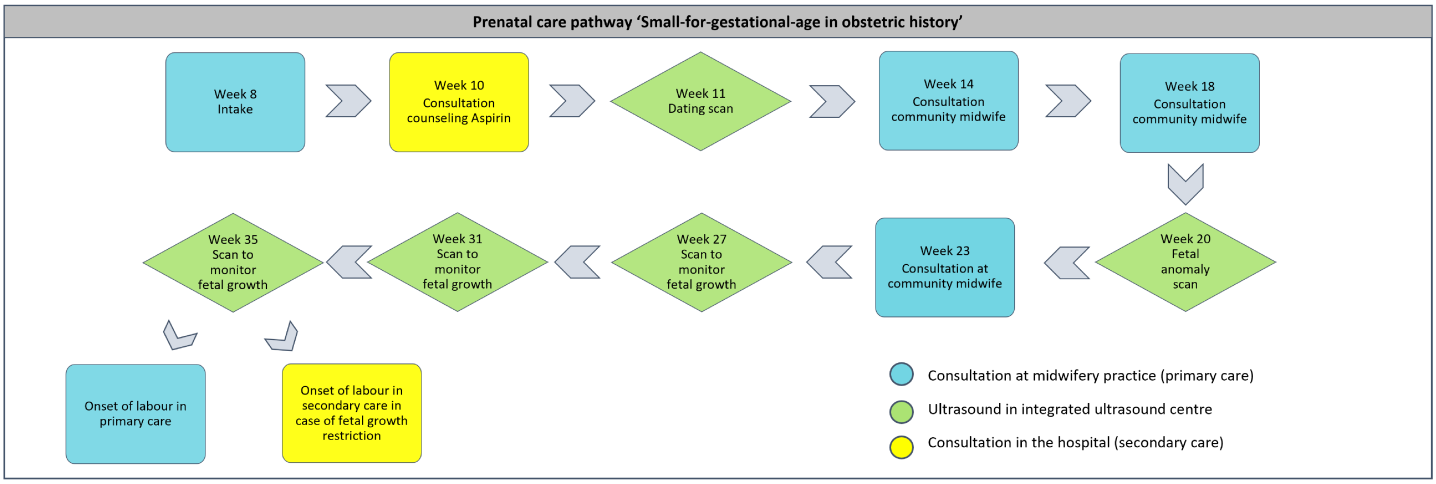

Timeline of implementation of integrated maternity care
Foundation of Amphia hospital
'Buddy consultation'
Foundation of 'Annature'
Integrated patient record
Multidisciplinary consultation to determine individual care pathway
2001
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
Foundation of integrated ultrasound centre
Integrated team for external cephalic version
Integrated care pathways
Integrated assessment of calamities
Integrated training of obstetric caregivers


Prenatal care pathway 'Small-for-gestational-age in obstetric history'
Week 8 Intake
Week 10 Consultation counseling Aspirin
Week 11 Dating scan
Week 14 Consultation community midwife
Week 18 Consultation community midwife
Week 20 Fetal anomaly scan
Week 23 Consultation at community midwife
Week 27 Scan to monitor fetal growth
Week 31 Scan to monitor fetal growth
Week 35 Scan to monitor fetal growth
Onset of labour in primary care
Onset of labour in secondary care in case of fetal growth restriction
Consultation at midwifery practice (primary care)
Ultrasound in integrated ultrasound centre
Consultation in the hospital (secondary care)

Supplemental tables

Supplemental Table 1. Multivariate logistic regression analysis on the risk for SGA-PTB, comparing time period 2018-2020 versus 2015-2017, adjusted for maternal age, ethnicity, parity, and living in a deprived neighbourhood. OR odds ratio, CI: confidence interval.

		Adjusted OR	95% CI	p-value
Parity				
	Primiparous	1.91	1.84 – 1.98	< 0.001
	Multiparous (REF)			
Maternal age				
	≤ 24 years old	1.05	0.91 – 1.19	0.479
	25-34 years old (REF)			
	≥ 35 years old	1.16	1.07 – 1.25	0.001
Neighbourhood				
	Undeprived neighbourhood (REF)			
	Deprived neighbourhood	1.21	1.06 – 1.37	0.018
Ethnicity				
	Dutch (REF)			
	Non Dutch	1.33	1.23 – 1.43	<0.001
Time period				
	2015-2017 (REF)			
	2018-2020	0.83	0.77 - 0.89	<0.001

Supplemental Table 2. Parameter estimates, 95% confidence intervals, and p-values of the segmented regression model predicting mean monthly prevalence of SGA-PTB within Integrated maternity care organisation 'Annature', Breda region, the Netherlands.

	Coefficient	95% confidence interval	t-statistic	P-value
Intercept β_0 **Prevalence of SGA-PTB in January 2018**	0.160	0.151 – 0.169	18.591	< 0.001
Baseline trend β_1 **Month-to-month change in mean SGA-PTB prevalence just before intervention**	-0.001	-0.001 - -0.001	-1.964	0.05
Slope change after intervention β_2 **Change in SGA-PTB prevalence slope after intervention**	0.001	0.000 – 0.002	1.420	0.16
Trend change after intervention β_3 **Jump in prevalence in January 2018**	-0.014	-0.026 - -0.002	-1.136	0.260

Supplemental Table 3. Mean number of prenatal primary and secondary care consultations per pregnancy per year for pregnant women served by Integrated maternity care organisation 'Annature', Breda region, The Netherlands.

	2015	2016	2017	2018	2019	2020
Average number of primary care consultations	-	-	-	10	10	8
Average number of secondary care consultations	6	6	5	5	5	3

Supplemental Table 4. Parameter estimates, 95% confidence intervals, and p-values of the segmented regression model predicting mean number of secondary care consultations per patient during her pregnancy within Integrated maternity care organisation 'Annature', Breda region, the Netherlands

	Coefficient	95% confidence interval	t-statistic	P-value
Intercept β_0 **Mean number of secondary care consultations before the intervention**	5.499	5.132 - 5.866	29.452	<0.001
Baseline trend β_1 **Change in month-to-month mean number of secondary care consultations before intervention**	-0.124	-0.142 - -0.106	-5.210	<0.001
Level change after intervention β_2 **Mean number of secondary care consultations per month immediately after intervention**	5.536	5.185 – 5.887	30.915	<0.001
Level change after intervention β_3 **Change in month-to-month trend of mean number of secondary care consultations after intervention**	-0.152	-0.170 - -0.134	-6.687	<0.001