

Effect of interpregnancy interval on outcomes of pregnancy after miscarriage: retrospective analysis of hospital episode statistics in Scotland

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ABSTRACT

Objective To determine the optimum interpregnancy interval after miscarriage in a first recorded pregnancy.

Design Population based retrospective cohort study.

Setting Scottish hospitals between 1981 and 2000.

Participants 30 937 women who had a miscarriage in their first recorded pregnancy and subsequently became pregnant.

Main outcome measures The primary end point was miscarriage, live birth, termination, stillbirth, or ectopic pregnancy in the second pregnancy. Secondary outcomes were rates of caesarean section and preterm delivery, low birthweight infants, pre-eclampsia, placenta praevia, placental abruption, and induced labour in the second pregnancy.

Results Compared with women with an interpregnancy interval of 6-12 months, those who conceived again within six months were less likely to have another miscarriage (adjusted odds ratio 0.66, 95% confidence interval 0.57 to 0.77), termination (0.43, 0.33 to 0.57), or ectopic pregnancy (0.48, 0.34 to 0.69). Women with an interpregnancy interval of more than 24 months were more likely to have an ectopic second pregnancy (1.97, 1.42 to 2.72) or termination (2.40, 1.91 to 3.01).

Compared with women with an interpregnancy interval of 6-12 months, women who conceived again within six months and went on to have a live birth in the second pregnancy were less likely to have a caesarean section (0.90, 0.83 to 0.98), preterm delivery (0.89, 0.81 to 0.98), or infant of low birth weight (0.84, 0.71 to 0.89) but were more likely to have an induced labour (1.08, 1.02 to 1.23).

Conclusions Women who conceive within six months of an initial miscarriage have the best reproductive outcomes and lowest complication rates in a subsequent pregnancy.

INTRODUCTION

Miscarriage or spontaneous pregnancy loss before 24 completed weeks of gestation affects one in five pregnancies.¹ Women with an initial miscarriage are at increased risk not only of a second miscarriage² but also of complications in a subsequent pregnancy. Compared with women who have never been

pregnant, those who have miscarried are more likely to experience threatened miscarriage, preterm birth, induced labour, and postpartum haemorrhage in the next pregnancy.³

Any miscarriage is associated with distress and prompts questions about the optimal timing of the next pregnancy. How long a couple should wait before trying for another pregnancy after a miscarriage is controversial. Some clinicians believe that there is little justification for delaying the next pregnancy,⁴⁻⁶ as an increased interpregnancy interval is unlikely to improve perinatal outcomes,² whereas a new viable pregnancy and the birth of a child could enhance the women's chances of recovery.^{4,7,8} Others suggest waiting at least six months for full mental and physical recovery before another pregnancy. Current guidelines from the World Health Organization recommend that women should wait for at least six months before trying again,⁹ whereas others suggest a delay of up to 18 months, based on reports that interpregnancy intervals of 18-23 months after a live birth can enhance maternal and perinatal outcomes in the next pregnancy.¹⁰⁻¹³ This length of delay, however, poses a particular problem for women in the Western world as they tend to delay childbearing for several social and economic reasons. Women over 35 are more likely to experience difficulties in conceiving and women aged 40 have a 30% chance of miscarriage, which rises to 50% in those aged 45 or more.¹⁴ Any delay in attempting conception could further decrease the chances of a healthy baby. Many women are aware of this potential problem, which is why first time mothers aged 35 or over are more likely to plan a second pregnancy shortly after their first.¹⁵

We compared maternal and perinatal outcomes in women with different interpregnancy intervals after a miscarriage in an initial pregnancy. The Scottish morbidity records collect information on all hospital admissions in Scotland and therefore offer an ideal opportunity to examine the effects of interpregnancy intervals after miscarriage on outcomes of the subsequent pregnancy.

Table 1 | Characteristics of women who had a second pregnancy after miscarriage, by interpregnancy intervals. Values are numbers (percentages) of women unless stated otherwise

Characteristics	Interpregnancy intervals (months)					P value
	<6 (n=12 744)	6-12 (n=7791)	12-18 (n=2958)	18-24 (n=1995)	>24 (n=5449)	
Mean (SD) age during pregnancy:						
First pregnancy	26.0 (5.4)	25.9 (5.8)	25.6 (6.0)	25.3(6.2)	23.9 (5.9)	<0.01
Second pregnancy	26.9 (5.4)	27.3 (5.8)	27.4 (6.0)	27.6 (6.2)	28.7 (5.9)	<0.01
Carstairs category 1-4:						
First pregnancy	4449 (34.9)	2621 (33.6)	916 (31.0)	623 (31.2)	1547 (28.4)	<0.01
Second pregnancy	4724 (37.1)	2773 (35.6)	1001 (33.8)	677 (33.9)	1763 (32.4)	<0.01
Smoking status:						
Ever smoked	1261 (9.9)	835 (10.7)	398 (13.5)	290 (14.5)	963 (17.7)	
Never smoked	4230 (33.2)	2308 (29.6)	845 (28.6)	575 (28.8)	1543 (28.3)	<0.01
Not known	7253 (56.9)	4648 (59.7)	1715 (58.0)	1130 (56.6)	2943 (54.0)	

METHODS

The Information Services Division of the National Health Service, Scotland, is a national organisation for health information, statistics, and computing services and has been in existence for over 40 years. Anonymised patient based data for inpatient and day case activity in the specialty of obstetrics are routinely collected from the whole of Scotland as Scottish morbidity records. We used information from this database (specifically SMR01 and SMR02) for this study. The database is subjected to regular quality assurance checks and has been more than 99% complete since the late 1970s.¹⁶

We used a retrospective cohort study design where exposure was taken as increasing interpregnancy intervals between a first and second pregnancy. We extracted data on all women who had a miscarriage recorded for a first pregnancy between 1981 and 2000 in Scotland and went on to have a subsequent pregnancy, as identified by internal linkage of SMR01 and SMR02 datasets using probability matching. Women who had twin or multiple pregnancies were excluded.

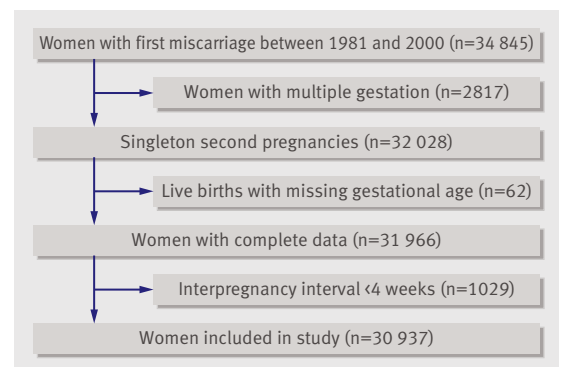
To determine the interpregnancy interval we calculated the time interval between the pregnancy related admission to hospital, and then subtracted the number of weeks' gestation of the second pregnancy at the time of the second admission, as recorded in the database. We then divided the women into five groups depending on the time interval between the two pregnancies: less than six months, 6-12 months, 12-18 months, 18-24 months, and more than 24 months. Our reference category was an interpregnancy interval of 6-12 months.

We assumed admission dates less than four weeks apart for first and second pregnancy events to be related to the same event, and we excluded the relevant woman from analysis. We also excluded women if the calculated interpregnancy interval (interval between two admissions minus the gestational age of second pregnancy) was less than four weeks and where gestational age at the second delivery was missing (n=60).

The primary end point was reproductive outcome in the second pregnancy—namely, miscarriage, ectopic

pregnancy, termination, stillbirth, and live birth. Confounding factors comprised maternal age at delivery, socioeconomic status (classified according to the Carstairs index as “deprived” for categories 4 and above and “not deprived” for categories 1-3).¹⁷ As smoking status was unknown for 57.2% of the women, we carried out a sensitivity analysis including and excluding the smoking variable. The smoking variable is excluded in the results shown in this paper.

To assess the effects of interpregnancy interval on obstetric and perinatal complications we carried out a subgroup analysis of women who had a second pregnancy continuing beyond 24 weeks and resulting in a live birth. Secondary outcomes in ongoing pregnancies were pre-eclampsia, placenta praevia, placental abruption, mode of delivery, preterm and very preterm delivery, and low birthweight infants (<2500 g). We classified preterm birth as occurring at 36 completed weeks of gestation or less and very preterm birth at 32 weeks or less. All other outcomes listed in the database were defined using the ICD-9 classifications (international classification of diseases, ninth revision) until 1994 when the ICD-10 came into use. In addition to the sociodemographic variables, we adjusted for other pregnancy specific variables such as induction of labour, gestational age, and caesarean delivery, as appropriate.



Flow of population selection

Table 2 | Outcomes of second pregnancy after miscarriage in first pregnancy. Values are numbers (percentages)

Outcomes of second pregnancy	Interpregnancy intervals (months)				
	<6 (n=12 744)	6-12 (n=7791)	12-18 (n=2958)	18-24 (n=1995)	>24 (n=5449)
Miscarriage	1308 (10.3)	1004 (12.9)	371 (12.5)	260 (13.0)	676 (12.4)
Ectopic pregnancy	53 (0.4)	67 (0.9)	25 (0.8)	11 (0.6)	87 (1.6)
Termination	297 (2.3)	367 (4.7)	168 (5.7)	141 (7.1)	537 (9.9)
Stillbirth	70 (0.5)	55 (0.7)	26 (0.9)	13 (0.7)	35 (0.6)
Live birth	10 856 (85.2)	6154 (79.0)	2301 (77.8)	1530 (76.7)	3992 (73.3)
Other*	160 (1.3)	144 (1.8)	67 (2.3)	40 (2.0)	122 (2.2)

P<0.01.

*Includes molar pregnancy and pregnancy of unknown location.

Statistical analysis

To compare sociodemographic variables across the different bands of interpregnancy interval, we carried out a one way analysis of variance for normally distributed continuous variables, with χ^2 tests for categorical variables. We used SPSS version 17 for the statistical analysis. Results are presented as both crude and adjusted odds ratios with 95% confidence intervals, using univariate and multivariate logistic regression (stepwise backward likelihood ratio method). In both the univariate and multivariate analyses we considered a P value of less than 0.05 to be significant. We used the Hosmer and Lemeshow test to assess goodness of fit of the models and the likelihood ratio test to assess the relative contribution of terms entered into the model. To assess interaction over time we entered into the model the interaction terms interpregnancy intervals \times five year bands of year of first hospital admission.

A retrospective power calculation showed that the study had 99% power at the two sided 5% significance level to detect a difference of 2% or more in the occurrence of a second miscarriage, given that there were 12 744 women in the exposed (interpregnancy interval <6 months) and 7791 women in the reference category (6-12 months).

RESULTS

Data were available on a total of 34 845 women who had experienced a miscarriage in their first pregnancy and had a subsequent pregnancy. After the exclusion of multiple births and records with improbable interpregnancy intervals, 30 937 women constituted the study population. The figure presents the flow of population selection.

Of these 30 937 women, 12 744 (41.2%) conceived within six months of the miscarriage, 7791 (25.2%) after 6-12 months, 2958 (9.6%) after 12-18 months, 1995 (6.4%) after 18-24 months, and 5449 (17.6%) after 24 months.

Older women and those belonging to a higher social class tended to have shorter interpregnancy intervals (table 1). Compared with those with an interpregnancy interval of more than 24 months, women with an interpregnancy interval of less than six months were likely to be older (26.0 years (SD 5.4 years) *v* 23.9 (5.9) years; P<0.001) and from a less deprived Carstairs category at the time of their first pregnancy (4449 women, 34.9% *v* 1547 women, 28.4%; P<0.001), and less likely to have

ever smoked (1261 women 9.9% *v* 963 women, 17.7%; P<0.001).

Live birth rates were highest (10 856 women, 85.2%) in women with an interpregnancy interval of less than six months and lowest (n=3992, 73.3%) in those with an interpregnancy interval exceeding 24 months (P<0.01; table 2). The data on termination of pregnancies also displayed a similar pattern, with longer interpregnancy intervals associated with a higher chance of termination in the next pregnancy.

After adjustment for maternal age at first pregnancy event, socioeconomic status, and year of first pregnancy, adverse pregnancy outcomes in women with an interpregnancy interval of less than six months differed significantly from the other groups (table 3). The models also included interaction terms: interpregnancy interval (six month bands) \times year of first admission (five year bands). However, the interaction terms were found to be statistically significant only in the model for a second miscarriage (data available on request). Compared with the reference group (interpregnancy interval 6-12 months), women with an interpregnancy interval of less than six months were less likely to experience a miscarriage (adjusted odds ratio 0.66, 95% confidence interval 0.57 to 0.77), termination (0.43, 0.33 to 0.57), or ectopic pregnancy (0.48, 0.34 to 0.69). The highest risk of adverse outcomes was in women with an interpregnancy interval of more than 24 months, who were more likely in their second pregnancy to have an ectopic pregnancy (1.97, 1.42 to 2.72) or termination (2.40, 1.91 to 3.01).

Including smoking status (when available) as a covariate in a subset of women showed similar patterns of risk, although some odds ratios (such as that for ectopic pregnancy or stillbirth) were no longer significant as the confidence intervals were widened to include 1 or the models did not converge because of smaller numbers. (Data available on request.)

Table 4 shows the proportions of women with maternal and perinatal complications in their second pregnancy. Women with an interpregnancy interval of less than six months were less likely to have caesarean section, preterm delivery (before 36 weeks), or an infant of low birth weight (<2500 g) but were more likely to have an induced labour (table 5). Women with an interpregnancy interval of more than 24 months were most likely to have a preterm delivery (1.21, 1.07 to 1.36) or very preterm delivery (1.40, 1.11

Table 3 | Crude and adjusted odds ratios of adverse pregnancy outcomes for different interpregnancy intervals

Second pregnancy outcomes	Interpregnancy intervals (months)			
	<6	12-18	18-24	>24
Miscarriage:				
Crude odds ratio (95% CI)	0.77 (0.71 to 0.84)*	0.97 (0.85 to 1.10)	1.01 (0.88 to 1.17)	0.96 (0.86 to 1.06)
Adjusted† odds ratio (95% CI)	0.66 (0.57 to 0.77)*	0.98 (0.80 to 1.21)	0.99 (0.78 to 1.27)	0.99 (0.84 to 1.18)*
Ectopic pregnancy:				
Crude odds ratio (95% CI)	0.48 (0.34 to 0.69)*	0.99 (0.62 to 1.56)	0.64 (0.34 to 1.21)	1.87 (1.36 to 2.58)*
Adjusted† odds ratio (95% CI)	0.48 (0.34 to 0.69)*	0.99 (0.63 to 1.57)	0.65 (0.34 to 1.23)	1.97 (1.42 to 2.72)*
Termination:				
Crude odds ratio (95% CI)	0.48 (0.41 to 0.56)*	1.22 (1.01 to 1.47)*	1.54 (1.26 to 1.88)*	2.21 (1.93 to 2.54)*
Adjusted† odds ratio (95% CI)	0.43 (0.33 to 0.57)*	1.15 (0.83 to 1.59)	1.55 (1.10 to 2.19)*	2.40 (1.91 to 3.01)*
Stillbirth:				
Crude odd ratio (95% CI)	0.72 (0.51 to 1.03)	1.26 (0.79 to 2.02)	0.95 (0.52 to 1.75)	0.98 (0.64 to 1.50)
Adjusted† odds ratio (95% CI)	0.70 (0.38 to 1.29)	1.20 (0.54 to 2.67)	0.83 (0.28 to 2.44)	1.07 (0.54 to 2.15)

Reference category was interpregnancy interval of 6-12 months. Interaction terms interpregnancy interval × year of admission in five year bands were entered into the model, but only that for miscarriage was statistically significant.

*P<0.05.

†Adjusted for maternal age at first pregnancy, Carstairs social deprivation category, and year of first pregnancy.

to 1.70) than women with an interpregnancy interval of 6-12 months. They were also more likely to have a caesarean section (1.39, 1.26 to 1.54) or an infant of low birth weight (1.23, 1.02 to 1.48).

No association was found between interpregnancy interval after miscarriage and pre-eclampsia, placenta praevia, or placental abruption in the second ongoing pregnancy.

DISCUSSION

Women who conceived within six months of an initial recorded miscarriage had the lowest rates of miscarriage, ectopic pregnancy, and termination in a subsequent pregnancy than those who conceived later. They were also least likely to deliver preterm or very preterm or have an infant of low birth weight but were at highest risk of induced labour. Women with an interpregnancy interval of more than 24 months had the highest risks of ectopic pregnancy and termination and were most likely to have a caesarean section or preterm delivery and an infant of low birth weight.

Comparison with other studies

The only studies to have dealt with the effect of interpregnancy intervals on pregnancy outcome after miscarriage have been from developing countries with different systems of family planning, access to maternity care, and methods of data collection. In the developing world, women also tend to bear children at a younger age, thus reducing their age dependent risk of an adverse pregnancy outcome.

Additionally, most published research has focused on interpregnancy intervals after live birth. Few have investigated interpregnancy intervals after other types of pregnancy outcomes, possibly because of smaller numbers of women in these groups. One study reported perinatal outcomes after varying interpregnancy intervals and according to the type of pregnancy outcome that began the interval,¹⁸ but data in this study were drawn from a demographic

surveillance site in Bangladesh where induced abortion is illegal, possibly resulting in over-reporting of miscarriages owing to the sensitivity of this information. Moreover, the reference group was women who had an initial live birth, thus potentially inflating the risk of adverse outcomes after miscarriage.

Another study examined the effects of varying interpregnancy intervals after pregnancy termination (both miscarriage and induced) on maternal and perinatal health in a sample of 258 108 Latin American women. An interpregnancy interval of less than six months after abortion was independently associated with increased risks of adverse maternal and perinatal outcomes, including maternal anaemia, low birth-weight infants, and preterm delivery in the next pregnancy.¹⁹ This study did not, however, differentiate between induced abortion and miscarriage in the index pregnancy. This limitation, along with the geographical context of the study, may affect the generalisability of the results to other regions. Despite these limitations, these data were the sole basis for a WHO recommendation⁹ on birth spacing after abortion, calling for more studies on pregnancy intervals after miscarriage in different populations and healthcare settings.

Previous Scottish studies²⁰ have shown that a short interpregnancy interval after stillbirth is associated with increased risks in the next pregnancy but did not explore the association between interpregnancy interval and outcomes after miscarriage. Two other European reports^{21,22} have suggested that adverse pregnancy outcomes are more likely to occur after miscarriage in women with increasing interpregnancy intervals.

Much of the existing literature comprises studies on perinatal outcomes after a previous live birth and suggests that short interpregnancy intervals are detrimental to maternal and perinatal wellbeing. Our results challenge this view but are consistent with the maternal depletion hypothesis suggested by one study.²³ The researchers propose that decreasing levels of folate in

Table 4 Maternal and perinatal complications by interpregnancy interval in women with live births in pregnancy after initial miscarriage. Values are numbers (percentages) of women

Complications in second ongoing pregnancy	Interpregnancy interval (months)					P value
	<6 (n=10 856)	6-12 (n=6154)	12-18 (n=2301)	18-24 (n=1530)	>24 (n=3992)	
Pre-eclampsia	485 (4.5)	265 (4.3)	117 (5.1)	72 (4.7)	180 (4.5)	0.637
Placenta praevia	86 (0.8)	57 (0.9)	23 (1.0)	20 (1.3)	38 (1.0)	0.323
Placental abruption	417 (3.8)	269 (4.4)	106 (4.6)	74 (4.8)	187 (4.8)	0.073
Induction of labour	2963 (27.3)	1599 (26.0)	617 (26.8)	454 (29.7)	1065 (26.7)	0.050
Caesarean delivery	2002 (18.5)	1230 (20.0)	485 (21.0)	301 (19.7)	939 (23.5)	<0.01
Preterm delivery (<36 weeks)	782 (7.2)	500 (8.1)	196 (8.5)	125 (8.2)	422 (10.6)	<0.01
Very preterm delivery (<32 weeks)	182 (1.7)	117 (1.9)	55 (2.4)	34 (2.2)	122 (3.1)	<0.01
Low birth weight (<2500 g)	776 (7.15)	527 (8.6)	227 (9.9)	131 (8.6)	473 (11.9)	<0.01

the mother after the fifth month of gestation onwards that remain low for an extended period of time after delivery could result in folate insufficiency in women with short interpregnancy intervals leading to neural tube defects, intrauterine growth restriction, and pre-term birth. Additionally, breast feeding after a live birth leads to further depletion of folate in the mother,¹⁸ compounding this effect. As most miscarriages occur in the first trimester and are not associated with breast feeding, women conceiving again soon after their pregnancy loss may not have any depletion of vital nutrients and thus have a reduced risk of adverse outcomes.

Some authors attribute the higher risks of adverse maternal outcomes after a short interpregnancy interval to socioeconomic status, unstable lifestyles, failure to use healthcare services, unplanned pregnancies, and other behavioural or psychological factors.²⁴ Our data, however, show the effect of interpregnancy interval after a miscarriage to be different. In our cohort, fewer women with interpregnancy intervals of less than six months were classed as deprived compared with any of the other groups (65.1% *v* 71.6% in women with an interpregnancy interval >24 months). Thus, although a short interpregnancy interval after a live birth is more likely in a woman with poor education and with limited access to family planning resources, this may not be the case after a miscarriage, at least in our population of women. It is unknown why a longer interval is associated with adverse outcomes such as miscarriage or ectopic pregnancy. One study offered two hypotheses.¹¹ Firstly, a pregnancy may enhance the functional capacity of the reproductive system, which can wane over time, and with longer intervals the risks to a mother and baby may resemble those in a primigravida. An alternative hypothesis is that factors associated with underlying subfertility, which can increase the time to the next pregnancy, could result in adverse perinatal outcomes.²⁴

It is also possible, as suggested by a previous study,⁶ that women who become pregnant soon after an initial miscarriage may have been highly motivated such that their health related behaviours may have favoured more successful pregnancies. Of the studies that distinguished between the different types of initial pregnancies, one¹⁸ also found that the rates of live birth in the

subsequent pregnancy decreased in a linear fashion with increasing interpregnancy intervals.

In a systematic review²⁵ it was reported that women who conceived again within a short time after delivery tended to have a lower parity than those who waited longer. A higher proportion of women with an interpregnancy interval of less than six months also did not have antenatal care; again, this could have influenced the outcomes reported in their review. Previous studies have reported that inadequate use of prenatal care is a more potent predictor of adverse pregnancy outcomes than interpregnancy interval.^{26,27} We were unable to estimate the potential confounding effects of quality of, access to, and use of prenatal care in our population. Nevertheless, as medical care is available to all, free of charge at the point of access in Scotland, this is unlikely to be a major limitation in our study.

Strengths and weaknesses of the study

The main strength of this research lies in its large population based nature, and the use of routinely collected data on hospital admissions. The data are cross checked with other hospital data for completeness and accuracy. A set of validation rules is applied to all Scottish morbidity records both locally, before submission to Information Services Division, and again once each record has been submitted. These checks can detect errors where information is missing, invalid, or does not conform to a logical sequence of events. The data monitoring team also carry out local quality checks by investigating anomalies in Scottish morbidity records and ensuring that data are amended through usual submission protocols. Regular clean-up programs on national files are undertaken. Additionally, the data quality assurance team routinely compare samples of data from the Scottish national database with the original patient case notes to ensure correct interpretation of the data definitions and recording rules.

This study is not without its limitations. One of the problems in using routinely collected data is the potential lack of uniformity in the documentation of gestational age and outcomes of interest as well as the possibility of misclassification. As parity is not routinely recorded in the morbidity records for women who have early pregnancy loss, we were unable to

Table 5 | Crude and adjusted odds ratios for complications in second pregnancy after initial miscarriage

Complications in second ongoing pregnancy	Interpregnancy interval (months)			
	<6	12-18	18-24	>24
Pre-eclampsia:				
Crude odds ratio (95% CI)	1.04 (0.89 to 1.21)	1.19 (0.95 to 1.49)	1.10 (0.84 to 1.43)	1.05 (0.87 to 1.27)
Adjusted* odds ratio (95% CI)	1.18 (0.82 to 1.23)	1.19 (0.96 to 1.49)	1.10 (0.84 to 1.44)	1.05 (0.87 to 1.28)
Placenta praevia:				
Crude odds ratio (95% CI)	0.85 (0.61 to 1.20)	1.08 (0.66 to 1.76)	1.42 (0.85 to 2.37)	1.03 (0.68 to 1.55)
Adjusted* odds ratio (95% CI)	0.89 (0.63 to 1.24)	1.06 (0.65 to 1.72)	1.38 (0.82 to 2.30)	0.97 (0.64 to 1.48)
Placental abruption:				
Crude odds ratio (95% CI)	0.87 (0.75 to 1.02)	1.06 (0.84 to 1.33)	1.11 (0.85 to 1.45)	1.08 (0.89 to 1.30)
Adjusted* odds ratio (95% CI)	0.87 (0.75 to 1.02)	1.04 (0.82 to 1.31)	1.11 (0.85 to 1.45)	1.10 (0.91 to 1.34)
Induction of labour:				
Crude odds ratio (95% CI)	1.07 (1.00 to 1.15)	1.04 (0.94 to 1.16)	1.20 (1.06 to 1.36)	1.04 (0.95 to 1.14)
Adjusted*† odds ratio (95% CI)	1.08 (1.02 to 1.23)	0.96 (0.85 to 1.09)	1.05 (0.89 to 1.23)	0.94 (0.82 to 1.08)
Caesarean delivery:				
Crude odds ratio (95% CI)	0.91 (0.84 to 0.98)	1.07 (0.95 to 1.20)	0.98 (0.85 to 1.13)	1.23 (1.12 to 1.36)
Adjusted*‡ odds ratio (95% CI)	0.90 (0.83 to 0.98)	1.08 (0.96 to 1.23)	0.96 (0.80 to 1.16)	1.39 (1.26 to 1.54)
Preterm delivery (<36 weeks):				
Crude odds ratio (95% CI)	0.88 (0.78 to 0.99)	1.05 (0.89 to 1.25)	1.01 (0.82 to 1.23)	1.34 (1.17 to 1.53)
Adjusted*§ odds ratio (95% CI)	0.89 (0.81 to 0.98)	1.07 (0.93 to 1.23)	1.05 (0.88 to 1.24)	1.21 (1.07 to 1.36)
Very preterm delivery (<32 weeks):				
Crude odds ratio (95% CI)	0.88 (0.70 to 1.11)	1.26 (0.91 to 1.76)	1.17 (0.80 to 1.73)	1.63 (1.26 to 2.10)
Adjusted*§ odds ratio (95% CI)	0.92 (0.77 to 1.10)	1.23 (0.97 to 1.58)	1.01 (0.75 to 1.37)	1.40 (1.11 to 1.70)
Low birth weight (<2500 g):				
Crude odds ratio (95% CI)	0.70 (0.61 to 0.79)	0.86 (0.73 to 1.01)	1.00 (0.82 to 1.22)	1.22 (1.08 to 1.37)
Adjusted*¶ odds ratio (95% CI)	0.84 (0.71 to 0.89)	1.17 (0.93 to 1.47)	0.92 (0.69 to 1.21)	1.23 (1.02 to 1.48)

Reference category was interpregnancy interval of 6-12 months.

*Adjusted for maternal age at first pregnancy, Carstairs social deprivation category, and year of first miscarriage.

†Also adjusted for pre-eclampsia and placental abruption.

‡Also adjusted for pre-eclampsia, placenta praevia, and placental abruption.

§Also adjusted for pre-eclampsia, placenta praevia, placental abruption, and induction of labour.

¶Also adjusted for gestation at delivery.

confirm if the earliest miscarriages recorded were indeed the first pregnancy event. For women who went on to have a delivery, it was possible to check if an initial miscarriage was recorded. However, we believe that the large size of the dataset may offset any minor discrepancies such that the overall pattern of any trends remains unaffected. Further disadvantages in using information from the Scottish dataset include potential inaccuracies in estimation of times between pregnancies due to misclassification of hospital admissions that could have been the result of the same event. This study also spans a long period during which advances in obstetric practice may have influenced the outcomes of interest. Specifically, the routine use of ultrasound for diagnosis, increasing availability of assisted reproduction techniques, and the formation of dedicated early pregnancy units for the management of pregnancy loss all represent recent advances and are likely to affect outcomes. However, as the women in all the interpregnancy interval groups were identified from the same period, and the year of occurrence of the first pregnancy event was included as a covariate in the model, this is unlikely to have produced a significant effect on the results. We also looked for interaction of interpregnancy intervals over time, but this

was only found to be statistically significant in some women who had a second miscarriage.

Additionally, this study examined miscarriages that led to hospital contact only, and results therefore cannot be generalised to all women with a miscarriage. However, most women in Scotland who are aware that they have miscarried are likely to attend hospitals. Moreover, there is a possibility that adverse second pregnancy outcomes may be over-represented in our sample as women who were pregnant for the first time towards the latter part of the study period may have had a second pregnancy of normal duration. These women will have been missed as they had no reason to have any hospital admissions at that time. The causes of miscarriages in the second trimester are different from those in the first, which are more common and can be missed. We therefore did a subgroup analysis on women with an initial second trimester miscarriage (data not shown) and found that the results were consistent with the findings of this study. Unrecorded miscarriages could also result in misclassification bias in our estimates of interpregnancy intervals.¹³ We are also uncertain whether the intervals between pregnancies were voluntary or not. Women taking longer to conceive may be more likely to have worse pregnancy

WHAT IS ALREADY KNOWN ON THIS TOPIC

Little is known about the effect of the intervals between pregnancies after an initial miscarriage

Previous studies have focused on the interpregnancy interval after a live birth or focused on women in developing countries

WHAT THIS STUDY ADDS

After an initial miscarriage, women from a developed country had the best outcomes in a subsequent pregnancy if they conceived again within six months

outcomes owing to factors causing a delay in fertility rather than the interpregnancy interval itself.

It should also be mentioned that the Scottish population is a relatively homogeneous, stable population. Although this may help reveal differences that may not surface in a heterogeneous society, it means that the results of this study may not be generalised to other populations. Finally, the potential for residual confounding by factors unknown exists; a substantial amount of data on the women's smoking status was missing and other potentially important confounding factors (for example, body mass index) were not measured.

Implications for research

Sporadic miscarriage is common and given the divided nature of the literature it is clear that further research needs to be done on the influence of interpregnancy intervals on pregnancy outcome after a miscarriage in different sociocultural settings. The ability to adjust for additional confounding factors such as ethnicity, change of partner, maternal weight, and separation of voluntary from involuntary interpregnancy intervals would lend credibility to future research.

Implications for clinical practice

Our research shows that it is unnecessary for women to delay conception after a miscarriage. As such the current WHO guidelines may need to be reconsidered. In accordance with our results, women wanting to become pregnant soon after a miscarriage should not be discouraged. There may be cases where a delay is desirable, for example if there are signs of infection, and women should be advised appropriately. Also, in a molar pregnancy, current guidelines advise delaying the next pregnancy for at least one year after treatment.²⁸

After a miscarriage, women should also be counselled about how to optimise their own health before and during pregnancy in preparation for subsequent conception. The potential negative effects of delaying the next pregnancy for more than 18-24 months should also be discussed with couples, allowing them to make a fully informed decision about future pregnancy.

Conclusion

In the Scottish population, women who conceive within six months of an initial miscarriage have the

best outcomes and lowest complication rates in their subsequent pregnancy.

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Ethical approval: This research proposal was approved by the privacy advisory committee of the Information and Services Division N HS Scotland. Formal ethical approval was not considered necessary by North of Scotland Research Ethics Service, as only anonymised data were analysed in this study.

Data sharing: No additional data available.

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